DENMARK'S NATIONAL INVENTORY REPORT 2012

Emission Inventories 1990-2010 - Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

Scientific Report from DCE – Danish Centre for Environment and Energy No. 19 2012

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Data sheet

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Abstract: This report is Denmark's National Inventory Report 2012. The report contains information on Denmark's emission inventories for all years' from 1990 to 2010 for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, NO_x, CO, NMVOC, SO_2

Keywords: Emission Inventory; UNFCCC; IPCC; CO_2; CH_4; N_2O; HFCs; PFCs; SF_6

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Contents

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Executive summary

ES.1 Background information on greenhouse gas inventories and climate change

ES.1.1 Reporting

This report is Denmark's National Inventory Report (NIR) 2012 for submission to the United Nations Framework Convention on Climate change and the Kyoto Protocol, due April 15, 2012. The report contains detailed information about Denmark's inventories for all years from 1990 to 2010. The structure of the report is in accordance with the UNFCCC guidelines on reporting and review. The main difference between Denmark's NIR 2012 report to the European Commission, due March 15, 2012, and this report to UNFCCC is reporting of territories. The NIR 2012 to the EU Commission was for Denmark, while this NIR 2012 to UNFCCC is for Denmark, Greenland and the Faroe Islands. The suggested outline provided by the UNFCCC secretariat has been followed to include the necessary information under the Kyoto Protocol. The report includes detailed and complete information on the inventories for all years from year 1990 to the year 2010, in order to ensure transparency.

The annual emission inventories for the years from 1990 to 2010 are reported in the Common Reporting Format (CRF). Within this submission separate CRF's are available for Denmark (EU), Greenland, the Faroe Islands, for Denmark and Greenland (KP) as well as for Denmark, Greenland and the Faroe Islands (UNFCCC). The CRF spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for total greenhouse gas emissions in CO_2 equivalents.

The issues addressed in this report are: Trends in greenhouse gas emissions, description of each emission category of the CRF, uncertainty estimates, explanations on recalculations, planned improvements and procedure for quality assurance and control.

This report itself does not contain the full set of CRF tables. The full set of CRF tables is available at the EIONET, Central Data Repository, kept by the European Environmental Agency:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories

In the report English notation is used: "." (full stop) for decimal sign and mostly space for division of thousands. The English notation for division of thousand as "," (comma) is not used due to the risk of being misinterpreted by Danish readers.

ES.1.2 Institutions responsible

On behalf of the Ministry of the Environment and the Ministry of Climate, Energy and Building the Danish Centre for Environment and Energy (DCE), Aarhus University, is responsible for the calculation and reporting of the Danish national emission inventory to EU and the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (Convention on Long Range Transboundary Air Pollution) conventions. Hence, DCE prepares and publishes the annual submission for Denmark to the EU and UNFCCC of the National Inventory Report and the greenhouse gas (GHG) inventories in the Common Reporting Format, in accordance with the UNFCCC guidelines. Further, DCE is responsible for reporting the national inventory for the Kingdom of Denmark to the UNFCCC. DCE is also the body designated with overall responsibility for the national inventory under the Kyoto Protocol for Greenland and Denmark. Furthermore, DCE participates when reporting issues are discussed in the regime of UNFCCC and EU (Monitoring Mechanism).

The work concerning the annual greenhouse gas emission inventory is carried out in cooperation with Danish ministries, research institutes, organisations and companies. The Government of Greenland is responsible for finalising and transferring the inventory for Greenland to DCE. The Faroe Islands Environmental Agency is responsible for finalising and transferring the inventory for the Faroe Islands to DCE.

ES.1.3 Greenhouse gases

The greenhouse gases reported are those under the UN Climate Convention:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

The global warming potential (GWP) for various greenhouse gases has been defined as the warming effect over a given time frame of a given weight of a specific substance relative to the same weight of CO_2. The purpose of this measure is to be able to compare and integrate the effects of the individual greenhouse gases on the global climate. Typical lifetimes in the atmosphere of greenhouse gases are very different, e.g. approximately 12 and 120 years for CH_4 and N_2O, respectively. So the time perspective clearly plays a decisive role. The life frame chosen is typically 100 years. The effect of the various greenhouse gases can then be converted into the equivalent quantity of CO_2, i.e. the quantity of CO_2 giving the same effect in absorbing solar radiation. According to the IPCC and their Second Assessment Report, which UNFCCC has decided to use as reference, the global warming potentials for a 100-year time horizon are:

- Carbon dioxide (CO_2): 1
- Methane (CH_4): 21
- Nitrous oxide (N_2O): 310

Based on weight and a 100-year period, CH_4 is thus 21 times more powerful a greenhouse gas than CO_2 and N_2O is 310 times more powerful than CO_2. Some of the other greenhouse gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) have considerably higher global warming potentials. For example, sulphur hexafluoride has a global warming potential of 23 900. The values for global warming potential used in this report are those prescribed by UNFCCC. The indirect greenhouse gases reported are Nitrogenoxide (NO_x), Carbonmonooxide (CO), Non-Methane Volatile Organic

Compound (NMVOC) and Sulphurdioxid (SO_2). Since no GWP is assigned these gases they do not contribute to GHG emissions in CO_2 equivalents.

ES.2 Summary of national emission and removal trends

Summary ES.2-4 is the inventory for Denmark only. The inventories for Greenland, Denmark and Greenland and the Faroe islands are described in Chapter 16 and 17 and Annex 8, respectively.

ES.2.1 Greenhouse gas emissions inventory

The greenhouse gas emissions are estimated according to the IPCC guidelines and guidance and are aggregated into seven main sectors. According to decisions made under the UNFCCC and the Kyoto Protocol the greenhouse gas emissions are estimated according to the IPCC 1996 guidelines and the IPCC 2000 good practice guidance. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure ES.1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2010. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2010 to national total in CO_2 equivalents excluding LULUCF (Land Use and Land Use Change and Forestry) with 79.1 % followed by N_2O with 10.0 %, CH_4 9.4 % and F-gases (HFCs, PFCs and SF_6) with 1.5 %. Seen over the time-series from 1990 to 2010 these percentages have been increasing for F-gases, almost constant for CO_2 and CH_4 and decreasing for N_2O. Stationary combustion plants, Transport and Agriculture represent the largest contributing categories, followed by Industrial processes, Waste and Solvents, see Figure ES.1. The net CO_2 uptake by LULUCF in 2010 is 3.6 % of the total emission in CO_2 equivalents excl. LULUCF. The national total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 11.0 % from 1990 to 2010 and decreased 19.4 % including LULUCF. Comments to the overall trends for the individual greenhouse gases etc. seen in Figure ES.1 are given in the sections below.

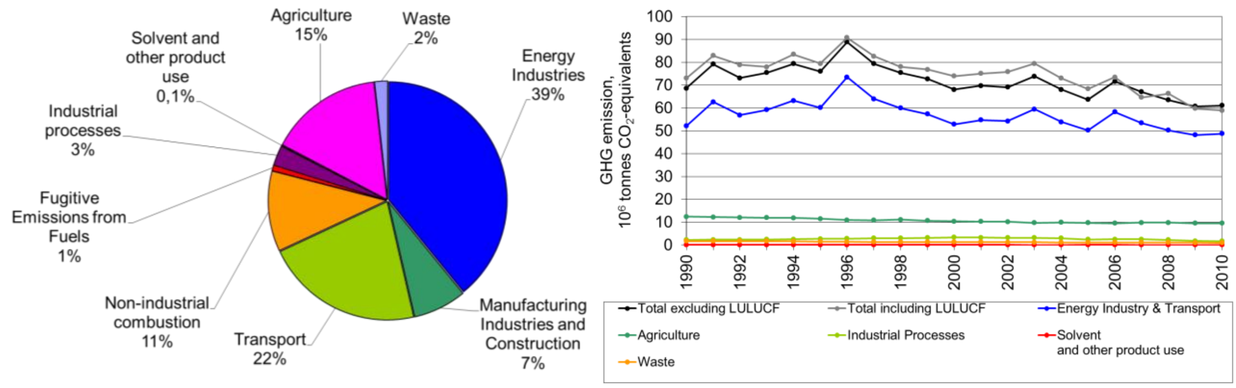


Figure ES.1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors (excl. LULUCF) for 2010 and time series for 1990 to 2010, where data are given with or without LULUCF.

ES.2.2 KP-LULUCF activities

Net emissions from Afforestation, Reforestation and Deforestation (ARD) activities in 2010 were 41.1 Gg CO_2 equivalents, hereof 0.6 Gg CO_2 equivalents owe to N_2O emissions from disturbance of soils. Net removals from Forest Matter (FM) were 5 677.3 Gg CO_2 equivalents (Table ES.1) hereof 12.0 Gg CO_2 equivalents owe to N_2O emissions from drainage of soils.

For Cropland Management (CM) the net emissions in 2010 were 3284.6 Gg CO_2 equivalents compared to a net emission in 1990 of 6 650.4 Gg CO_2 equivalents.

For Grassland Management (GM) the net emissions in 2010 were 171.3 Gg CO_2 equivalents compared to a net emission in 1990 of 205.1 Gg CO_2 equivalents.

Table ES.1 Emissions and removals in 2010 for activities relating to Article 3.3 and Article 3.4.

	Net CO_2 emissions/ removals	CH_4	N_2O	Net CO_2 equivalent emissions/removals
			(Gg)	
A. Article 3.3 activities				41.05
A.1. Afforestation and Reforestation	0.37	NO	IE, NA, NO	0.37
Jnits of land not harvested since the beginning of the commitment period	0.37	NO	IE, NA, NO	0.37
Jnits of land harvested since the beginning of the commitment period	IE, NO	NO	IE, NO	IE, NO
A.2. Deforestation	40.06	NO	0.00	40.69
B. Article 3.4 activities				-2.221.40
B.1. Forest Management	-5.689.31	NA. NO	0.04	-5.677.27
B.2. Cropland Management	3.284.56	NO	IE, NA, NO	3.284.56
B.3. Grazing Land Management	171.28	0.00	0.00	171.31
B.4. Revegetation	NA	NA	NA	NA

ES.3 Overview of source and sink category emission estimates and trends

ES.3.1 Greenhouse gas emissions inventory

Energy

The largest source of the emission of CO_2 is the energy sector, which includes the combustion of fossil fuels such as oil, coal and natural gas.

The emission of CO_2 from Energy Industries has decreased by 9.8 % from 1990 to 2010. The relatively large fluctuation in the emission is due to inter-country electricity trade. Thus, the high emissions in 1991, 1996, 2003 and 2006 reflect a large electricity export and the low emissions in 1990 and 2005 are due to a large import of electricity. The increasing emission of CH_4 during the nineties is due to the increasing use of gas engines in decentralised cogeneration plants. The CH_4 emissions from this sector have been decreasing since 2001 due to the liberalisation of the electricity market. The CO_2 emission from the transport sector increased by 23.4 % from 1990 to 2010, mainly due to increasing road traffic.

Industrial processes

The emissions from industrial processes, i.e. emissions from processes other than fuel combustion, amount in 2010 to 2.8 % of the total emission in CO_2 equivalents (excl. LULUCF). The main sources are cement production, refrigeration, foam blowing and calcination of limestone. The CO_2 emission from cement production – which is the largest source contributing in 2010 with 1.1 % of the national total – decreased by 23.8 % from 1990 to 2010. The second largest source has previously been N_2O from the production of nitric acid. However, the production of nitric acid/fertiliser ceased in 2004 and therefore the emission of N_2O also ceased.

The emission of HFCs, PFCs and SF_6 has increased by 161.5 % from 1995 until 2010, largely due to the increasing emission of HFCs. The use of HFCs, and especially HFC-134a, has increased several fold and thus HFCs have become the dominant F-gases, contributing 67 % to the F-gas total in 1995, rising to 94 % in 2010. HFC-134a is mainly used as a refrigerant. However, the use of HFC-134a is now stabilising. This is due to Danish legislation, which in 2007 banned new HFC-based refrigerant stationary systems. However, in contrast to this trend is the increasing use of air conditioning systems in mobile systems.

Solvent and other product use

The use of solvents in industries and households and other product use contribute 0.1 % of the total greenhouse gas emissions in CO_2 equivalents. There is an 18 % decrease in greenhouse gas emissions from 1990 to 2010. In 2010 N_2O comprises 19 % of the total CO_2 equivalent emissions for solvent and other product use.

Agriculture

The agricultural sector contributes in 2010 with 15.6 % of the total greenhouse gas emission in CO_2 equivalents (excl. LULUCF) and is the most important sector regarding the emissions of N_2O and CH_4. In 2010, the contribution of N_2O and CH_4 to the total emission of these gases was 91.2 % and 73.8 %, respectively. The N_2O emission from agriculture decreased by 34.6 % from 1990 to 2010. The main reason for the decrease is a legislative demand for an improved utilisation of nitrogen in manure. This result in less nitrogen excreted per livestock unit produced and a considerable reduction in the use of fertilisers. From 1990 to 2010, the emission of CH_4 from enteric fermentation has decreased due to decreasing numbers of cattle. However, the emission from manure management has increased due to changes in stable management systems towards an increase in slurry-based systems. Altogether, the emission of CH_4 for the agricultural sector has decreased by 2.3 % from 1990 to 2010.

Land Use and Land Use Change and Forestry (LULUCF)

The LULUCF sector alters between being a net sink and a net source of GHG. In 2010 LULUCF was a net sink with 3.5 % of the total GHG emission excluding LULUCF. In 2009 LULUCF was a net sink equivalent to 1.4 % of the total GHG emission (excluding LULUCF). In 2010 Forest Land was a large sink of 5 677 CO_2 equivalents, while Cropland, Grassland, Wetlands and Settlements was net sources contributing with 3 186 Gg CO_2 equivalents, 186 Gg CO_2 equivalents, -0.02 Gg CO_2 equivalents and 134 Gg CO_2 equivalents, respectively. The emission from Croplands is mainly due to emissions from organic soils. Since 1990 there has been a decrease in the total C-stock in mineral agricultural soils. Despite the global warming it seems that this decrease has stabilized so that it is possible to maintain the current C-stock level in soil. The area classified as organic agricultural soils is decreasing rapidly due its shallow nature. As a consequence the emission from these is decreasing too.

Waste

The waste sector contributes in 2010 with 1.6 % to the national total of greenhouse gas emissions (excl. LULUCF), 15.4 % of the total CH_4 emission and 2.2 % of the total N_2O emission. The sector comprises solid waste disposal on land, wastewater handling, waste incineration without energy recovery (e.g. incineration of animal carcasses) and other waste (e.g. composting and accidental fires).

The GHG emission from the sector has decreased by 41.8 % from 1990 to 2010. This decrease is a result of (1) a decrease in the CH_4 emission from solid waste disposal sites (SWDS) by 53.1 % due to the increasing use of waste for power and heat production, and (2) a decrease in emission of N_2O from wastewater (WW) handling systems of 23.4 % due to upgrading of WW treatment plants. These decreases are counteracted by an increase in CH_4 from WW of 13.8 % due to increasing industrial load to WW systems. In 2010 the contribution of CH_4 from SWDS was 12.5 % of the total CH_4 emission. The CH_4 emission from WW amounts in 2010 to 1.4 % of the total CH_4 emissions. The emission of N_2O from WW in 2010 is 1.4 % of national total of N_2O. Since all incinerated waste is used for power and heat production, the emissions are included in the 1A CRF category.

ES.3.2 KP-LULUCF activities

In 2010 the activities under Article 3.3 was a net source of 41 Gg CO_2 equivalents and the activities under Article 3.4 was a net sink of 2 221 Gg CO_2 equivalents. A short overview of KP-LULUCF is given in Chapter ES.2.2 and a more detailed description is given in Chapter 11.

ES.4 Other information

ES.4.1 Quality assurance and quality control

A plan for Quality Assurance (QA) and Quality Control (QC) in greenhouse gas emission inventories is included in the report. The plan is in accordance with the guidelines provided by the UNFCCC (Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Guidelines for National Systems). ISO 9000 standards are also used as an important input for the plan.

The plan comprises a framework for documenting and reporting emissions in a way that emphasize transparency, consistency, comparability, completeness and accuracy. To fulfil these high criteria, the data structure describes the pathway, from the collection of raw data to data compilation and modelling and finally reporting.

As part of the Quality Assurance (QA) activities, emission inventory sector reports are being prepared and sent for review to national experts, not involved in the inventory development. To date, the reviews have been completed for the stationary combustion plants sector, the fugitive emissions from fuels sector, the transport sector, the solvents and other product use sector and the agricultural sector. In order to evaluate the Danish emission inventories, a project where emission levels and emission factors are compared with those in other countries has been conducted.

ES.4.2 Completeness

The Danish greenhouse gas emission inventories include all sources identified by the revised IPPC guidelines.

Please see Annex 5 for more information.

ES.4.3 Recalculations and improvements

The main improvements of the inventories are:

Energy

Stationary Combustion

For stationary combustion plants, the emission estimates for the years 1990-2009 have been updated according to the latest energy statistics published by the Danish Energy Agency. The update included both end use and transformation sectors as well as a source category update.

The relatively large recalculations for CO_2 emission from the fuel category "Other fuels" is a result a revised CO_2 emission factor for fossil waste incineration. This emission factor has been recalculated based on a large number of measurements performed at Danish plants in 2010-2011. The CO_2 emission factor is 14 % higher than the emission factor applied last year. The estimated emission from fuel category Other fuels in 1A1a Public electricity and Heat production in 2009 has increased 14 % corresponding to 170 Gg CO_2.

The disaggregation of emissions in 1A2 Manufacturing industries and construction has been recalculated based on a new improved methodology. Thus, the changes of the estimated CO_2 emission for gaseous fuels and liquid fuels in the sectors 1A2c, d, e and f are considerable, but the change in total CO_2 emission in sector 1A2 are low (<1.5 % for 2009) for both fuel categories. This change is caused by other changes e.g. updating of the energy statistics. Correspondingly, some considerable recalculations for CH_4 and N_2O in the subsectors do not result in large changes in the aggregated sector 1A2.

The recalculations in CO_2 emission from biomass (+174 Gg CO_2 for 1A2 and +419 Gg for sector 1A4) are a result of revised CO_2 emission factors for wood and straw. Both emission factors now refer to the IPCC Guidelines.

The CH_4 emission from residential wood combustion has been recalculated based on improved technology disaggregation data. This has resulted in a 21 Gg CO_2 equivalents lower emission in 2009 than reported last year.

The CH_4 emission factor for refineries have been included or revised for several years. This results in improved time-series consistency but also in large relative changes for some years. However, the emission level is low and the recalculation for 2009 is below 0.5 Gg CO_2 equivalents.

The N_2O emission from gaseous fuels in sector 1A1c has been recalculated resulting in a decrease of 10 Gg CO_2 equivalents. The N_2O emission factor for off shore gas turbines now follows the emission factor for on shore gas turbines.

Mobile sources

Road transport

The total mileage per vehicle category from 1985-2009 have been updated based on new data prepared by DTU Transport. Important changes are a different split of total mileage between gasoline and diesel passenger cars based on data for the year 2008 from the Danish vehicle inspection and maintenance programme. Also updated mileage for foreign vehicles driven on Danish roads has been included.

The percentage emission change interval and year of largest percentage differences (low %; high %, year) for the different emission components are: CO_2 (0.2 %; 2.6 %, 2009), CH_4 (0.6 %; 1.6 %, 2009) and N_2O (-0.9 %; 4.6 %, 1994)

Agriculture/forestry/fisheries

The sales distribution into engine sizes for harvesters has been updated for the years 2002, 2003 and 2009. The following largest percentage differences (in brackets) for agriculture/forestry/fisheries are noted for: CO_2 (-0.3 %), CH_4 (0 %) and N_2O (-0.2 %).

Military

Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2009. The following largest percentage differences (in brackets) for military are noted for: CO_2 (0 %), CH_4 (0.6 %) and N_2O (0.5 %).

Aviation

Emission changes occur for the years 2007-2009, due to a correction in the representative aircraft type for new aircraft used for flying in Denmark. Due to an error F28 was previously used as a representative aircraft type for the new aircraft types CRJ9, E70, E170 and E175. However, F28 is a very old aircraft which cannot represent these new aircraft types. Instead new fuel consumption and emission factors have been calculated for the CRJ9, E70, E170 and E175 jets. The following largest percentage differences (in brackets) are noted for the year 2009: CO_2 (-1.7 %), CH_4 (-46.3 %), N_2O (-0.6 %).

Fugitive emissions

In the 2012 emission inventory submission there have been some recalculations as listed below.

New sources

CO_2 emissions have been included in the inventory for offshore extraction, pipeline transport and storage of oil, transmission of natural gas, and distribution of natural gas and town gas. This has increased the total fugitive CO_2 emission in 2009 by 1.4 % and in 1990 by 0.6 %.

Refineries

Emissions of CH_4 and NMVOC has been changed for the years 1994-2000 and 2002-2009 according to VOC measurements carried out in 2001, as no further information on fugitive emissions from the refineries are or will become available for other historical years. This is the result of an extended communication with one refinery leading to a recommendation to use measured emissions, rather than estimated emissions calculated by weighting the measured emissions by the annual processed crude oil amount as done in previous inventories. The fugitive emissions are more related to other conditions than the processed amounts. The split of VOC emissions provided by the refineries have been revised in order to apply a similar approach for the two refineries. For both refineries annual emissions of NMVOC and CH_4 are not available, and emissions are calculated based on the provided VOC emissions and assumptions for the part of VOC being NMVOC and CH_4, respectively. Assumptions are based on information from the refineries and on literature study of international proportions/-conditions.

The CH_4 recalculation has increased the total fugitive emission by 1 % in 2009. The largest recalculation is in 2007 (3 %).

Updated SO_2 emissions for the years 2005-2009 provided by a refinery are included in the inventory. The recalculation has increased the total fugitive SO_2 emissions by 6 % in 2009.

Gas distribution

Emission factors for CH_4 and NMVOC for town gas distribution has been corrected for an error. Distribution of town gas is a minor source and the recalculation is insignificant for all years (max. 0.003 % of the total fugitive CH_4 emission in 2009).

Offshore flaring

Activity data has been corrected for 2008 for two offshore installations. The calorific value has been corrected for the whole time series according to the average calorific value in the EU ETS reports for 2008-2010 which affects the emission factor for CO_2 and NMVOC. Further the emission factor for NMVOC has been corrected by including a conversion from Sm^3 to Nm^3. For 2007 the emission factor is changed to the average CO_2 emission factor from EU ETS for 2008-2010 as the 2007 EU ETS reports are not as detailed for 2007 as for the following years. The activity data has been updated according to the latest figures from the Danish Energy Agency.

The recalculation has increased the fugitive CO_2 emission by 1 % in 2009 and 8 % in 1990.

Flaring in refineries

The CO_2 emission factor has been updated for the years 1990-2006 for flaring in refineries. The emission factor applied is estimated as the average emission factor from the EU ETS reports for the years 2006-2010 and 2007-2010 for the two refineries.

The recalculation has decreased the fugitive CO_2 emission by 0.2 % in 2009 and 0.4 % in 1990.

Industrial processes

F-gas – Hard foam: A few changes have been made in the CRF-tables regarding activity data for consumption of HFCs and "IEF" as a consequence of the findings by the UNFCCC expert review team.

SF_6 double glazed windows: The model for calculation of SF_6 emission has been revised for 1998/1999 resulting in small changes all the following years as SF_6 from double glazed windows is emitted with 1% of stock per year.

Solvent and other product use

Historic production, import and export data for NMVOCs have been included for the period 1990 to 1994. Data are collected from Statistics Denmark and the methodology is now consistent for the entire 1990 to 2010 period. N_2O sales figures for 2000 to 2010 have been adjusted for export. N_2O for use in race cars and in laboratories has been included. The N_2O use in fire extinguishers has been investigated and no use is reported.

Emissions from charcoal use for barbeques and tobacco smoking have been included in this category.

Agriculture

Some changes of emissions from the agricultural sector have taken place. These changes reflect increased emissions in the years 1990-2008 up to 1 % and decreased emissions in 2009 of 0.7 % compared to the total CO_2 equivalent emission from the agricultural sector. The increase in 1990-2008 is due to an increase in the emissions of CH_4 and the decrease in 2009 is due to a decrease in the emission of N_2O while the CH_4 is almost unaltered.

The increase in CH_4 emission is due to changes in both CH_4 from enteric fermentation and manure management. As recommended by the ERT an error in the calculation of CH_4 from enteric fermentation from swine is corrected. For CH_4 from manure management changes are made for sows, where the data have been updated for all years and for dairy cattle a correction of an error in the calculation has been made.

For the N_2O emission a range of small changes have been made which have both increasing and decreasing effect. Due to changes in the emission factor for NH_3 the N_2O emission from manure on soil and synthetic fertilisers increased, while the N_2O emission from atmospheric deposition decreased. Data for histosols have been updated for all years and this have caused an increased N_2O emission in the years 1990-1999 and a decreased emission in 2000-2009.

LULUCF

Forestry

Since the NFI was initiated in 2002 and have a 5-year rotation, a full measurement is available from 2006. Calculation of carbon stock in the period 2000-2005 is based on interpolation between the carbon stock observed in the NFI in 2006 and the carbon stock as calculated for 2000. For 2006-2011 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping. Reported values from the NFI correspond to the last year of a five year measurement cycle (i.e. reported values for 2010 rely on data from 2006-2010). This differed from previous reporting where reported values corresponded to the midpoint of a five year rotation (i.e. reported values for 2008 rely on data from 2006-2010). This was done to enable timely and consistent reporting, as data for 2010 would otherwise not be available before winter 2012.

The recalculations have resulted in Forestry having affected the single year values but the overall development of the forest area in 2008-2010 is unchanged. N_2O is only slightly affected.

Cropland, grassland, wetlands and settlements

The major change come from our study on the area with organic soils where our data has shown that today only 42 000 hectares in Cropland and 28 000 hectares in Grassland qualify as true organic soils. Furthermore, our analysis on the organic soils has shown that since 1975 the area with organic soils in cropland has decreased rapidly with an average annual decrease of 1400 hectares. The reason for this is the intensive cultivation of our very thin and shallow organic soils implying that many of them now contain 5-10 % organic carbon and not > 12 %.

The emission estimate from mineral agricultural soils is made with a Tier 3 dynamic modelling tool (C-TOOL). More thorough analysis of C-TOOL has shown that the model do not satisfactorily estimate the emissions from soils having 6-12 % organic carbon. As a consequence a fixed emission factor has been introduced for soils with 6-12 % organic carbon. This area is around 40.000 hectares in 2010. The overall emission estimates for organic agricultural soils as well as the mineral soils have therefore been recalculated.

A minor change in the default soil carbon stock for mineral soils in Cropland has been introduced. This affects all emission estimates for land use conversion to and from cropland for the whole period.

In the previous submissions no losses in mineral soils for land use conversion to Settlements has been included as there is no guidance from the IPCC on this issue. In the current submission a default C-stock of 120 ton C per ha (0-100 cm) in mineral soils in Settlements has been introduced for all land use conversion to and from Settlements. This affects all emissions from mineral soils due to land use conversion to Settlements.

Waste

For the category SWDS, each of the former waste categories have been subcategorised into 9 fractions (waste food, cardboard, paper, wet cardboard & paper, plastics, other combustible, glass, metal and other not combustible). The SWDS model has been extended to include sub-fraction specific half-life's and carbon content. Lastly, the methane content of the collected landfill gas has been changed from 50 % to 41 % according to new documented knowledge. These recalculations result in an increase of CH_4 emissions for 1990 to 2002 and a decrease for 2003 to 2009. The largest changes are an increase of 38 % in 1990 and a decrease of 18 % in 2009.

For wastewater handling recalculations were made for CH_4 emissions for 1999 to 2009, the result is an increase between 0.2 % (2000) and 1.3 % (2003). The increase in 2009 is 0.4 %. The minor changes are due to an error in one of the activity references within the model in the 2011 submission. No methodological changes have occurred.

There are no recalculations in the waste incineration category.

For the category waste other; emissions of CO_2 and CH_4 have decreased throughout the time series due to changes in the methodology. Changes have been made for both vehicle and building fires. For building fires these changes include two new categories of container fires and additional building fires (such as sheds and garages). Furthermore, the full scale equivalents are now calculated from 4 damage categories of 100 %, 75 %, 30 % and 5 % instead of just 3 categories in the last submission. For vehicle fires the changes include new categories of caravan-, train-, ship-, airplane-, bicycle-, tractor-, combined harvester-, other transport- and machine fires. In the 2011 submission, an average burnout of 70 % was assumed for all vehicle fires. This year, full scale equivalents are calculated using the same 4 damage categories as for building fires.

2009 activity data for composting are now available. The activity data reported last year were overestimated, and the correction has caused a decrease in CO_2, CH_4 and N_2O for 2009.

CO_2 equivalent emissions from the waste other category has decreased between 4.84 % (2002) and 8.67 % (1995). For 1990 and 2009 the decrease was 7.96 and 8.31 %, respectively

The total sectoral change is an increase for 1990-2000 and a decrease for 2001-2009. The largest changes are an increase of 31 % in 1990, and the decrease of -20 % in 2009.

KP-LULUCF

Almost all sectors in the KP-LULUCF have been recalculated.

This is due to:

- Updated data from the Danish NFI for C-stock changes in above-, below-ground, dead wood and litter,
- The new soil map for organic soils,
- That the tool which estimates the emission from mineral soils has not shown to be suitable for soils having 6-12% OC.
- New and updated data on C-stock in mineral soils from our research (0-100 cm depth).

For deforestation the main reason is a small change in living biomass and updated values on C-stock in mineral soils.

For forest management the major change is due to updated values from the NFI on C-stocks in living biomass.

For cropland management and grazing land management the changes are primarily due to the new soil map for organic soils and the new emission factors for organic soils. Analysis has shown that C-TOOL is not reliable on soil having 6-12% OC. These soils have been given a fixed emission factor of 50% of true organic soils (>12 % OC).

Further analysis of the new soil map has shown that the area with organic soils (>12 % OC) is decreasing rapidly. The effect of this has been implemented in the inventory.

In total this has increased the base emission from agricultural soils with approximately 1,000 Gg CO_2 equivalent.

Loss in C stock in soils due to conversion to Settlements from all other land use categories has been implemented with a default C stock in Settlements of 120 tonnes C per ha.

For more information on KP-LULUCF recalculations please refer to Chapter 10 and 11.

Sammenfatning

S.1 Baggrund for opgørelse af drivhusgasemissioner og klimaændringer

S.1.1 Rapporteringen

Denne rapport er Danmarks rapport om drivhusgasopgørelser som sendes til EU Kommissionen den 15. marts 2012. Rapporten udarbejdes i overensstemmelse med EU beslutning nummer 280/2004/EC og udgør en komplet national rapport om drivhusgasopgørelser og skal ses i forlængelse af de tidligere årlige rapporter herfor. Rapporten indeholder detaljerede oplysninger om Danmarks opgørelser fra 1990 til 2010. Rapporten er struktureret som angivet i de under Klimakonventionen (UNFCCC) vedtagne retningslinjer for rapportering og evaluering af drivhusgasopgørelser. For at sikre at opgørelserne er sammenhængende og gennemskuelige indeholder rapporten detaljerede oplysninger om opgørelsesmetoder og baggrundsdata for alle årene fra 1990 og til 2010.

Denne emissionsopgørelse for årene 1990 til 2010, er som tidligere årlige opgørelser, rapporteret i formatet Common Reporting Format (CRF) som Klimakonventionen foreskriver anvendt. Emissionsopgørelsen i CRF foreligger med denne rapportering således, at der er separate CRF for Danmark (EU), Grønland, Færøerne, for Danmark og Grønland (KP) samt for Danmark, Grønland og Færøerne (Klimakonventionen). CRF-tabellerne indeholder oplysninger om emissioner, aktivitetsdata og emissionsfaktorer for hvert år, emissionsudvikling for de enkelte drivhusgasser samt den totale drivhusgasemission i CO_2-ækvivalenter.

Følgende emner er beskrevet i rapporten: Udviklingen i drivhusgasemissionerne, metoder mv. som anvendes til opgørelserne i de emissionskategorier som findes i CRF-formatet, usikkerheder, rekalkulationer, planlagte forbedringer og procedure for kvalitetssikring og –kontrol.

Denne rapport indeholder ikke det fulde sæt af CRF-tabeller. Det fulde sæt af CRF-tabeller er tilgængelige på EIONET, som er det Europæiske Miljøagenturs rapporterings-internetsite:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories

Med hensyn til gengivelsen af tal i CRF-formatet, gøres opmærksom på at det er med dansk notation: "," (komma) for decimaladskillelse og "." (punktum) til adskillelse af tusinder. I rapporten er den engelske notation brugt: "." (punktum) for decimaltegn og for det meste mellemrum for adskillelse af tusinder. Den engelske notation for adskillelse af tusinder med "," (komma) er for det meste ikke brugt på grund af risikoen for fejltolkninger for danske læsere.

S.1.2 Ansvarlige institutioner

DCE - Nationalt Center for Miljø og Energi ved Aarhus Universitet er på vegne af Miljøministeriet samt Klima-, Energi- og Bygningsministeriet ansvarlig for udregning og afrapportering af den nationale emissionsopgørelse til EU og til UNFCCC (FN's konvention om klimaændringer) såvel som til UNECE-konventionen om langtransporteret grænseoverskridende luftforurening. Som følge heraf er DCE ansvarlig for udførelse og publicering af opgørelserne af drivhusgasemissioner og den årlige rapportering til EU og UNFCCC for Danmark. DCE er den centrale institution for Danmarks nationale system til drivhusgasopgørelser under Kyotoprotokollen. Ydermere er DCE ansvarlig for rapportering af drivhusgasemissionsopgørelser til Klimakonventionen for Kongeriget Danmark (Færøerne, Grønland og Danmark), samt Danmarks og Grønlands samlede rapportering til Kyotoprotokollen. DCE deltager desuden i arbejdet i regi af Klimakonventionen og Kyotoprotokollen, hvor retningslinjer for rapportering diskuteres og vedtages og i EU's moniteringsmekanisme for opgørelse af drivhusgasser, hvor retningslinjer for rapportering til EU reguleres.

Arbejdet med de årlige opgørelser udføres i samarbejde med andre danske ministerier, forskningsinstitutioner, organisationer og private virksomheder. Grønlands Klima- og Infrastrukturstyrelse er ansvarlig for levering af opgørelser for Grønland til DCE. Færøernes miljømyndighed (Umhvørvisstovan) er ansvarlig for de færøske opgørelser.

S.1.3 Drivhusgasser

Til Klimakonventionen rapporteres følgende drivhusgasser:

- Kuldioxid CO_2
- Metan CH_4
- Lattergas N_2O
- Hydrofluorcarboner HFC'er
- Perfluorcarboner PFC'er
- Svovlhexafluorid SF_6

Det globale opvarmningspotentiale, på engelsk Global Warming Potential (GWP), udtrykker klimapåvirkningen over en nærmere angivet tid af en vægtenhed af en given drivhusgas relativt til samme vægtenhed af CO_2. Drivhusgasser har forskellige karakteristiske levetider i atmosfæren, således for CH_4 ca. 12 år og for N_2O ca. 120 år. Derfor spiller tidshorisonten en afgørende rolle for størrelsen af GWP. Typisk vælges 100 år. Herefter kan effekten af de forskellige drivhusgasser omregnes til en ækvivalent mængde CO_2, dvs. til den mængde CO_2 der vil give samme klimapåvirkning. Til rapporteringen til Klimakonventionen er vedtaget at anvende GWP-værdier for en 100-årig tidshorisont, som ifølge IPCC's anden vurderingsrapport er:

- Kuldioxid, CO_2: 1
- Metan, CH_4: 21
- Lattergas, N_2O: 310

Regnet efter vægt og over en 100-årig periode er metan således ca. 21 og lattergas ca. 310 gange så effektive drivhusgasser som kuldioxid. For andre drivhusgasser der indgår i rapporteringen, de såkaldte F-gasser (HFC, PFC, SF_6) findes væsentlig højere GWP-værdier. Under Klimakonventionen er der ligeledes vedtaget GWP-værdier for disse baseret på IPCC's anbefalinger. Således har f.eks. SF_6 en GWP-værdi på 23 900. I denne rapport anvendes de GWP-værdier, som UNFCCC har vedtaget.

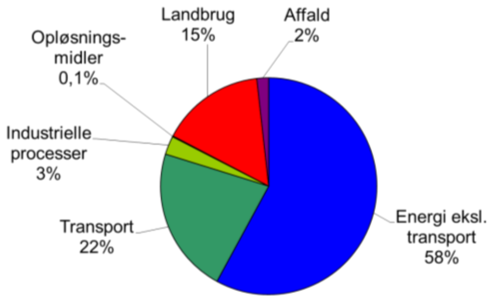
Endvidere rapporteres de indirekte drivhusgasser Kvælstofilte (NO_x), Kulilte (CO), Ikke-metan flygtige organiske forbindelser (NMVOC) og Svovldioxid (SO_2). Da der ikke tilskrives disse gasser GWP-værdier, medregnes disse ikke i drivhusgasemissioner i CO_2-ækvivalenter.

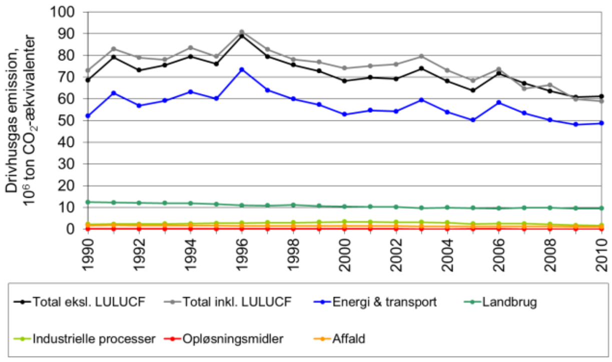
S.2 Udviklingen i drivhusgasemissioner og optag

Sammenfatning S.2.-4. omhandler alene opgørelsen for Danmark. Opgørelsen for Grønland, Danmark og Grønland samt for Færøerne beskrives i kapitel 16 og 17 samt i Annex 8.

S.2.1 Drivhusgasemissionsopgørelse

De danske opgørelser af drivhusgasemissioner følger metoderne som beskrevet i IPCC's retningslinjer. I den forbindelse skal nævnes at det under Klimakonventionen og Kyotoprotokollen er vedtaget at IPCC's 1996 retningslinjer og IPCC's 2000 anvisninger skal anvendes. Opgørelserne er opdelt i seks overordnede sektorer, 1. energi, 2. industrielle processer, 3. opløsningsmidler, 4. landbrug, 5. arealanvendelse for skove og jorder (Land Use Land Use Change and Forestry: LULUCF) og 6. affald. Drivhusgasserne omfatter CO_2, CH_4, N_2O og F-gasserne: HFC'er, PFC'er og SF_6. I Figur S.1 ses de estimerede drivhusgasemissioner for Danmark i CO_2-ækvivalenter for perioden 1990 til 2010. Figuren viser Danmarks totale udledning med og uden LULUCF-sektoren (Land Use and Land Use Change and Forestry). Til venstre i figur S.1 ses det relative bidrag til Danmarks totale udledning (uden LULUCF) i 2010 for sektorerne 1. – 4. og 6. For sektor 1. energi er vejtrafik vist særskilt. Sektor 5. LULUCF indgår ikke i denne figur da sektoren omfatter kilder der bidrager med både optag og udledninger.





Figur S.1 Danske drivhusgasemissioner. Bidrag til total emission fra hovedsektorer for 2010 og tidsserier i CO_2-ækvivalenter for 1990-2010, hvor data er angivet med og uden LULUCF.

I overensstemmelse med retningslinjerne for opgørelserne er emissionerne ikke korrigerede for handel med elektricitet med andre lande og temperatursvingninger fra år til år. CO_2 er den vigtigste drivhusgas og bidrager i 2010 med 79,1 % af den nationale totale udledning, efterfulgt af N_2O med 10,0 % og CH_4 med 9,4 %, mens HFC'er, PFC'er og SF_6 kun udgør 1,5 % af de totale emissioner. Set over perioden 1990-2010 så har disse procenter været stigende for CO_2 og F-gasser, nær konstant for CH_4 og faldende for N_2O. Netto CO_2-optaget fra LULUCF er i 2010 3,6 % af den nationale totale emission eksklusiv LULUCF. Med hensyn til sektorerne (figur S.1) så bidrager energi ekskl. vejtransport (hovedsageligt stationære forbrændingsanlæg), transport og landbrug mest med i 2010 henholdsvis 58 %, 22 % og 15 % af den nationale udledning eksklusiv LULUCF. De nationale totale drivhusgasemissioner i CO_2-ækvivalenter er faldet med 11,0 % fra 1990 til 2010, hvis nettobidraget fra skovenes og jordernes udledninger og optag af CO_2 (LULUCF) ikke indregnes, og faldet med 19,4 % hvis de indregnes.

S.2.2 KP-LULUCF-aktiviteter

Den samlede udledning af drivhusgasser i skov omfattet af Kyotoprotokollens artikel 3.3 udgør 41,1 Gg CO_2-ækvivalenter i 2010, heraf stammer 0,6 Gg CO_2-ækvivalenter fra N_2O udledning i forbindelse med skovrydning. Nettooptaget fra skov plantet før 1990 under Kyotoprotokollens artikel 3.4 udgør 5 677,3 Gg CO_2-ækvivalenter i 2010, heraf 12,0 Gg CO_2-ækvivalenter i form af N_2O fra dræning af jorde (tabel S.1). Nettoemissionen fra landbrugsarealer under artikel 3.4 udgør 3 284,6 Gg CO_2-ækvivalenter i 2010. Til sammenligning var nettoemissionen fra samme kilde 4 650,4 Gg CO_2-æqvivalenter i 1990.

Det samlede emission fra permanente græsarealer under artikel 3.4 udgør 171,3 Gg CO_2-ækvivalenter i 2010. I 1990 var den tilsvarende emission på 205,1 Gg CO_2--ækvivalenter.

Tabel S.1 Emissioner og optag i 2010 for aktiviteter under Kyotoprotokollens artikel 3.3 og 3.4.

	Netto CO_2 emission/optag	CH_4	N_2O	Netto CO_2 ækvivalent emission/optag
		(Gg)		
A. Aktiviteter under artikel 3.3				41,05
A.1. Skovrejsning	0,37	NO	IE, NA, NO	0,37
A.1.1. Arealer der ikke er afskovet siden starten af 2008	0,37	NO	IE, NA, NO	0,37
A.1.2. Arealer der er afskovet siden starten af 2008	IE, NO	NO	IE, NO	IE, NO
A.2. Skovrydning	40,06	NO	0,00	40,69
B. Aktiviteter under artikel 3.4				-2.221,40
B.1. Forvaltning af skov plantet før 1990	-5.689,31	NA, NO	0,04	-5.677,27
B.2. Forvaltning af landbrugsarealer	3.284,56	NO	IE, NA, NO	3.284,56
B.3. Forvaltning af permanente græsarealer	171,28	0,00	0,00	171,31
B.4. Gentilplantning	NA	NA	NA	NA

S.3 Oversigt over drivhusgasemissioner og optag fra sektorer

S.3.1 Drivhusgasemissionsopgørelse

Energi

Udledningen af CO_2 stammer altovervejende fra forbrænding af kul, olie, benzin og naturgas på kraftværker, i beboelsesejendomme, industri og vejtransport. CO_2-emissionen fra energisektorerne faldt med omkring 9,8 % fra 1990 til 2010. De relative store udsving i emissionerne fra år til år skyldes handel med elektricitet med andre lande, herunder særligt de nordiske. De høje emissioner i 1991, 1994, 1996, 2003 og 2006 er et resultat af stor eksport af elektricitet, mens de lave emissioner i 1990 og 2005 skyldes import af elektricitet. Udledningen af CH_4 fra energiproduktion har været stigende på grund af øget anvendelse af gasmotorer, som har en stor CH_4-emission i forhold til andre forbrændingsteknologier. Anvendelsen af gasmotorer er dog blevet mindre siden liberaliseringen af elmarkedet, hvilket har ført til lavere CH_4-emissioner fra energisektoren. Transportsektorens CO_2-emissioner er steget med 23,4 % siden 1990 hovedsagelig på grund af voksende vejtrafik.

Industrielle processer

Emissionen fra industrielle processer – hvilket vil sige andre processer end forbrændingsprocesser – udgør i 2010 2,8 % af de totale danske drivhusgasemissioner. De vigtigste kilder er cementproduktion, kølesystemer, opskumning af plast og kalcinering af kalksten. CO_2-emissionen fra cementproduktion - som er den største kilde - bidrager med 1,1 % af den totale emission i 2010. Emissionen fra cementproduktion er dog faldet med 23,8 % fra 1990 til 2010. Den anden største kilde har tidligere været N_2O fra produktion af salpetersyre. Produktionen af salpetersyre stoppede i midten af 2004, hvilket betyder, at N_2O-emissionen er nul for denne kilde fra 2005.

Emissionen af HFC'er, PFC'er og SF_6 er i perioden fra 1995 og til 2010 steget med 161,5 %, hovedsageligt på grund af stigende emissioner af HFC'er. Anvendelsen af HFC'er, og specielt HFC-134a, er steget kraftigt, hvilket har betydet, at andelen af HFC'er af den samlede F-gas emission steg fra 67 % i 1995 og til 94 % i 2010. HFC'er anvendes primært inden for køleindustrien. Anvendelsen er dog nu stagnerende, som et resultat af dansk lovgivning, der forbyder anvendelsen af nye HFC-baserede stationære kølesystemer fra 2007. I modsætning til denne udvikling ses et stigende brug af airconditionsystemer i køretøjer. Den samlede effekt er, at emissionen forventes at falde fremover.

Opløsningsmidler og relaterede produkter

Forbrug af opløsningsmidler i industrier og husholdninger bidrager i 2010 med 0,1 % af totalmængden af emitterede drivhusgasser i CO_2-ækvivalenter. Der er en reduktion på 18 % i drivhusgasemissionen i perioden 1990 til 2010. Bidraget fra N_2O til den totale emission i CO_2-ækvivalenter for solventer og anden produktanvendelse er 19 %.

Landbrug

Landbrugssektoren bidrager i 2010 med 15,6 % til den totale drivhusgasemission i CO_2-ækvivalenter og er den vigtigste sektor hvad angår emissioner af N_2O og CH_4. I 2010 var landbrugets bidrag til de totale emissioner af N_2O og CH_4 henholdsvis 91,2 % og 73,8 %. Fra 1990 til 2010 ses et fald på 34,6 % i N_2O-emissionen fra landbrug. Dette skyldes mindre brug af kvælstofhandelsgødning og bedre udnyttelse af kvælstof i husdyrgødningen, hvilket resulterer i mindre emissioner pr. produceret dyreenhed. Emissioner af CH_4 fra husdyrenes fordøjelsessystem er faldet fra 1990 til 2010 grundet et faldende antal kvæg. På den anden side har en stigende andel af gyllebaserede staldsystemer bevirket at emissionerne fra husdyrgødning er steget. I alt er CH_4-emissionerne fra landbrugssektoren faldet med 2,3 % fra 1990 til 2010.

Arealanvendelse - skove og jorder (LULUCF)

LULUCF-sektoren skifter mellem at udgøre et nettooptag og en nettoudledning. I 2010 udgør LULUCF et nettooptag svarende til 3,5 % af den samlede drivhusgasudledning, eksklusiv LULUCF. I 2009 udgjorde LULUCF et nettooptag svarende til 1,4 % af den samlede drivhusgasudledning eksklusiv LULUCF. I 2010 bidrager arealer med skov med et optag på 5 677 Gg CO_2-ækvivalenter, mens dyrkede jorder, græsning, vådområder og bebyggelse bidrager med emissioner på henholdsvis 3186 Gg CO_2-ækvivalenter, 186 Gg CO_2- ækvivalenter, -0,02 Gg CO_2- ækvivalenter og 134 Gg CO_2- ækvivalenter. Emissionen fra landbrugsjorde stammer hovedsageligt fra organiske jorder. Siden 1990 har der været et fald i den totale mængde kulstof (C) der er lagret i jorder.

Affald

Affaldssektoren udgør i 2010 1,6 % af den danske total-emission, 15,4 % af den totale CH_4 emission og 2,2 % af den totale N_2O emission. Sektoren omfatter lossepladser, spildevandshåndtering, affaldsforbrænding uden energiudnyttelse (f.eks. kremeringer af dyr), og andet affald (f.eks. kompostering og ildebrande). Da al traditionel affaldsforbrænding bruges til produktion af elektricitet og varme, er emissionerne herfra inkluderet i CRF-kategorien 1A.

Drivhusgasemissionen fra sektoren er faldet med 41,8 % fra 1990 til 2010. Reduktionen skyldes især (1) et fald i CH_4 emissionen fra lossepladser på 53,1 % pga. reducerede mængder affald, der går til deponi, og (2) et fald i N_2O emissionen fra spildevandshåndtering på 23,4 % pga. fornyelse af spildvandsanlæggene.

Disse fald er delvist modvirket af en stigning i CH_4 emissionen fra spildevandshåndtering på 13,8 % pga. en stigning i det industrielle spildevand. I 2010 bidrog lossepladser med 12,5 % af den totale nationale CH_4 emission. CH_4 emissionen fra spildevandshåndtering udgør i 2010 1,4 % af den totale nationale CH_4 emission.

S.3.2 KP-LULUCF-aktiviteter

I 2010 udgjorde aktiviteterne under Kyotoprotokollens artikel 3.3 en netto udledning på 41 Gg CO_2-ækv. mens aktiviteterne under artikel 3.4 udgjorde et netto optag på 2 221 Gg CO_2-ækv. En kort oversigt over KP-LULUCF findes i kapitel S.2.2 mens en mere detaljeret redegørelse findes i kapitel 11.

S.4 Andre informationer

S.4.1 Kvalitetssikring og - kontrol

Rapporten indeholder en plan for kvalitetssikring og -kontrol af emissionsopgørelserne. Kvalitetsplanen bygger på IPCC's retningslinjer og ISO 9000 standarderne. Planen skaber rammer for dokumentation og rapportering af emissionerne, så opgørelserne er gennemskuelige, konsistente, sammenlignelige, komplette og nøjagtige. For at opfylde disse kriterier, understøtter datastrukturen arbejdsgangen fra indsamling af data til sammenstilling, modellering og til sidst rapportering af data.

Som en del af kvalitetssikringen, udarbejdes der for emissionskilderne rapporter, der detaljeret beskriver og dokumenterer anvendte data og beregningsmetoder. Disse rapporter evalueres af personer uden for Aarhus Universitet, der har høj faglig ekspertise indenfor det pågældende område, men som ikke direkte er involveret i arbejdet med opgørelserne. Indtil nu er rapporter for stationære forbrændingsanlæg, transport og landbrug blevet evalueret. Desuden er der gennemført et projekt, hvor de danske opgørelsesmetoder, emissionsfaktorer og usikkerheder sammenlignes med andre landes, for yderligere at verificere rigtigheden af opgørelserne.

S.4.2 Fuldstændighed i forhold til IPCC's retningslinjer for kilder og gasser

De danske opgørelser af drivhusgasemissioner indeholder alle de kilder, der er beskrevet i IPCC's retningsliner.

I annex 5 er der flere informationer om fuldstændigheden af den danske drivhusgasopgørelse.

S. 4.3 Rekalkulationer og forbedringer

De vigtigste forbedringer af opgørelserne er:

Energi

Stationær forbrænding

Den seneste officielle energistatistik er implementeret i opgørelsen for årene 1990-2009. Opdateringen omfatter både slutforbrug og konverteringssektoren samt opdatering af kilde kategorier.

Den relativt store genberegning for CO_2 emissionen fra brændselskategorien "Other fuels" skyldes en revision af CO_2 emissionsfaktoren for forbrænding af fossilt affald. Emissionsfaktoren er ændret på baggrund af et betydeligt antal målinger foretaget på danske affaldsforbrændingsanlæg i 2010 og 2011. Den reviderede CO_2 emissionsfaktor er 14 % højere end den tidligere anvendte. CO_2 emissionen fra brændselskategorien "Other fuels" i offentlig el- og varmeproduktion (CRF kode 1A1a) er derfor tilsvarende steget med 14 % i 2009 svarende til 170 Gg CO_2.

Disaggregeringen af industriens energiforbrug er blevet genberegnet baseret på en forbedret metode. Dette har medført ændringer i enkelte undersektorer, f.eks. for CO_2 emissionen fra gasformige og flydende brændsler i undersektorerne 1A2c, 1A2d, 1A2e og 1A2f. Den samlede ændring er dog lille, og skyldes andre ændringer, som f.eks. opdatering af data i energistatistikken. For både gasformige og flydende brændsler er ændringen i den samlede CO_2 emission i 2009 mindre end 1,5 %. Ændringen har også påvirket emissionen af CH_4 og N_2O fra undersektorer.

Genberegningen af CO_2 emissionen fra forbrænding af biomasse (+174 Gg CO_2 for 1A2 og +419 Gg CO_2 for 1A4) skyldes reviderede emissionsfaktorer for træ og halm. Begge emissionsfaktorer henviser nu til IPCC Guidelines.

CH_4 emissionen fra træfyring i husholdninger er genberegnet på baggrund af forbedret viden omkring fordeling af træforbruget på teknologier. Emissionen for 2009 rapporteret i denne rapport er 21 Gg CO_2-ækvivalenter lavere end i sidste års rapportering.

CH_4 emissionsfaktoren for raffinaderier er indført eller revideret for flere år i tidsserien. Dette har gjort tidsserien mere konsistent, men har betydet store procentuelle ændringer i nogle år. Da emissionen fra denne kilde er begrænset, er genberegningen for 2009 mindre end 0,5 Gg CO_2-ækvivalenter.

N_2O emissionen fra gasformige brændsler i sektor 1A1c er blevet genberegnet resulterende i et fald på 10 Gg CO_2-ækvivalenter. N_2O emissionsfaktoren for gasturbiner i off-shore industrien følger nu emissionsfaktoren for on-shore gasturbiner.

Mobile kilder

Vejtransport

Data for årskørsler for de forskellige køretøjskategorier er blevet opdateret for 1985 til 2009 baseret på nye data estimeret af DTU Transport. En vigtig ændring er en ændring i fordelingen mellem de totale kørte kilometre mellem benzin- og dieseldrevne personbiler. Den opdaterede fordeling er baseret på data fra 2008 fra det lovpligtige syn. Der har også været en opdatering af antallet af kørte kilometre af udenlandske køretøjer i Danmark.

Minimum og maksimum procentvis difference og år for numerisk maksimum difference (min. %, maks. %, år med maks. %) for emissionskomponenterne er: CO_2 (-0,2 %, 2,6 %, 2009), CH_4 (0,6 %, 1,6 %, 2009) og N_2O (-0,9 %, 4,6 %, 1994).

Landbrug/skovbrug/fiskeri

Fordelingen af motorstørrelser for mejetærskere er opdateret på baggrund af salgsstatistik for årene 2002, 2003 og 2009.

Den samlede betydning for landbrug/skovbrug/fiskeri, udtrykt ved maksimum procentvis difference for emissionskomponenterne er: CO_2 (-0,3 %), CH_4 (0 %) og N_2O (-0,2 %).

Militær

Emissionsfaktorer afledt fra de nye modelsimulationer for vejtransport har medført små ændringer i emissionerne i perioden 1985-2009. Maksimum emissionsdifference er: CO_2 (0 %), CH_4 (0,6 %) og N_2O (0,5 %).

Luftfart

Der er foretaget en genberegning af emissionerne for årene 2007-2009 på grund af en korrektion i forhold til tildeling af en repræsentativ flytype for en ny flytype, der optrådte i Danmark første gang i 2007. På grund af en fejl var F28 blevet anvendt som repræsentativ flytype for de nye flytyper CRJ9, E70, E170 og E175. F28 er imidlertid en meget gammel flytype, som ikke er repræsentativ for disse nyere flytyper. I stedet er brændselsforbrug og emissionsfaktorer blevet beregnet specifikt for flytyperne CRJ9, E70, E170 og E175. Maksimum emissionsdifference er observeret for 2009 og er: CO_2 (-1,7 %), CH_4 (-46,3 %) og N_2O (-0,6 %).

Flygtige emissioner

I forbindelse med emissionsopgørelsen for 2010 er der foretaget en række genberegninger som specificeret nedenfor.

Nye kilder

CO_2-emissioner fra udvinding, transport og lagring af olie samt fra transmission og distribution af naturgas og bygas er inkluderet i opgørelsen for første gang. Dette har medført en stigning i CO_2-emissionen fra sektoren på 1,4 % i 2009 og 0,6 % i 1990.

Raffinaderier

Emissionerne af CH_4 og NMVOC er genberegnet for årene 1994-2000 og 2002-2009 på baggrund af VOC-målinger udført i 2001. Der er ikke yderligere data for flygtige emissioner fra raffinaderierne for historiske år, og der vil heller ikke kunne fremskaffes sådanne data i fremtiden. Beslutningen er truffet efter en længerevarende dialog med et af de danske raffinaderier, hvilket har medført en anbefaling om at anvende de tilgængelige måledata, og ikke en beregnet emission baseret på måledata vægtet med den behandlede mængde råolie, som har været praksis tidligere. De flygtige emissioner er mere relateret til andre procesparametre end den behandlede mængde råolie. Splittet af VOC-emissioner til CH_4 og NMVOC oplyst af raffinaderierne er blevet revideret for at sikre en harmoniseret behandling af de danske raffinaderier. For begge raffinaderier gælder det, at årlige oplysninger om splittet mellem CH_4 og NMVOC ikke er tilgængelige. Emissionerne er derfor baseret på data for VOC emissioner oplyst af raffinaderierne og en antagelse om andelen af VOC, der er henholdsvis CH_4 og NMVOC. Antagelsen er baseret på kommunikation med raffinaderierne samt et litteraturstudie.

Genberegningen har medført en stigning i CH_4-emissionen fra sektoren for 2009 på 1 %. Den maksimale stigning er for 2007 (3 %).

Baseret på nye SO_2-data fra et af de danske raffinaderier er SO_2-emissionen genberegnet for 2005-2009. Dette har medført en stigning i SO_2-emissionen fra sektoren på 6 % i 2009.

Gasdistribution

Emissionsfaktorerne for CH_4 og N_2O for distribution af bygas er blevet rettet på grund af en fejl. Distribution af bygas er en meget lille kilde og genberegningen har derfor en ubetydelig indflydelse på sektorens samlede emission (maks. 0,003 % af den totale CH_4 emission fra sektoren i 2009).

Off-shore flaring

Aktivitetsdata er blevet opdateret for 2008 for to off-shore-installationer. Brændværdien er blevet opdateret for hele tidsserien baseret på den gennemsnitlige brændværdi rapporteret under EU ETS (Emission Trading Scheme) for årene 2008-2010, dette influerer på emissionsfaktoren for CO_2 og NMVOC. Derudover er emissionsfaktoren for NMVOC blevet korrigeret med en omregning fra standard til normal kubikmetre. For 2007 er CO_2 emissionsfaktoren ændret til gennemsnitsværdien for 2008-2010, dette er gjort fordi data i EU ETS indberetningerne for 2007 ikke er på et tilsvarende detaljeringsniveau som i de efterfølgende år. Generelt er aktivitetsdata opdateret i henhold til den seneste officielle statistik fra Energistyrelsen.

Genberegningen har medført en stigning i CO_2 emissionen på mellem 1 % i 2009 og 8 % i 1990.

Flaring i raffinaderier

CO_2-emissionsfaktoren for flaring i raffinaderier er opdateret for årene 1990-2006. Den anvendte emissionsfaktor er baseret på gennemsnitsemissionsfaktorer rapporteret under EU ETS for henholdsvis 2006-2010 og 2007-2010 for de to danske raffinaderier.

Genberegningen har medført at emissionen af CO_2 er faldet med 0,2 % i 2009 og 0,4 % i 1990.

Industrielle processer

Ændringer af aktivitetsdata er foretaget for anvendelse af HFC'er som følge af FN review-processen.

Emissionsmodellen for SF_6 emission fra termoruder er blevet revideret for 1998/1999. Dette resulterer i små ændringer i SF_6 emissionen de følgende år, da SF_6 emission fra termoruder antages at finde sted med 1 % af den samlede anvendte mængde pr. år.

Opløsningsmidler og anden produktanvendelse

Historiske data for produktion, import og eksport af NMVOC er blevet inkluderet for perioden 1990-1994. Data er indsamlet fra Danmarks Statistik og metoden er nu konsistent for hele perioden mellem 1990 og 2010. Salgstal for N_2O for årene 2000-2010 er blevet korrigeret for eksport. N_2O anvendt til racerbiler og i laboratorier er inkluderet. Det er undersøgt om der er anvendelse af N_2O til brandslukningsudstyr i Danmark, og det er konkluderet, at det ikke er tilfældet.

Emissioner fra anvendelse af grillkul og tobak er inkluderet for første gang i emissionsopgørelsen.

Landbrug

Genberegninger for landbrugssektoren har medført en stigning i emissionerne for årene 1990-2008 på op til 1 % og et fald i emissionen for 2009 på 0,7 % sammenlignet med den totale emission i CO_2-ækvivalenter fra landbrugssektoren. Stigningen i perioden 1990 til 2008 skyldes en stigning i CH_4-emissionen, mens faldet i 2009 skyldes et fald i N_2O emissionen, mens CH_4-emissionen er stort set uændret.

Stigningen i CH_4-emissionen skyldes både ændringer for fordøjelse og gødningshåndtering. Som anbefalet af FN's review-team er en fejl i beregningen af CH_4-emissionen fra fordøjelse hos svin blevet rettet. For gødningshåndtering er der foretaget ændringer for søer for alle år i tidsserien. For malkekvæg er der foretaget en rettelse af en fejl i beregningen.

For N_2O-emissionen er der foretaget en række genberegninger, som både har påvirket emissionen i stigende og faldende retning. På grund af ændringer i emissionsfaktorerne for NH_3 er emissionen af N_2O fra handelsgødning og husdyrgødning steget, mens emissionen fra atmosfærisk deposition er faldet. Data for arealet med organiske jorde er opdateret for hele tidsserien, hvilket har medført en stigning i N_2O-emissionen for 1990-1999 og et fald i N_2O-emissionen fra 2000-2009.

Arealanvendelse (LULUCF)

Skov

Da NFI'en blev iværksat i 2002, er den repræsentativ fra 2006. Beregning af kulstoflagring i årene 2000-2005 er baseret på NFI 2006 og kulstofmængden beregnet for år 2000. For 2006-2010 er kulstofmængden beregnet alene på baggrund af NFI – med yderligere information om det totale skovareal baseret på satellitfotos. Rapporterede data fra NFI'en svarer til det sidste år i 5-års cyklussen (dvs. at de rapporterede data for 2010 er baseret på data for 2006-2010). Dette er ændret i forhold til tidligere rapporteringer, hvor midtpunktet i 5-års perioden blev anvendt (dvs. rapporterede data for 2008 var baseret på data for 2006-2010). Ændringen er foretaget for at sikre rettidig og konsistent rapportering, da 2010 data ellers først ville være tilgængelige i 2012.

Genberegningen har medført ændringer for skov for enkelte år, men den overordnede trend er uforandret. N_2O-emissionen er kun ændret i begrænset omfang.

Landbrugsarealer, græsningsarealer, vådområder og bebyggelse

Den største ændring er baseret på et studie af organiske jorde i Danmark. De nye data viser, at der i dag kun er 42 000 hektar organiske landbrugsjorde og 28 000 hektar organiske jorde i græsarealer. Undersøgelsen viser desuden at arealet af organiske landbrugsjorde er faldet kraftigt siden 1975 med et gennemsnitligt årligt fald på 1400 hektar. Faldet skyldes den intensive opdyrkning af de jorde med et meget tyndt lag organisk materiale, hvilket har reduceret det organiske indhold til 5-10 % i stedet for > 12 %.

Emissionen fra mineralske landbrugsjorde bliver beregnet med en dynamisk model (C-TOOL) svarende til en tier 3 model. En grundig analyse af modellen har vist, at den ikke kan modellere emissionen tilfredsstillende for landbrugsjorde med et organisk indhold på mellem 6 % og 12 %. Dette er et areal på ca. 40 000 hektar i 2010. Emissionen fra både organiske og mineralske landbrugsjorde er derfor blevet genberegnet.

En mindre ændring i standardværdien for kulstofindholdet i mineralske landbrugsjorde er foretaget. Dette har indflydelse på emissionerne fra alle arealovergange til og fra landbrug gennem hele tidsserien.

I tidligere emissionsopgørelser har der ikke været inkluderet emissioner fra arealovergange til bebyggede arealer, da der ikke er nogen standardmetode fra IPCC for denne type arealovergange. I denne aflevering er der som respons til FN's review-proces blevet anvendt et standard kulstofindhold på 120 t C pr. hektar (0-100 cm) for bebyggede arealer. Denne værdi er anvendt for alle arealovergange til og fra bebyggede arealer, og påvirker derfor emissionen for alle år i tidsserien.

Affald

For deponi er hver affaldskategori blevet underopdelt i ni fraktioner (madaffald, pap, papir, vådt pap og papir, plastik, andet forbrændingsegnet, glas, metal samt andet ikke-forbrændingsegnet). Emissionsmodellen for deponi er blevet udbygget således, at den nu har specifikke halveringstider og kulstofindhold for de ni fraktioner. Derudover er CH_4-indholdet i den opsamlede deponigas blevet ændret fra 50 % til 41 % i henhold til nye informationer. Disse ændringer medfører en stigning i CH_4-emissionen for 1990 til 2002 og et fald i emissionen fra 2003-2009. De største ændringer er en stigning i emissionen på 38 % i 1990 og et fald i emissionen på 18 % i 2009.

For spildevandshåndtering er der foretaget en genberegning af CH_4-emissionen for perioden 1999-2009. Dette har resulteret i en stigning af emission på mellem 0,2 % (2000) og 1,3 % (2003). Stigningen i 2009 er på 0,4 %. Genberegningen skyldes en fejlrettelse på aktivitetsdata i modellen i forhold til den tidligere aflevering. Der er ikke foretaget metodeændringer.

Der er ikke foretaget genberegninger i kategorien affaldsforbrænding.

For kategorien "Andet affald" er emissionerne af CO_2 og CH_4 faldet som følge af en ændring i metoden. Ændringer er foretaget både for brande i bygninger og køretøjer. For bygningsbrande er der inkluderet yderligere bygningstyper (udhuse, drivhuse etc.) og containerbrande. Der er også ændret i skadeskategorierne, så der nu opereres med 4 kategorier svarende til 100, 75, 30 og 5 % skade. Effekten af disse ændringer er et fald i emissionerne, f.eks. for partikler mellem 4 og 9 % og for NMVOC mellem 44 og 47 %. I tidligere opgørelser blev brande i f.eks. carporte og skure regnet for husbrande, og emissionerne blev beregnet ud fra antagelse gældende for huse, hvilket medførte en overestimering af emissionerne. Indførslen af nye kategorier har bevirket at emissionerne er faldet i forhold til tidligere opgørelser. For bilbrande er der sket en yderligere opdeling i køretøjstyper ligesom der er fortaget en tilsvarende ændring angående skadeskategorier som for bygningsbrande. I tidligere opgørelse er det antaget at alle bilbrande resulterede i 70 % skade. I denne opgørelse er der indført fire skadekategorier svarende til kategorierne for husbrande. Det vægtede skadesgennemsnit for perioden 2007-2010 er 34 % og dermed væsentligt lavere end den tidligere antagede skade på 70 %.

Den totale emission fra affaldssektoren er steget mellem 1990 og 2000 og faldet i perioden 2001-2009. De største ændringer er en stigning i 1990 på 31 % og et fald i 2009 på 20 %.

KP-LULUCF

Stort set alle sektorer under KP-LULUCF er blevet genberegnet.

Genberegningerne skyldes:

- opdaterede data fra den danske NFI for kulstoflagring i vedmasse over jorden, vedmasse under jorden, dødt ved og vedmasse/blade på skovbunden,
- et nyt kort over organiske jorde,
- at C-TOOL som estimerer emissionen fra mineralske landbrugsjorde ikke har vist sig at kunne simulere ændringer i jorde med 6-12 % organisk kulstof.
- nye data for kulstofindhold i mineral jorder fra vores forskningsprogram (0-100 cm dybde)

For skov skyldes den største ændring nye data fra NFI'en og nye data for skovjorde.

Genberegninger for forvaltning af landbrugsarealer og permanente græsarealer skyldes hovedsageligt anvendelse af det nye kort over organiske jorde samt nye emissionsfaktorer for organiske jorde. Analyser har vist at C-TOOL ikke er tilstrækkelig præcis i intervallet 6-12 % organisk kulstof. For disse jorde er der i stedet anvendt en fast emissionsfaktor som er halvdelen af den for organiske jorde med >12 % organisk kulstof.

Yderligere analyser af det nye jordbundskort for organiske jorde har vist at jorde med >12 % organisk kulstof forsvinder hurtigt. Effekten af dette er inddraget i opgørelserne.

Samlet har denne ændring øget den samlede emission fra landbrugsjorde med ca. 1 000 Gg CO_2-ækvivalenter i både basisåret og følgende år.

For yderligere beskrivelse af genberegninger og KP-LULUCF henvises til kapitel 10 og 11.

1 Introduction

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 Annual report

This report is Denmark's National Inventory Report (NIR), for submission to the European Commission, for March 15, 2012. The report is worked out in accordance with decision no 280/2004/EC of European Parliament and the Council and is a complete NIR and contains detailed information on Denmark's inventories for all years from 1990 to 2010. The structure of the report is in accordance with the UNFCCC guidelines on reporting and review. The suggested outline provided by the UNFCCC secretariat has been followed to include the necessary information under the Kyoto Protocol.

The issues addressed in this report are trends in greenhouse gas emissions, a description of each IPCC category, uncertainty estimates, recalculations, planned improvements and procedures for quality assurance and control.

The annual emission inventories for the years from 1990 to 2010, are reported in the Common Reporting Format (CRF) as requested in the reporting guidelines. The CRF-spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for the total greenhouse gas emissions in CO_2 equivalents.

According to the instrument of ratification, the Danish government has ratified the UNFCCC on behalf of Denmark, Greenland and the Faroe Islands. The Danish government has ratified the Kyoto Protocol on behalf of Denmark and Greenland. The information in the sectoral chapters in this report relates to Denmark only, while information for Greenland is included in Chapter 16 and for the Faroe Islands in Annex 8.

This report itself does not contain the full set of CRF Tables. The full set of CRF tables is available at the EIONET, Central Data Repository, kept by the European Environmental Agency:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_UNFCCC

1.1.2 Greenhouse gases

The greenhouse gases reported under the Climate Convention are:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

The main greenhouse gas responsible for the anthropogenic influence on the heat balance is CO_2. The atmospheric concentration of CO_2 has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005 (an increase of about 35 %), and exceeds now the natural range of 180-300 ppm over the last 650 000 years as determined by ice cores (IPCC, Fourth Assessment Report, 2007). The main cause for the increase in CO_2 is the use of fossil fuels, but changing land use, including forest clearance, has also been a significant factor. The greenhouse gases CH_4 and N_2O are very much linked to agricultural production; CH_4 has increased from a pre-industrial atmospheric concentration of about 715 ppb to 1774 ppb in 2005 (an increase of about 140 %) and N_2O has increased from a pre-industrial atmospheric concentration of about 270 ppb to 319 ppb in 2005 (an increase of about 18 %) (IPCC, Fourth Assessment Report, 2007). Changes in the concentrations of greenhouse gases are not related in simple terms to the effect on the heat balance, however. The various gases absorb radiation at different wavelengths and with different efficiency. This must be considered in assessing the effects of changes in the concentrations of various gases. Furthermore, the lifetime of the gases in the atmosphere needs to be taken into account – the longer they remain in the atmosphere, the greater the overall effect. The global warming potential (GWP) for various gases has been defined as the warming effect over a given time of a given weight of a specific substance relative to the same weight of CO_2. The purpose of this measure is to be able to compare and integrate the effects of individual substances on the global climate. Typical lifetimes in the atmosphere of substances are very different, e.g. 12 and 120 years approximately for CH_4 and N_2O, respectively. So the time perspective clearly plays a decisive role. The time frame chosen is typically 100 years. The effect of the various greenhouse gases can, then, be converted into the equivalent quantity of CO_2, i.e. the quantity of CO_2 giving the same effect in absorbing solar radiation. According to the IPCC and their Second Assessment Report, which UNFCCC has decided to use as reference for reporting for inventory years throughout the commitment period 2008-2012, the global warming potentials for a 100-year time horizon are:

- Carbon dioxide (CO_2): 1
- Methane (CH_4): 21
- Nitrous oxide (N_2O): 310

Based on weight and a 100-year period, methane is thus 21 times more powerful a greenhouse gas than CO_2, and N_2O is 310 times more powerful. Some of the other greenhouse gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) have considerably higher global warming potential values. For example, sulphur hexafluoride has a global warming potential of 23 900.

The indirect greenhouse gases reported are nitrogenoxide (NO_x), carbonmonooxide (CO), Non-Methane Volatile Organic Compounds (NMVOC) and sulphurdioxid (SO_2). Since no GWP is assigned these gases they do not contribute to GHG emissions in CO_2-equivalents.

1.1.3 The Climate Convention and the Kyoto Protocol

At the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992, more than 150 countries signed the UNFCCC (the Climate Convention). On the 21st of December 1993, the Climate Convention was ratified by a sufficient number of countries, including Denmark, for it to enter into force on the 21st of March 1994. One of the provisions of the treaty was to stabilise the greenhouse gas emissions from the industrialised nations by the end of 2000. At the first conference under the UN Climate Convention in March 1995, it was decided that the stabilisation goal was inadequate. At the third conference in December 1997 in Kyoto in Japan, a legally binding agreement was reached committing the industrialised countries to reduce the six greenhouse gases by 5.2 % by 2008-2012 compared with the base year. For F-gases, the countries can choose freely between 1990 and 1995 as the base year. On May 16, 2002, the Danish parliament voted for the Danish ratification of the Kyoto Protocol. Denmark (including Greenland and excluding the Faroe Islands) is, thus, under a legal commitment to meet the requirements of the Kyoto Protocol, when it came into force on the 16th of February 2005. Hence, Denmark (including Greenland) is committed to reduce greenhouse gases with 8 %. The European Union is under the KP committed to reduce emissions of greenhouse gases by 8 %. However, within the EU member states have made a political agreement – the Burden Sharing Agreement – on the contributions to be made by each member state to the overall EU reduction level of 8 %.

Under the Burden Sharing Agreement, Denmark (excluding Greenland and the Faroe Islands) must reduce emissions by an average of 21 % in the period 2008-2012 compared with the base year emission level.

In accordance with the Kyoto Protocol, Denmark's base year emissions include the emissions of CO_2, CH_4 and N_2O in 1990 in CO_2 equivalents and Denmark has chosen 1995 as the base year for the emissions of HFCs, PFCs and SF_6.

1.1.4 The role of the European Union

The European Union (EU) is a party to the UNFCCC and the Kyoto Protocol. Therefore, the EU has to submit similar datasets and reports for the collective 15 EU Member States under the burden sharing. The EU imposes some additional guidelines and obligations to these EU Member States through Decision No. 280/2004/EC concerning a mechanism for monitoring community greenhouse gas emissions and for implementing the Kyoto Protocol (EU monitoring mechanism).

1.1.5 Background information on supplementary information required under KP article 7.1

For the LULUCF activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol Denmark has chosen annual accounting. Article 3.3 covers direct, human induced afforestation (A), reforestation (R) and deforestation (D) activities, and accounting of these activities is mandatory. Under Article 3.4 Denmark has elected the activities Forest Management (FM), Cropland Management (CM) and Grazing Land Management (GM) for optional accounting of the first Commitment Period (CP). Net removals from FM activity can be used to compensate net emissions from activities under Article 3.3., and through the issuance of removal units (RMUs) up to a cap value. Denmark's cap value for the CP is 916 667 tonnes CO_2 equivalents.

1.2 A description of the institutional arrangement for inventory preparation

On behalf of the Ministry of the Environment and the Ministry of Climate, Energy and Building the Danish Centre for Environment and Energy (DCE) is responsible for the calculation and reporting of the Danish national emission inventory to the EU, the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (Convention on Long-Range Transboundary Air Pollution). Hence, DCE prepares and publishes the annual submission for Denmark to the EU and UNFCCC of the National Inventory Report and the GHG inventories in the Common Reporting Format, in accordance with the UNFCCC guidelines. Furthermore, DCE is responsible for reporting the national inventory for the Kingdom of Denmark to the UNFCCC. DCE is also the body designated with overall responsibility for the national inventory under the Kyoto Protocol for Greenland and Denmark.

The work concerning the annual greenhouse gas emission inventory is carried out in cooperation with Danish ministries, research institutes, organisations and companies. The Government of Greenland is responsible for finalising and transferring the inventory for Greenland to DCE. The Faroe Islands Environmental Agency is responsible for finalising and transferring the inventory for the Faroe Islands to DCE.

There are now data agreements in place with both Greenland and the Faroe Islands ensuring the data delivery. These agreements contain deadlines for when DCE is to receive the data and documentation.

DCE has been and is engaged in work in connection with meetings of the Conference of Parties (COP) to the UNFCCC and the meetings of the parties (COP/MOP) to the Kyoto protocol and its subsidiary bodies, where the reporting rules are negotiated and settled. Furthermore, DCE participates in the EU Monitoring Mechanism, Working Group 1 (WG1), where the guidelines, methodologies etc. on inventories to be prepared by the EU Member States are regulated.

The main experts responsible for the sectoral inventories and the corresponding chapters and annexes in this report are:

Project leader		**Ole-Kenneth Nielsen (okn@dmu.dk)**
Sector	Sub-sector	Expert name
Energy	Stationary combustion:	Malene Nielsen
	Transport and other mobile sources	Morten Winther
	Fugitive emissions:	Marlene Plejdrup
Industrial processes		Leif Hoffmann
Solvent and other product use		Patrik Fauser, Katja Hjelgaard
Agriculture		Mette Hjorth Mikkelsen, Rikke Albrektsen & Steen Gyldenkærne
LULUCF		Vivian Kvist Johannsen, Thomas Nord-Larsen, Inge Stupak Møller, Lars Vesterdal & Steen Gyldenkærne
Waste	Solid waste disposal on land	Marianne Thomsen, Katja Hjelgaard
	Wastewater handling	Marianne Thomsen
	Waste incineration & Other waste	Katja Hjelgaard
Greenland		Lene Baunbæk
Faroe Islands		Maria Gunnleivsdóttir Hansen

The work concerning the annual greenhouse emission inventory is carried out in cooperation with other Danish ministries, research institutes, organisations and companies:

Danish Energy Agency, the Ministry of Climate, Energy and Building: Annual energy statistics in a format suitable for the emission inventory work and fuel-use data for the large combustion plants. Company reports submitted under EU ETS.

Danish Environmental Protection Agency, the Ministry of the Environment: Database on waste and emissions of the F-gases.

Danish Nature Agency, the Ministry of the Environment: Database on Danish waste water quality parameters.

Statistics Denmark, the Ministry of Economic Affairs and the Interior: Statistical yearbook, sales statistics for manufacturing industries and agricultural statistics.

Danish Centre for Food and Agriculture (DCA), Aarhus University: Data on use of mineral fertiliser, feeding stuff consumption and nitrogen turnover in animals.

The Road Directorate, the Ministry of Transport: Number of vehicles grouped in categories corresponding to the EU classification, mileage (urban, rural, highway), trip speed (urban, rural, highway).

Danish Centre for Forest, Landscape and Planning, University of Copenhagen: Background data for Forestry and CO_2 uptake by forest. Responsible for preparing estimates of emissions/removals for reporting under KP article 3.3 and for reporting FM under article 3.4.

Civil Aviation Agency of Denmark, the Ministry of Transport: City-pair flight data (aircraft type and origin and destination airports) for all flights leaving major Danish airports.

Danish Railways, the Ministry of Transport: Fuel-related emission factors for diesel locomotives.

Danish companies: Audited green accounts and direct information gathered from producers and agency enterprises.

Formerly, the provision of data was on a voluntary basis, but more formal agreements are now prepared. This is the case for e.g. the Danish Energy Agency, where the data agreement specifies the data needed and the deadlines for when DCE is to receive the data.

Additionally DCE receives data from Greenland and the Faroe Islands in order to report for the Kingdom of Denmark:

Statistics Greenland: Complete CRF tables for Greenland and documentation for the inventory process.

The Faroe Islands Environmental Agency: Complete CRF tables for the Faroe Islands and documentation for the inventory process.

The complete emission inventories for the three different submissions (EU, Kyoto Protocol and UNFCCC) by Denmark are compiled by DCE and along with the documentation report (NIR) sent for official approval. In recent years the responsibility for official approval has changed. Previously it was the Danish Environmental Protection Agency (Ministry of the Environment) now it is the Danish Energy Agency (Ministry of Climate, Energy and Building). This means that the emission inventory is finalised no later than March 15, whereupon the official approval is done prior to the reporting deadlines under the UNFCCC and the Kyoto Protocol.

1.3 Brief description of the process of inventory preparation. Data collection and processing, data storage and archiving

The background data (activity data and emission factors) for estimation of the Danish emission inventories is collected and stored in central databases located at the Department of Environmental Science (ENVS), Aarhus University. The databases are in Access format and handled with software developed by the European Environmental Agency and developed originally by the former National Environmental Research Institute (NERI), but is now maintained and further developed by ENVS. As input to the databases, various sub-models are used to estimate and aggregate the background data in order to fit the format and level in the central databases. The methodologies and data sources used for the different sectors are described in Chapter 1.4 and Chapters 3 to 9. As part of the QA/QC plan (Chapter 1.6), the data structure for data processing supports the pathway from collection of raw data to data compilation, modelling and final reporting.

For each submission, databases and additional tools and submodels are frozen together with the resulting CRF-reporting format. This material is placed on central institutional servers, which are subject to routine back-up services. Material, which has been backed up, is archived safely. A further documentation and archiving system is the official journal for DCE. In this journal system, correspondence, both in-going and out-going, is registered, which in this case involves the registration of submissions and communication on inventories with the UNFCCC Secretariat, the European Commission, review teams, etc.

Figure 1.1 shows a schematic overview of the process of inventory preparation. The figure illustrates the process of inventory preparation from the first step of collecting external data to the last step, where the reporting schemes are generated for the UNFCCC and EU (in the CRF format (Common Reporting Format)) and to the United Nations Economic Commission for Europe/Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE/EMEP) (in the NFR format (Nomenclature For Reporting)). For data handling, the software tool is CollectER (Pulles et al., 1999) and for reporting the software tool is the CRF reporter tool developed by the UNFCCC Secretariat together with additional tools originally developed by NERI, but now maintained and further developed by ENVS. Data files and programme files used in the inventory preparation process are listed in Table 1.1.

Table 1.1 List of current data structure; data files and programme files in use.

QA/QC Level	Name	Application type	Path	Type	Input sources
4 store	CFR Submissions (UNFCCC and EU)	External report	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_4a_Storage\	MS Excel, xml	CRF Reporter
4 store	NFR Report	External report	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_4a_Storage\	xls	NRF Report N8 Process
3 process	CRF Reporter	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	(exe + mdb)	National Compliler and Importer2CRF(xml) and IDAtoCRF(xml)
3 process	NRF Report N8 Process	Helptool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes\NFR	Excel	NERIRep and Report Template (xls)
3 process	Importer2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	MS Access	CRF Reporter, Col-lectEr2CRF, and excel files
3 process	CollectER2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	MS Access	NERIRep
3 proces	IDA2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	MS Access	IDA_backend
2 process 3 store	NERIRep	Help tool	Working path: I:\ROSPROJ\LUFT_EMI\DMURep	MS Access	CollectER databases; dk1972.mdb..dkxxxx.mdb and IDA_backend
2 process	CollectER	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_2b_Processes	(exe +mdb)	Sector Expert
2 store	dk1980.mdb.dkxxxx.mdb	Datastore	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_2a_Storage	MS Access	CollectER
1 process	IDA	Management	I:\ROSPROJ\LUFT_EMI\Agriculture\InventoryAgricultureData	MS Access	Sector Expert
1 store	IDA_Backend	Datastore	I:\ROSPROJ\LUFT_EMI\Agriculture\InventoryAgricultureData	MS Access	IDA

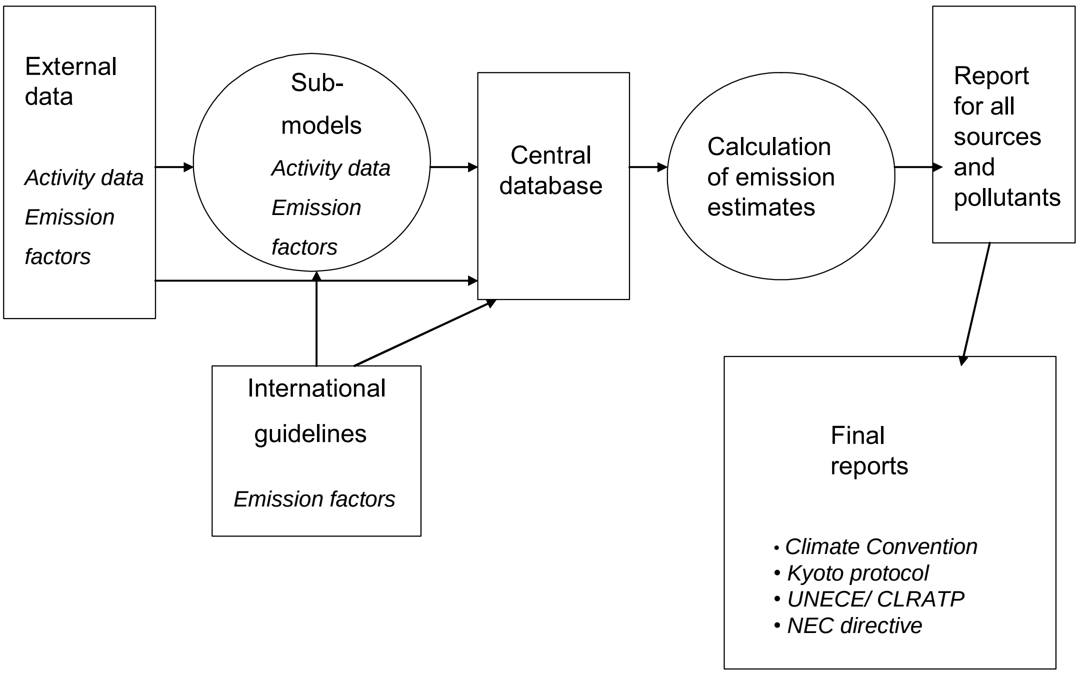


Figure 1.1 Schematic diagram of the process of inventory preparation.

Denmark has different geographical definitions for different submissions. Under the European Union only mainland Denmark is included. For the reporting under the Kyoto Protocol the submission includes Denmark and Greenland, while the reporting under the UNFCCC includes Denmark, Greenland and the Faroe Islands.

Due to the different geographical scopes of the Danish inventory submissions it is necessary to operate three independent installations of the CRF Reporter software on different virtual computers.

For the preparation of the Danish submission under the Kyoto Protocol the full Danish CRF is aggregated with the Greenlandic CRF and for the UNFCCC reporting this is also aggregated with the CRF of the Faroe Islands. The process of aggregation requires additional software tools and two additional installations of CRF Reporter. The process of aggregating the KP inventory is described in Chapter 17.

1.4 Brief general description of methodologies and data sources used

Denmark's air emission inventories are based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) and the CORINAIR methodology. CORINAIR (COoRdination of INformation on AIR emissions) is a European air emission inventory programme for national sector-wise emission estimations, harmonised with the IPCC guidelines. To ensure estimates are as timely, consistent, transparent, accurate and comparable as possible, the inventory programme has developed calculation methodologies for most subsectors and software for storage and further data processing (EMEP-/CORINAIR, 2007).

A thorough description of the CORINAIR inventory programme used for Danish emission estimations is given in Illerup et al. (2000). The CORINAIR calculation principle is to calculate the emissions as activities multiplied by emission factors. Activities are numbers referring to a specific process generating emissions, while an emission factor is the mass of emissions per unit activity. Information on activities to carry out the CORINAIR inventory is largely based on official statistics. The most consistent emission factors have been used, either as national values or default factors proposed by international guidelines.

A list of all subsectors at the most detailed level is given in Illerup et al. (2000) together with a translation between CORINAIR and IPCC codes for sector classifications.

1.4.1 Stationary Combustion Plants

Stationary combustion plants are part of the CRF emission sources *1A1 Energy Industries*, *1A2 Manufacturing Industries* and *1A4 Other sectors*.

The Danish emission inventory for stationary combustion plants is based on the CORINAIR system described in Illerup et al. (2000). The emission inventory for stationary combustion is based on activity rates from the Danish energy statistics. General emission factors for various fuels, plants and sectors have been determined. Some large plants, such as power plants, are registered individually as large point sources and plant-specific emission data are used.

The fuel consumption rates are based on the official Danish energy statistics prepared by the Danish Energy Agency (DEA). DCE aggregates fuel consumption rates to SNAP categories. The fuel consumption of the NFR category 1A4 Manufacturing industries and construction is disaggregated to subsectors according to the DEA data prepared and reported to Eurostat.

For each of the fuel and SNAP categories (sector and e.g. type of plant), a set of general emission factors has been determined. Some emission factors refer to the EMEP/EEA guidebook and some are country specific and refer to Danish legislation, Danish research reports or calculations based on emission data from a considerable number of plants.

Some of the large plants, such as e.g. power plants and municipal waste incineration plants are registered individually as large point sources and emission data from the actual plants are used. This enables use of plant specific emission factors that refer to emission measurements stated in annual environmental reports, etc. At present, the emission factors for CH_4 and N_2O are, however, not plant-specific, whereas emission factors for SO_2 and NO_X often are. For CO_2 it was possible to use data reported under the EU-ETS in the emission inventory from 2006. Therefore it was possible to derive some plant specific CO_2 emission factors for coal and oil fired power plants.

The CO_2 from incineration of the plastic part of municipal waste is included in the Danish inventory.

In addition to the detailed emission calculation in the national approach, CO_2 emission from fuel combustion is aggregated using the reference approach. In 2010, the CO_2 emission inventory based on the reference approach and the national approach, respectively, differ by 0.75 %.

Please refer to Chapter 3.2 and Annex 3A for further information on the emission inventory for stationary combustion plants.

1.4.2 Transport

The emissions from transport, referring to SNAP category 07 (road transport) and the sub-categories in 08 (other mobile sources), are made up in the IPCC categories: 1A2f (Industry-other), 1A3a (Civil aviation), 1A3b (road transport), 1A3c (Railways), 1A3d (Navigation), 1A4a (Commercial and Institutional), 1A4b (Residential), 1A4c (Agriculture/forestry/fisheries) and 1A5 (Other).

An internal DCE model with a structure similar to the European COPERT IV emission model (EMEP/EEA, 2009) is used to calculate the Danish annual emissions for road traffic. The emissions are calculated for operationally hot engines, during cold start and fuel evaporation. The model also includes the emission effect of catalyst wear. Input data for vehicle stock and mileage is obtained from DTU Transport and Statistics Denmark, and is grouped according to average fuel consumption and emission behaviour. For each group, the emissions are estimated by combining vehicle type and annual mileage figures with hot emission factors, cold:hot ratios and evaporation factors (Tier 2 approach).

For air traffic, from 2001 onwards estimates are made on a city-pair level, using flight data provided by the Danish Civil Aviation Agency (CAA-DK) for flights between Danish airports and flights between Denmark and Greenland/Faroe Islands), and LTO and distance-related emission factors from the CORINAIR guidelines (Tier 2 approach). For previous years, the background data consists of LTO/aircraft type statistics from Copenhagen Airport and total LTO numbers from CAA-DK. With appropriate assumptions, consistent time series of emissions are produced back to 1990 and include the findings from a Danish city-pair emission inventory in 1998.

Off-road working machines and equipment are grouped in the following sectors: inland waterways (pleasure craft), agriculture, forestry, industry, and household and gardening. The sources for stock and operational data are various branch organisations and key experts. In general, the emissions are calculated by combining information on the number of different machine types and their respective load factors, engine sizes, annual working hours and emission factors (Tier 2 approach).

The inventory for navigation consists of regional ferries, local ferries and other national sea transport (sea transport between Danish ports and between Denmark and Greenland/Faroe Islands). For regional ferries, the fuel consumption and emissions are calculated as a product of number of round trips per ferry route (Statistics Denmark), sailing time per round trip, share of round trips per ferry, engine size, engine load factor and fuel consumption/emission factor. The estimates take into account the changes in emission factors and ferry specific data during the inventory period.

For the remaining navigation categories, the emissions are calculated simply as a product of total fuel consumption and average emission factors. For each inventory year, this emission factor average comprises the emission factors for all present engine production years, according to engine life times.

Please refer to Chapter 3.3 and Annex 3B for further information on emissions from transport.

1.4.3 Fugitive emissions from fuels

Fugitive emissions from oil (1.B.2.a)

Fugitive emissions from oil are estimated according to the methodology described in the Emission Inventory Guidebook (EMEP/EEA, 2009). The sources include offshore extraction of oil and gas, onshore oil tanks, onshore and offshore loading of ships, and gasoline distribution. Activity data is given in the Danish Energy Statistics by the Danish Energy Agency. The emission factors are based on the figures given in the guidebook except in the case of onshore oil tanks and gasoline distribution where national values are included.

The VOC emissions from petroleum refinery processes cover non-combustion emissions from feed stock handling/storage, petroleum products processing, and product storage/handling. SO_2 is also emitted from non-combustion processes and includes emissions from product processing and sulphur-recovery plants. The emission calculations are based on information from the Danish refineries.

Fugitive emissions from natural gas (1.B.2.b)

Inventories of NMVOC emission from transmission and distribution of natural gas and town gas are based on annual environmental reports from the Danish gas transmission company and annual reports for the gas distribution companies. The annual gas composition is based on Energinet.dk.

Fugitive emissions from flaring (1.B.2.c)

Emissions from flaring offshore, in gas treatment and storage plants, and in refineries are included in the inventory. Emissions calculations are based on annual reports from the Danish Energy Agency and environmental reports from gas storage and treatment plants and the refineries. Calorific values are based on the reports for the EU ETS for offshore flaring, on annual gas quality data from Energinet.dk, and on additional data from the refineries. Emission factors are based on the Emission Inventory Guidebook (EMEP/EEA, 2009).

Please refer to Chapter 3.5 for further information on fugitive emissions from fuels.

1.4.4 Industrial processes

Energy consumption associated with industrial processes and the emissions thereof are included in the Energy sector of the inventory. This is due to the overall use of energy balance statistics for the inventory.

There is only one producer of cement in Denmark, Aalborg Portland Ltd. The activity data for the production of cement clinker is obtained from the company and the CO_2 emission is from the company report to EU-ETS. The methodology is approved by the Danish Energy Agency and the yearly emission estimate is in accordance with the methodology.

The reference for the activity data for production of lime, hydrated lime, expanded clay products and bricks is the production statistics from the manufacturing industries, published by Statistics Denmark.

Limestone is used for the refining of sugar as well as for wet flue gas cleaning at power plants and waste incineration plants. The reference for the activity data is Statistics Denmark for sugar, Energinet.dk for gypsum from power plants combined with specific information on consumption of $CaCO_3$ at specific power plants and National Waste Statistics for gypsum from waste incineration. The emission factors are based on stoichiometric relations between consumption of $CaCO_3$ and gypsum generation as well as consumption of lime for sugar refining and precipitation with CO_2. This information is supplemented with company reports to EU-ETS.

The reference for the activity data for asphalt roofing is Statistics Denmark for consumption of roofing materials, combined with technical specifications for roofing materials produced in Denmark. The emission factors are default factors.

For road paving with asphalt the reference for the activity data is Statistics Denmark for consumption of asphalt and cut-back asphalt. The emission factors are default factors for consumption of asphalt and an estimated emission factor for cut-back asphalt based on the statistics on the emission of NMVOC compiled by the industrial organisations in question.

The reference for activity data for the production of glass and glass wool are obtained from the producers published in their environmental reports. Emission factors are based on stoichiometric relations between raw materials and CO_2 emissions. This information is supplemented with company reports to EU-ETS.

The production of lime and yellow bricks gives rise to CO_2 emissions. The emission factors are based on stoichiometric relations, assumption on $CaCO_3$ content in clay as well as a default emission factor for expanded clay products. This information is supplemented with company reports to EU-ETS.

There was one producer of nitric acid in Denmark. The data in the inventory relies on information from the producer. The producer reported emissions of NO_x and NH_3 as measured emissions and emissions of N_2O for 2003 as estimated emissions. The emission of N_2O in 2005 and forward is not occurring as the nitric acid production was closed down in the middle of 2004.

There is one producer of catalysts in Denmark. The data in the inventory relies on information published by the producer in environmental reports.

There is one steelwork in Denmark. The activity data as well as data on consumption of raw materials (coke) has been published by the producer in environmental reports. Emission factors are based on stoichiometric relations between raw materials and CO_2 emission. The electro steelwork was closed in 2005.

The inventory on the F-gases (HFCs, PFCs and SF_6) is based on work carried out by the Danish Consultant Company "Planmiljø". Their yearly report (DEPA, 2012) documents the inventory data up to the year 2010. The methodology is implemented for the whole time series 1990-2010, but full information on activities only exists since 1995.

Please refer to Chapter 4 for further information on industrial processes.

1.4.5 Solvents

The approach for calculating the emissions of Non-Methane Volatile Organic Carbon (NMVOC) from industrial and household use in Denmark focuses on single chemicals rather than activities. This leads to a clearer picture of the influence from each specific chemical, which enables a more detailed differentiation on products and the influence of product use on emissions. The procedure is to quantify the use of the chemicals and estimate the fraction of the chemicals that is emitted as a consequence of use.

The detailed approach in EMEP/EEA Guidebook (2009) is used. Here all relevant consumption data on all relevant solvents must be inventoried or at least those together representing more than 90 % of the total NMVOC emission. Simple mass balances for calculating the use and emissions of chemicals are set up 1) use = production + import – export, 2) emission = use x emission factor. Production, import and export figures are extracted from Statistics Denmark, from which a list of more than 400 single chemicals, a few groups and products is generated. For each of these, a "use" amount in tonnes per year (from 1990 to 2010) is calculated. For some chemicals and/or products, e.g. propellants used in aerosol cans and ethanol used in windscreen washing agents, use amounts are obtained from the industry as the information from Statistics Denmark does not comply with required specificity. It is found that approx. 40 different NMVOCs comprise over 95 % of the total use and it is these 40 chemicals that are investigated further. The "use" amounts are distributed across industrial activities according to the Nordic SPIN (Substances in Preparations in Nordic Countries) database, where information on industrial use categories is available in a NACE coding system. The chemicals are also related to specific products according to the Use Category (UCN) system. Emission factors are obtained from regulators, literature or the industry.

Outputs from the inventory are: a list where the approximately 40 most predominant NMVOCs are ranked according to emissions to air; specification of emissions from industrial sectors and from households - contribution from each chemical to emissions from industrial sectors and households; tidal (annual) trend in NMVOC emissions, expressed as total NMVOC and single chemical, and specified in industrial sectors and households.

This emission inventory includes N_2O emissions from the use of anaesthesia for 2005-2009. Five companies sell N_2O in Denmark and only one company produces N_2O. Due to confidentiality no data on produced amount are available and thus the emissions related to N_2O production are unknown. An emission factor of one is assumed for all use, which equals the sold amount to the emitted amount.

Emissions from other product use such as fireworks, tobacco and charcoal for grilling are included in the inventory. Activity data on consumption of fireworks, tobacco and charcoal are obtained from Statistics Denmark. The emission factors used refer to international literature.

Please refer to Chapter 5 and Annex 3D for further information on the emission inventory for solvent and other product use.

1.4.6 Agriculture

The emissions are provided in CRF: Table 4 Sectoral Report for Agriculture and Table 4.A, 4.B(a), 4.B(b), 4.D and 4.F Sectoral Background Data for Agriculture. The calculation of emissions from the agricultural sector is based on methods described in the IPCC Guidelines (IPCC, 1996) and the Good Practice Guidance (IPCC, 2000). Activity data for livestock is on a one-year average basis from the agricultural statistics published by Statistics Denmark (2011). Data concerning the land use and crop yield is also from the agricultural statistics. Data concerning the feed consumption and nitrogen excretion is based on information from the Danish Centre for Food and Agriculture (Aarhus University). The CH_4 Implied Emission Factors for Enteric Fermentation and Manure Management are based on a Tier 2/CS approach for all animal categories except for poultry which are based on a Tier 1 approach. All livestock categories in the Danish emission inventory are based on an average of certain subgroups separated by differences in animal breed, age and weight class. The emissions from enteric fermentation for fur farming are estimated to be not applicable.

Emission of N_2O is closely related to the nitrogen balance. Thus, quite a lot of the activity data is related to the Danish calculations for ammonia emission (Mikkelsen et al., 2011). National standards are used to estimate the amount of ammonia emission. When estimating the N_2O emission the IPCC standard value is used for all emission sources. The emission of CO_2 from Agricultural Soils is included in the LULUCF sector.

A model-based system is applied for the calculation of the emissions in Denmark. This model (IDA – Integrated Database model for Agricultural emissions) is used to estimate emission from both greenhouse gases and ammonia. A more detailed description is published in Mikkelsen et al. (2011). The emissions from the agricultural sector are mainly related to livestock production. IDA works on a detailed level and includes around 38 livestock categories, and each category is subdivided according to housing type and manure type. The emissions are calculated from each subcategory and the emissions are aggregated in accordance with the livestock category given in the CRF.

To ensure data quality, both data used as activity data and background data used to estimate the emission factor are collected, and discussed in cooperation with specialists and researchers in different institutions. Thus, the emission inventory will be evaluated continuously according to the latest knowledge. Furthermore, time series of both emission factors and emissions in relation to the CRF categories are prepared. Any considerable variations in the time series are explained.

The uncertainties for assessment of emissions from enteric fermentation, manure management, agricultural soils and field burning of agricultural residue have been estimated based on a Tier 1 and Tier 2 approach. The most significant uncertainties are related to the emissions of N_2O from agricultural soils.

A more detailed description of the methodology for the agricultural sector is given in Chapter 6 and Annex 3E.

1.4.7 Forestry, Land Use and Land Use Change

A complete Land Use Change matrix based on satellite imaging of the whole Danish land area has been prepared for the six major area classes. This has improved the coverage and the quality of the inventory substantially.

CO_2 emissions from Cropland and Grassland are based on census data from Statistics Denmark as regards size of area and crop yield combined with GIS-analysis on land use from the EU agricultural subsidiary system. This gives a very high accuracy for land use. All applicable pools are reported for Cropland and Grassland. The emission from mineral soils for cropland is estimated with a three-pooled dynamical soil carbon model (C-TOOL). C-TOOL was initialised in 1980. The model is run for each region corresponding to former counties in Denmark. Emissions from organic soils in Cropland are based on new nationally developed emission factors. For Grassland IPCC Tier 1b values are used. National models have been developed for wooden perennial crops in Cropland based on land use statistics from Statistic Denmark. These are of minor importance. Sinks in hedgerows are calculated based on a nationally developed model. The area with hedgerows is estimated from information on hedgerows established with financial support from the Danish Government and aerial photos. Emissions from liming are calculated from annual sales data collected by the Danish Agricultural Advisory Centre, combined with the acid neutralisation capacity for each lot produced.

For Wetlands emissions are reported from peat extraction areas. Natural wetlands are not reported. A comprehensive programme for restoration of wetlands is omplemented in Denmark. Other land uses converted to Wetlands is therefore reported.

For the purpose of having estimates for the KP accounting Other land uses converted to Settlements is reported but not Settlements remaining as Settlements.

No estimates are made for Other Land remaining as Other Land and no conversion of land to Other Land is occurring. For the purpose of having estimates for the KP accounting estimates for living biomass are provided for land converted from Other Land to other land use.

1.4.8 Waste

For 6.A Solid Waste Disposal on Land, only managed waste disposal sites are of importance and registered; i.e. unmanaged and illegal disposal of waste is considered to play a negligible role in the context of this category. The CH_4 emission at the Danish SWDSs is based on a First Order Decay (FOD) model according to an IPCC tier 2 approach (IPCC 1997, 2000 and 2006). Data on waste types and amounts deposited at solid waste disposal sites is according to the official registration collected by the Danish Environmental Protection Agency (DEPA, 2011). The model calculations are performed using landfill site characteristics and statistics on the amounts of waste fractions deposited each year. Improved documentation of the methodology, input parameter data including uncertainty analysis is described in Chapter 8.2.

For 6.B Waste Water Handling, country-specific methodologies are used for calculating the emissions of CH_4 and N_2O at wastewater treatment plants (WWTPs). Recent expert review teams (ERTs) in the UNFCCC review have requested better documentation of derived EF and national activity data, and improvements has been performed with respect to dividing the contributions to the net methane emission into specific treatment processes. Fugitive methane releases from the municipal and private WWTPs have been divided into contributions from 1) the sewer system, primary settling tank and biological N and P removal processes, 2) from anaerobic treatment processes in closed systems with biogas extraction and combustion for energy production and 3) septic tanks. N_2O formation and releases during the treatment processes at the WWTPs and from discharged effluent waste water are included. Documentation of the improved methodology, emission factors and activity data are described in Chapter 8.3.

Regarding 6.C Waste Incineration, all municipal, industrial, hazardous and medical waste incinerated is used for energy and heat production. This production is included in the energy statistics, hence emissions are included in the CRF under fuel combustion activities (CRF sector 1A), and more specifically waste incineration takes place in CRF sectors 1A1a, 1A2f and 1A4a. For the 2011 submission reporting in this category covers incineration of corpses and carcasses. The activity data are obtained from the National Association of Danish Crematoria and the three facilities incinerating carcasses.

In CRF category 6.D Other small emissions due to gasification of waste are included for the years 1994-2005. In 2006 onwards these emissions do not occur. In the 2011 submission emissions from accidental fires have been reallocated from category 6C to category 6D

Please refer to Chapter 8 and Annex 3F for further information on emission inventories for waste.

1.4.9 KP-LULUCF

Regarding the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, Denmark decided to include emissions and removals from Forest Management (FM), Cropland Management (CM) and Grazing land Management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of the EU Land Parcel Information System (LPIS), detailed crop information data on field level, soil mapping and sample plots from the National Forest Inventory (NFI). All land converted from other activities into Cropland and Grassland is accounted for. No land can leave selected areas under art. 3.4.

The forest definition adopted in the NFI is identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10 %". The minimum width is 20 m. For afforestation the carbon stock change in the period 1990 - 2010 is calculated based on the area of afforestation, the information on species composition from the Forest Census 2000 and from the NFI. In the afforestation a steady increase in carbon stock is found. The estimates for the carbon pools in the afforestation are similar to previous estimates, with a slight increase due to the new knowledge on species composition, average carbon stock in those areas based on the NFI data and new data on the carbon stock in soils. Carbon stock change caused by deforestation is estimated based on the deforested area and the mean values of carbon stock in the total forest area. This is due to the fact that no specific knowledge is available on the carbon pools of the deforested areas. For Forest Management census and NFI data are used.

For Cropland and Grassland the same methodology is used in the Convention reporting as used in the KP reporting.

Please see Chapter 11 for further details.

1.4.10 Use of EU Emission Trading Scheme data

In 2004 the first guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to the EU Emission Trading Scheme (ETS) Directive (2003/87/EC) were implemented (EU Commission, 2004). These were updated in 2007 and are available from the EU Commission website (EU Commission, 2007).

The Danish emission inventory only includes data from plants using higher tier methods as defined in the EU decision establishing guidelines for monitoring and reporting (EU Commission, 2007). In the Guidelines the specific methods for determining carbon contents, oxidation factor and calorific value are specified.

In the Danish inventory plant or activity based CO_2 emission factors have been derived for power plants combusting coal and oil, refinery gas and flare gas in refineries, fuel gas and flare gas at off-shore installations, cement production, production of brick and tiles and lime production. For all these sources the EU ETS reports are only used in the Danish inventory for plants using high tier methods. The EU ETS data have been applied for the years 2006 - 2010.

The EU ETS reporting guidelines emphasizes the need for a high quality reporting through ensuring completeness, consistency, accuracy, transparency and faithfulness. The quality criteria as defined under the EU ETS reporting guidelines are in complete agreement with the principles in the IPCC good practice guidance. For all activities covered by the EU ETS installations are divided into three categories (A, B and C) depending on the annual CO_2 emission. A category A installation has an annual emission of less than 50 Gg CO_2, a category B installation has an annual emission of between 50 and 500 Gg CO_2 and a category C installation has an annual emission of more than 500 Gg CO_2. For each activity table 1 of the EU ETS guidelines (EU Commission, 2007) specifies the minimum tier level for the different calculation parameters. An example for combustion installations is shown in Table 1.2, the full list for all activities is available in the EU ETS guidelines (EU Commission, 2007).

Table 1.2 Example of minimum requirements in EU ETS guidelines (EU Commission, 2007).

	Activity data						Emission factor			Oxidation factor		
	Fuel flow			Net calorific value								
Activity	A	B	C	A	B	C	A	B	C	A	B	C
Commercial standard fuels	2	3	4	2a/2b	2a/2b	2a/2b	2a/2b	2a/2b	2a/2b	1	1	1
Other gaseous and liquid fuels	2	3	4	2a/2b	2a/2b	3	2a/2b	2a/2b	3	1	1	1
Solid fuels	1	2	3	2a/2b	3	3	2a/2b	3	3	1	1	1

The determination of the variables needed for the emission calculation has to be done in accordance with international standards. It is not possible to list all the relevant standards here, but an overview is available in annex 1, chapter 13 of the EU ETS guidelines. There are also demands concerning sampling methods and frequency of analysis.

As an example the tier 3 regarding fuel flow for fuel combustion, corresponds to a determination of the fuel consumption with an maximum uncertainty of 2.5 % taking into account possible effects of stock change. Tier 4 has a maximum uncertainty of 1.5 %. These uncertainties are very low and are in line with what could be expected from a well-functioning energy statistics system. More information regarding the use of EU ETS data in the specific subsectors of the inventory is included in Chapter 3.2.5 (Power plants), Chapter 3.5.2 (Refineries and off-shore installations) and Chapter 4.2.2 (Cement production and other mineral products).

The operators shall establish, document, implement and maintain effective data acquisition and handling activities. This means assigning responsibilities for the quality process, as well as quality assurance, reviews and validation of data. Furthermore an independent verification ensuring that emissions have been monitored in accordance with the EU ETS guidelines and that reliable and correct emission data are reported. There are also demands that records and documentation of the control activities must be stored for at least 10 years. The demands for the QA/QC system in the EU ETS guidelines are fully comparable to the requirements in the IPCC good practice guidance. Even so DCE also performs QC checks of the data received as part of company reporting under EU ETS. This includes comparing the reported parameters with previous years, identifying outliers etc. In case DCE detects what is considered to be abnormal values DCE contacts the Danish Energy Agency, which is the regulating authority for the EU ETS system in Denmark.

1.5 Brief description of key categories

The key category analysis described in this section covers only Denmark. The aggregation used for the analysis is not directly suited for emissions from Greenland. If Greenlandic emissions were included in the analysis, they would not affect the overall results of the key category analysis. For a key category analysis covering Greenland refer to Chapter 16 and for Denmark and Greenland refer to Chapter 17.

All KCA have been carried out in accordance with Good Practice Guidance (GPG) and IPCC Guidelines.

The KCA for Denmark includes a total of 12 different analyses:

- Base year, reporting year and trend
- Including and excluding LULUCF
- Tier 1 and tier 2 approach

The KCA is based on 149 emission source categories including 22 LULUCF source categories.

The 12 different KCA for Denmark point out 24-32 key source categories each and a total of 54 different key source categories. The number of key categories in each of the main sectors is: energy 28, industrial processes 3, solvents and other product use 0, agriculture 11, LULUCF 10 and waste 2.

The tier 1 approach point out mainly the large emission sources as key categories and thus CO_2 emission from stationary and mobile combustion are important key categories. The tier 2 approach point out some of the sources with larger uncertainty rates.

The categorisation and results of all KCA are included in Annex 1.

1.5.1 Tier 1 key category analysis

The KCA for **1990** including LULUCF points out 32 key categories (26 key categories for the KCA not including LULUCF). CO_2 from stationary combustion of coal is the main source category accounting for 32 % of the emission[1]. CO_2 from road transport, CO_2 from stationary combustion of gas oil and CO_2 from stationary combustion of natural gas account for 13 %, 6 % and 6 % respectively.

The KCA for **2010** including LULUCF points out 30 key categories (25 key categories for the KCA not including LULUCF). CO_2 from stationary combustion of coal is the main source category accounting for 22 % of the emis-

[1] Data for the KCA including LULUCF.

sion[1]. CO_2 from road transport, CO_2 from stationary combustion of natural gas and CO_2 from broadleaves account for 17 %, 15 % and 5 % respectively.

The KCA for **trend (1990-2010)** including LULUCF points out 31 key categories (24 key categories for the KCA not including LULUCF). CO_2 from stationary combustion of natural gas is the main source category accounting for 21 % of the emission trend[1]. CO_2 from road transport, CO_2 from stationary combustion of coal, CO_2 from broadleaves, CO_2 from stationary combustion of gas oil and CO_2 from conifers account for 13 %, 12 %, 9 %, 6 % and 6 % respectively.

1.5.2 Tier 2 key category analysis

The KCA for **1990** including LULUCF points out 29 key categories (24 key categories for the KCA not including LULUCF). N_2O from leaching is the main source category accounting for 12 % of the aggregation value[2]. N_2O from synthetic fertilizer, CO_2 from cropland organic soils, CH_4 from solid waste disposal on land, N_2O from animal waste applied to soils and CO_2 from cropland, mineral soils account for 12 %, 11 %, 9 %, 6 % and 5 % respectively.

The KCA for **2010** including LULUCF points out 32 key categories (28 key categories for the KCA not including LULUCF). CO_2 from broadleaves is the main source category accounting for 11 % of the aggregation value[2]. CO_2 from cropland organic soils, N_2O from leaching, N_2O from animal waste applied to soils, N_2O from synthetic fertilizer, CO_2 from conifers and N_2O from combustion of biomass in stationary plants account for 9 %, 8 %, 6 %, 6 %, 5 % and 5 % respectively.

The KCA for **trend (1990-2010)** including LULUCF points out 31 key categories (24 key categories for the KCA not including LULUCF). CO_2 from broadleaves is the main source category accounting for 17 % of the aggregation value[2]. CO_2 from conifers, N_2O from synthetic fertilizer, N_2O from biomass combustion in stationary plants, CH_4 from solid waste disposal on land and N_2O from leaching account for 10 %, 9 %, 7 %, 7 % and 6 % respectively.

1.5.3 KP-LULUCF

See Chapter 11.9.1 for discussion on the key category analysis of KP-LULUCF.

1.6 Information on QA/QC plan including verification and treatment of confidential issues where relevant

1.6.1 Introduction

This section outlines the Quality Control (QC) and Quality Assurance (QA) plan for greenhouse gas emission inventories performed by DCE (Sørensen et al., 2005). The plan is in accordance with the guidelines provided by the IPCC (IPCC, 1997), and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The ISO 9000 standards are also used as important input for the plan.

[2] According to IPCC Guidelines (2006).

An updated version of the quality manual is currently being elaborated and will be published by the end of 2012.

The QA/QC plan also covers Greenland. DCE receives the data corresponding to data processing level 3 and data storage level 4 and the data undergoes the same QA/QC procedure as the Danish data, some further QC checks are described in Chapter 17. The QA/QC specific to the Greenlandic emission inventory is described in Chapter 16.

1.6.2 Concepts of quality work

The quality planning is based on the following definitions as outlined by the ISO 9000 standards as well as the Good Practice Guidance (IPCC, 2000):

- Quality management (*QM*) Coordinates activity to direct and control with regard to quality.
- Quality Planning (*QP*) Defines quality objectives including specification of necessary operational processes and resources to fulfil the quality objectives.
- Quality Control (*QC*) Fulfils quality requirements.
- Quality Assurance (*QA*) Provides confidence that quality requirements will be fulfilled.
- Quality Improvement (*QI*) Increases the ability to fulfil quality requirements.

The activities are considered inter-related in this report as shown in Figure 1.2.

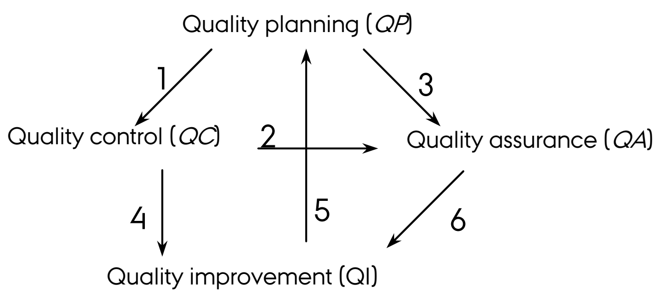


Figure 1.2 Interrelation between the activities with regard to quality. The arrows are explained in the text below this figure.

1: The *QP* sets up the objectives and, from these, measurable properties valid for the *QC*.

2: The *QC* investigates the measurable properties that are communicated to *QA* for assessment in order to ensure sufficient quality.

3. The *QP* identifies and defines measurable indicators for the fulfilment of the quality objectives. This yields the basis for the *QA* and has to be supported by the input coming from the *QC*.

4: The result from *QC* highlights the degree of fulfilment for every quality objective. It is thus a good basis for suggestions for improvements to the inventory to meet the quality objectives.

5: Suggested improvements in the quality may induce changes in the quality objectives and their measurability.

6: The evaluation carried out by external authorities is important input when improvements in quality are being considered.

1.6.3 Definition of quality

A solid definition of quality is essential. Without such a solid definition, the fulfilment of the objectives will never be clear and the process of quality control and assurance can easily turn out to be a fuzzy and unpleasant experience for the people involved. On the contrary, in case of a solid definition and thus a clear goal, it will be possible the make a valid statement of "good quality" and thus form constructive conditions and motivate the inventory work positively. A clear definition of quality has not been given in the UNFCCCC guidelines. In the Good Practice Guidance, Chapter 8.2, however, it is mentioned that:

"Quality control requirements, improved accuracy and reduced uncertainty need to be balanced against requirements for timeliness and cost effectiveness." The statement of balancing requirements and costs is not a solid basis for QC as long as this balancing is not well defined.

The resulting standard of the inventory is defined as being composed of accuracy and regulatory usefulness. The goal is to maximise the standard of the inventory and the following statement defines the quality objective:

The quality objective is only inadequately fulfilled if it is possible to make an inventory of a higher standard without exceeding the frame of resources.

1.6.4 Definition of Critical Control Points (*CCP*)

A Critical Control Point (*CCP*) is defined in this submission as an element or an action which needs to be taken into account in order to fulfil the quality objectives. Every *CCP* has to be necessary for the objectives and the *CCP* list needs to be extended if other factors, not defined by the *CCP* list, are needed in order to reach at least one of the quality objectives.

The objectives for the *QM*, as formulated by IPCC (2000), are to improve elements of transparency, consistency, comparability, completeness and confidence. In the IPCC guidelines (IPCC, 1997), the element "confidence" is replaced by "accuracy" and in this plan "accuracy" is used.

The objectives for the *QM* are used as *CCP*s, including the elements mentioned above. The following explanation is given by IPCC guidelines (IPCC, 1997) for each *CCP*:

Transparency means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of the inventories is fundamental to the success of the process for communication and consideration.

Consistency means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and for all subsequent years and if consistent datasets are used to estimate emissions or removals from source or sinks. Under certain circumstances, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner in accordance with the Intergovernmental Panel on Climate Change (IPCC) guidelines and good practice guidance.

Comparability means that estimates of emission and removals reported by Annex I Parties in inventories should be comparable among Annex I parties. For this purpose, Annex I Parties should use the methodologies and formats agreed upon by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of *Revised 1996 IPCC Guidelines for national Greenhouse Gas Inventories* (IPCC, 1997) at the level of its summary and sectoral tables.

Completeness means that an inventory covers all sources and sinks, as well as all gases, included in the IPCC guidelines as well as other existing relevant source/sink categories, which are specific to individual Annex I Parties and, therefore, may not be included in the IPCC guidelines. Completeness also means full geographic coverage of sources and sinks of an Annex I Party.

Accuracy is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate and should systematically neither over- nor underestimate emissions or removals. Uncertainties on estimates should be reduced if possible. Appropriate methodologies should be used in accordance with the *IPCC good practice guidance*, to promote data accuracy in inventories.

The robustness against unexpected disturbance of the inventory work has to be high in order to secure high quality, which is not covered by the *CCP*s above. The correctness of the inventory is formulated as an independent objective. This is so because the correctness of the inventory is a condition for all other objectives to be effective. A large part of the Tier 1 procedure given by the Good Practice Guidance (IPCC, 2000) is actually checks for miscalculations and, thus, supports the objective of correctness. Correctness, as defined here, is not similar to accuracy, because the correctness takes into account miscalculations, while accuracy relates to minimizing the always present data-value uncertainty.

Robustness implies arrangement of inventory work as regards e.g. inventory experts and data sources in order to minimize the consequences of any unexpected disturbance due to external and internal conditions. A change in an external condition could be interruption of access to an external data source and an internal change could be a sudden reduction in qualified staff, where a skilled person suddenly leaves the inventory work.

Correctness has to be secured in order to avoid uncontrollable occurrence of uncertainty directly due to errors in the calculations.

The different *CCP*s are not independent and represent different degrees of generality. E.g. deviation from *comparability* may be accepted if a high degree of *transparency* is applied. Furthermore, there may even be a conflict between the different *CCP*s. E.g. new knowledge may suggest improvements in calculation methods for better *completeness*, but the same improvements may to some degree violate the *consistency* and *comparability* criteria with regard to earlier years' inventories and the reporting from other nations. It is, therefore, a multi-criteria problem of optimisation to apply the set of *CCP*s in the aim for good quality.

1.6.5 Process-oriented QC

The strategy is based on a process-oriented principle (ISO 9000 series) and the first step is, thus, to set up a system for the process of the inventory work. The product specification for the inventory is a dataset of emission figures and the process, thereby, equates with the data flow in the preparation of the inventory.

The data flow needs to support the QC/QA in order to facilitate a cost-effective procedure. The flow of data has to take place in a transparent way by making the transformation of data detectable. It should be easy to find the original background data for any calculation and to trace the sequence of calculations from the raw data to the final emission result. Computer programming for automated calculations and checking will enhance the accuracy and minimize the number of miscalculations and flaws in input value settings. Especially manual typing of numbers needs to be minimized. This assumes, however, that the quality of the programming has been verified to ensure the correctness of the automated calculations. Automated value control is also one of the important means to secure accuracy. Realistic uncertainty estimates are necessary for securing accuracy, but they can be difficult to produce due to the uncertainty related to the uncertainty estimates themselves. It is, therefore, important to include the uncertainty calculation procedures into the data structure as far as possible. The QC/QA needs to be supported as far as possible by the data structure; otherwise the procedures can easily become troublesome and subject to frustration.

Both data processing and data storage form the data structure. The data processing is carried out using mathematical operations or models. The models may be complicated where they concern human activity or be simple summations of lower aggregated data. The data storage includes databases and file systems of data that are either calculated using the data processing at the lower level, using input to new processing steps or even using both output and input in the data structure. The measure for quality is basically different for processing and storage, so these need to be kept separate in a well-designed quality manual. A graphical display of the data flow is seen in Figure 1.3 and explained in the following.

The data storage takes place for the following types of data:

***External Data*:** a single numerical value of a parameter coming from an external source. These data govern the calculation of *Emission calculation input.*

***Emission calculation input*:** Data for input to the final emission calculation in terms of data for release source strength and activity. The data is directly applicable for use in the standardized forms for calculation. These data are calculated using external data or represent a direct use of *External Data* when they are directly applicable for *Emission Calculations*.

***Emission Data*:** Estimated emissions based on the *emission calculation input.*

***Emission Reporting*:** Reporting of emission data in requested formats and aggregation level.

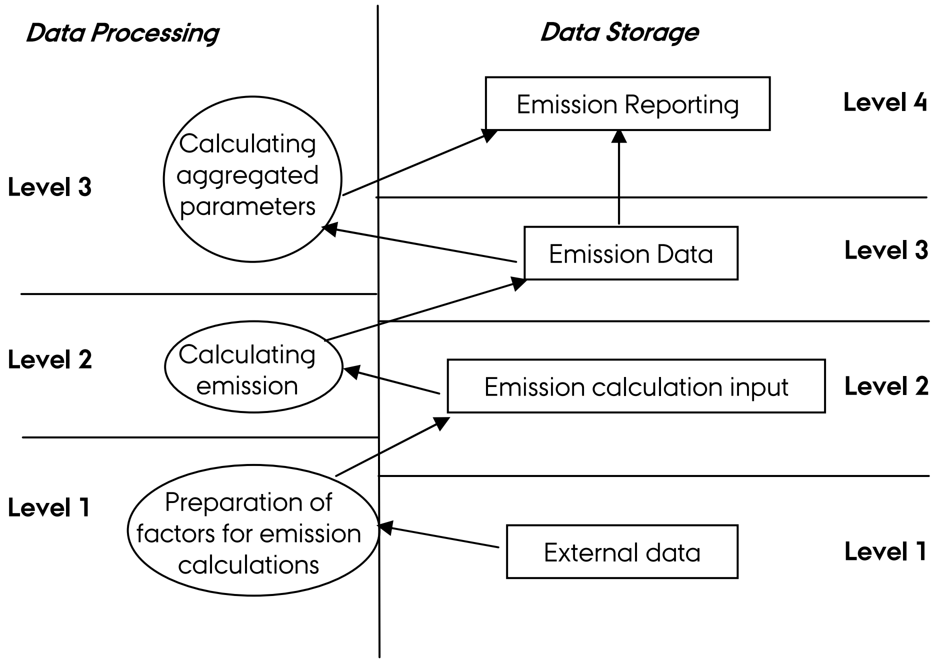


Figure 1.3 The general data structure for the emission inventory.

Key levels are defined in the data structure as:

Data storage Level 1**, **External data

Collection of external data for calculation of emission factors and activity data. The activity data are collected from different sectors and statistical surveys, typically reported on a yearly basis. The data consist of raw data, having an identical format to the data received and gathered from external sources. Level 1 data acts as a base-set, on which all subsequent calculations are based. If alterations in calculation procedures are made, they are based on the same dataset. When new data are introduced they can be implemented in accordance with the QA/QC structure of the inventory.

Data storage Level 2, Data directly usable for the inventory

This level represents data that have been prepared and compiled in a form that is directly applicable for calculation of emissions. The compiled data are structured in a database for internal use as a link between more or less raw data and data that are ready for reporting. The data are compiled in a way that elucidates the different approaches in emission assessment: (1) directly on measured emission rates, especially for larger point sources, (2) based on activities and emission factors, where the value setting of these factors are stored at this level.

Data storage Level 3, Emission data

The emission calculations are reported by the most detailed figures and divided in sectors. The unit at this level is typically mass pr yr for the country. For sources included in the SNAP system, the SNAP level 3 is relevant. Internal reporting is performed at this level to feed the external communication of results.

Data storage Level 4, Final reports for all subcategories

The complete emission inventory is reported to UNFCCC at this level by summing up the results from every subcategory.

Data processing Level 1 Compilation of external data

Preparation of input data for the emission inventory based on the external data sources. Some external data may be used directly as input to the data processing at level 2, while other data needs to be interpreted using more or less complicated models, which takes place at this level. The interpretation of activity data is to be seen in connection with availability of emission factors and vice versa. These models are compiled and processed as an integrated part of the inventory preparation.

Data processing Level 2 Calculation of inventory figures

The emission for every subcategory is calculated, including the uncertainty for all sectors and activities. The summation of all contributions from subsources makes up the inventory.

Data processing Level 3 Calculation aggregated parameters

Some aggregated parameters need to be reported as part of the final reporting. This does not involve complicated calculations but important figures, e.g. implied emission factors at a higher aggregated level to be compared in time series and with other countries.

1.6.6 Definition of Point of Measurements (*PM*)

The *CCP*s have to be based on clear measurable factors - otherwise the *QP* will end up being just a loose declaration of intent. Thus, in the following, a series of *Points for Measuring* (*PM*) is identified as building blocks for a solid *QC*. Table 8.1 in Good Practice Guidance is a listing of such *PM*s. However, the listing in Table 1.2 below is an extended and modified listing, in comparison to Table 8.1 in the Good Practice Guidance supporting all the *CCP*s. The *PM*s will be routinely checked in the QC reporting and, when external reviews take place, the reviewers will be asked to assess the fulfilment of the *PM*s using a checklist system. The list of *PM*s is continually evaluated and modified to offer the best possible support for the *CCP*s. The actual list used is seen in Table 1.2.

Table 1.2 The list of *PMs* as used.

Level	CCP	Id	Description	
Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values	Sectoral
		DS.1.1.2	Quantification of the uncertainty level of every single data value, including the reasoning for the specific values.	Sectoral
	2. Comparability	DS1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of the discrepancy.	Sectoral
	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included, by setting down the reasoning behind the selection of datasets.	Sectoral
	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs)	Sectoral
	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and DCE about the conditions of delivery	Sectoral
		DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external dataset.	General
	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning behind the selection of the specific dataset	Sectoral
		DS.1.7.2	The archiving of datasets needs to be easily accessible for any person in the emission inventory	General
		DS.1.7.3	References for citation for any external dataset have to be available for any single number in any dataset.	Sectoral
		DS.1.7.4	Listing of external contacts for every dataset	Sectoral
Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)	Sectoral
		DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)	Sectoral
		DP.1.1.3	Evaluation of the methodological approach using international guidelines	Sectoral
		DP.1.1.4	Verification of calculation results using guideline values	Sectoral
	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.	Sectoral
	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.	Sectoral
		DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.	Sectoral
	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure	Sectoral
		DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations	General
	5.Correctness	DP.1.5.1	Shows at least once, by independent calculation, the correctness of every data manipulation	Sectoral
		DP.1.5.2	Verification of calculation results using time series	Sectoral
		DP.1.5.3	Verification of calculation results using other measures	Sectoral

Level	CCP	Id	Description	
		DP.1.5.4	Show one-to-one correctness between external data sources and the databases at Data Storage level 2	Sectoral
	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.	General
	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described	Sectoral
		DP.1.7.2	The theoretical reasoning for all methods must be described	Sectoral
		DP.1.7.3	Explicit listing of assumptions behind all methods	Sectoral
		DP.1.7.4	Clear reference to dataset at Data Storage level 1	Sectoral
		DP.1.7.5	A manual log to collect information about recalculations	Sectoral
Data Storage level 2	2.Comparability	DS.2.2.1	Comparison with other countries that are closely related to Denmark and explanation of the largest discrepancies	General
	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1	Sectoral
		DS.2.5.2	Check if a correct data import to level 2 has been made	Sectoral
	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.	General
	7.Transparency	DS.2.7.1	The time trend for every single parameter must be graphically available and easy to map	General
Data Processing level 2	1. Accuracy	DP.2.1.1	Documentation of the methodological approach for the uncertainty analysis	General
		DP.2.1.2	Quantification of uncertainty	General
	2.Comparability	DP.2.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC	General
	6.Robustness	DP.2.6.1	Any calculation at level 4 must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.	General
	7.Transparency	DP.2.7.1	Reporting of the calculation principle and equations used	General
		DP.2.7.2	The reasoning for the choice of methodology for uncertainty analysis needs to be written explicitly.	General
Data Storage level 3	1. Accuracy	DS.3.1.1	Quantification of uncertainty	General
	5.Correctness	DS.3.5.1	Comparison with inventories of the previous years on the level of the categories of the CRF as well as on SNAP source categories. Any major changes are checked, verified, etc.	General
		DS.3.5.2	Total emissions, when aggregated to CRF source categories, are compared with totals based on SNAP source categories (control of data transfer).	General
		DS.3.5.3	Checking of time series of the CRF and SNAP source categories as they are found in the Corinair databases. Considerable trends and changes are checked and explained.	General

Level	CCP	Id	Description	
Data Processing level 3	6. Robustness	DP.3.6.1	The process of generating the official submissions must be anchored by at least two responsible persons who can replace each other in the technical issue of generating CRF tables including of the aggregation of submissions for Denmark and Greenland.	General
Data Storage level 4	2.Comparability	DS.4.2.1	Description of similarities and differences in relation to other countries' inventories for the methodological approach.	General
	3.Completeness	DS.4.3.1	National and international verification including explanation of the discrepancies.	General
		DS.4.3.2	Check that the no sources where a methodology exists in the IPCC guidelines are reported as NE.	General
	4.Consistency	DS.4.4.1	The inventory reporting must follow the international guidelines suggested by UNFCCC and IPCC.	General
		DS.4.4.2	Check time series consistency of the reporting by Greenland and the Faroe Islands prior to aggregating the final submissions.	General
		DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.	Sectoral
	5.Correctness	DS.4.5.1	Check that the aggregated submissions for Denmark under the Kyoto Protocol and the UNFCCC match the sum of the individual submissions.	General
		DS.4.5.2	Check that additional information and information related to land-use changes has been correctly aggregated compared to the individual submissions of Denmark and Greenland.	Sectoral
	6. Robustness	DS.4.6.1	The reporting to the UNFCCC must be anchored to two responsible persons who can replace each other in the technical issue of reporting to and communicating with the UNFCCC secretariat.	General
	7.Transparency	DS.4.7.1	Perform QA on the documentation report provided by the Government of Greenland.	General

1.6.7 Plan for the quality work

The IPCC uses the concept of a tiered approach, i.e. a stepwise approach, where complexity, advancement and comprehensiveness increase. Generally, more detailed and advanced methods are recommended in order to give guidance to countries which have more detailed datasets and more capacity, as well as to countries with less available data and manpower. The tiered approach helps to focus attention on the areas of the inventories that are relatively weak, rather than investing effort in irrelevant areas. Furthermore, the IPCC guidelines recommend using higher tier methods for key categories in particular. Therefore, the identification of key categories is crucial for planning quality work. However, there exist several issues regarding the listing of priority categories: (1) The contribution to the total emission figure (key source listing); (2) The contribution to the total uncertainty; (3) Most critical categories in relation to implementation of new methodologies and thus highest risk for miscalculations. All the points listed are necessary for different aspects of producing high quality work. These listings will be used to secure implementation of the full quality scheme for the most relevant categories. Verification in relation to other countries has been undertaken for priority categories.

1.6.8 Implementation of the QA/QC plan

The PMs listed in Table 1.2 are described for each sector in the QA/QC sections of Chapters 3-8, where a status with regard to implementation is also given. Some of the PMs are the same for all sectors and a common description for these PMs is given in Section 1.6.10, below. The focus has been on level 1 for both data storage and data processing as this is the most labour-intensive part. The quality system will be evaluated and adjusted continuously.

1.6.9 Archiving of data and documentations

The QA/QC work is supported by an inventory file system, where all data, models and QA/QC procedures and checks are stored as files in folders (Figure 1.4).

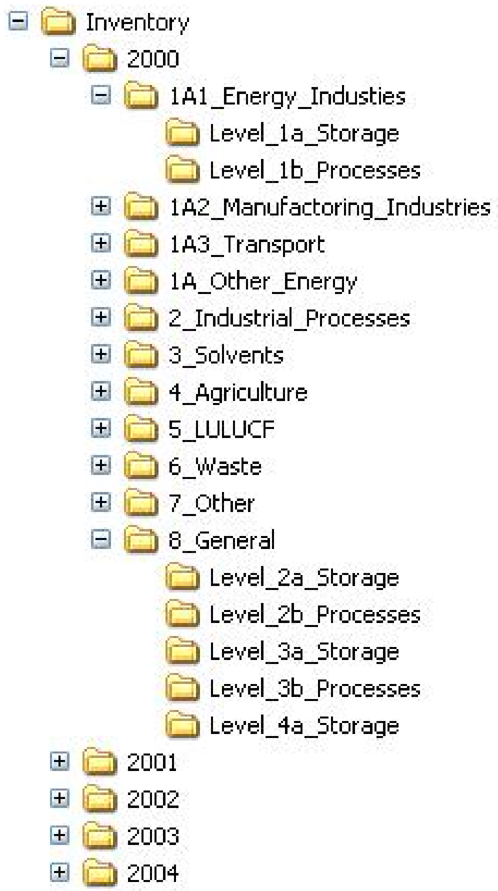


Figure 1.4 Schematic diagram of the folder structure in the inventory file system.

The inventory file system consists of the following levels: year, sector and the level for the process of the inventory work, as illustrated in Figure 1.4. The first level in the file system is year, which here means the inventory year and not the calendar year. The sector level contains the PMs relevant for the individual sectors i.e. the first levels (DS1 and DP1) (except the PMs described in Section 1.6.10), while the rest of the PMs (DS2-4 and DP2-3), are common for all sectors.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all staff involved in the inventory work.

1.6.10 Common QA/QC PMs

The following PMs are common for all the sectors:

Data storage Level 1

Data Storage level 1	6. Robustness	DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external dataset.

For all sectors: energy, industrial processes, solvent and other product use, agriculture, LULUCF and waste, two persons have detailed insight in data gathering and processing. A strong effort is continuously made to ensure the robustness of the inventory process.

Data Storage level 1	7. Transparency	DS.1.7.2	The archiving of datasets needs to be easily accessible for any person involved in the emission inventory.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all inventory staff members. Refer to Section 1.6.9.

Data processing Level 1

Data Processing level 1	4. Consistency	DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations.

This PM is supported by the inventory file system where it is possible to compare and harmonise parameters that are common to multiple source categories.

Data Processing level 1	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all inventory staff members. Refer to Section 1.6.9.

Data storage Level 2

Data Storage level 2	2.Comparability	DS.2.2.1	Comparison with other countries that are closely related to Denmark and explanation of the largest discrepancies.

Systematic inter-country comparison has only been made on data storage level 4. Refer to DS 4.3.2.

Data Storage level 2	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.

This PM is fulfilled for all sectors. The PM is supported by the inventory file system. Refer to Section 1.6.9.

Data Storage level 2	7.Transparency	DS.2.7.1	The time trend for every single parameter must be graphically available and easy to map.

Programs exist to make time series for all parameters. A tool for graphically showing time series has not yet been developed.

Data Processing Level 2

Data Processing level 2	1. Accuracy	DP.2.1.1	Documentation of the methodological approach for the uncertainty analysis

Refer to Chapter 1.7.

Data Processing level 2	1. Accuracy	DP.2.1.2	Quantification of uncertainty

Refer to Chapter 1.7 and the uncertainty sections in the sectoral chapters (Chapter 3-8).

Data Processing level 2	2.Comparability	DP.2.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The emission calculations follow the international guidelines.

Data Processing level 2	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.

At present the emission calculations are carried out using applications developed at DCE. The software development and programme runs are anchored to two inventory staff members.

Data Processing level 2	7.Transparency	DP.2.7.1	Reporting of the calculation principle and equations used.

Due to the uniform treatment of input data in the calculation routines used by the DCE software programmes, a central documentation of calculation principles, equations, theoretical reasoning and assumptions must be given, treating all national emission sources. This documentation still remains to be made, but is planned to be carried out in the future.

Data Processing level 2	7.Transparency	DP.2.7.2	The reasoning for the choice of methodology for uncertainty analysis needs to written explicitly.

Refer to Chapter 1.7 and the QA/QC sections in the sectoral chapters.

Data storage Level 3

Data Storage level 3	1. Accuracy	DS.3.1.1	Quantification of uncertainty

Refer to Chapter 1.7 and the QA/QC sections in the sector chapters.

Data Storage level 3	5.Correctness	DS.3.5.1	Comparison with inventories of the previous years on the level of the categories of the CRF as well as on SNAP source categories. Any major changes are checked, verified, etc.

Time series is prepared and checked, any major change is closely examined with the purpose of verifying and explaining changes from earlier inventories.

Data Storage level 3	5.Correctness	DS.3.5.2	Total emissions when aggregated to CRF source categories are compared with totals based on SNAP source categories (control of data transfer).

Total emission, when aggregated to IPCC and LRTAP reporting tables, is compared with totals based on SNAP source categories (control of data transfer).

Data Storage level 3	5.Correctness	DS.3.5.3	Checking of time series of the CRF and SNAP source categories as they are found in the Corinair databases. Considerable trends and changes are checked and explained.

Time series are prepared and checked, any major change is closely examined with the purpose of verifying and explaining fluctuations.

Data Processing Level 3

Data Processing level 3	6. Robustness	DP.3.6.1	The process of generating the official submissions must be anchored by at least two responsible persons who can replace each other in the technical issue of generating CRF tables including of the aggregation of submissions for Denmark and Greenland.

The process of generating the official submissions including the aggregation of submissions to the UNFCCC and the Kyoto Protocol is currently anchored by two people within the team. In the future the goal is to have three team members capable of completing this task.

Data Storage Level 4

Data Storage level 4	2.Comparability	DS.4.2.1	Description of similarities and differences in relation to other countries' inventories for the methodological approach

For each key source category, a comparison has been made between Denmark and the EU-15 countries. This is performed by comparing emission density indicators, defined as emission intensity value divided by a chosen indicator. The indicators are identical to the ones identified in the Norwegian verification inventory (Holtskog et al., 2000). The correlation between emissions and an independent indicator does not necessarily imply cause and effect, but in cases where the indicator is directly associated with the emission intensity value, such as for the energy sector, the emission density indicator is a measure of the implied emission factor and a direct comparison can be made. A qualitative verification of implied emission factors can, furthermore, be made when a measured or theoretical value of the CO_2 content in the respective fuel type (or other relevant parameter) is available. For the energy sector, all countries are, in principle, comparable and inter-country deviations arise from variations in fuel purities and fuel combustion efficiencies. A comparison of national emission density indicators, analogous to the implied emission factors, will give valuable information on the quality and efficiency of the national energy sectors.

Furthermore, the inter-country comparison of emission density indicators and comparison of theoretical values gives a methodological verification of the derivation of emission intensity values, and of the correlation between emission intensity values and activity values.

When emissions are compared with non-dependent parameters, similarities with regard to geography, climate, industry structure and level of economic development may be necessary for obtaining comparable emission density indicators (Fauser et al., 2007).

Data Storage level 4	3.Completeness	DS.4.3.1	National and international validation including explanation of the discrepancies.

Refer to DS 4.2.1

Data Storage level 4	3.Completeness	DS.4.3.2	Check that the no sources where a methodology exists in the IPCC guidelines are reported as NE.

It is verified both by DCE experts and by EU consistency checks that no sources where methodologies and default parameters exist have been reported as NE. If methodologies do exist efforts are made to estimate and report emissions.

Data Storage level 4	4.Consistency	DS.4.4.1	The inventory reporting must follow the international guidelines suggested by UNFCCC and IPCC.

The inventory reporting is in accordance with the UNFCCC guidelines on reporting and review (UNFCCC, 2007). The present report includes detailed and complete information on the inventories for all years from the base year to the year of the current annual inventory submission, in order to ensure the transparency of the inventory. The annual emission inventory for Denmark is reported in the Common Reporting Format (CRF) as requested in the reporting guidelines. The CRF-spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for total greenhouse gas emissions in CO_2 equivalents. The complete sets of CRF-files are available on the NERI homepage (www.dmu.dk).

Data Storage level 4	4.Consistency	DS.4.4.2	Check time series consistency of the reporting of Greenland and the Faroe Islands prior to aggregating the final submissions

The time series for all pollutants in the submissions from Greenland and the Faroe Islands are checked at the CRF 3 level for large variations in the time series. Any large variations are explained or corrected in cooperation with the authorities in Greenland and the Faroe Islands.

Data Storage level 4	5.Correctness	DS.4.5.1	Check that the aggregated submissions for Denmark under the Kyoto Protocol and the UNFCCC matches the sum of the individual submissions

To ensure that the submission for Denmark under the Kyoto Protocol matches the sum of the submissions of Denmark and Greenland a spreadsheet check has been implemented to ensure complete correctness of the submitted inventory. The same procedure is followed for the submission under the UNFCCC, where it is ensured that the submitted emissions equate to the sum of Denmark, Greenland and the Faroe Islands. Special attention is paid to the additional information provided in the CRF, e.g. for the agricultural sector. Certain parameters cannot simply be added, e.g. animal weights. In these cases a weighted average is reported in the CRF tables.

Data Storage level 4	6. Robustness	DS.4.6.1	The reporting to the UNFCCC must be anchored to two responsible persons who can replace each other in the technical issue of reporting to and communicating with the UNFCCC secretariat.

The reporting to the UNFCCC secretariat is currently anchored by two team members. All official correspondence between the secretariat and DCE involves both the responsible team members.

Data Storage level 4	7.Transparency	DS.4.7.1	Perform QA on the documentation report provided by the Government of Greenland

The documentation report is received by DCE from the Government of Greenland in the early spring every year. The documentation report is included in the NIR as Chapter 16. DCE experts read and provide comments on the report to the Government of Greenland, so that any questions are resolved prior to the UNFCCC reporting deadline of April 15.

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

1.7.1 Tier 1 uncertainties

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the following sectors are included in the current year: stationary combustion plants, mobile combustion, fugitive emissions from fuels, industry, solid waste and wastewater treatment, CO_2 from solvents, agriculture and LULUCF. The sources included in the uncertainty estimate cover 100 % of the total net Danish greenhouse gas emissions and removals.

The uncertainties for the activity rates and emission factors are shown in Table 1.3.

Table 1.3 Summary of base year and 2010 emissions in Gg CO_2-eq and activity data and emission factor uncertainties. Calculated Tier 1 and Tier 2 uncertainties for each emission source are given as % of the total 2010 emission. The base year for F-gases is 1995 and for all other sources the base year is 1990. Tier 2 uncertainty is not calculated for LULUCF.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Tier 1 Combined uncertainty % of total emissions	Tier 2 uncertainty % of total emissions
		Gg CO_2 eq	Gg CO_2 eq	%	%		
Stationary Combustion, Coal	CO_2	23834	15224	1	1	0.27	0.26
Stationary Combustion, BKB	CO_2	11	3	3	5	0.00026	0.00024
Stationary Combustion, Coke	CO_2	138	84	2	5	0.0076	0.0073
Stationary Combustion, Fossil waste	CO_2	573	1410	5	10	0.27	0.26
Stationary Combustion, Petroleum coke	CO_2	410	477	5	5	0.057	0.056
Stationary Combustion, Residual oil	CO_2	2440	880	1	2	0.033	0.032
Stationary Combustion, Gas oil	CO_2	4547	1577	2	4	0.13	0.12
Stationary Combustion, Kerosene	CO_2	366	4	3	5	0.00038	0.00036
Stationary Combustion, LPG	CO_2	164	89	2	5	0.0083	0.0078
Stationary Combustion, Refinery gas	CO_2	816	817	1	2	0.031	0.069
Stationary Combustion, Natural gas	CO_2	4335	10607	1	0	0.20	0.19
Stationary Combustion, SOLID	CH_4	13	4	1	100	0.0074	0.011
Stationary Combustion, LIQUID	CH_4	3	1	1	100	0.0022	0.0033
Stationary Combustion, GAS	CH_4	3	7	1	100	0.011	0.017
Natural gas fuelled engines, GAS	CH_4	5	234	1	2	0.0089	0.0085
Stationary Combustion, WASTE	CH_4	1	1	5	100	0.0023	0.0033
Stationary Combustion, BIOMASS	CH_4	97	133	13	100	0.23	0.32
Biogas fuelled engines, BIOMASS	CH_4	1	28	4	10	0.0050	0.0049
Stationary Combustion, SOLID	N_2O	68	42	1	400	0.28	0.39
Stationary Combustion, LIQUID	N_2O	43	14	1	1000	0.23	0.30
Stationary Combustion, GAS	N_2O	16	36	1	750	0.45	0.60
Stationary Combustion, WASTE	N_2O	7	16	5	400	0.11	0.15
Stationary Combustion, BIOMASS	N_2O	38	93	2	1000	1.6	0.86
Transport, Road transport	CO_2	9282	12108	2	5	1.1	1.1
Transport, Military	CO_2	119	107	2	5	0.010	0.0094
Transport, Railways	CO_2	297	242	2	5	0.022	0.021
Transport, Navigation (small boats)	CO_2	48	99	41	5	0.070	0.081
Transport, Navigation (large vessels)	CO_2	748	494	11	5	0.10	0.14
Transport, Fisheries	CO_2	591	575	2	5	0.053	0.050
Transport, Agriculture	CO_2	1272	1273	24	5	0.53	0.58
Transport, Forestry	CO_2	36	17	30	5	0.0088	0.0096
Transport, Industry (mobile)	CO_2	839	1037	41	5	0.73	0.82
Transport, Residential	CO_2	39	63	35	5	0.038	0.042
Transport, Commercial/institutional	CO_2	74	173	35	5	0.10	0.11
Transport, Civil aviation	CO_2	243	156	10	5	0.030	0.029
Transport, Road transport	CH_4	53	14	2	40	0.0092	0.010
Transport, Military	CH_4	0	0	2	100	0.00013	0.00018
Transport, Railways	CH_4	0	0	2	100	0.00026	0.00038
Transport, Navigation (small boats)	CH_4	0	1	41	100	0.00094	0.0015
Transport, Navigation (large vessels)	CH_4	0	0	11	100	0.00040	0.00045
Transport, Fisheries	CH_4	0	0	2	100	0.00049	0.00072
Transport, Agriculture	CH_4	2	2	24	100	0.0035	0.0051
Transport, Forestry	CH_4	0	0	30	100	0.00011	0.00017
Transport, Industry (mobile)	CH_4	1	1	41	100	0.0014	0.0021
Transport, Residential	CH_4	1	1	35	100	0.0025	0.0038
Transport, Commercial/institutional	CH_4	2	3	35	100	0.0060	0.0090
Transport, Civil aviation	CH_4	0	0	10	100	0.00014	0.00021
Transport, Road transport	N_2O	93	119	2	50	0.10	0.12
Transport, Military	N_2O	1	1	2	1000	0.019	0.030
Transport, Railways	N_2O	3	2	2	1000	0.035	0.050

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Tier 1 Combined uncertainty % of total emissions	Tier 2 uncertainty % of total emissions
		Gg CO_2 eq	Gg CO_2 eq	%	%		
Transport, Navigation (small boats)	N_2O	0	1	41	1000	0.018	0.027
Transport, Navigation (large vessels)	N_2O	15	10	11	1000	0.16	0.19
Transport, Fisheries	N_2O	11	11	2	1000	0.19	0.25
Transport, Agriculture	N_2O	15	17	24	1000	0.28	0.41
Transport, Forestry	N_2O	0	0	30	1000	0.0029	0.0041
Transport, Industry (mobile)	N_2O	11	14	41	1000	0.23	0.32
Transport, Residential	N_2O	0	0	35	1000	0.0057	0.0084
Transport, Commercial/institutional	N_2O	0	1	35	1000	0.014	0.018
Transport, Civil aviation	N_2O	3	3	10	1000	0.045	0.064
1.B.2 Flaring in refinery	CO_2	23	19	11	2	0.0036	0.0035
1.B.2 Flaring off-shore	CO_2	300	333	8	2	0.044	0.043
1.B.2 Land based activities	CO_2	0	0	2	40	4.2E-06	4.7E-06
1.B.2 Off-shore activities	CO_2	2	5	2	30	0.0024	0.0025
1.B.2 Transmission of natural gas	CO_2	0	0	15	2	1.4E-07	1.4E-07
1.B.2 Distribution of natural gas	CO_2	0	0	25	10	1.2E-06	1.3E-06
1.B.2 Venting in gas storage	CO_2	0	0	15	2	3.1E-07	3.1E-07
1.B.2. Flaring in refinery	CH_4	1	0	11	15	4.2E-05	4.2E-05
1.B.2. Flaring off-shore	CH_4	0	1	8	125	0.0012	0.0019
1.B.2 Refinery processes	CH_4	1	47	1	125	0.099	0.16
1.B.2 Land based activities	CH_4	17	18	2	40	0.012	0.013
1.B.2 Off-shore activities	CH_4	15	37	2	30	0.019	0.021
1.B.2 Transmission of natural gas	CH_4	4	1	15	2	0.00014	0.00014
1.B.2 Distribution of natural gas	CH_4	5	3	25	10	0.0014	0.0014
1.B.2 Venting in gas storage	CH_4	0	1	15	2	0.00031	0.00031
1.B.2 Flaring in refinery	N_2O	0	0	11	1000	0.00086	0.0011
1.B.2 Flaring off-shore	N_2O	1	1	8	1000	0.013	0.017
2A1 Cement production	CO_2	882	672	1	2	0.026	0.024
2A2 Lime production	CO_2	116	46	5	5	0.0055	0.0054
2A3 Limestone and dolomite use	CO_2	14	46	5	5	0.0055	0.0052
2A5 Asphalt roofing	CO_2	0	0	5	25	7.1E-06	7.3E-06
2A6 Road paving with asphalt	CO_2	2	2	5	25	0.00075	0.00080
2A7 Glass and Glass wool	CO_2	55	31	5	2	0.0028	0.00082
2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	1	2	5	5	0.00025	0.00025
2C1 Iron and steel production	CO_2	28	0	5	5	0	0
2D2 Food and Drink	CO_2	4	2	5	5	0.00019	0.00017
2G Lubricants	CO_2	50	33	2	5	0.0030	0.0029
2B2 Nitric acid production	N_2O	1043	0	2	25	0	0
2F Consumption of HFC	HFC	218	800	10	50	0.69	0.58
2F Consumption of PFC	PFC	1	13	10	50	0.011	0.0089
2F Consumption of SF6	SF_6	107	38	10	50	0.033	0.019
3A Paint application	CO_2	16	7,96	10	15	0.0024	0.0024
3B Degreasing and dry cleaning	CO_2	0	0,00	10	15	2.0E-09	2.0E-09
3C Chemical products, manufacturing and processing	CO_2	19	12,31	10	15	0.0038	0.0038
3D5 Other	CO_2	57	41,75	10	20	0.016	0.016
3D5 Consumption of fireworks	CO_2	0	0,23	8	100	0.00040	0.00059
3D1 Other - Use of N2O for Anaesthesia	N_2O	0	10,66	5	5	0.0013	0.0012
3D5 Use of tobacco	N_2O	0	0,17	20	30	0.00011	0.00012
3D5 Use of charcoal for BBQ	N_2O	0	0,08	10	100	0.00013	0.00019
3D5 Consumption of fireworks	N_2O	1	3,25	8	100	0.0055	0.0080
4A Enteric Fermentation	CH_4	3247	2856	2	20	0.97	0.99
4B Manure Management	CH_4	993	1288	5	20	0.45	0.47
4F Field burning af agricultural residues	CH_4	2	2	25	50	0.0020	0.0024

IPCC Source category	Gas	Base year emission Gg CO_2 eq	Year t emission Gg CO_2 eq	Activity data uncertainty %	Emission factor uncertainty %	Tier 1 Combined uncertainty % of total emissions	Tier 2 uncertainty % of total emissions
4.B Manure Management	N_2O	600	421	22	50	0.39	0.48
4.D1.1 Syntehetic Fertilizer	N_2O	2405	1139	25	100	1.99	3.0
4.D1.2 Animal waste applied to soils	N_2O	1112	1154	30	100	2.0	3.1
4.D1.3 N-fixing crops	N_2O	269	238	20	100	0.41	0.59
4.D1.4 Crop Residue	N_2O	361	315	20	100	0.54	0.82
4.D1.5 Cultivation of histosols	N_2O	226	163	20	100	0.28	0.42
4.D.2 Grassing animals	N_2O	311	197	25	100	0.35	0.51
4.D3 Atmospheric deposition	N_2O	455	288	19	100	0.50	0.73
4.D3 Leaching	N_2O	2452	1415	20	100	2.5	3.6
4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	28	41	20	100	0.072	0.10
4.F Field Burning of Agricultural Residues	N_2O	1	1	25	50	0.00076	0.00091
5.A.1 Broadleaves	CO_2	-708	-3752	15	50	-3.3	
5.A.1 Conifers	CO_2	-136	-1937	15	50	-1.7	
5.A.2 Broadleaves	CO_2	3	178	15	50	0.16	
5.A.2 Conifers	CO_2	6	-177	15	50	-0.16	
5(II) Forest Land.	N_2O	16	12	30	75	0.017	
5.B Cropland, Living biomass	CO_2	177	102	10	50	0.088	
5.B Cropland, Dead organic matter	CO_2	7	1	10	50	0.0011	
5.B Cropland, Mineral soils	CO_2	1415	1152	10	75	1.5	
5.B Cropland, Organic soils	CO_2	2420	1745	10	90	2.7	
5(III) Disturbance, Land converted to cropland	N_2O	3	1	50	75	0.0010	
5.C Grassland, Living biomass	CO_2	186	34	10	50	0.029	
5.C Grassland, Dead organic matter	CO_2	37	2	10	50	0.0021	
5.C Grassland, Mineral soils	CO_2	0	5	10	75	0.0065	
5.C Grassland, Organic soils	CO_2	183	145	10	90	0.22	
5.D Wetlands, Living biomass	CO_2	0	-5	10	50	-0.0046	
5.D Wetlands, Dead organic matter	CO_2	0	0	10	100	0.00017	
5.D Wetlands, Soils	CO_2	86	5	10	100	0.0086	
5(II) Wetlands	N_2O	0	0	10	100	0.00023	
5.E Settlements, Living biomass	CO_2	104	134	10	50	0.12	
5(IV) Cropland Limestone	CO_2	623	185	5	50	0.16	
5(V) Biomass Burning	CH_4	1	0	50	30	1.2E-05	
5(V) Biomass Burning	N_2O	0	0	50	30	1.7E-05	
6 A. Solid Waste Disposal on Land	CH_4	1477	693	10	118	1.4	2.1
6 B. Wastewater Handling	CH_4	66	75	44	78	0.11	0.070
6 B. Wastewater Handling - Direct	N_2O	27	51	37	98	0.091	2.6E-05
6 B. Wastewater Handling - Indirect	N_2O	82	33	59	39	0.039	0.0099
6.D Accidental fires, buildings	CO_2	11	11	10	300	0.057	0.13
6.D Accidental fires, vehicles	CO_2	7	7	10	500	0.060	0.16
6.C Incineration of corpses	CH_4	0	0	1	150	2.6E-05	4.5E-05
6.C Incineration of carcasses	CH_4	0	0	40	150	1.5E-05	2.4E-05
6.D Compost production	CH_4	27	80	40	100	0.15	0.22
6.D Accidental fires, buildings	CH_4	1	1	10	500	0.012	0.031
6.D Accidental fires, vehicles	CH_4	0	0	10	700	0.0037	0.011
6.C Incineration of corpses	N_2O	0	0	1	150	0.00049	0.00084
6.C Incineration of carcasses	N_2O	0	0	40	150	0.00027	0.00045
6.D Compost production	N_2O	11	43	40	100	0.078	0.12

1.7.2 Results of the tier 1 uncertainty estimation

The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 1.4. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total Danish net GHG emission is estimated with an uncertainty of ±6.9 % and the trend in net GHG emission since 1990 has been estimated to be -19.7 % ± 3.8 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CH_4 emission from solid waste disposal, N_2O emission from leaching and run-off and N_2O emission from animal waste applied to soil and synthetic fertiliser are the largest sources of uncertainty for the Danish GHG inventory (excluding LULUCF). For LULUCF the largest sources of uncertainty are forest land remaining forest land and soil emissions from cropland.

The uncertainty of the GHG emission from combustion (sector 1A) is 2.8 % and the trend uncertainty is -6.6 % ±2.2 %-age points.

Table 1.4 Uncertainties 1990-2010.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	6.9	-19.7	± 3.8
CO_2	6.4	-18.5	± 4.0
CH_4	19	-8.4	± 13.3
N_2O	43	-39	± 12.8
F-gases	48	162	± 62
GHG excl. LULUCF	4.8	-11.4	± 3.0

1.7.3 Tier 2 uncertainties

On the recommendation of the UNFCCC expert review team (ERT) in 2009 Denmark has undertaken a tier 2 uncertainty analysis. Please see the sectoral chapters for the sectoral results of the tier 2 uncertainty analysis. Below is a description on the theoretical basis for the tier 2 uncertainty calculations. For the overall result please refer to Chapter 1.7.4.

When to use Tier 2

When the activity data and emission factors cannot fulfil the criteria for using the error propagation equations in Tier 1 an alternative stochastic simulation, i.e. Monte Carlo method, can be employed. The Monte Carlo method constitutes Tier 2 and Approach 2 in IPCC (2000 and 2006) and is suitable for estimating uncertainty in emission rates, from uncertainties in activity data and emission factors, when:

- Uncertainties are large.
- Their distribution is non-normal.
- The algorithms are complex function and not only simple multiplication of activity data with emission factors.
- Correlations occur between some of the activity data sets, emission factors, or both.

Uncertainties found in inventory source categories can vary widely from a few per cent to orders of magnitude. When using a normal distribution for a parameter with large uncertainty there is a risk of having a certain probability for negative values, which is not possible in reality. Furthermore large uncertainty gives a certain probability of having extremely large values, i.e. values orders of magnitude larger than the mean value. Extreme values are an often occurring quality for the distribution of realistic activity data and emission factors. However, in some cases the extreme values are unrealistic and here the method allows for upper and lower truncation of input parameters. This implies applying a lower and/or upper boundary for the distribution function of input parameters. A logarithmic plot of data with large uncertainties will transform a skewed distribution probability function (a) into a bell-shaped log-normal distribution function (b), cf. Figure 1.5. The latter can be defined by a mean value, α, and standard deviation, σ, respectively. The log-normal distribution is selected as standard in the first version of the Tier 2 and Approach 2 uncertainty assessment for year 2009. A further feature of applying truncation boundaries is that a probability distribution will converge towards a box distribution when narrowing the truncation interval.

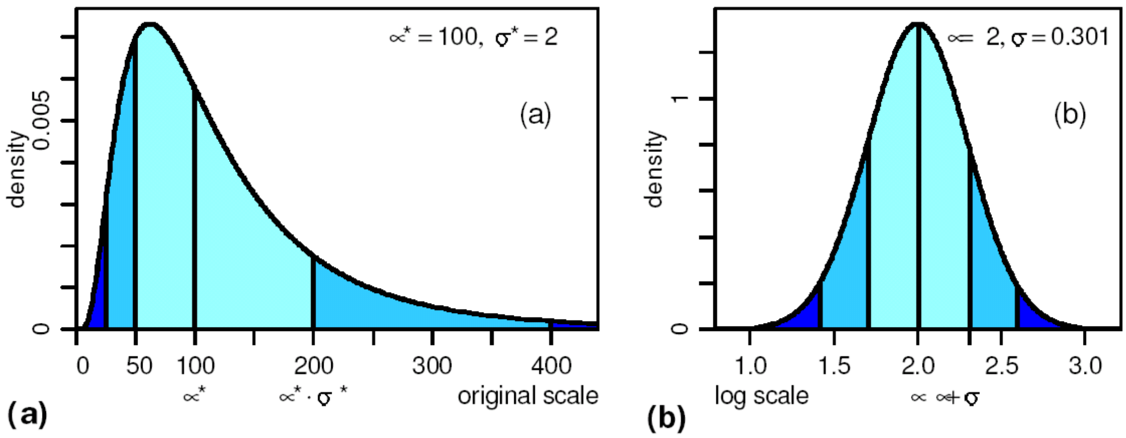


Figure 1.5 Log-normal distribution ($\log_{10}$), both on original (a) and log scale (b). The median (α^*) is 100 and the multiple standard deviation (σ^*) is 2. The resulting median (equal mean) and the standard deviation in the $\log_{10}$ distribution is respectively $\alpha = \log_{10}(100) = 2$ and $\sigma = \log_{10}(2) = 0.301$ (Limbert et al., 2001).

In case the uncertainty is much smaller than the mean value, then the normal and log-normal distributions will not differ much, cf. Figure 1.6, where the relationship between normal and log-normal distributions are illustrated (Limbert et al., 2001).

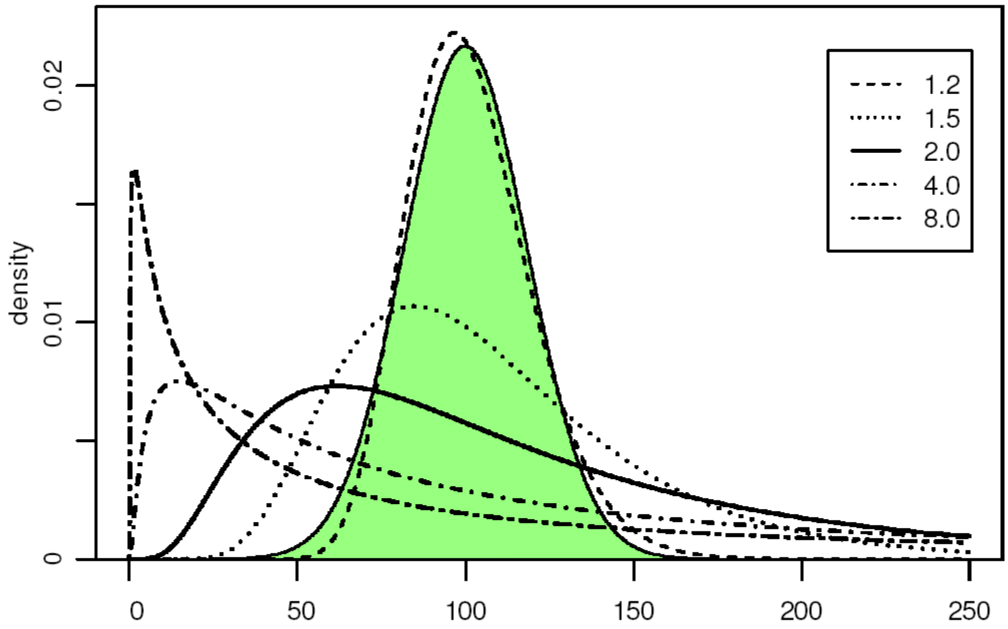


Figure 1.6 Comparison between the normal distribution (green area, median 100, standard deviation 20) the different degrees of variability (described by σ*) for log-normal distributions that all have the same median value, i.e. α^* on original scale, of 100 (Limbert et al., 2001).

The difference in shape between a normal and log-normal distribution is seen in Figure 1.6 for different values of σ*. The standard deviation for the normal distribution is 20 and thus equal to 20 % of the mean value and the log-normal distribution having a σ* value of 1.2 reflects the same level of "deviation" as in the normal distribution. So, the discrepancy between the green area and the curve for σ*=1.2 illustrates the difference in interpretation of a 20 % deviation as measured by respectively the normal and log-normal distribution. This discrepancy is so limited that it is overruled by the vagueness related to empirical quantification of the uncertainty level based on expert knowledge and data and the fact that any assumed distribution function is an approximation. Therefore, by using log-normal distributions as standard description of all uncertainty input it will in reality include normal distributions when the magnitude of uncertainty is limited to a minor fraction of the mean value.

A way of calculating the intervals of confidence, expressed by the median (α^*) and standard deviation (σ*), for a log-normal distribution on original scale, cf. Figure 1a, is presented in Limbert et al. (2001). For normally distributed data, the interval [median ± standard deviation] covers a probability of 68.3 %, while [median ± 2*standard deviation] covers 95.5 %. Correspondingly for log normal data on original scale, cf. Figure 1a, the interval [α^* / σ*, α^* * σ*] covers 68.3 % and the interval [α^* / $(\sigma^*)^2$, α^* * $(\sigma^*)^2$] covers 95.5 %.

Often the default uncertainty values in IPCC (2000) e.g. for emission factors, are expressed as a percentage, e.g. 30 %. When this represents a standard deviation (68.3 %) on original scale we will proceed using σ* = 1.3 in the uncertainty analysis. When it represents a 95 % interval of confidence, we will use σ* = (1.3)^0.5 = 1.14 in the uncertainty analysis. When the 95 % interval of confidence on original scale is below approximately 300 % the standard deviation for a log-normal distribution on original scale, can be approximated by dividing with a factor of 2, i.e. 0.3/2 = 0.15, and thus σ* = 1.15.

Procedure of Tier 2 (Monte Carlo method)

The procedure of the Tier 2 (MC) analysis consists of four steps where only Step 1 requires effort from the user:

- Step 1: Estimation of activity data and emission factors, their associated mean values, uncertainties such as standard deviation, probability density functions and any correlations.
- Step 2: Selection of random values of activity data and emission factors.
- Step 3: Calculate emissions from selected random values.
- Step 4: The calculated result in step 3 is stored and the process is repeated from step 2.

Repetition of steps 2 and 3 are continued until the calculated mean value and error intervals are sufficiently determined (typically 10,000 times). Each single repetition is denoted a "single sample" in the following and one execution of steps 2 and 3 is denoted a "MC sample".

The software is developed in excel VBA programming by a scientist associated with the sector experts, which enables a transparent and accurate transfer and interpretation of emission factors and activity data (input) and calculated emissions with uncertainties (output).

Different criteria and guidelines for estimation of value uncertainty for activity data and emission factors are outlined in the next section. Whether they are based on information from models, empirical data or expert judgement, they form lines of evidence towards the most appropriate estimate. The basic paradigm for a MC analysis is outlined in Figure 1.7.

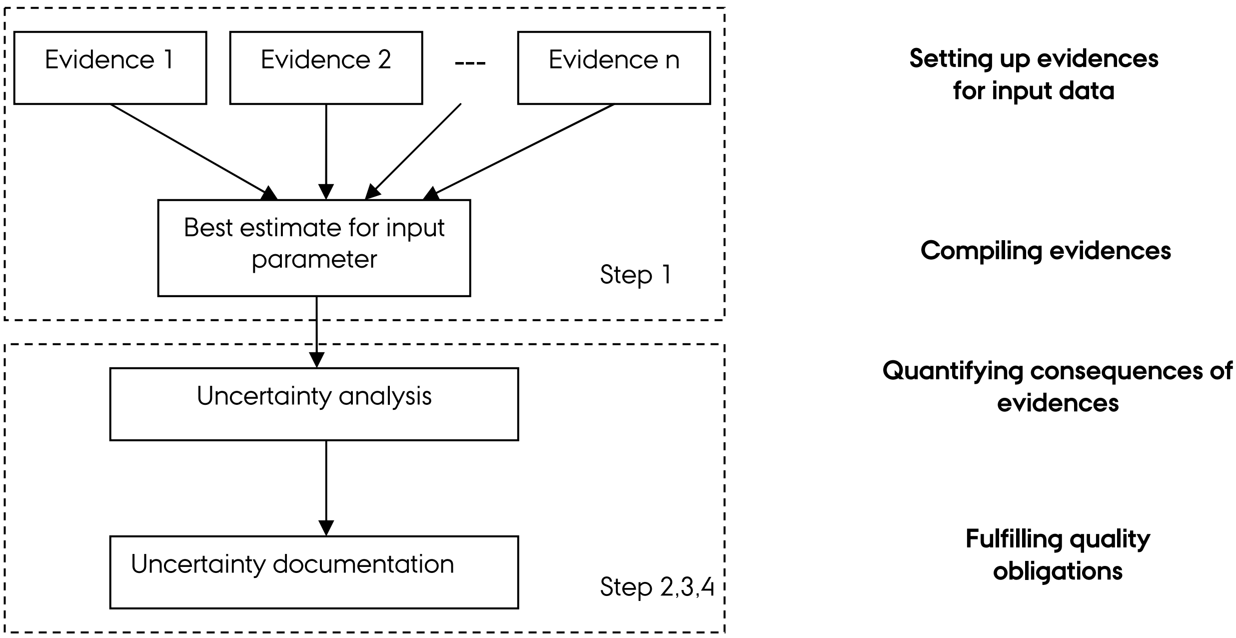


Figure 1.7 Methodological principle in compiling and quantifying input data for input parameters, e.g. emission factors, which are to be used in Tier 2 (MC) uncertainty analysis. Each evidence is formed from assessment of information from models, empirical data or expert judgement. The upper dotted box represents step 1 in the MC analysis, which is performed for each input parameter. The lower dotted box represents steps 2 to 4, and is performed in the emission modelling with all input parameters.

The principle of the MC method is to generate many "possible" calculations and thus map the resulting "possible" results. The possible calculations are made based on the "realistic" variability (uncertainty) related to the input parameter values. This variability needs to be described as a distribution function. The MC method is considered in two parts: (1) A distribution estimation part, where the variabilities of the input parameters are parameterised; (2) A technical part that makes the simulation based on the estimated distributions. The first part is highly critical and requires high attention. The second part is a question of programming and therefore mostly a technical issue. The MC method is a model for how uncertainty of input parameters influences the calculation results, so the MC also involves uncertainty in the prediction of uncertainty. It is therefore important to predict the variability of the input parameters as correctly as possible. The MC method does not include the validity of the calculations as estimators of reality but only the uncertainty of the input parameter values. Consequently, there are many fundamental types of uncertainty that are not included in the MC method.

The method is based on single samples, where the mean is unity and where the variability is determined by the uncertainty of the parameter as discussed above, see Figure 1.8. This sampled value is subsequently multiplied with the best estimate of the parameter value to yield a sampled value for this parameter. The reason for this two stage sampling is that it makes it possible directly to include correlation in uncertainty between years as explained below.

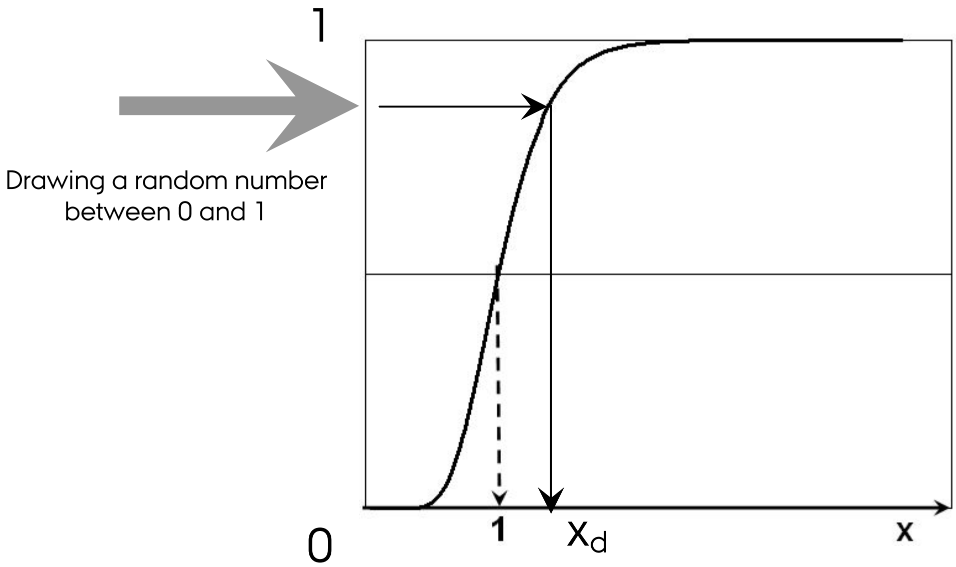


Figure 1.8 The principle in a single MC draw of the value x_d, where the median (α^*) is unity and where the standard deviation (σ^*) determines the variation around 1.

Correlation in the uncertainty may occur between years, e.g. when the same sources are responsible for uncertainties in several years. This takes place because many sources of uncertainty are dependent between years, so if a parameter is over-estimated for one year then this parameter may also tend to be overestimated other years. This implies that when the uncertainty is high one year the uncertainty will also be high the other year(s). The principle of performing a MC analysis with an emission factor and activity data that have uncertainties that are correlated between one or more years is illustrated in Figure 1.9.

The principle in Figure 1.9 is to sample a value (x) as shown in Figure 4, where the median value is unity and subsequently multiply the sampled value with the estimated median value (e.g. $AD_{s1}=AD_1 \cdot x$). This two-step approach makes is possible to include correlating uncertainty between different years. If two years are correlated then a deviation from the estimated mean value is assumed to be the same in relative terms for the two years. By sampling, using the median of unity once, and subsequently use this value to estimate the value for the two years, using the two medians for each year, this will yield the correlation between the two years as a simple consequence and thereby be directly simulated in the MC sampling.

The MC sampling is illustrated in Figure 1.9 for a single source, where *s* is the sampling number index, counting up to e.g. 10,000. In Figure 5 there will be a strong correlation between year 2 and 3, because both the uncertainty of *EF* and *AD* is correlated, for year 1 there will be a partial correlation with respectively year 2 and 3 because the uncertainty of the *EF* value is correlated, but the uncertainty is independent for *AD*. Year 4 is completely independent of the other years. The figure is only illustrating a single source and typically the emission estimates includes several sources each having some more or less correlated uncertainty. The final emission estimates are thus more or less correlated between years in a highly complex way.

Performing MC analysis for correlated parameters corresponds to the calculation scheme for MC analysis of emissions and the trend of a category as shown in Appendix A (IPCC, 2006) (Figure 3.7 pp. 3.36). The scheme shows calculations for correlated and non-correlated parameters.

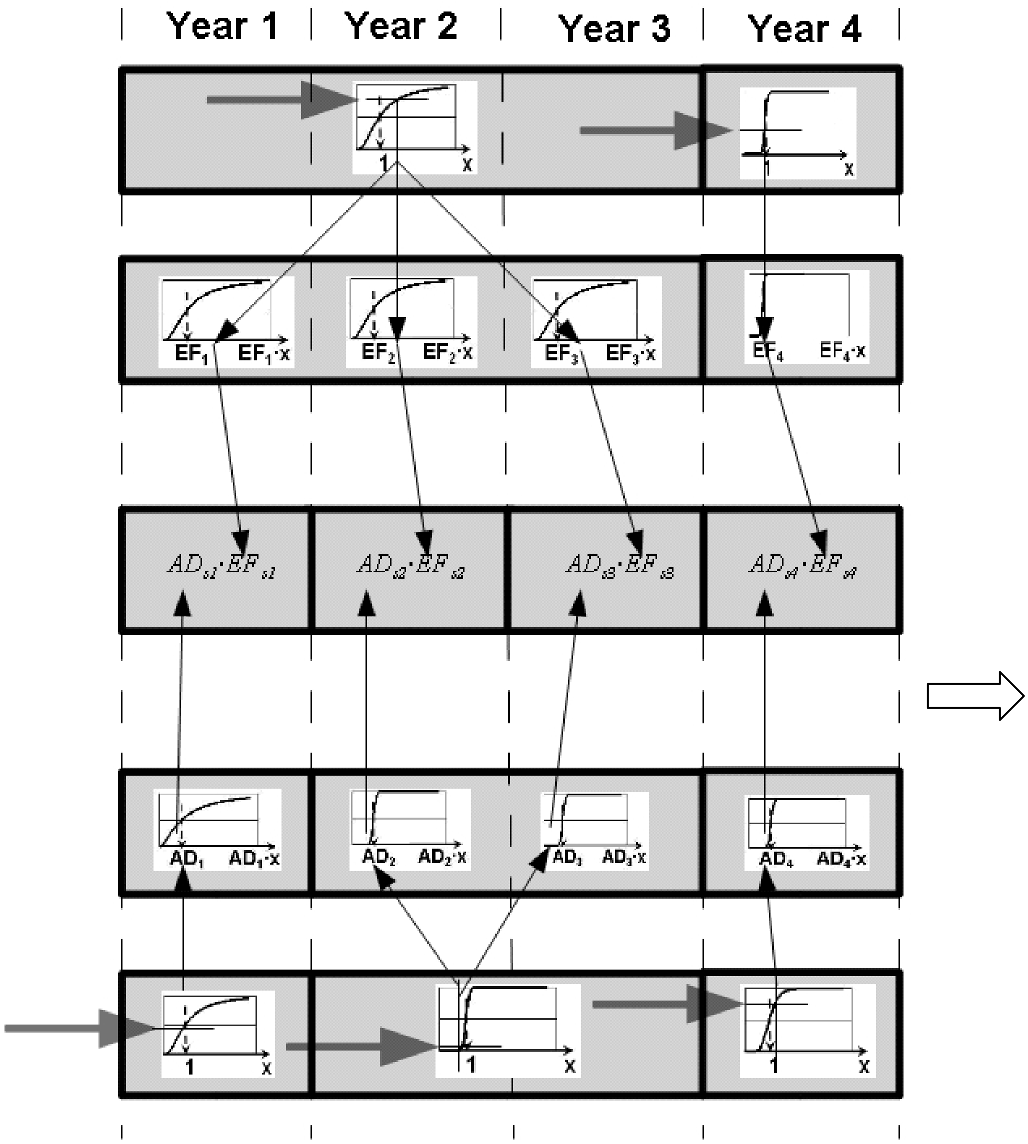


Figure 1.9 The principle of a MC sample for draws of random numbers and generation of any emission factor and activity data for a four year period. The upper half illustrates the sampling of any emission factor for year 1 to year 4. The uncertainty associated to the emission factor is correlated for year 1, 2 and 3 and therefore the same random number is used for generating EF1, EF2 and EF3. The lower half illustrates the sampling of activity data. The uncertainty associated to the activity data is correlated for year 2 and 3 and therefore the same random number is used for generating AD2 and AD3. In the middle row the emission factor and activity data are multiplied for each year.

In some cases there exists additional a priori information about categories of activity data, where the total sum is known with high certainty, but where the sub categories are more uncertain. In this case the single samples within one year are adjusted so all sub sources together adds up to the correct total number and the single sampling in this case will describe the uncertainty between the single categories.

MC analyses for emissions

When a 95% confidence interval has been entered as percentages of median values of the input parameters, i.e. emission factors and activity data, for source categories and sub-categories, the above MC procedure is executed 10,000 times. The output of the MC analysis is reported as in Table 1.5 where the median emissions are shown together with the 95% confidence interval (2.5% - 97.5%).

Two basic questions are important to answer: (1) What is the uncertainty for a time trend estimate; (2) What is the uncertainty within the same year of the single sub-categories, source categories and the total estimate. The first question takes correlation of uncertainty between years into account and the second question considers one year at a time and correlation between years is not relevant.

In the ideal case it will be possible to answer the two questions based on the same MC samples, where every single sample is stored for every source and for every year. However, this is not possible in the VBA programming due to limitations in variable table on a normal pc. Thus two MC samplings take place: (1) The total emission is calculated for every year and every MC sample, so for 10,000 MC samples and 20 years, this needs storage of 200,000 numbers; (2) Every year is analysed separately where only results for one year is stored at a time, so for 10,000 MC samples and 50 sources this yields 500,000 numbers to be stored. Using this two-stage approach it is easily possible to run the MC analysis in Excel. Consequently, the exact value for the median analysed for a specific year (question 2 above) is not similar with the medians in the time trend analysis (question 1 above) due to a finite number of MC samples, but this is not a real problem. If this discrepancy is considered as critical then it simply tells that the number of MC samples should be increased and that the analysis thus has to be redone.

Table 1.5 Example of output scheme for tier 2 MC uncertainty analysis. Median emissions and 95 % confidence intervals are calculated for total emission, emissions for source categories and emissions for sub-categories. Calculated 95% confidence intervals are furthermore calculated for activity data and emission factors.

Source category	Sub-categories	Activity			EF			Emissions			
		< 2.5%	>97.5%	Interval	< 2.5%	> 97.5%	Interval	Median	< 2.5%	> 97.5%	Interval
all	all	-	-	-	-	-	-				
A	all	-	-	-	-	-	-				
B	all	-	-	-	-	-	-				
C	all	-	-	-	-	-	-				
A	1										
A	2										
A	3										
B	1										
B	2										
C	1										
C	2										
C	3										
C	4										

Results for each row can also be reported as:

Median emission [- (median - <2.5%)/median/100%, + (>97.5% - median)/median/100%]

MC trend analysis

The trend analysis is performed by comparing emissions two years at a time. The probability for Year 1 to be above Year 2 is calculated using the equation:

$$P_{Year1>Year2} = \frac{N_{year1>year2} - N_{year2>year1}}{N_{year1>year2} + N_{year2>year1}},$$

where $N_{year1>year\,2}$ is the number of MC samples where year 1 is estimated to have higher emission than year 2, while $N_{year2>year2}$ is the reverse, where year 2 is estimated to have higher emission compared to year 1. In case of $P_{year1>year2} \approx 1$ it is strongly significant to conclude that year 1 has higher emission than year 2, and reverse (significant that year 2 > year 1) for $P_{year1>year2} \approx -1$. This is a comparison between years in pairs that can be filled in to a matrix, where all years are compared with all other years.

Table 1.6 Comparison of emissions between years in trend analysis.

	Year 1	Year 2	Year 3	Year 4
Year 1	0			
Year 2		0		
Year 3			0	
Year 4				0

Results for trend analysis of emissions between two years, year 1 and year 2, can be reported as median difference, <2.5% and >97.5%, or as:

Median difference [- (median difference - <2.5%)/median difference/100%, + (>97.5% - median difference)/median difference/100%]

Quantifying uncertainties in Tier 2

In order to perform the four steps of a Tier 2 (MC) uncertainty analysis as described in the previous paragraph the user has to gather the information stated in step 1. It is essential to establish the best possible estimate, and the following guide sets up a procedure for assessing, quantifying and compiling uncertainties for the parameters that are entered in the emission models. The guide is based on IPCC guidelines (IPCC, 2000 & 2006) and NUSAP and expert elicitation in van der Sluijs et al. (2004).

The uncertainty of a parameter, e.g. activity data and emission factor, is considered to be proportional to the associated parameter. This means that the uncertainty is expressed as a percentage of the parameter value. The median value is used and the uncertainties represent the parameter standard deviation, σ^*. We assume log-normal distributions, which equals normal distributions at low uncertainty values. Although van der Sluijs et al. (2004) suggest different probability distribution functions depending on the level of knowledge on input parameters we will use log-normal distributions for all parameters, as argued in the previous section.

The methodology offers a possibility for correlating the uncertainties of two or more parameters. When uncertainties of two or more parameters are assumed to be correlated they will be attributed the same random number in any MC sample, as explained in the previous paragraph.

Uncertainties will be reported according to the IPCC General Reporting Table for Uncertainty. Uncertainties will be reported for:

- Total uncertainty of the entire sector
- Key source categories
- Aggregated CRF levels

- Most differentiated CRF category levels that are entered by the user

IPCC guideline - Sources of data

Quantifying uncertainties is dependent on the source of data, and in general there are three broad sources of data and information (IPCC, 2000 & 2006):

Information contained in models

A model is a representation of the real world and does therefore not exactly mimic real-world systems. The structure of a model is often thought of in terms of the equations used. The key considerations in model uncertainty are; has the correct, most relevant real-world system been identified and are the model equations accurate representations of the chosen system. Typically the model equations are the product of activity data and emission factors, cf. Eq 1, but there may also be more complex model equations for emissions and also for derivation of activity data and emission factors.

In some cases, model uncertainty can be significant. It is typically poorly characterised and may not be characterised at all. The inventory expert must consider the parameters that are used and assess if there are model assumptions that are imprecise or inaccurate. For the most critical models an effort can be made to evaluate and quantify the size of the potential error that occurs from using the model. There are at least three approaches for estimating the model uncertainty: 1) comparison of a model result with independent data, 2) comparison of a model result with the result of alternative models, and 3) expert judgement regarding the magnitude of the model uncertainty. These approaches can be used in combination.

Empirical data for sources and sinks and activity

This implies empirical data associated with measurements of emissions, emission factors and activity data from surveys and censuses. When estimating uncertainty from measured emissions data, considerations include; representativeness of the data and potential for bias, precision and accuracy of the measurements, sample size and inter-individual variability in measurements and their implications for uncertainty in mean annual emissions, inter-annual variability in emissions and whether estimates are based on an average of several years or on the basis of a particular year.

Quantification of uncertainties and defining the probability distribution function (PDF) for empirical data can be summarised as follows: 1) Compilation of activity data, emission factors and other parameters. These data typically represent variability, 2) Visualisation of data by plotting empirical distribution functions for each parameter; horizontally according to numerical value or interval and vertically by frequency, 3) Fitting, evaluation and selection of PDFs for representing variability of data, 4) Characterisation of mean value and of uncertainty in the mean of the distributions for variability. If the standard error of the mean is small, a normality assumption can be made regardless of the sample size or skewness of data. If the standard error of the mean is large, then typically a log-normality assumption can be made, 5) Once mean values, uncertainties and standard errors have been specified, these can be used as input to Tier 2 MC analysis for estimating uncertainties in total emissions, 6) Sensitivity analysis can be used to determine which parameters induce highest uncertainties in the total uncertainty, and prioritise efforts to develop good estimates of these key uncertainties.

Expert judgement as a source of information

In many situations, relevant empirical data are not available for activity data, emission factors etc. to an inventory. In such situations, a practical solution is to obtain well informed judgements from domain experts regarding best estimates and uncertainties of input data.

Commonly used methods for converting an expert's judgement regarding uncertainty into a quantitative PDF are: 1) Fixed value; Estimate the probability of being higher (or lower) than an arbitrary value and repeat, three or five times. For example, what is the probability that an emission factor would be less than 100? 2) Fixed probability; Estimate the value associated with a specified probability of being higher (or lower). For example, what is the emission factor such that there is only a 2.5% probability that the emission factor could be lower (or higher) than that value, 3) Interval methods; For example, choose a value of the emission factor such that it is equally likely that the true emission factor would be higher or lower than that value. This yields the median. Then divide the lower range into two bins such that there is assumed to be equally likely (25% probability) that the emission factor could be in either bin. Repeat this for the other end of the distribution. Finally, either fixed probability or fixed value methods could be used to get judgements for extreme values, 4) Graphing; the expert draws a distribution. This should be used cautiously because some experts are overconfident about their knowledge of PDFs.

Sometimes the only available expert judgement consists of a range, maybe quoted together with a most likely value. Under these circumstances the following rules are considered good practice: Where experts only provide an upper and a lower value, assume that the PDF is uniform and that the range corresponds to the 95 per cent confidence interval. Where experts also provide a most likely value (point estimate), assume a triangular PDF using the most likely values as the mode and assume that the upper and lower values each exclude 2.5% of the population. The distribution needs not to be symmetrical. Normal or log-normal distributions can be used given appropriate justifications.

Concluding remarks and planned improvements

Tier 2 uncertainties are found to be greater than Tier 1 uncertainties. When large input uncertainties, e.g. > 10%, are used, the deviation becomes pronounced. For smaller input uncertainties, e.g. < 1%, Tier 1 approximates Tier 2 calculations.

The Log-normal distribution was selected due the likely conditions for the distribution as being close to a normal distribution for smaller uncertainties on one hand and close to the understanding of larger uncertainties on the other hand. However, in case of larger uncertainty the outcome of the MC analysis includes rather extreme values that in some cases are unrealistic. The method therefore allows for truncation of input uncertainties, either a lower boundary, upper boundary or both, depending of which truncation are most realistic.

1.7.4 Results of the tier 2 uncertainty estimation

Tier 2 uncertainty results for sectors and categories are shown in Table 1.3. The input uncertainties for activity data and emission factors stated in Table 1.3 are used both in Tier 1 and Tier 2 uncertainty calculations. The total Danish net GHG emission for 2010 is estimated with an uncertainty of +5.4 %

and -4.1 and the trend in net GHG emission since 1990 is estimated to be -11.1 % (+8.9 and -7.6 %-age points).

Tier 2 uncertainties are typically larger than Tier 1 uncertainties when input uncertainties are larger than approximately 25%, which corresponds to the model domain of Tier 1 method. This implies that the Tier 2 method is more reliable for large input uncertainties.

1.8 General assessment of the completeness

The present Danish greenhouse gas emission inventory includes all major sources identified by the Revised 1996 IPPC Guidelines. Please see Annex 5 for detailed discussion on minor sources that are not included.

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2 Trends in Greenhouse Gas Emissions

The trends presented in this Chapter cover the emissions from Denmark. Due to the small emissions originating from Greenland the trends are very similar in fact close to identical. A trend discussion of the aggregated greenhouse gas emissions from Denmark and Greenland is included in Chapter 17.1.

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emissions

2.1.1 Greenhouse Gas Emissions

The greenhouse gas emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure 2.1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2010. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2010 to the national total in CO_2 equivalents excluding LULUCF (Land Use and Land Use Change and Forestry) with 79.1 % followed by N_2O with 10.0 %, CH_4 9.4 % and F-gases (HFCs, PFCs and SF_6) with 1.5 %. Seen over the time series from 1990 to 2010 these percentages have been increasing for F-gases, almost constant for CO_2 and CH_4 and falling for N_2O. Stationary combustion plants, transport and agriculture represent the largest categories, followed by Industrial processes, Waste and Solvents, see Figure 2.1. The net CO_2 uptake by LULUCF in 2010 is 3.6 % of the total emission in CO_2 equivalents excl. LULUCF. The national total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 11.0 % from 1990 to 2010 and decreased 19.4 % including LULUCF. Comments on the overall trends etc seen in Figure 2.1 are given in the sections below on the individual greenhouse gases.

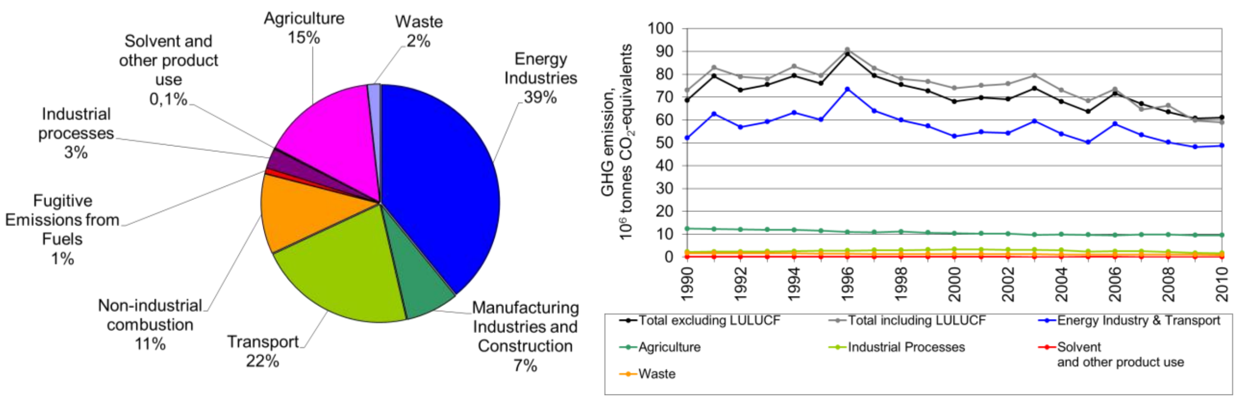


Figure 2.1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors for 2010 (excluding LULUCF) and time series for 1990 to 2010 (including LULUCF).

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide

The largest source to the emission of CO_2 is the energy sector, which includes combustion of fossil fuels like oil, coal and natural gas (Figure 2.2). Energy Industries contribute with 48 % of the emissions (excl. LULUCF). About 27 % come from the transport sector. The CO_2 emission (excl. LULUCF) increased by 0.9 % from 2009 to 2010. The main reason for the increase was the cold winter, which caused an increase in emissions from non-industrial combustion but also the emissions from manufacturing industries increased due to a slight increase in the activity level. In 2010, the actual CO_2 emission (incl. LULUCF) was 18.5 % less than the emission in 1990.

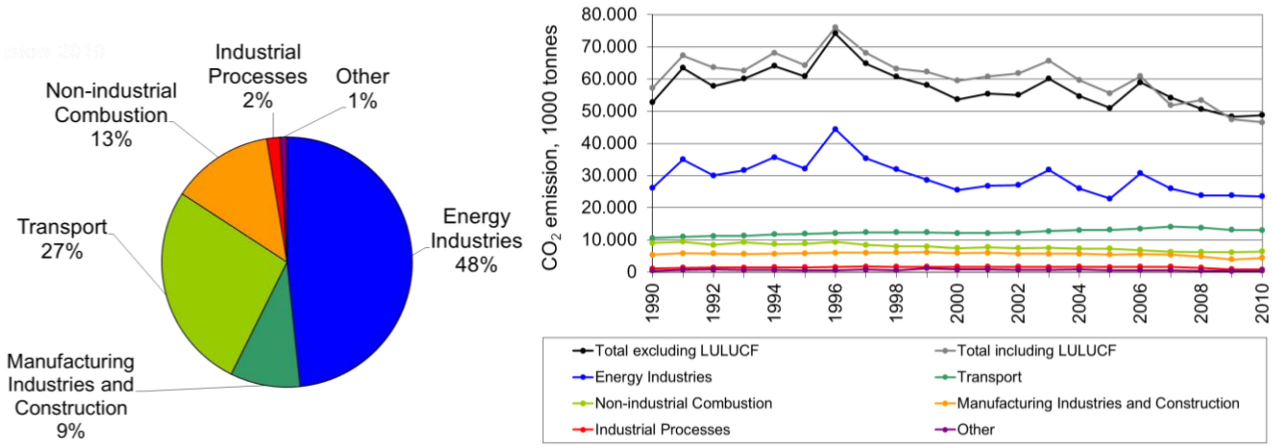


Figure 2.2 CO_2 emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.2.2 Nitrous oxide

Agriculture is the most important N_2O emission source in 2010 contributing 91.1 % (Figure 2.3) of which N_2O from agricultural soils accounts for 92.2 %. N_2O is emitted as a result of microbial processes in the soil. Substantial emissions also come from drainage water and coastal waters where nitrogen is converted to N_2O through bacterial processes. However, the nitrogen converted in these processes originates mainly from the agricultural use of manure and nitrogen fertilisers. The main reason for the drop in the emissions of N_2O in the agricultural sector of 34.6 % from 1990 to 2010 is legislation to improve the utilisation of nitrogen in manure. The legislation has resulted in less nitrogen excreted pr unit of livestock produced and a considerable reduction in the use of nitrogen fertilisers. The basis for the N_2O emission is then reduced. Combustion of fossil fuels in the energy sector, both stationary and mobile sources, contributes 6.4 %. The N_2O emission from transport contributed by 2.5 % in 2010. This emission has increased during the nineties because of the increase in the use of catalyst cars. Production of nitric acid stopped in 2004 and the emissions from industrial processes is therefore not occurring from 2005 onwards. The sector Solvent and Other Product Use covers N_2O from e.g. anaesthesia.

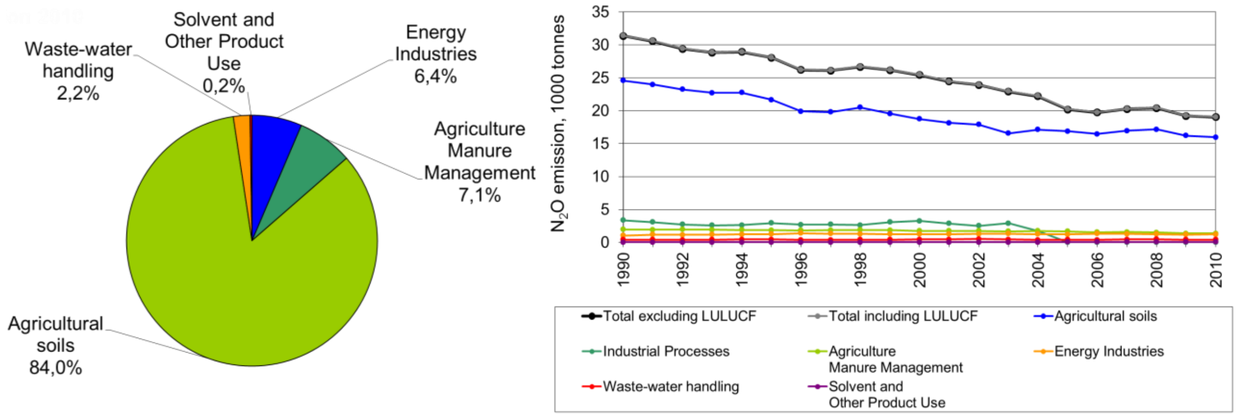


Figure 2.3 N_2O emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.2.3 Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities contributing in 2010 with 74.9 %, waste (15.4 %), public power and energy industries (4.2 %), see Figure 2.4. The emission from agriculture derives from enteric fermentation and management of animal manure contributing with 51.6 % and 23.3 % of the national CH_4 emission excl. LULUCF in 2010. The CH_4 emission from public power and district heating plants increased in the nineties, mainly 1992-1996, due to the increasing use of gas engines in the decentralised cogeneration plant sector. Up to 3 % of the natural gas in the gas engines is not combusted. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption has decreased and hence the CH_4 emission has decreased. Over the time series from 1990 to 2010, the emission of CH_4 from enteric fermentation has decreased 12.0 % due to the decrease in the number of cattle. However, the emission from manure management has in the same period increased 29.7 % due to a change in traditional stable systems towards an increase in slurry-based stable systems. Altogether, the emission of CH_4 from the agriculture sector has decreased by 2.3 % from 1990 to 2010. The emission of CH_4 from solid waste disposal has decreased 53.1 % since 1990 due to an increase in the incineration of waste and hence a decrease in the waste being deposited at landfills and a ban on depositing waste fit for incineration.

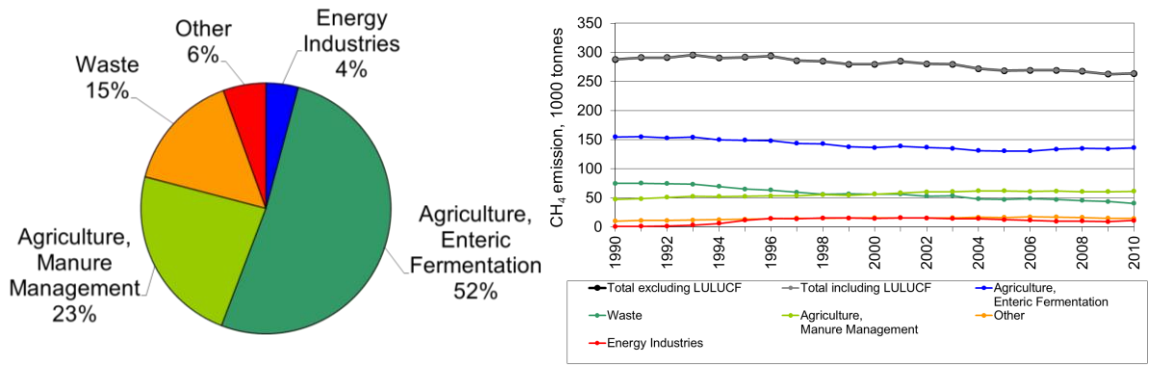


Figure 2.4 CH_4 emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.2.4 HFCs, PFCs and SF_6

This part of the Danish inventory only comprises a full data set for all substances from 1995. From 1995 to 2000, there has been a continuous and substantial increase in the contribution from the range of F-gases as a whole, calculated as the sum of emissions in CO_2 equivalents, see Figure 2.5. This increase is simultaneous with the increase in the emission of HFCs. For the time series 2000-2010, the increase is lower than for the years 1995 to 2000. The increase from 1995 to 2010 for the total F-gas emission is 161.5 %. SF_6 contributed considerably to the F-gas sum in earlier years, with 33 % in 1995. Environmental awareness and regulation of this gas under Danish law has reduced its use in industry, see Figure 2.5. A further result is that the contribution of SF_6 to F-gases in 2010 was only 4.4 %. The use of HFCs has increased several folds. HFCs have, therefore, become even more dominant, comprising 66.9 % in 1995, but 94.0 % in 2010. HFCs are mainly used as a refrigerant. Danish legislation regulates the use of F-gases, e.g. since January 1, 2007, new HFC-based refrigerant stationary systems are forbidden. Refill of old systems is still allowed. The use of air conditioning in mobile systems and the amount of HFC for this purpose increases.

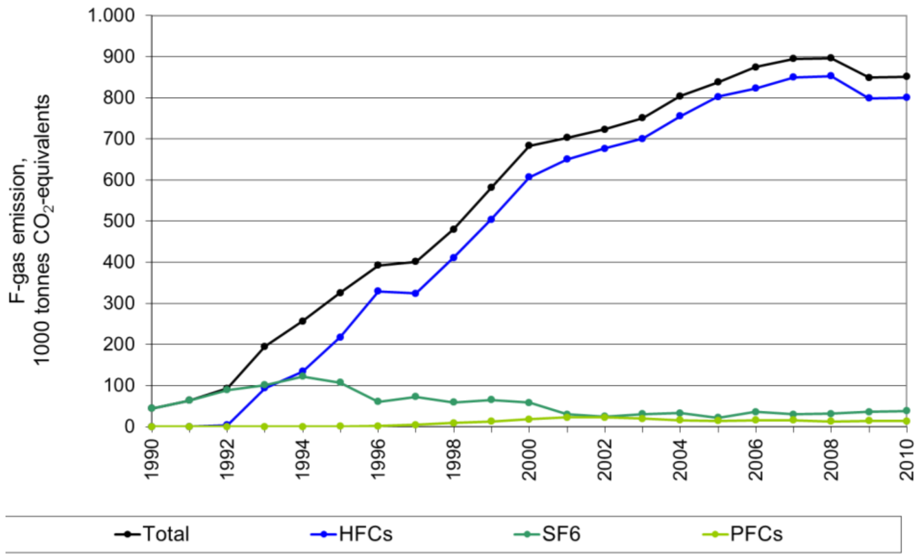


Figure 2.5 F-gas emissions. time series for 1990 to 2010.

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

The emission of CO_2 from Energy Industries has decreased by 9.8 % from 1990 to 2010. The relatively large fluctuation in the emission is due to inter-country electricity trade. Thus, the high emissions in 1991, 1996, 2003 and 2006 reflect a large electricity export and the low emissions in 1990 and 2005 are due to a large import of electricity. The increasing emission of CH_4 during the nineties is due to the increasing use of gas engines in decentralised cogeneration plants. The CH_4 emissions from this sector have been decreasing since 2001 due to the liberalisation of the electricity market. The CO_2 emission from the transport sector increased by 23.4 % from 1990 to 2010, mainly due to increasing road traffic.

2.3.2 Industrial processes

The emissions from industrial process, i.e. emissions from processes other than fuel combustion, amount in 2010 to 2.8 % of the total emission in CO_2 equivalents (excl. LULUCF). The main sources are cement production, refrigeration, foam blowing and calcination of limestone. The CO_2 emission from cement production – which is the largest source contributing in 2010 with 1.1 % of the national total – decreased by 23.8 % from 1990 to 2010. The second largest source has previously been N_2O from the production of nitric acid. However, the production of nitric acid/fertiliser ceased in 2004 and therefore the emission of N_2O also ceased.

2.3.3 Agriculture

The agricultural sector contributes in 2010 with 15.6 % of the total greenhouse gas emission in CO_2 equivalents (excl. LULUCF) and is the most important sector regarding the emissions of N_2O and CH_4. In 2010, the contribution of N_2O and CH_4 to the total emission of these gases was 91.2 % and 73.8 %, respectively. The N_2O emission from agriculture decreased by 34.6 % and the CH_4 emission including field burning and reduction of biogas decreased by 2.3 % from 1990 to 2010.

2.3.4 Forestry

The trend in CO_2 uptake from forests varies greatly due to several factors both relating to weather and other effects. The carbon stock change for forests has been estimated based on best available data. Based on mapped forest area in 1990 and in 2005 a calculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated for the times. The calculation of carbon stock in 1990 and in 2000 used age distribution as reported in census 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes with the current National Forest Inventory, the total standing carbon stock was calculated. For each of the years 1990 - 2000 calculated a standing carbon stock as a moving average, corrected for the deforestation which was detected. Windthrows and the effects of these are included in the overall estimation of changes in carbon stock. As carbon stock is based on moving average the annual effect is not dramatic.

Since the NFI was initiated in 2002, it is representative from 2005. Calculation of carbon stock in the period 2000-2004 is based on NFI in 2005 and carbon stock as calculated for 2000. For 2005-2010 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping. The data for 2010 estimates the Danish forests to be a large sink of 5 689 Gg CO_2.

2.3.5 Cropland, Grassland and Wetlands

The emission estimates for mineral cropland soils is estimated with a dynamic Tier 3 model which take into account actual biomass input to the soil and actual temperatures. The harvest yield in 2009 was the highest ever recorded in Denmark and combined with moderate temperatures the mineral soils turned to be a small sink compared to 2008. 2008 were very warm which resulted in a net loss of carbon from the cropland soils. A new map of organic soils and new national EF for organic soils has been implemented in the current inventory. This has, among other things, altered the distribution of the emission from organic soils between cropland soils and grassland soils. The emission in 2010 from organic cropland soils has been estimated to 1 745 Gg CO_2 and the total emission from Cropland to 3 000 Gg CO_2. Since 1990 there has been a decrease in the total C-stock in mineral soils which partly can be allocated to the global warming. A continuous increase in raised number of shelterbelts increases the C sequestration here.

Grassland is showing a stable annual emission around 200 Gg CO_2 per year which mainly comes from the utilisation of organic soils.

Emissions from managed wetlands with peat extraction are unaltered at a low level.

2.3.6 Waste

The waste sector contributes in 2010 with 1.6 % to the national total of greenhouse gas emissions (excl. LULUCF), 15.4 % of the total CH_4 emission and 2.2 % of the total N_2O emission. The GHG emission from the sector has decreased by 41.8 % from 1990 to 2010. This decrease is a result of (1) a decrease in the CH_4 emission from solid waste disposal sites (SWDS) by 53.1 % due to the increasing use of waste for power and heat production, and (2) a decrease in emission of N_2O from wastewater (WW) handling systems of 23.4 % due to upgrading of WW treatment plants. These decreases are counteracted by an increase in CH_4 from WW of 13.8 % due to increasing industrial load to WW systems. In 2010 the contribution of CH_4 from SWDS was 12.5 % of the total CH_4 emission. The CH_4 emission from WW amounts in 2010 to 1.4 % of the total CH_4 emissions. The emission of N_2O from WW in 2010 is 1.4 % of national total of N_2O. Since all incinerated waste is used for power and heat production, the emissions are included in the 1A CRF category.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

2.4.1 NO_x

The largest sources of emissions of NO_x are road transport followed by other mobile sources and combustion in energy industries (mainly public power and district heating plants). The transport sector is the sector contributing the most to the emission of NO_X and, in 2010, 44.6 % of the Danish emissions of NO_X stems from road transport, national navigation, railways and civil aviation. Also emissions from national fishing and off-road vehicles contribute significantly to the NO_X emission. For non-industrial combustion plants, the main sources are combustion of wood, gas oil and natural gas in residential plants. The emissions from energy industries have decreased by 79.4 % from 1990 to 2010. In the same period, the total emission decreased by 53.1 %. The reduction is due to the increasing use of catalyst cars and installation of low-NO_X burners and denitrifying units in power and district heating plants.

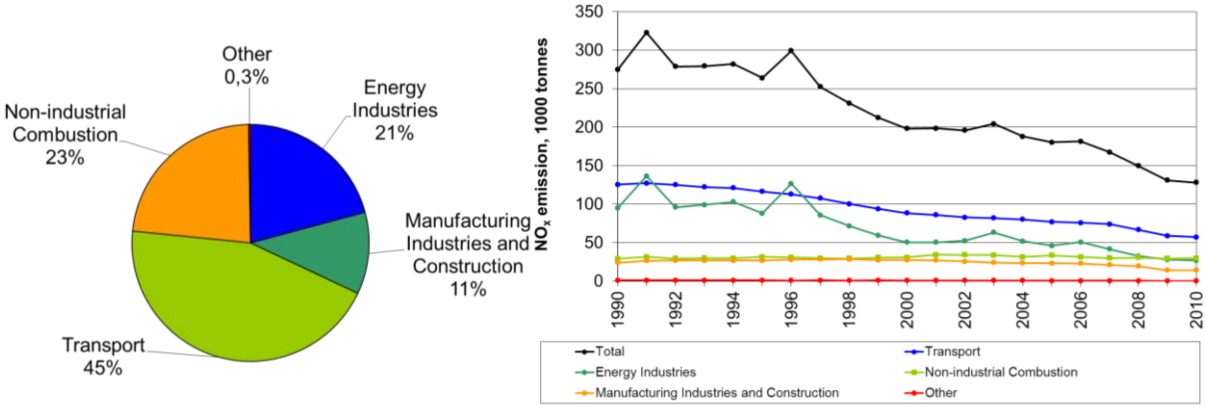


Figure 2.6 NO_X emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.4.2 CO

Non-industrial combustion plants and transport are by far the major contributors to the total emission of this pollutant with 65.1 % and 28.5 % of the total CO emission. The total CO emission decreased by 45 % from 1990 to 2010, largely because of decreasing emissions from road transportation due to the introduction of private catalyst cars in 1990 and the introduction of even more emission efficient private cars in the following years.

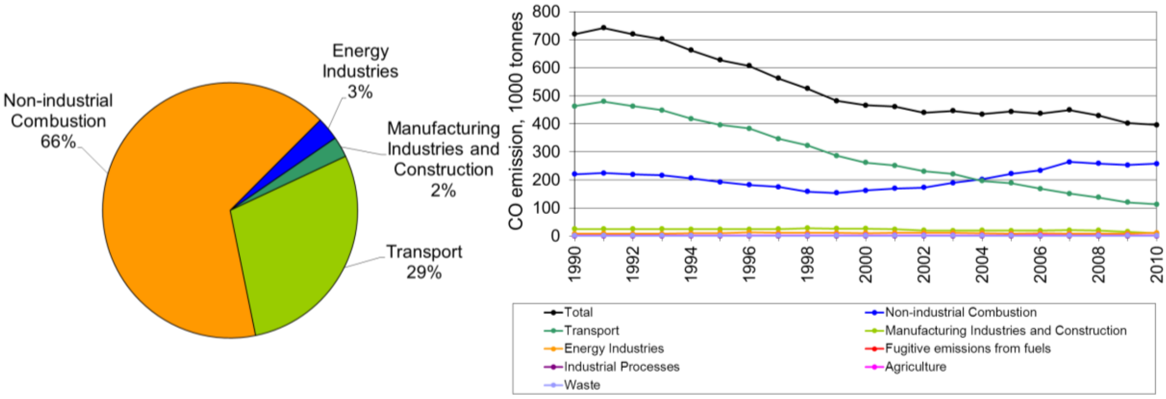


Figure 2.7 CO emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.4.3 NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation vehicles are still the main contributors even though the emissions have declined since the introduction of catalyst cars in 1990. The evaporative emissions mainly originate from the use of solvents and the extraction, handling and storage of oil and natural gas. The emissions from the energy industries have increased during the nineties due to the increasing use of stationary gas engines, which have much higher emissions of NMVOC than conventional boilers. The total anthropogenic emissions have decreased by 48.1 % from 1990 to 2010, largely due to the increased use of catalysts in cars and reduced emissions from use of solvents.

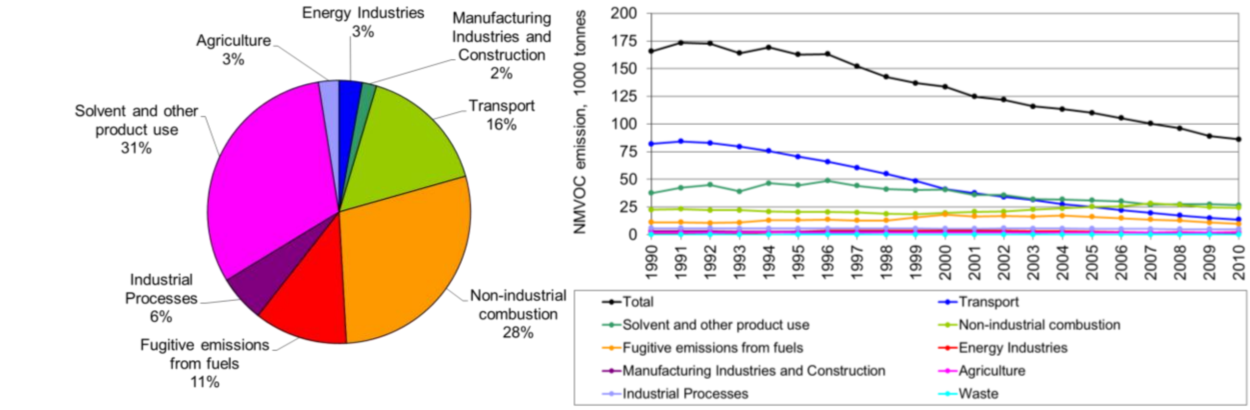


Figure 2.8 NMVOC emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.4.4 SO_2

The main part of the SO_2 emission originates from combustion of fossil fuels, i.e. mainly coal and oil, in public power and district heating plants. From 1990 to 2010, the total emission decreased by 92.1 %. The large reduction is mainly due to installation of desulphurisation plant and use of fuels with lower content of sulphur in public power and district heating plants. Despite the large reduction of the SO_2 emissions, these plants make up 28.2 % of the total emission in 2010. Also emissions from industrial combustion plants, non-industrial combustion plants and other mobile sources are important. National sea traffic (navigation and fishing) contributes with about 12.9 % of the total SO_2 emission. This is due to the use of residual oil with high sulphur content.

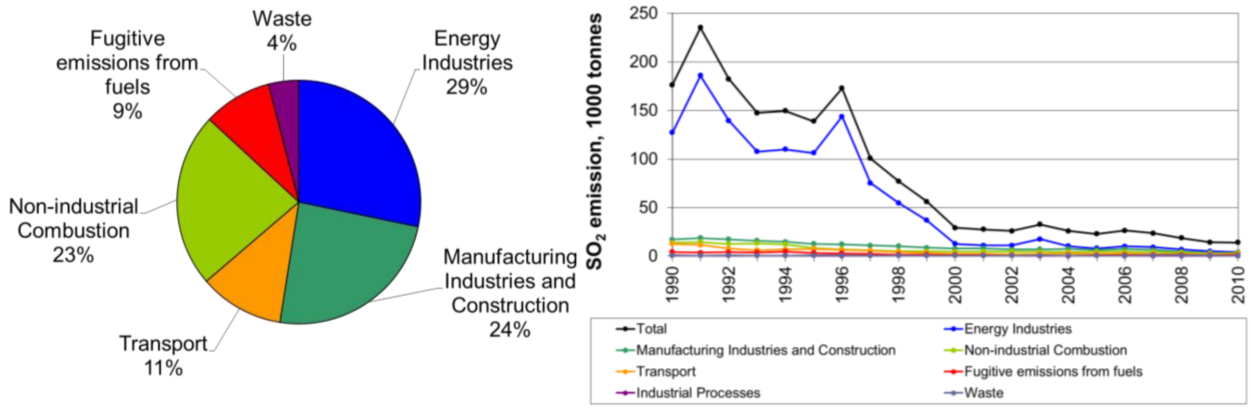


Figure 2.9 SO_2 emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

2.5 Description and interpretation of emission trends for KP-LULUCF inventory in aggregate, by activity and by gas

Coverage relating to reporting of activities under Article 3.3 and selected activities under Article 3.4 are listed in Table 2.1 for reporting concerning change in carbon pool and for greenhouse gas sources. All pools are reported. Carbon stock change in below-ground biomass for Cropland Management and Grazing Land Management under Article 3.4 are included under Above-ground biomass for the same area categories. Fertilisation of forests and other land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. All liming is reported under Cropland because only very limited amounts are used in forestry and on permanent grassland. Field burning of wooden biomass is prohibited in Denmark and therefore reported as not occurring. Wildfires are very seldom and if occurring very small in Denmark.

CO_2 is by far the most important greenhouse gas relating to activities under Article 3.3 and Article 3.4. There is however a minor contribution of N_2O due to Deforestation (1.5 % of GHG from Deforestation in 2010) and Forest Management (0.2 % of GHG from Forest Management in 2010). Additionally, there is a small emission of greenhouse gases from biomass burning of 0.03 Gg CO_2 equivalents in 2010.

Table 2.1 Coverage of reporting of change of carbon pools relating to activities under Article 3.3 and elected activities under Article 3.4.

		Change in carbon pool reported					Greenhouse gas sources reported						
		Above-ground bio-mass	Below-ground bio-mass	Litter	Dead wood	Soil	Fertili-zation	Drainage of soils under forest manage-ment	Disturbance associated with land-use conver-sion to croplands	Liming	Biomass burning		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3	Afforestation and Reforestation	R	R	R	R	R	IE			IE	NO	IE	IE
	Deforestation	R	R	R	R	R			R	IE	NO	IE	IE
Article 3.4	Forest Management	R	R	R	R	R	IE	R		IE	NO	R	R
	Cropland Management	R	IE	NO	NO	R			R	R	NO	NO	NO
	Grazing Land Management	R	IE	NO	NO	R				IE	NO	R	R
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

R: reported, NR: not reported, IE: included elsewhere, NO: not occurring, NA: not applicable.

2.5.1 Forest

The trends in forest in the first commitment period are dependent on both the current structure of the forests and the management actions in the coming years. If similar management is applied as in the previous 15 years a decline in the total carbon stock in the forest is expected. However, for 2008 to 2010 a sink in forest is reported. For the afforestated areas a steady increase in carbon stocks is expected also in the future years. The rate of increase of area will depend on both availability of land and on possible subsidies for afforestation. Deforestation occurs mainly in relation to other specific projects e.g. for nature restoration or test areas for wind turbines.

2.5.2 Cropland, Grassland and Wetlands

The trend for the Cropland and Grassland under KP-LULUCF seems to be that there has been a stabilisation of the loss of carbon from agricultural soils compared to previously due to an increased input of organic matter in the soil. However, the loss depends much of the climatic conditions. As a consequence of the global warming, where 18 years out of the last 20 years has been above the average for 1961-1990, it is difficult to avoid substantial losses of carbon from the agricultural soils in the future. The changes in Cropland management since 1990 have undoubtedly prevented further losses of soil carbon. A further increase in the actual temperature will affect the ability to prevent further losses of soil carbon.

The reestablishment of wetlands on agricultural land is especially targeted towards organic soils, which leads to a decreased emission from these soils. Further reestablishments are expected to take place in the future.

3 Energy (CRF sector 1)

3.1 Overview of the sector

The energy sector has been reported in four main chapters:

3.2 Stationary combustion plants (CRF sector 1A1, 1A2 and 1A4)
3.3 Transport (CRF sector 1A2, 1A3, 1A4 and 1A5)
3.4 Additional information on fuel combustion (CRF sector 1A)
3.5 Fugitive emissions (CRF sector 1B)

Though industrial combustion is part of stationary combustion, detailed documentation for some of the specific industries is discussed in the industry chapters. Table 3.1.1 shows detailed source categories for the energy sector and plant category in which the sector is discussed in this report.

Table 3.1.1 CRF energy sectors and relevant NIR chapters.

IPCC id	IPCC sector name	NIR chapter
1	Energy	Stationary combustion, Transport, Fugitive, Industry
1A	Fuel Combustion Activities	Stationary combustion, Transport, Industry
1A1	Energy Industries	Stationary combustion
1A1a	Electricity and Heat Production	Stationary combustion
1A1b	Petroleum Refining	Stationary combustion, Fugitive
1A1c	Solid Fuel Transf./Other Energy Industries	Stationary combustion
1A2	Fuel Combustion Activities/Industry (ISIC)	Stationary combustion, Transport, Industry
1A2a	Iron and Steel	Stationary combustion, Industry
1A2b	Non-Ferrous Metals	Stationary combustion, Industry
1A2c	Chemicals	Stationary combustion, Industry
1A2d	Pulp, Paper and Print	Stationary combustion, Industry
1A2e	Food Processing, Beverages and Tobacco	Stationary combustion, Industry
1A2f	Other (please specify)	Stationary combustion, Transport, Industry
1A3	Transport	Transport
1A3a	Civil Aviation	Transport
1A3b	Road Transportation	Transport
1A3c	Railways	Transport
1A3d	Navigation	Transport
1A3e	Other (please specify)	Transport
1A4	Other Sectors	Stationary combustion, Transport
1A4a	Commercial/Institutional	Stationary combustion
1A4b	Residential	Stationary combustion, Transport
1A4c	Agriculture/Forestry/Fishing	Stationary combustion, Transport
1A5	Other (please specify)	Stationary combustion, Transport
1A5a	Stationary	Stationary combustion
1A5b	Mobile	Transport
1B	Fugitive Emissions from Fuels	Fugitive
1B1	Solid Fuels	Fugitive
1B1a	Coal Mining	Fugitive
1B1a1	Underground Mines	Fugitive
1B1a2	Surface Mines	Fugitive
1B1b	Solid Fuel Transformation	Fugitive
1B1c	Other (please specify)	Fugitive
1B2	Oil and Natural Gas	Fugitive
1B2a	Oil	Fugitive
1B2a2	Production	Fugitive
1B2a3	Transport	Fugitive
1B2a4	Refining/Storage	Fugitive
1B2a5	Distribution of oil products	Fugitive
1B2a6	Other	Fugitive
1B2b	Natural Gas	Fugitive
1B2b1	Production/processing	Fugitive
1B2b2	Transmission/distribution	Fugitive
1B2c	Venting and Flaring	Fugitive
1B2c1	Venting and Flaring Oil	Fugitive
1B2c2	Venting and Flaring Gas	Fugitive
1B2d	Other	Fugitive

Summary tables for the energy sector are shown below.

Table 3.1.2 CO_2 emission from the energy sector.

Greenhouse gas source categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)									
1. Energy	51,545	62,069	56,226	58,536	62,487	59,282	72,492	62,991	58,938	56,353
A. Fuel Combustion (Sectoral Approach)	51,221	61,426	55,562	57,958	61,917	58,832	71,998	62,296	58,423	55,259
1. Energy Industries	26,146	35,015	30,086	31,661	35,692	32,163	44,421	35,394	31,989	28,706
2. Manufacturing Industries and Construction	5,385	5,915	5,778	5,642	5,738	5,852	6,006	6,057	6,077	6,165
3. Transport	10,617	11,001	11,199	11,319	11,802	11,939	12,188	12,381	12,353	12,373
4. Other Sectors	8,954	9,209	8,358	9,099	8,432	8,626	9,207	8,294	7,801	7,832
5. Other	119	287	141	237	252	252	176	171	204	182
B. Fugitive Emissions from Fuels	325	643	663	577	570	449	494	695	515	1,094
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	325	643	663	577	570	449	494	695	515	1,094
Continued	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	(Gg)									
1. Energy	51,847	53,663	53,252	58,478	52,891	49,311	57,238	52,472	49,278	47,366
A. Fuel Combustion (Sectoral Approach)	51,127	52,894	52,605	57,808	52,139	48,768	56,705	51,928	48,885	47,101
1. Energy Industries	25,544	26,845	27,061	31,811	26,007	22,838	30,711	26,002	23,887	23,832
2. Manufacturing Industries and Construction	5,961	6,051	5,761	5,693	5,749	5,459	5,584	5,404	4,910	3,981
3. Transport	12,173	12,184	12,282	12,738	13,047	13,166	13,544	14,161	13,862	13,141
4. Other Sectors	7,339	7,717	7,412	7,473	7,098	7,034	6,740	6,186	6,119	5,987
5. Other	111	97	89	92	239	271	126	175	108	160
B. Fugitive Emissions from Fuels	720	769	647	670	752	543	532	544	392	265
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	720	769	647	670	752	543	532	544	392	265
Continued	**2010**									
	(Gg)									
1. Energy	47,872									
A. Fuel Combustion (Sectoral Approach)	47,515									
1. Energy Industries	23,577									
2. Manufacturing Industries and Construction	4,402									
3. Transport	13,099									
4. Other Sectors	6,331									
5. Other	107									
B. Fugitive Emissions from Fuels	357									
1. Solid Fuels	NA,NO									
2. Oil and Natural Gas	357									

Table 3.1.3 CH_4 emission from the energy sector.

Greenhouse gas source categories	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
					(Gg)					
1. Energy	10.84	12.29	12.75	14.99	18.50	24.72	28.81	28.79	30.20	30.53
A. Fuel Combustion (Sectoral Approach)	8.76	9.72	10.29	12.31	15.51	21.33	25.49	25.23	26.69	26.57
1. Energy Industries	0.68	1.03	1.44	3.05	6.11	11.39	14.49	13.89	15.28	15.38
2. Manufacturing Industries and Construction	0.36	0.38	0.36	0.37	0.37	0.47	0.89	0.88	0.98	0.97
3. Transport	2.57	2.66	2.64	2.60	2.54	2.42	2.30	2.20	2.10	1.97
4. Other Sectors	5.14	5.63	5.83	6.28	6.48	7.04	7.80	8.23	8.32	8.25
5. Other	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
B. Fugitive Emissions from Fuels	2.07	2.57	2.46	2.68	2.99	3.39	3.32	3.56	3.51	3.95
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	2.07	2.57	2.46	2.68	2.99	3.39	3.32	3.56	3.51	3.95
Continued	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
					(Gg)					
1. Energy	30.15	31.07	30.49	30.10	30.66	28.90	28.79	26.81	26.39	24.03
A. Fuel Combustion (Sectoral Approach)	26.05	26.79	26.19	25.70	25.43	23.69	22.27	20.52	20.33	18.40
1. Energy Industries	14.66	15.57	15.14	14.42	14.10	12.47	11.57	9.65	10.22	8.93
2. Manufacturing Industries and Construction	1.19	1.23	1.13	1.10	1.11	0.97	0.85	0.63	0.68	0.64
3. Transport	1.83	1.71	1.60	1.51	1.41	1.29	1.19	1.08	0.91	0.77
4. Other Sectors	8.37	8.28	8.32	8.67	8.80	8.95	8.67	9.15	8.51	8.05
5. Other	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01
B. Fugitive Emissions from Fuels	4.10	4.27	4.30	4.40	5.23	5.21	6.51	6.29	6.06	5.64
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	4.10	4.27	4.30	4.40	5.23	5.21	6.51	6.29	6.06	5.64
Continued	**2010**									
	(Gg)									
1. Energy	25.60									
A. Fuel Combustion (Sectoral Approach)	20.50									
1. Energy Industries	11.01									
2. Manufacturing Industries and Construction	0.66									
3. Transport	0.69									
4. Other Sectors	8.14									
5. Other	0.00									
B. Fugitive Emissions from Fuels	5.10									
1. Solid Fuels	NA,NO									
2. Oil and Natural Gas	5.10									

Table 3.1.4 N_2O emission from the energy sector.

Greenhouse gas source categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Gg)					
1. Energy	1.05	1.18	1.15	1.18	1.22	1.23	1.39	1.32	1.28	1.26
A. Fuel Combustion (Sectoral Approach)	1.05	1.18	1.15	1.18	1.22	1.22	1.39	1.32	1.27	1.25
1. Energy Industries	0.28	0.36	0.32	0.35	0.38	0.36	0.49	0.43	0.40	0.38
2. Manufacturing Industries and Construction	0.17	0.19	0.19	0.17	0.16	0.15	0.15	0.15	0.15	0.15
3. Transport	0.37	0.38	0.41	0.42	0.45	0.47	0.50	0.52	0.51	0.51
4. Other Sectors	0.23	0.24	0.23	0.24	0.23	0.23	0.23	0.22	0.20	0.21
5. Other	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01
B. Fugitive Emissions from Fuels	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01

Continued	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
					(Gg)					
1. Energy	1.23	1.26	1.26	1.31	1.26	1.23	1.31	1.27	1.24	1.18
A. Fuel Combustion (Sectoral Approach)	1.23	1.25	1.26	1.31	1.25	1.22	1.30	1.27	1.23	1.18
1. Energy Industries	0.36	0.37	0.38	0.42	0.37	0.33	0.40	0.34	0.33	0.33
2. Manufacturing Industries and Construction	0.15	0.15	0.15	0.14	0.14	0.13	0.14	0.14	0.13	0.11
3. Transport	0.50	0.49	0.49	0.49	0.49	0.48	0.47	0.48	0.47	0.44
4. Other Sectors	0.22	0.24	0.24	0.26	0.25	0.27	0.28	0.30	0.30	0.30
5. Other	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01
B. Fugitive Emissions from Fuels	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Continued	**2010**
	(Gg)
1. Energy	1.23
A. Fuel Combustion (Sectoral Approach)	1.22
1. Energy Industries	0.34
2. Manufacturing Industries and Construction	0.12
3. Transport	0.44
4. Other Sectors	0.32
5. Other	0.00
B. Fugitive Emissions from Fuels	0.00
1. Solid Fuels	NA,NO
2. Oil and Natural Gas	0.00

3.2 Stationary combustion (CRF sector 1A1, 1A2 and 1A4)

Stationary combustion is the largest source of CO_2 emission in Denmark accounting for 64 % of the national total CO_2 emissions (excl. LULUCF) in 2010. The CO_2 emission from stationary combustion has increased by 0.9 % since 2009 and decreased by 17 % since 1990. The decreased emission since 1990 is a result of a change of fuels; the consumption of coal has decreased whereas the consumption of natural gas and biomass has increased since 1990. The relatively large fluctuations in the CO_2 emission time series from 1990 to 2010 are due to inter-country electricity trade fluctuations caused mainly by variation in hydropower generation in Norway and Sweden. The increase in emission since 2009 is a result of the fact that 2010 was a year with electricity export whereas 2009 was a year with electricity import.

The methane (CH_4) emission from stationary combustion plants accounted for 7 % of the national CH_4 emission in 2010. The CH_4 emission from stationary combustion has increased by a factor of 3.3 since 1990. This results from the considerable number of lean-burn gas engines installed in CHP plants in Denmark during the 1990s. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption and CH_4 emission has decreased since 2004. The CH_4 emission in 2010 was 13 % higher than in 2009 due to increased consumption in gas engines.

The nitrous oxide (N_2O) emission from stationary combustion plants accounted for 3 % of the national N_2O emission in 2010. The N_2O emission from stationary combustion has increased by 16 % since 1990, but as for CO_2 fluctuations in emission level due to electricity import/export are considerable. The emission in 2010 was 5 % higher than in 2009 due to fact that 2010 was a year with electricity export whereas 2009 was a year with electricity import.

3.2.1 Source category description

Source category definition

Stationary combustion plants are included in the emission source subcategories to *Energy, Fuel combustion*:

- 1A1 Energy Industries.
- 1A2 Manufacturing Industries and Construction.
- 1A4 Other Sectors.

However, the emission source categories *1A2 Manufacturing Industries and Construction* and *1A4 Other Sectors* also include emission from transport subcategories. The emission source *1A2* includes emissions from non-road machinery in the industry that have been reported separately in the CRF. The emission source *1A4* also includes non-road machinery and in the CRF, the stationary and mobile emissions have been reported together.

The emission and fuel consumption data included in tables and figures in Chapter 3.2 only include emissions originating from stationary combustion plants of a given CRF source category. The CRF source category codes have been applied unchanged, but some source category names have been changed to reflect the stationary combustion element of the source.

In the Danish emission database all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP source categories. Danish Centre for Environment and Energy, Aarhus University (DCE) has modified the SNAP categorisation to enable direct reporting of the disaggregated data for manufacturing industries and construction. Aggregation to the IPCC source category codes is based on a correspondence list enclosed in Annex 3A-1. Stationary combustion is defined as combustion activities in the SNAP sectors 01 – 03, not including SNAP 0303.

The CO_2 emission from calcinations is not part of the source category *Energy*. This emission is included in the source category *Industrial Processes*.

Methodology overview, tier

The type of emission factor and the applied tier level for each emission source are shown in Table 3.2.1 below. The tier level has been determined based on the 1996 Guidebook (IPCC 1997).

The fuel consumption data for transformation are technology specific. For end-use of fuels, the disaggregation to specific technologies is less detailed. However, for residential wood combustion the technology disaggregation is less detailed.

Distinguishing between tier level 2 and 3 have been based on the emission factor. The tier levels definitions have been interpreted as follows:

- Tier 1: The emission factor is an IPCC default tier 1 value.
- Tier 2: The emission factors are country specific and based on either a few emission measurements or IPCC tier 2 emission factors.
- Tier 3: Based on plant specific emission data or on a country specific emission factor based on a considerable number of plant specific emission measurements and detailed technology knowledge.

Table 3.2.1 gives an overview of the calculation methods and type of emission factor. The table also shows which of the source categories are key in any of the key source analysis[1] (including LULUCF, tier 1/tier 2, level/trend).

[1] Key category according to the KCA tier 1 or tier 2 for Denmark (excluding Greenland and Faroe Islands), including LULUCF, level 1990/ level 2010/ trend.

Table 3.2.1 Methodology and type of emission factor.

		Tier	EMF 1)	Key category
Stationary Combustion, Coal	CO_2	Tier 3[2] (Tier 3 / Tier 1[3])	PS[2] (CS / D[3])	Yes
Stationary Combustion, BKB	CO_2	Tier 1	D	No
Stationary Combustion, Coke	CO_2	Tier 1	D	No
Stationary Combustion, Fossil waste	CO_2	Tier 3	CS	Yes
Stationary Combustion, Petroleum coke	CO_2	Tier 2	CS	Yes
Stationary Combustion, Residual oil	CO_2	Tier 3 / Tier 3 / Tier 1[4]	PS / CS / D[4]	Yes
Stationary Combustion, Gas oil	CO_2	Tier 2 / Tier 3	CR / PS	Yes
Stationary Combustion, Kerosene	CO_2	Tier 1	D	Yes
Stationary Combustion, LPG	CO_2	Tier 1	D	No
Stationary Combustion, Refinery gas	CO_2	Tier 3	PS / CS	Yes
Stationary Combustion, Natural gas	CO_2	Tier 3	CS / PS[5]	Yes
Stationary Combustion, SOLID	CH_4	Tier 2 / Tier 1	D(2) / D	No
Stationary Combustion, LIQUID	CH_4	Tier 2 / Tier 2 / Tier 1	D(2) / CS / D	No
Stationary Combustion, GAS	CH_4	Tier 2 / Tier 3	D(2) / CS	No
Natural gas fuelled engines, GAS	CH_4	Tier 3	CS	Yes
Stationary Combustion, WASTE	CH_4	Tier 2	CS	No
Stationary Combustion, BIOMASS	CH_4	Tier 2 / Tier 1	D(2) / CS / D	Yes
Biogas fuelled engines, BIOMASS	CH_4	Tier 3	CS	No
Stationary Combustion, SOLID	N_2O	Tier 2 / Tier 1	CS / D	Yes
Stationary Combustion, LIQUID	N_2O	Tier 2 / Tier 1	D(2) / D / CS	Yes
Stationary Combustion, GAS	N_2O	Tier 1 / Tier 2	D / CS / D(2)	Yes
Stationary Combustion, WASTE	N_2O	Tier 2	CS	No
Stationary Combustion, BIOMASS	N_2O	Tier 1 / Tier 2	D / CS / D(2)	Yes

1) D: IPCC tier 1, D(2): IPCC tier 2/3, CR: Corinair default, CS: Country specific, PS: Plant specific.

Key Categories

Key Category Analysis (KCA) tier 1 and 2 for year 1990, 2010 and trend for Denmark has been carried out in accordance with the IPCC Good Practice Guidance / IPCC Guidelines (2006). Table 3.2.2 shows which of the stationary combustion source categories are key categories. The table is based on the analysis including LULUCF. Detailed key category analysis is shown in NIR Chapter 1.5 and Annex 1.

The CO_2 emissions from stationary combustion are key for all the major fuels. In addition, the CH_4 emission from natural gas fuelled engines and biomass are also key. Finally, due to the relatively high uncertainty for N_2O, emission factors the N_2O emission from solid, liquid and gaseous fuels and for biomass are also key categories in the tier 2 analysis.

2 For 2006 onwards. Country specific emission factors and tier 2 have been applied for 1990-2005.
3 For coal combustion in other source sectors than 1A1a corresponding to 3 % of the coal consumption in 2010.
4 Residual oil not applied in source category 1A1a.
5 Off shore gas turbines and a few power plants.

Table 3.2.2 Key categories[6], stationary combustion.

			Tier 1			Tier 2		
			1990	2010	1990-2010	1990	2010	1990-2010
Energy	Stationary Combustion, Coal	CO_2	Level	Level	Trend	Level	Level	Trend
Energy	Stationary Combustion, BKB	CO_2						
Energy	Stationary Combustion, Coke	CO_2						
Energy	Stationary Combustion, Fossil waste	CO_2	Level	Level	Trend	Level	Level	Trend
Energy	Stationary Combustion, Petroleum coke	CO_2	Level	Level	Trend			
Energy	Stationary Combustion, Residual oil	CO_2	Level	Level	Trend			
Energy	Stationary Combustion, Gas oil	CO_2	Level	Level	Trend	Level		Trend
Energy	Stationary Combustion, Kerosene	CO_2	Level		Trend			
Energy	Stationary Combustion, LPG	CO_2						
Energy	Stationary Combustion, Refinery gas	CO_2	Level	Level	Trend			
Energy	Stationary Combustion, Natural gas	CO_2	Level	Level	Trend			Trend
Energy	Stationary Combustion, SOLID	CH_4						
Energy	Stationary Combustion, LIQUID	CH_4						
Energy	Stationary Combustion, GAS	CH_4						
Energy	Natural gas fuelled engines, GAS	CH_4			Trend			
Energy	Stationary Combustion, WASTE	CH_4						
Energy	Stationary Combustion, BIOMASS	CH_4					Level	
Energy	Biogas fuelled engines, BIOMASS	CH_4						
Energy	Stationary Combustion, SOLID, N_2O	N_2O				Level	Level	Trend
Energy	Stationary Combustion, LIQUID, N_2O	N_2O				Level	Level	Trend
Energy	Stationary Combustion, GAS, N_2O	N_2O				Level	Level	Trend
Energy	Stationary Combustion, WASTE, N_2O	N_2O						
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O				Level	Level	Trend

3.2.2 Fuel consumption data

In 2010, the total fuel consumption for stationary combustion plants was 552 PJ of which 423 PJ was fossil fuels and 129 PJ was biomass.

Fuel consumption distributed according to the stationary combustion subcategories is shown in Figure 3.2.1 and Figure 3.2.2. The majority - 60 % - of all fuels is combusted in the source category, *Public electricity and heat production*. Other source categories with high fuel consumption are *Residential* and *Industry*.

[6] For Denmark not including Greenland and Faroe Island.

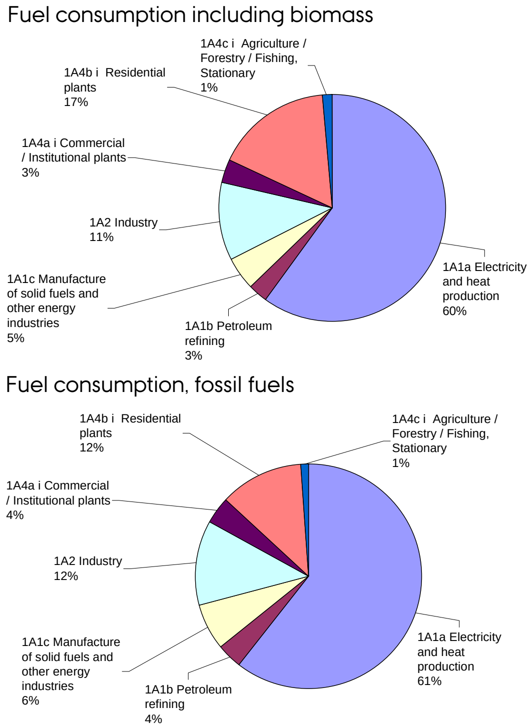


Figure 3.2.1 Fuel consumption of stationary combustion source categories, 2010. Based on DEA (2011a).

Coal and natural gas are the most utilised fuels for stationary combustion plants. Coal is mainly used in power plants and natural gas is used in power plants and decentralised combined heat and power (CHP) plants, as well as in industry, district heating, residential plants and offshore gas turbines (see Figure 3.2.2).

Detailed fuel consumption rates are shown in Annex 3A-2.

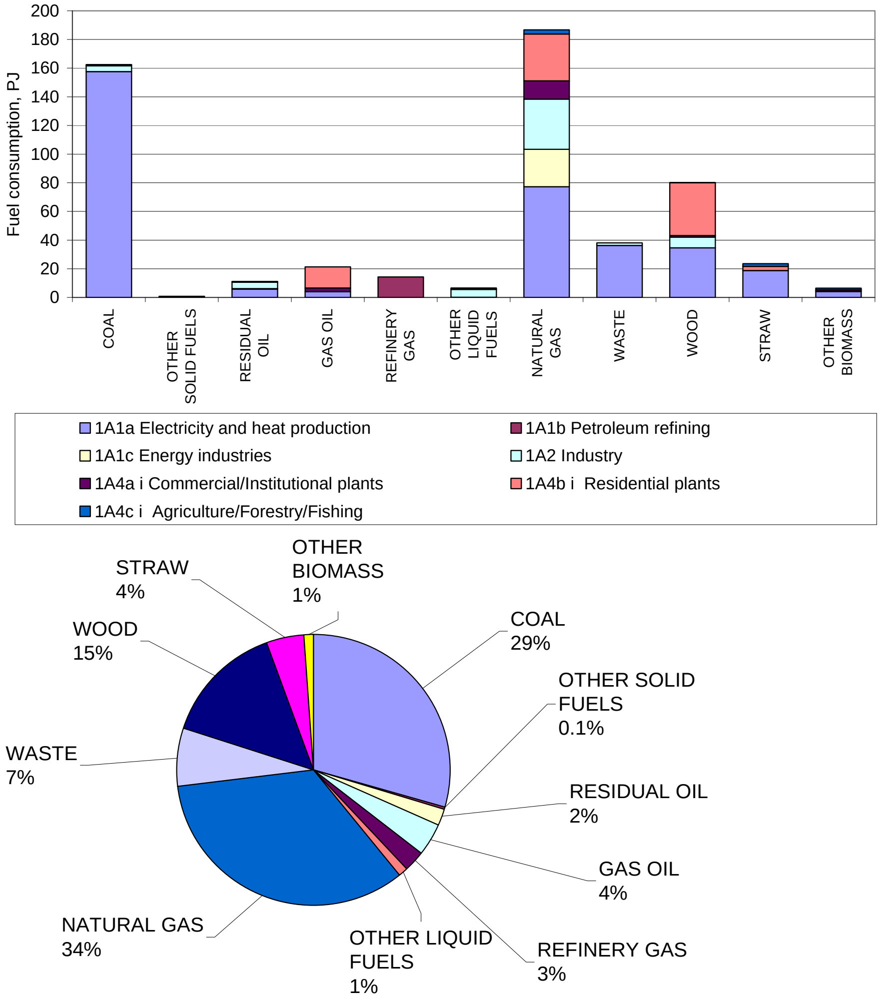


Figure 3.2.2 Fuel consumption of stationary combustion 2010, disaggregated to fuel type. Based on DEA (2011a).

Fuel consumption time series for stationary combustion plants are presented in Figure 3.2.3. The fuel consumption for stationary combustion was 11 % higher in 2010 than in 1990, while the fossil fuel consumption was 8 % lower and the biomass fuel consumption 3.2 times the level in 1990.

The consumption of natural gas and biomass has increased since 1990 whereas coal consumption has decreased.

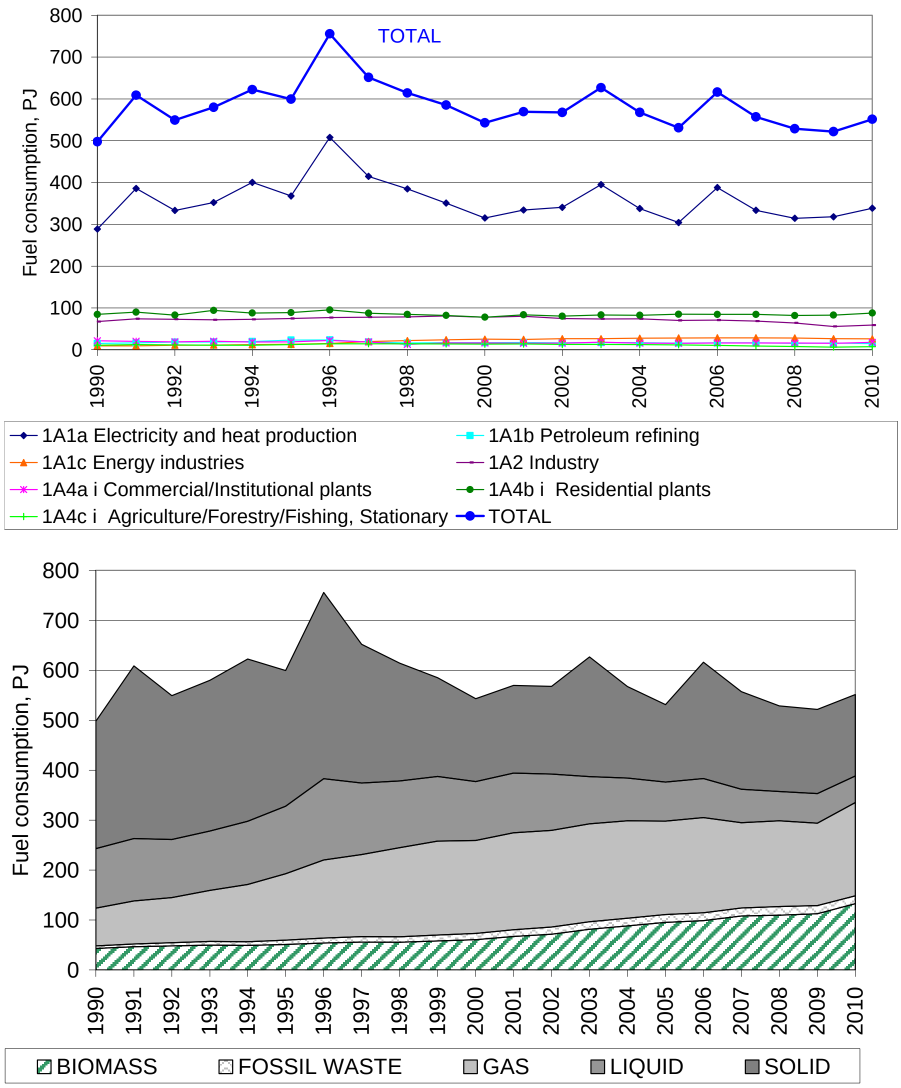


Figure 3.2.3 Fuel consumption time series, stationary combustion. Based on DEA (2011a).

The fluctuations in the time series for fuel consumption are mainly a result of electricity import/export, but also of outdoor temperature variations from year to year. This, in turn, leads to fluctuations in emission levels. The fluctuations in electricity trade, fuel consumption, CO_2 and NO_x emission are illustrated and compared in Figure 3.2.4. In 1990, the Danish electricity import was large causing relatively low fuel consumption, whereas the fuel consumption was high in 1996 due to a large electricity export. In 2010, the net electricity export was 4.1 PJ, whereas there was a 1.2 PJ electricity import in 2009. The large electricity export that occurs some years is a result of low rainfall in Norway and Sweden causing insufficient hydropower production in both countries.

To be able to follow the national energy consumption as well as for statistical and reporting purposes, the Danish Energy Agency (DEA) produces a correction of the actual fuel consumption and CO_2 emission without random variations in electricity imports/exports and in ambient temperature. This fuel consumption trend is also illustrated in Figure 3.2.4. The corrections are included here to explain the fluctuations in the time series for fuel rate and emission.

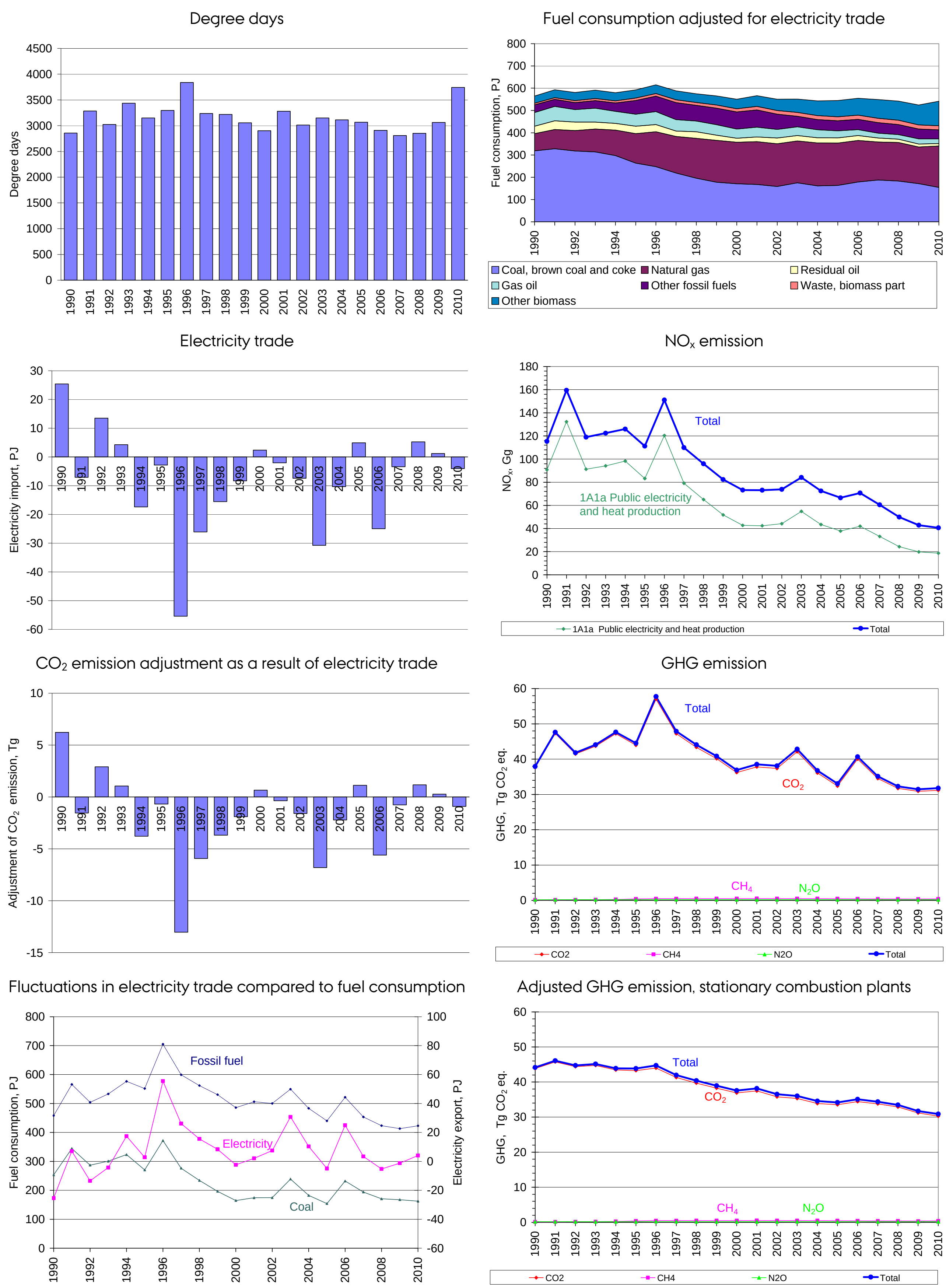


Figure 3.2.4 Comparison of time series fluctuations for electricity trade, fuel consumption and NO_x emission. Based on DEA (2011b).

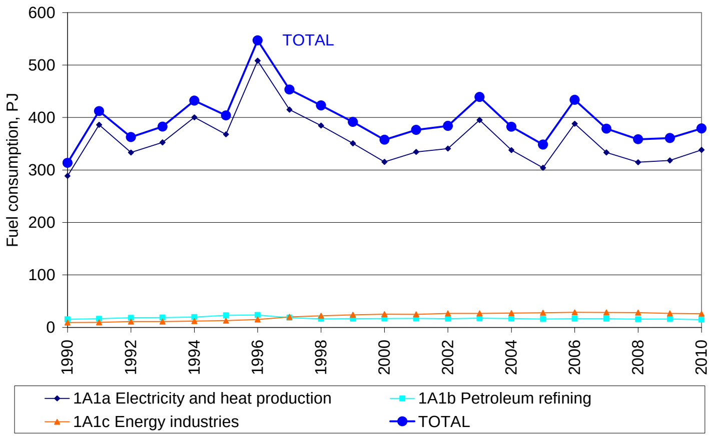
Fuel consumption time series for the subcategories to stationary combustion are shown in Figure 3.2.5, 3.2.6 and 3.2.7.

Fuel consumption for Energy Industries fluctuates due to electricity trade as discussed above. The fuel consumption in 2010 was 21 % higher than in 1990. The fluctuation in electricity production is based on fossil fuel consumption in the subcategory Electricity and Heat Production. The energy consumption in Other energy industries is mainly natural gas used in gas turbines in the off-shore industry. The biomass fuel consumption in Energy Industries 2010 added up to 75 PJ, which is 4.9 times the level in 1990 and a 31 % increase since 2009.

The fuel consumption in *Industry* was 12 % lower in 2010 than in 1990 (Figure 3.2.6). The fuel consumption in industrial plants has decreased considerably as a result of the financial crisis. However, the fuel consumption has increased 6 % since 2009. The biomass fuel consumption in Industry in 2010 added up to 9 PJ which is a 42 % increase since 1990.

The fuel consumption in *Other Sectors* has decreased by 3 % since 1990 and increased 8 % since 2009. (Figure 3.2.7). The biomass fuel consumption in Other sectors in 2010 added up to 45 PJ which is a 2.4 times the consumption in 1990 and a 6 % increase since 2009. Wood consumption in residential plants in 2010 was 2.3 times the consumption in year 2000.

time series for subcategories are shown in Chapter 3.2.4.



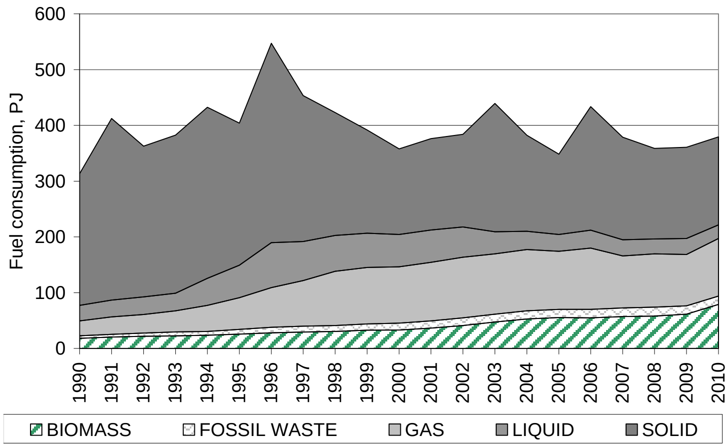


Figure 3.2.5 Fuel consumption time series for subcategories - 1A1 Energy Industries.

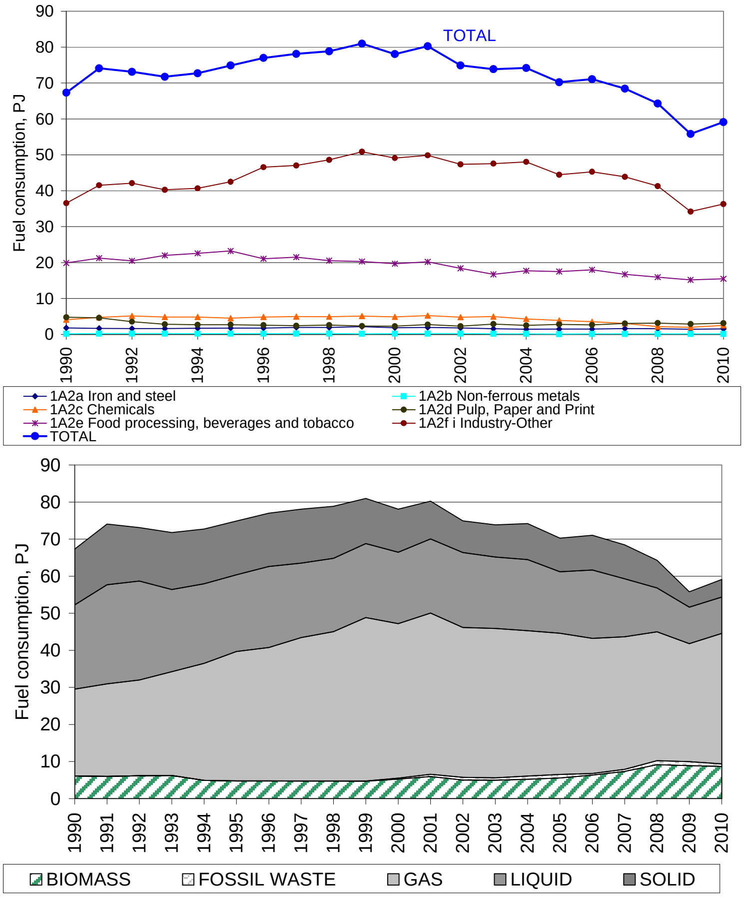


Figure 3.2.6 Fuel consumption time series for subcategories - 1A2 Industry.

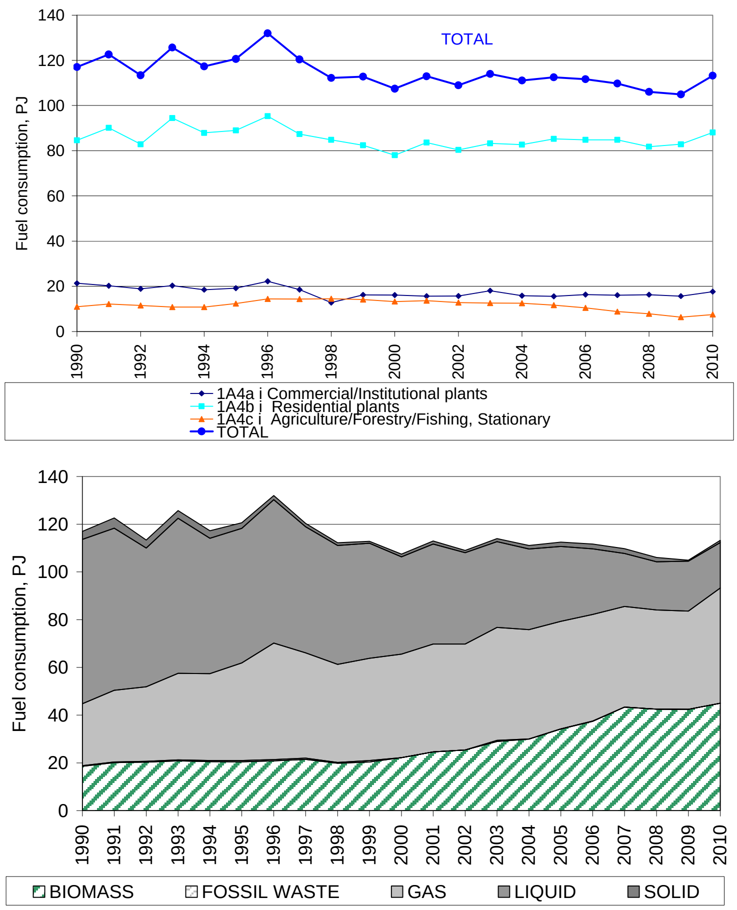


Figure 3.2.7 Fuel consumption time series for subcategories - 1A4 Other Sectors.

3.2.3 Emissions

Greenhouse gas emission

The greenhouse gas emissions from stationary combustion are listed in Table 3.2.3. The emission from stationary combustion accounted for 52 % of the national greenhouse gas emission (excluding LULUCF) in 2010.

The CO_2 emission from stationary combustion plants accounts for 64 % of the national CO_2 emission (excluding LULUCF). The CH_4 emission accounts for 7 % of the national CH_4 emission and the N_2O emission for 3 % of the national N_2O emission.

Table 3.2.3 Greenhouse gas emission, 2010 [1].

	CO_2	CH_4	N_2O
	Gg CO_2 equivalent		
1A1 Fuel Combustion, Energy industries	23 577	231	107
1A2 Fuel Combustion, Manufacturing Industries and Construction [1]	3 365	13	24
1A4 Fuel Combustion, Other sectors [1]	4 231	164	69
Emission from stationary combustion plants	31 172	408	200
Emission share for stationary combustion	64%	7%	3%

[1] Only stationary combustion sources of the category is included.

CO_2 is the most important greenhouse gas accounting for 98.1 % of the greenhouse gas emission (CO_2 eq.) from stationary combustion. CH_4 accounts for 1.3 % and N_2O for 0.6 % of the greenhouse gas emission (CO_2 eq.) from stationary combustion (Figure 3.2.8).

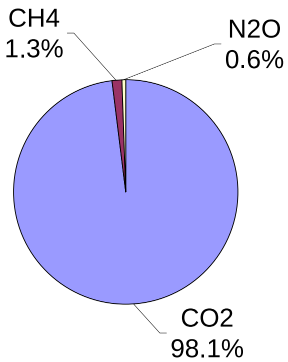


Figure 3.2.8 Stationary combustion - Greenhouse gas emission (CO_2 equivalent), contribution from each pollutant.

Figure 3.2.9 depicts the time series of greenhouse gas emission (CO_2 eq.) from stationary combustion and it can be seen that the greenhouse gas emission development follows the CO_2 emission development very closely. Both the CO_2 and the total greenhouse gas emission are lower in 2010 than in 1990, CO_2 by 17 % and greenhouse gas by 16 %. However, fluctuations in the GHG emission level are large.

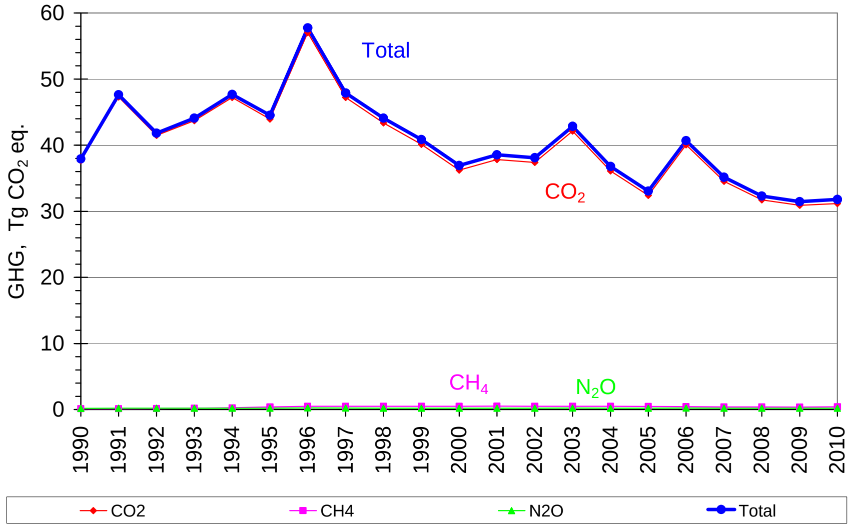


Figure 3.2.9 GHG emission time series for stationary combustion.

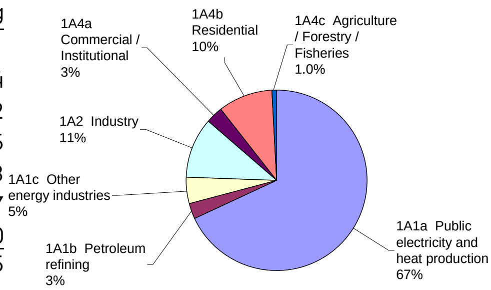
The fluctuations in the time series are largely a result of electricity import/export, but also of outdoor temperature variations from year to year. The fluctuations follow the fluctuations in fuel consumption discussed in Chapter 3.2.2. As mentioned in Chapter 3.2.2, the Danish Energy Agency estimates a correction of the actual CO_2 emission without random variations in electricity imports/exports and in ambient temperature. The greenhouse gas emission corrected for electricity import/export and ambient temperature has decreased by 30 % since 1990, and the CO_2 emission by 31 %. These data are included here to explain the fluctuations in the emission time series.

CO_2

The carbon dioxide (CO_2) emission from stationary combustion plants is one of the most important sources of greenhouse gas emissions. Thus, the CO_2 emission from stationary combustion plants accounts for 61 % of the national CO_2 emission. Table 3.2.4 lists the CO_2 emission inventory for stationary combustion plants for 2010. *Electricity and heat production* accounts for 67 % of the CO_2 emission from stationary combustion. This share is somewhat higher than the fossil fuel consumption share for this category, which is 61 % (Figure 3.2.1). This is due to a large share of coal in this category. Other large CO_2 emission sources are *Industry* and *Residential* plants. These are the source categories, which also account for a considerable share of fuel consumption.

Table 3.2.4 CO_2 emission from stationary combustion plants, 2010[1)].

		CO_2 Gg
1A1a	Public electricity and heat production	21231
1A1b	Petroleum refining	854
1A1c	Other energy industries	1492
1A2	Industry	3365
1A4a	Commercial/Institutional	933
1A4b	Residential	2997
1A4c	Agriculture/Forestry/Fisheries	300
Total		30845

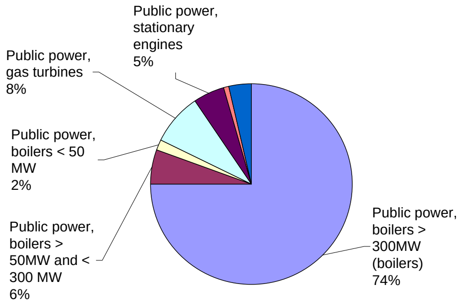


1) Only emission from stationary combustion plants in the categories is included.

In the Danish inventory, the source category *Electricity and heat production* is further disaggregated. The CO_2 emission from each of the subcategories is shown in Table 3.2.5. The largest subcategory is power plant boilers >300MW.

Table 3.2.5 CO_2 emission from subcategories to 1A1a Electricity and heat production.

Sub-category ID (SNAP)	Subcategory name	CO_2, Gg
0101	**Public power**	
010101	Combustion plants ≥ 300MW (boilers)	15 895
010102	Combustion plants ≥ 50MW and < 300 MW (boilers)	1 212
010103	Combustion plants <50 MW (boilers)	330
010104	Gas turbines	1 765
010105	Stationary engines	1 114
0102	**District heating plants**	
010202	Combustion plants ≥ 50MW and < 300 MW (boilers)	145
010203	Combustion plants <50 MW (boilers)	770



CO_2 emission from combustion of biomass fuels is not included in the total CO_2 emission data, because biomass fuels are considered CO_2 neutral. The CO_2 emission from biomass combustion is reported as a memo item in the Climate Convention reporting. In 2010, the CO_2 emission from biomass combustion was 14 781 Gg.

In Figure 3.2.10, the fuel consumption share (fossil fuels) is compared to the CO_2 emission share disaggregated to fuel origin. Due to the higher CO_2 emission factor for coal than oil and gas, the CO_2 emission share from coal combustion is higher than the fuel consumption share. Coal accounts for 37 % of the fossil fuel consumption and for 48 % of the CO_2 emission. Natural gas accounts for 41 % of the fossil fuel consumption but only 33 % of the CO_2 emission.

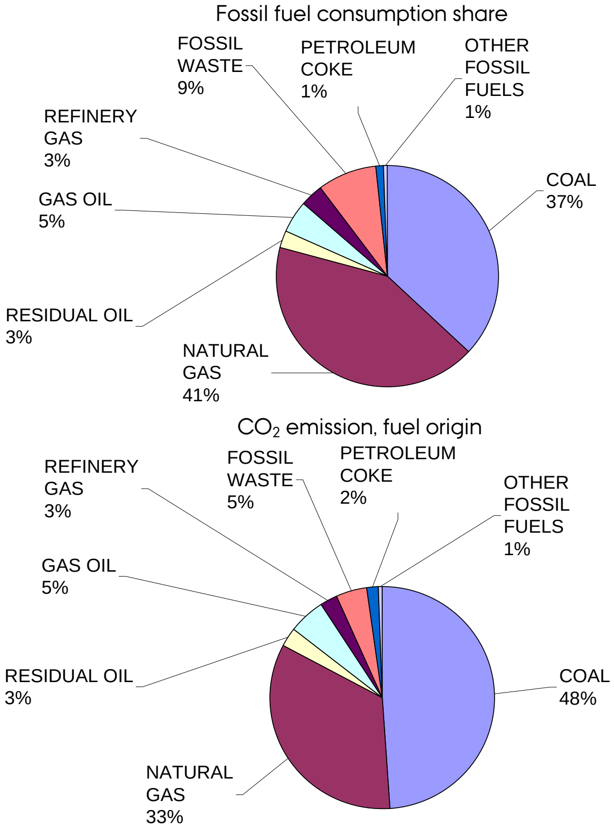


Figure 3.2.10 CO_2 emission, fuel origin.

The time series for CO_2 emission is provided in Figure 3.2.11. Despite an increase in fuel consumption of 11 %[7] since 1990, the CO_2 emission from stationary combustion has decreased by 17 % because of the change of fuel type used.

The fluctuations in total CO_2 emission follow the fluctuations in CO_2 emission from *Electricity and heat production* (Figure 3.2.11) and in coal consumption (Figure 3.2.4). The fluctuations are a result of electricity import/export as discussed in Chapter 3.2.2.

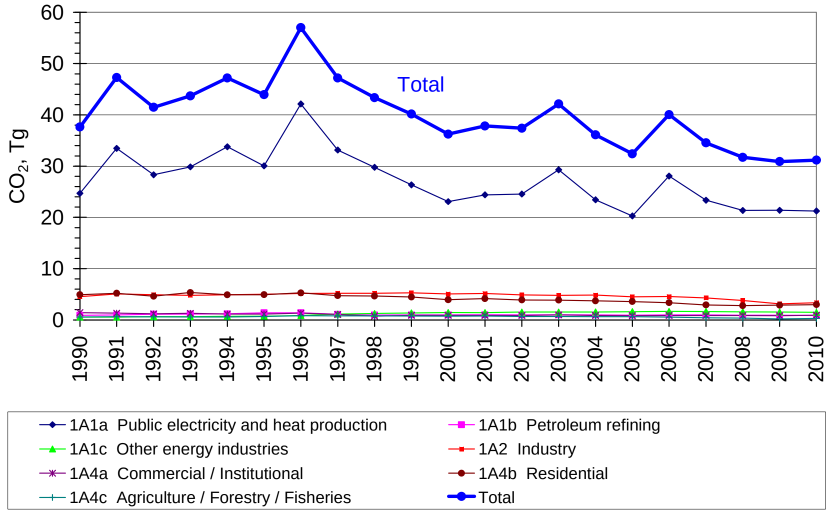


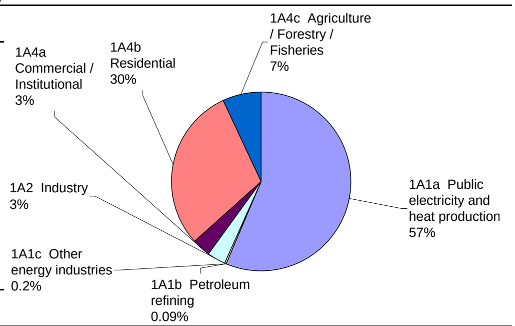
Figure 3.2.11 CO_2 emission time series for stationary combustion plants.

CH_4

The methane (CH_4) emission from stationary combustion plants accounts for 7 % of the national CH_4 emission. Table 3.2.6 lists the CH_4 emission inventory for stationary combustion plants in 2010. *Electricity and heat production* accounts for 57 % of the CH_4 emission from stationary combustion. The emission from residential plants adds up to 30 % of the emission.

Table 3.2.6 CH_4 emission from stationary combustion plants, 2010[1)].

	CH_4 Mg
1A1a Public electricity and heat production	10950
1A1b Petroleum refining	17
1A1c Other energy industries	44
1A2 Industry	624
1A4a Commercial/Institutional	662
1A4b Residential	5796
1A4c Agriculture/Forestry/Fisheries	1340
Total	19432



1) Only emission from stationary combustion plants in the source categories is included.

The CH_4 emission factor for reciprocating gas engines is much higher than for other combustion plants due to the continuous ignition/burn-out of the gas. Lean-burn gas engines have an especially high emission factor. A considerable number of lean-burn gas engines are in operation in Denmark and in 2010, these plants accounted for 64 % of the CH_4 emission from stationary combustion plants (Figure 3.2.12). Most engines are installed in CHP plants and the fuel used is either natural gas or biogas. Residential wood combus-

7 The consumption of fossil fuels has increased 8 %.

tion is also a large emission source accounting for 22 % of the emission in 2010.

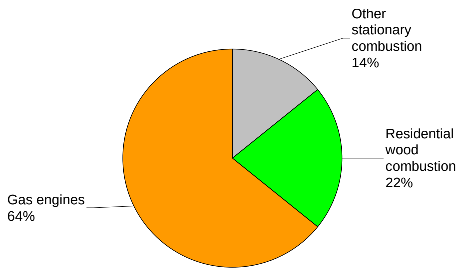


Figure 3.2.12 CH_4 emission share for gas engines and residential wood combustion, 2010.

Figure 3.2.13 shows the time series for CH_4 emission. The CH_4 emission from stationary combustion has increased by a factor of 3.3 since 1990. This results from the considerable number of lean-burn gas engines installed in CHP plants in Denmark during the 1990s. Figure 3.2.14 provides time series for the fuel consumption rate in gas engines and the corresponding increase of CH_4 emission. The decline in later years is due to structural changes in the Danish electricity market, which means that the fuel consumption in gas engines has been decreasing.

The CH_4 emission from residential plants has increased since 1990 due to increased combustion of biomass in residential plants. Combustion of wood accounted for 73 % of the CH_4 emission from residential plants in 2010.

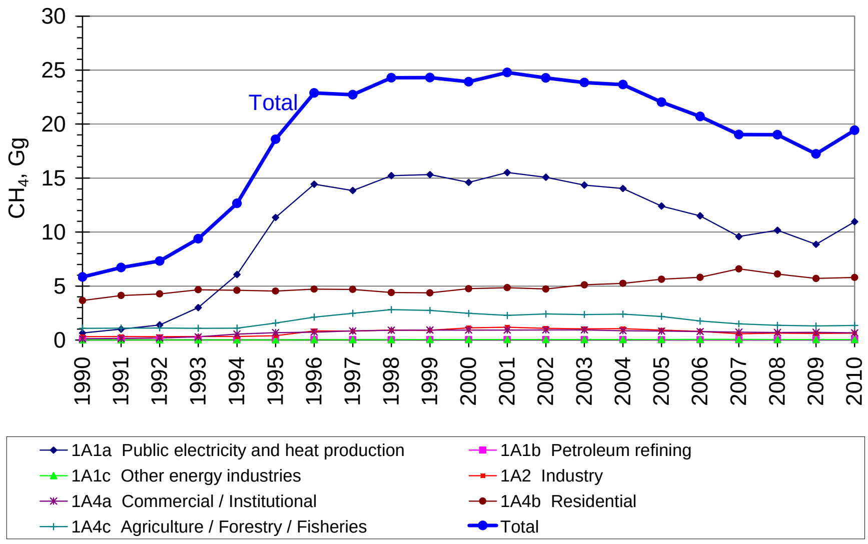


Figure 3.2.13 CH_4 emission time series for stationary combustion plants.

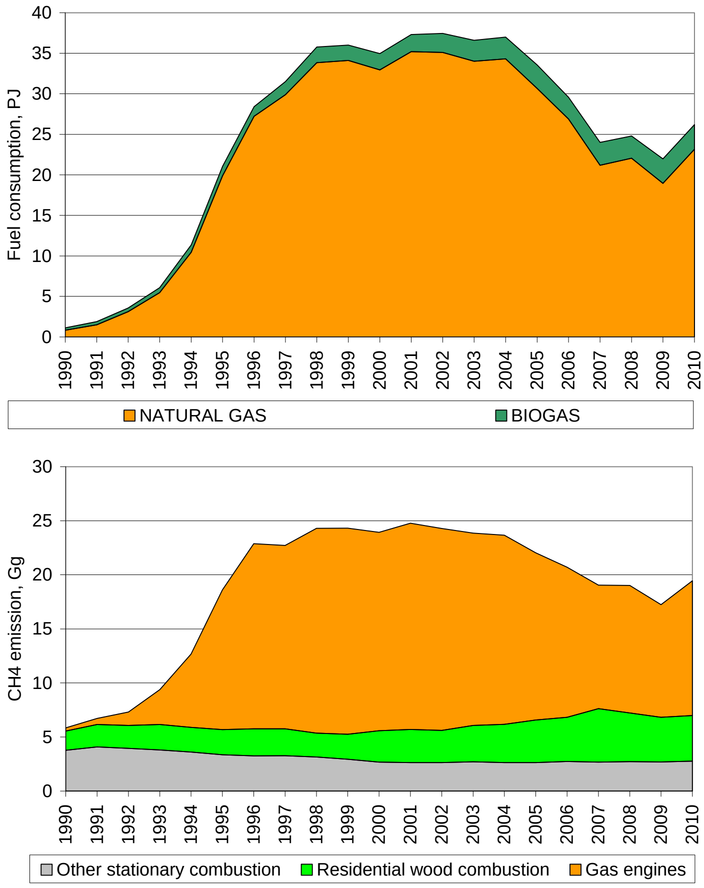


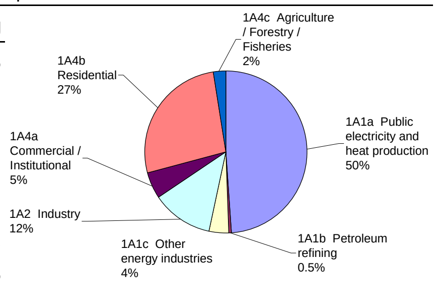
Figure 3.2.14 time series for a) fuel consumption in gas engines and b) CH_4 emission from gas engines, residential wood combustion and other plants.

N_2O

The nitrous oxide (N_2O) emission from stationary combustion plants accounts for 3 % of the national N_2O emission. Table 3.2.7 lists the N_2O emission inventory for stationary combustion plants in the year 2010. *Electricity and heat production* accounts for 50 % of the N_2O emission from stationary combustion.

Table 3.2.7 N_2O emission from stationary combustion plants, 2010[1].

	N_2O Mg
1A1a Public electricity and heat production	316
1A1b Petroleum refining	3
1A1c Other energy industries	26
1A2 Industry	78
1A4a Commercial/Institutional	34
1A4b Residential	172
1A4c Agriculture/Forestry/Fisheries	16
Total	645



[1] Only emission from stationary combustion plants in the source categories is included.

Figure 3.2.15 shows the time series for N_2O emission. The N_2O emission from stationary combustion has increased by 16 % from 1990 to 2010, but again fluctuations in emission level due to electricity import/export are considerable.

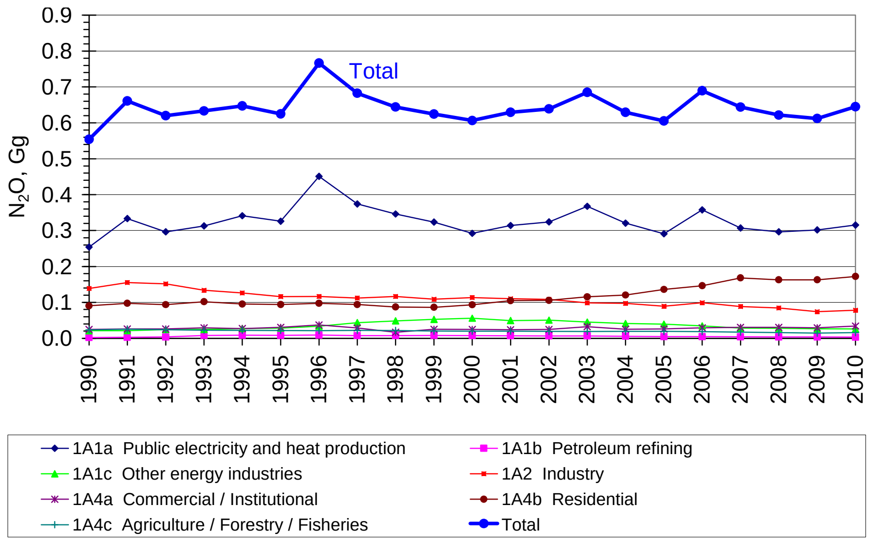


Figure 3.2.15 N_2O emission time series for stationary combustion plants.

SO_2, NO_x, NMVOC and CO

The emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), non volatile organic compounds (NMVOC) and carbon monoxide (CO) from Danish stationary combustion plants 2010 are presented in Table 3.2.8.

SO_2 from stationary combustion plants accounts for 73 % of the national emission. NO_x, CO and NMVOC account for 32 %, 39 % and 21 % of national emissions, respectively.

Table 3.2.8 SO_2, NO_x, NMVOC and CO emission, 2010[1].

Pollutant	NO_x	CO	NMVOC	SO_2
	Gg	Gg	Gg	Gg
1A1 Fuel consumption, Energy industries	26.7	11.5	2.4	3.9
1A2 Fuel consumption, Manufacturing Industries and Construction[1]	5.8	3.8	0.3	3.3
1A4 Fuel consumption, Other sectors[1]	8.1	140.4	15.6	2.8
Emission from stationary combustion plants	40.6	155.7	18.4	10.1
Emission share for stationary combustion, %	32	39	21	72

1) Only emissions from stationary combustion plants in the source categories are included.

SO_2

Stationary combustion is the most important emission source for SO_2 accounting for 72 % of the national emission. Table 3.2.9 presents the SO_2 emission inventory for the stationary combustion subcategories.

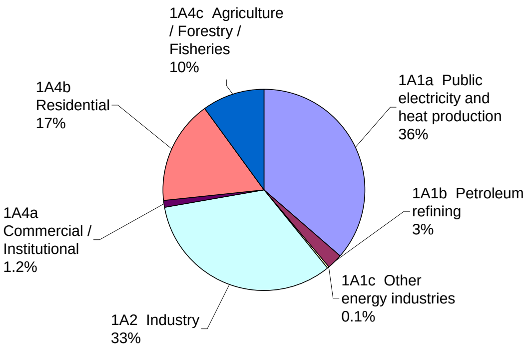
Electricity and heat production is the largest emission source accounting for 36 % of the emission. However, the SO_2 emission share is lower than the fuel consumption share for this source category, which is 60 %. This is a result of effective flue gas desulphurisation equipment installed in power plants combusting coal. In the Danish inventory, the source category *Electricity and heat production* is further disaggregated. Figure 3.2.16 shows the SO_2 emission from *Electricity and heat production* on a disaggregated level. Power plants >300MW$_{th}$ are the main emission source, accounting for 45 % of the emission.

The SO_2 emission from industrial plants is 33 %, a remarkably high emission share compared with fuel consumption. The main emission sources in the industrial category are combustion of coal and residual oil, but emissions from the cement industry is also a considerable emission source. Ten years ago SO_2 emission from the industrial category only accounted for a small part of the emission from stationary combustion, but as a result of reduced emissions from power plants the share has now increased.

The time series for SO_2 emission from stationary combustion are shown in Figure 3.2.17. The SO_2 emission from stationary combustion plants has decreased by 93 % since 1990. The large emission decrease is mainly a result of the reduced emission from *Electricity and heat production*, made possible due to installation of desulphurisation units and due to the use of fuels with lower sulphur content. Despite the considerable reduction in emission from electricity and heat production plants, these still account for 36 % of the emission from stationary combustion, as mentioned above. The emission from other source categories also decreased considerably since 1990. time series for subcategories are shown in Chapter 3.2.4.

Table 3.2.9 SO_2 emission from stationary combustion plants, 2010[1].

	SO_2 Mg
1A1a Public electricity and heat production	3664
1A1b Petroleum refining	269
1A1c Other energy industries	8
1A2 Industry	3349
1A4a Commercial/Institutional	123
1A4b Residential	1666
1A4c Agriculture/Forestry/Fisheries	1012
Total	10091



1) Only emission from stationary combustion plants in the source categories is included.

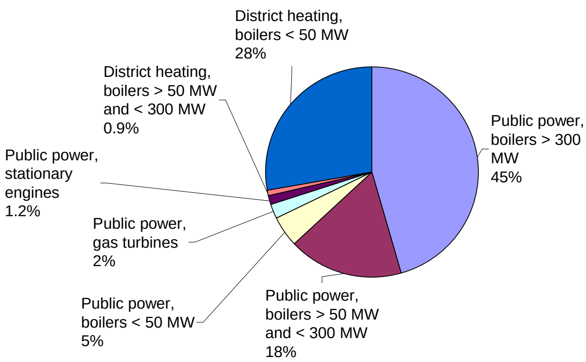


Figure 3.2.16 Disaggregated SO_2 emissions from 1A1a Energy and heat production.

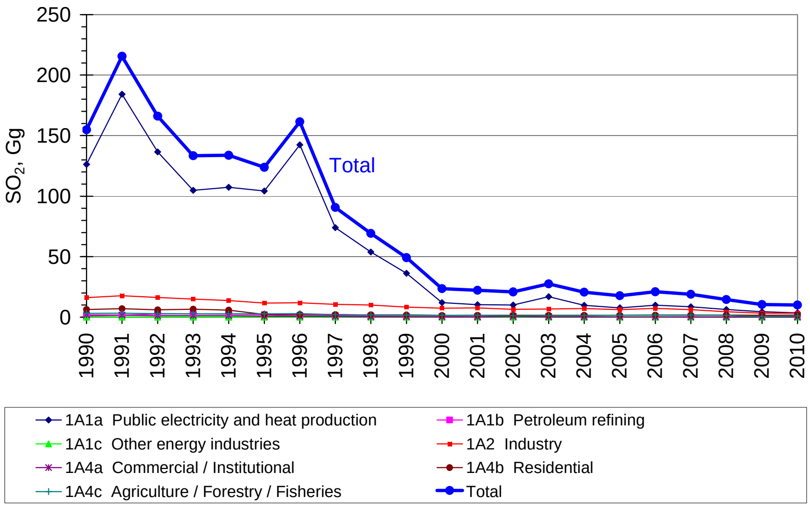


Figure 3.2.17 SO_2 emission time series for stationary combustion.

NO_x

Stationary combustion accounts for 32 % of the national NO_x emission. Table 3.2.10 shows the NO_x emission inventory for stationary combustion subcategories.

Electricity and heat production is the largest emission source accounting for 46 % of the emission from stationary combustion plants. The emission from public power boilers > 300 MWth accounts for 32 % of the emission in this subcategory.

Industrial combustion plants are also an important emission source accounting for 14 % of the emission. The main industrial emission source is cement production, which accounts for 37 % of the emission.

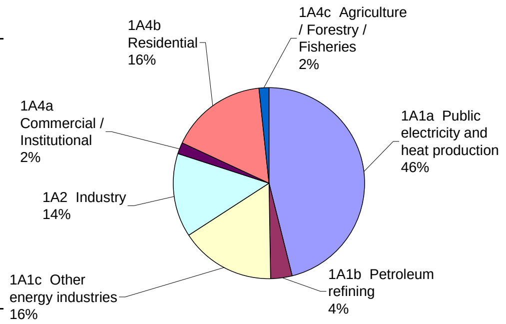
Residential plants account for 16 % of the NOx emission. The fuel origin of this emission is mainly wood accounting for 67 % of the residential plant emission.

Other energy industries, which is mainly off-shore gas turbines accounts for 16 % of the NO_x emission.

time series for NO_x emission from stationary combustion are shown in Figure 3.2.18. NO_x emission from stationary combustion plants has decreased by 65 % since 1990. The reduced emission is largely a result of the reduced emission from electricity and heat production due to installation of low NO_x burners, selective catalytic reduction (SCR) units and selective non-catalytic reduction (SNCR) units. The fluctuations in the time series follow the fluctuations in electricity and heat production, which, in turn, result from electricity trade fluctuations.

Table 3.2.10 NO_x emission from stationary combustion plants, 2010[1].

NO_x Mg	
1A1a Public electricity and heat production	18674
1A1b Petroleum refining	1544
1A1c Other energy industries	6490
1A2 Industry	5768
1A4a Commercial/Institutional	837
1A4b Residential	6615
1A4c Agriculture/Forestry/Fisheries	687
Total	40613



[1] Only emission from stationary combustion plants in the source categories is included.

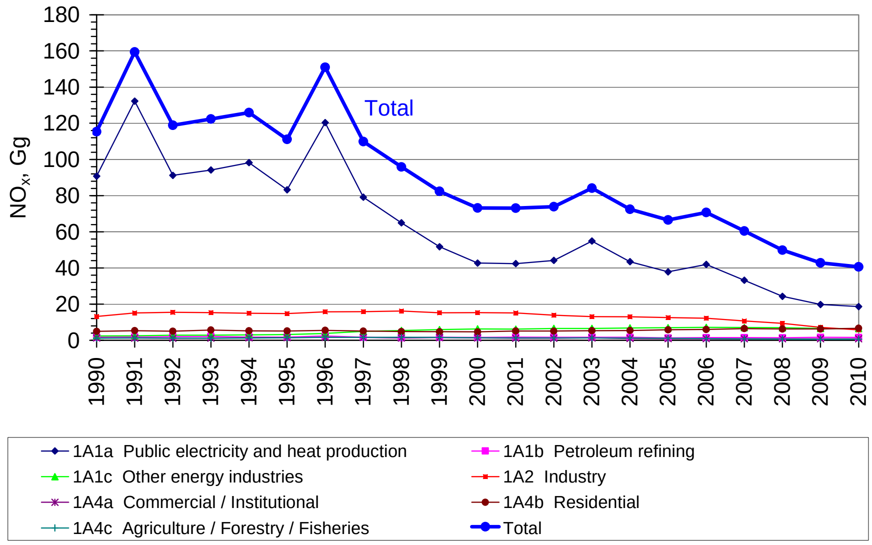


Figure 3.2.18 NO_x emission time series for stationary combustion.

NMVOC

Stationary combustion plants account for 21 % of the national NMVOC emission. Table 3.2.11 presents the NMVOC emission inventory for the stationary combustion subcategories.

Residential plants are the largest emission source accounting for 81 % of the emission from stationary combustion plants. For residential plants NMVOC is mainly emitted from wood and straw combustion, see Figure 3.2.19.

Electricity and heat production is also a considerable emission source, accounting for 13 % of the emission. Lean-burn gas engines have a relatively high NMVOC emission factor and are the most important emission source in this subcategory (see Figure 3.2.19). The gas engines are either natural gas or biogas fuelled.

time series for NMVOC emission from stationary combustion are shown in Figure 3.2.20. The emission has increased by 32 % from 1990. The increased emission is mainly a result of the increasing wood consumption in residential plants and of the increased use of lean-burn gas engines in CHP plants.

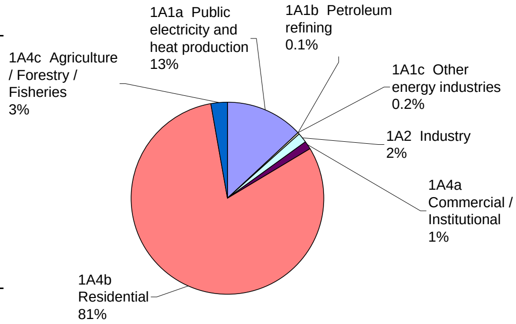
The emission from residential plants increased 30 % since 1990. The NMVOC emission from wood combustion in 2010 was 2.6 times the 1990 level due to increased wood consumption. However, the emission factor has decreased since 1990 due to installation of modern stoves and boilers with improved combustion technology. Further the emission from straw combustion in farmhouse boilers has decreased (76 %) over this period due to both a decreasing emission factor and decrease in straw consumption in this source category.

The use of wood in residential boilers and stoves was relatively low in 1998-99 resulting in a lower emission level.

The decrease of the NMVOC emission since 2007 is a result of both a decline of the consumption of wood in residential plants and a decreasing emission factor for firewood combustion in residential plants. The small increase in 2010 is a result of increased wood consumption in residential plants compared to 2009.

Table 3.2.11 NMVOC emission from stationary combustion plants, 2010[1].

	NMVOC Mg
1A1a Public electricity and heat production	2383
1A1b Petroleum refining	21
1A1c Other energy industries	42
1A2 Industry	301
1A4a Commercial/Institutional	262
1A4b Residential	14860
1A4c Agriculture/Forestry/Fisheries	485
Total	18354



1) Only emission from stationary combustion plants in the categories is included.

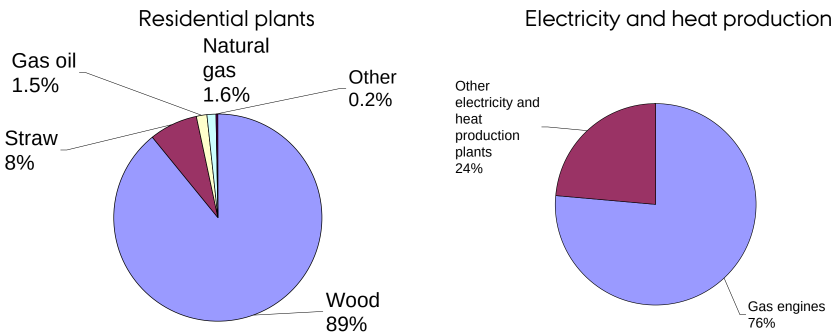


Figure 3.2.19 NMVOC emission from Residential plants and from Electricity and heat production, 2010.

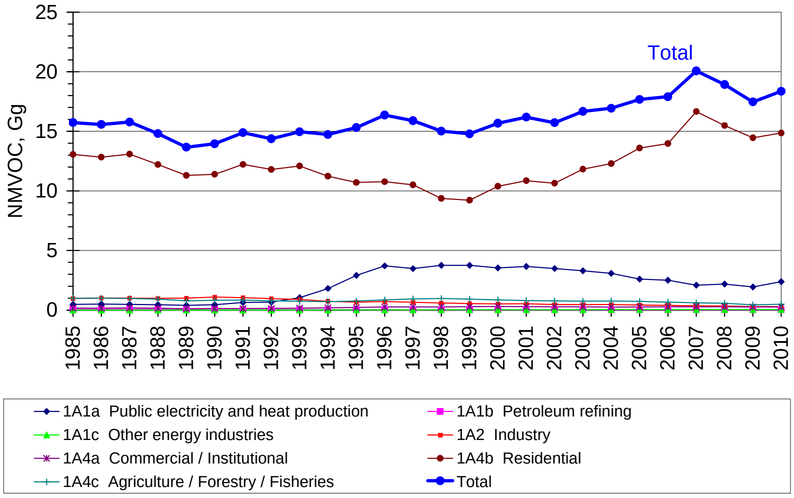


Figure 3.2.20 NMVOC emission time series for stationary combustion.

CO

Stationary combustion accounts for 39 % of the national CO emission. Table 3.2.12 presents the CO emission inventory for stationary combustion subcategories.

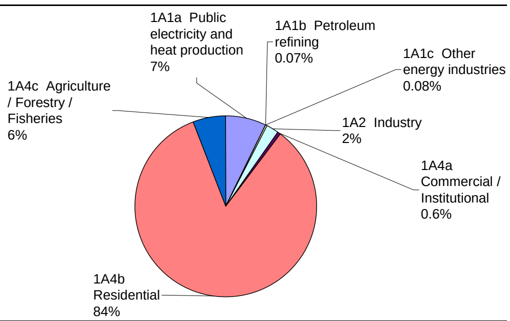
Residential plants are the largest emission source, accounting for 84 % of the emission. Wood combustion accounts for 90 % of the emission from residential plants, see Figure 3.2.21. This is in spite of the fact that the fuel consumption share is only 42 %. Combustion of straw is also a considerable emission source whereas the emission from other fuels used in residential plants is almost negligible.

time series for CO emission from stationary combustion are shown in Figure 3.2.22. The emission has increased by 17 % from 1990. The time series for CO from stationary combustion plants follows the time series for CO emission from residential plants. The decreased wood consumption in residential plants in 2007-2009 and the increase in 2010 is reflected in the time series for CO emission.

The consumption of wood in residential plants in 2010 was 4.4 times the 1990 level. However, the CO emission factor for wood has decreased since 1990 causing the CO emission from wood combustion in residential plants in 2010 to be only 3.0 times the 1990 level. Both straw consumption and CO emission factor for residential plants have decreased since 1990.

Table 3.2.12 CO emission from stationary combustion plants, 2010[1].

	CO Mg
1A1a Public electricity and heat production	11256
1A1b Petroleum refining	102
1A1c Other energy industries	125
1A2 Industry	3817
1A4a Commercial/Institutional	904
1A4b Residential	130609
1A4c Agriculture/Forestry/Fisheries	8914
Total	155728



1) Only emission from stationary combustion plants in the source categories is included.

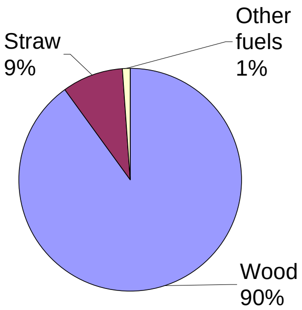
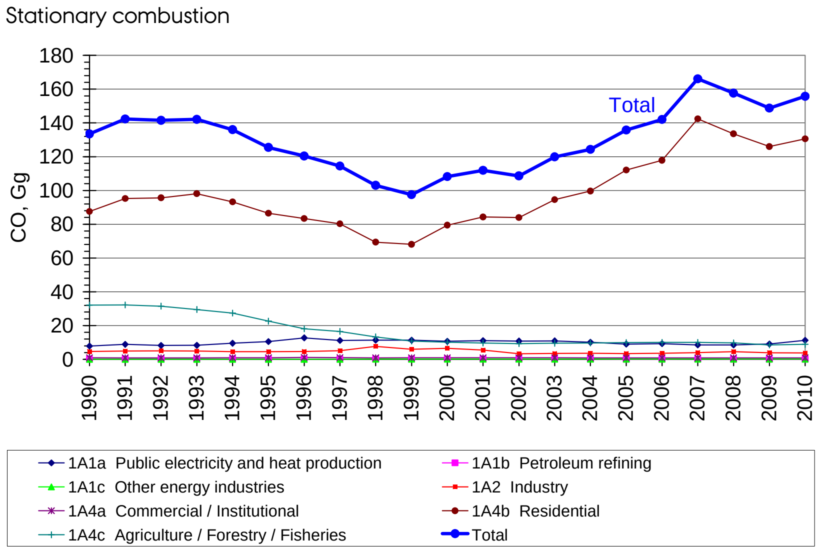


Figure 3.2.21 CO emission sources, residential plants, 2010.



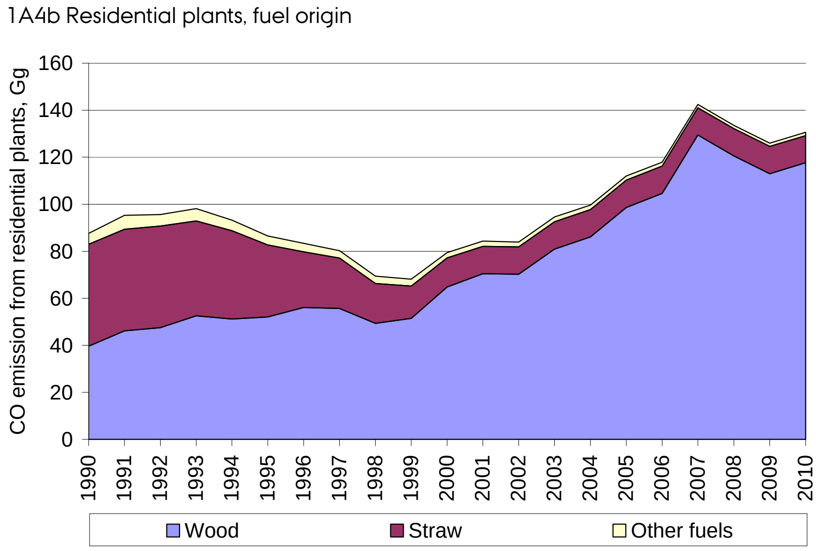


Figure 3.2.22 CO emission time series for stationary combustion.

3.2.4 Sectoral trend

In addition to the data for stationary combustion, this chapter presents and discusses data for each of the subcategories in which stationary combustion is included. Time series are presented for fuel consumption and emissions.

1A1 Energy industries

The emission source category *1A1 Energy Industries* consists of the subcategories:

- 1A1a Public electricity and heat production.
- 1A1b Petroleum refining.
- 1A1c Other energy industries.

Figure 3.2.23 – 3.2.25 present time series for the *Energy Industries*. *Electricity and heat production* is the largest subcategory accounting for the main part of all emissions. time series are discussed below for each subcategory.

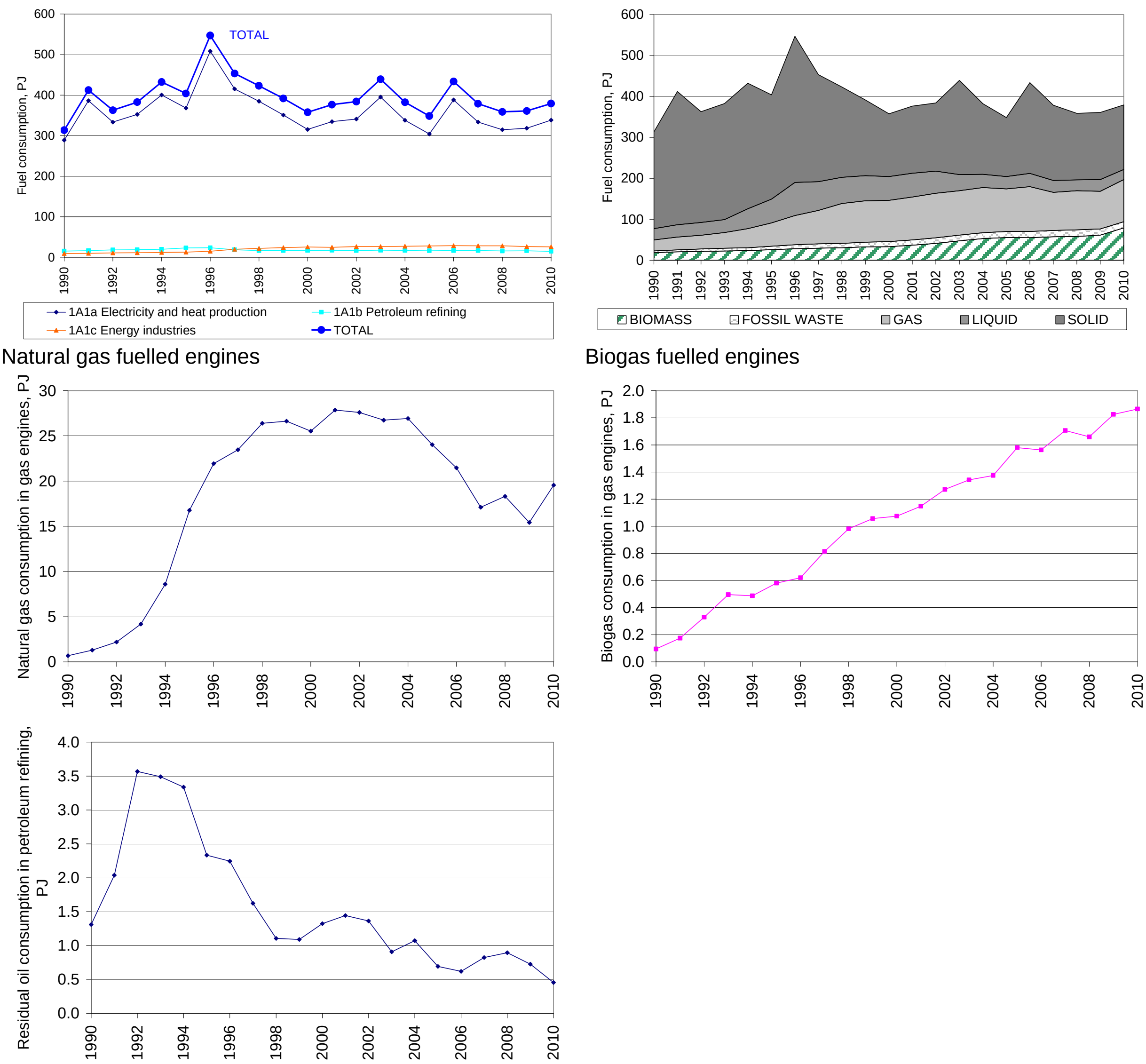


Figure 3.2.23 time series for fuel consumption, 1A1 Energy industries.

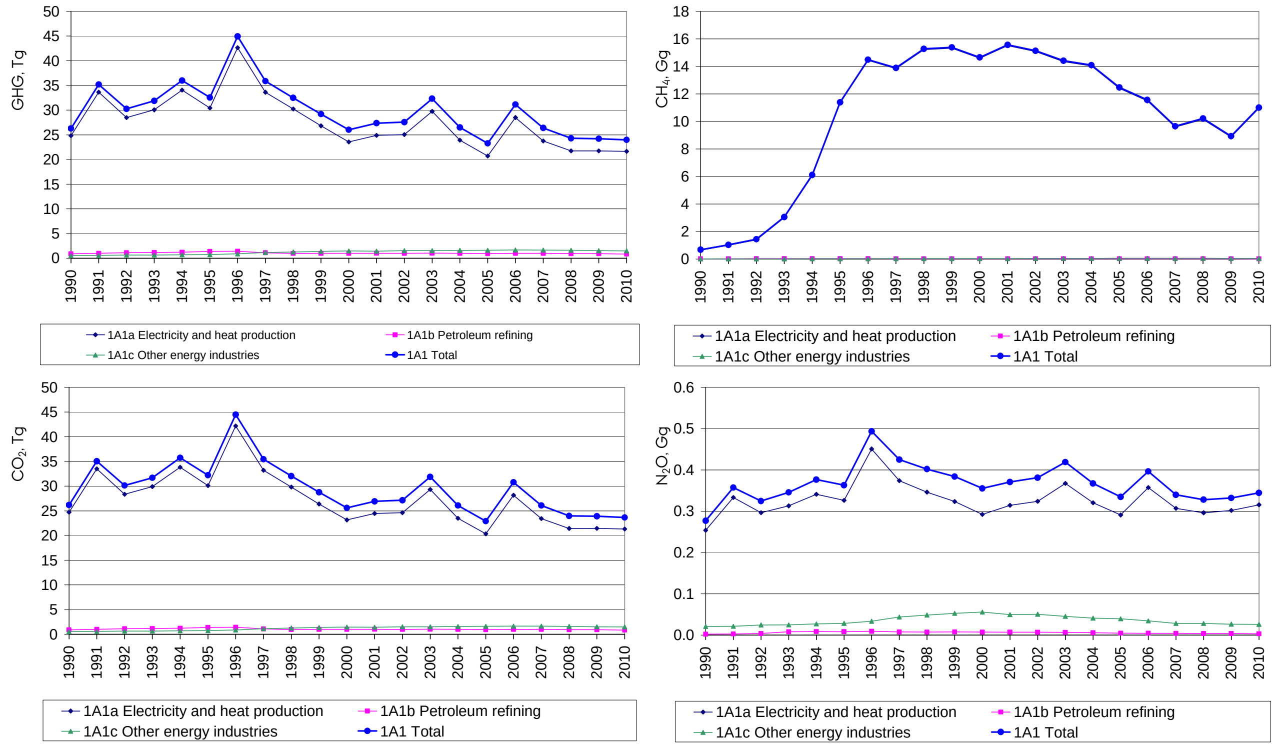


Figure 3.2.24 time series for greenhouse gas emission, 1A1 Energy industries.

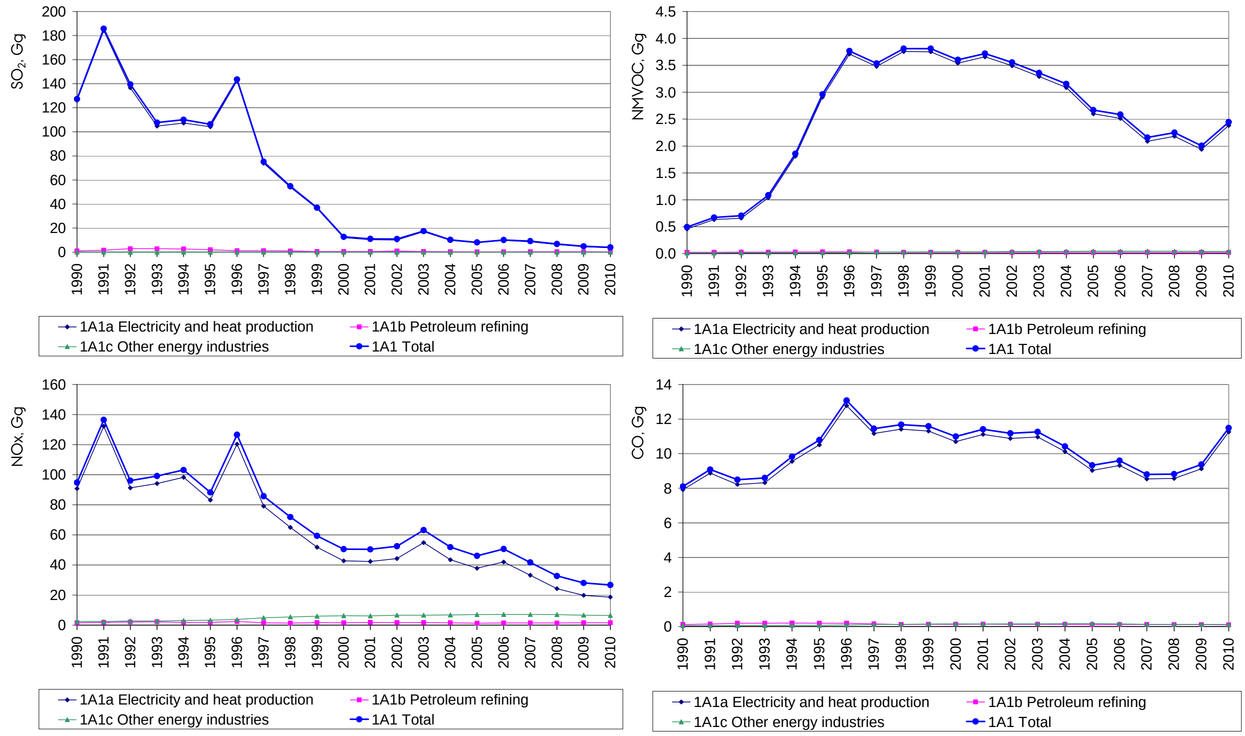


Figure 3.2.25 time series for SO_2, NO_x, NMVOC and CO emission, 1A1 Energy industries.

1A1a Electricity and heat production

Public electricity and heat production is the largest source category regarding both fuel consumption and greenhouse gas emissions for stationary combustion. Figure 3.2.26 shows the time series for fuel consumption and emissions.

The fuel consumption in electricity and heat production was 3 % higher in 2010 than in 1990. As discussed in Chapter 3.2.2 the fuel consumption fluctuates mainly as a consequence of electricity trade. Coal is the fuel that is affected the most by the fluctuating electricity trade. Coal is the main fuel in the source category even in years with electricity import. The coal consumption in 2010 was 33 % lower than in 1990. Natural gas is also an important fuel and the consumption of natural gas has increased since 1990, but decreased since 2003. A considerable part of the natural gas is combusted in gas engines (Figure 3.2.23). The consumption of waste and biomass has increased.

The CO_2 emission was 14 % lower in 2010 than in 1990. This decrease – in spite of higher fuel consumption - is a result of the change of fuels used as discussed above.

The CH_4 emission has increase until the mid-nineties as a result of the considerable number of lean-burn gas engines installed in CHP plants in Denmark in this period. The decline in later years is due to structural changes in the Danish electricity market, which means that the fuel consumption in gas engines has been decreasing (Figure 3.2.23). The emission in 2010 was 17 times the 1990 emission level.

The N_2O emission in 2010 was 24 % above the 1990 emission level. The emission fluctuates similar to the fuel consumption.

The SO_2 emission has decreased 97 % since 1990 and 19 % since 2009. This decrease is a result of both lower sulphur content in fuels and installation and improved performance of desulphurisation plants.

The NO_x emission has decreased 79 % due to installation of low NO_x burners, selective catalytic reduction (SCR) units and selective non-catalytic reduction (SNCR) units. The fluctuations in time series follow the fluctuations in fuel consumption and electricity trade.

The emission of NMVOC in 2010 was 5.2 times the 1990 emission level. This is a result of the large number of gas engines that has been installed in Danish CHP plants. The emission decreasing emission in 2004-2009 and the increase in 2010 compared to 2009 are a result of the time series for natural gas consumption in gas engines (Figure 3.2.23).

The CO emission was 42 % higher in 2010 than in 1990. The fluctuations follow the fluctuations of the fuel consumption. In addition, the emission from gas engines is considerable.

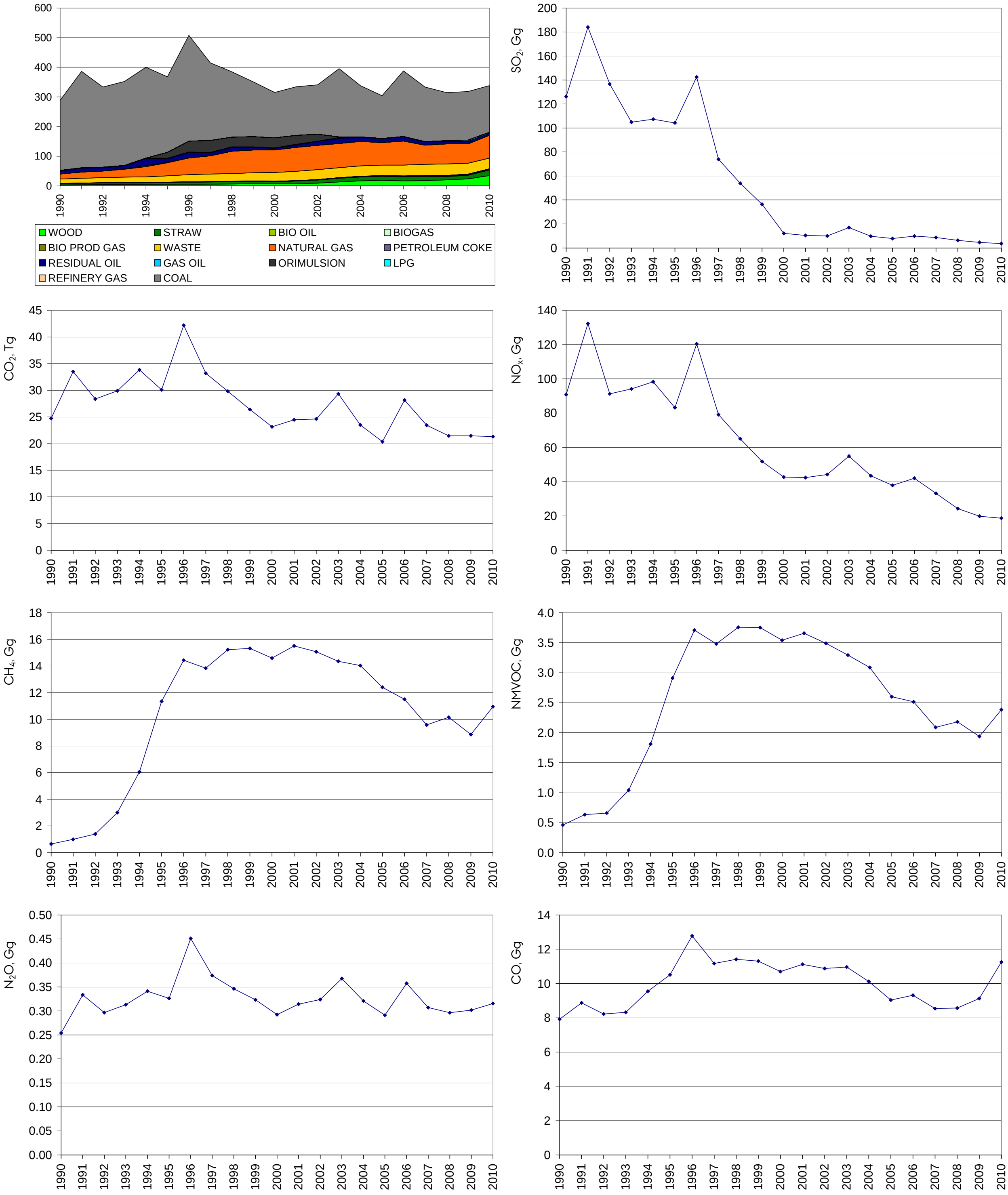


Figure 3.2.26 time series for 1A1a Electricity and heat production.

1A1b Petroleum refining

Petroleum refining is a small source category regarding both fuel consumption and greenhouse gas emissions for stationary combustion. There are presently only two refineries operating in Denmark. Figure 3.2.27 shows the time series for fuel consumption and emissions.

The significant decrease in both fuel consumption and emissions in 1996 is a result of the closure of a third refinery.

The fuel consumption has decreased 4 % since 1990 and the CO_2 emission has decreased 6 %.

The CH_4 emission has decreased 7 % since 1990 and 12 % since 2009. The reduction in CH_4 emission from 1995 to 1996 is caused by the closure of a refinery.

The N_2O emission was 41 % higher in 2010 than in 1990. The emission increased in 1990 – 1993 as a result of the installation of a gas turbine in one of the refineries. The gas turbine was installed in 1993 (DEA 2011c).

The N_2O emission factor for the refinery gas fuelled gas turbine has been assumed equal to the emission factor for natural gas fuelled turbines and thus the emission factor have been decreasing since 1994. This cause the decreasing trend in the time series since 1994. However, since only one gas turbine is included in the sector the same emission factor will be applied for all years in future inventories.

The emission of SO_2 has shown a pronounced decrease (75 %) since 1990, mainly due to the decreased consumption of residual oil (65%) also shown in Figure 3.2.27. The NO_x emission in 2010 was 4 % lower than in 1990. In recent years, data for both SO_2 and NO_x are plant specific data stated by the refineries.

The NMVOC and CO emission time series have been recalculated this year. Inconsistencies have been corrected.

Emissions from refineries are further discussed in Chapter 3.5.

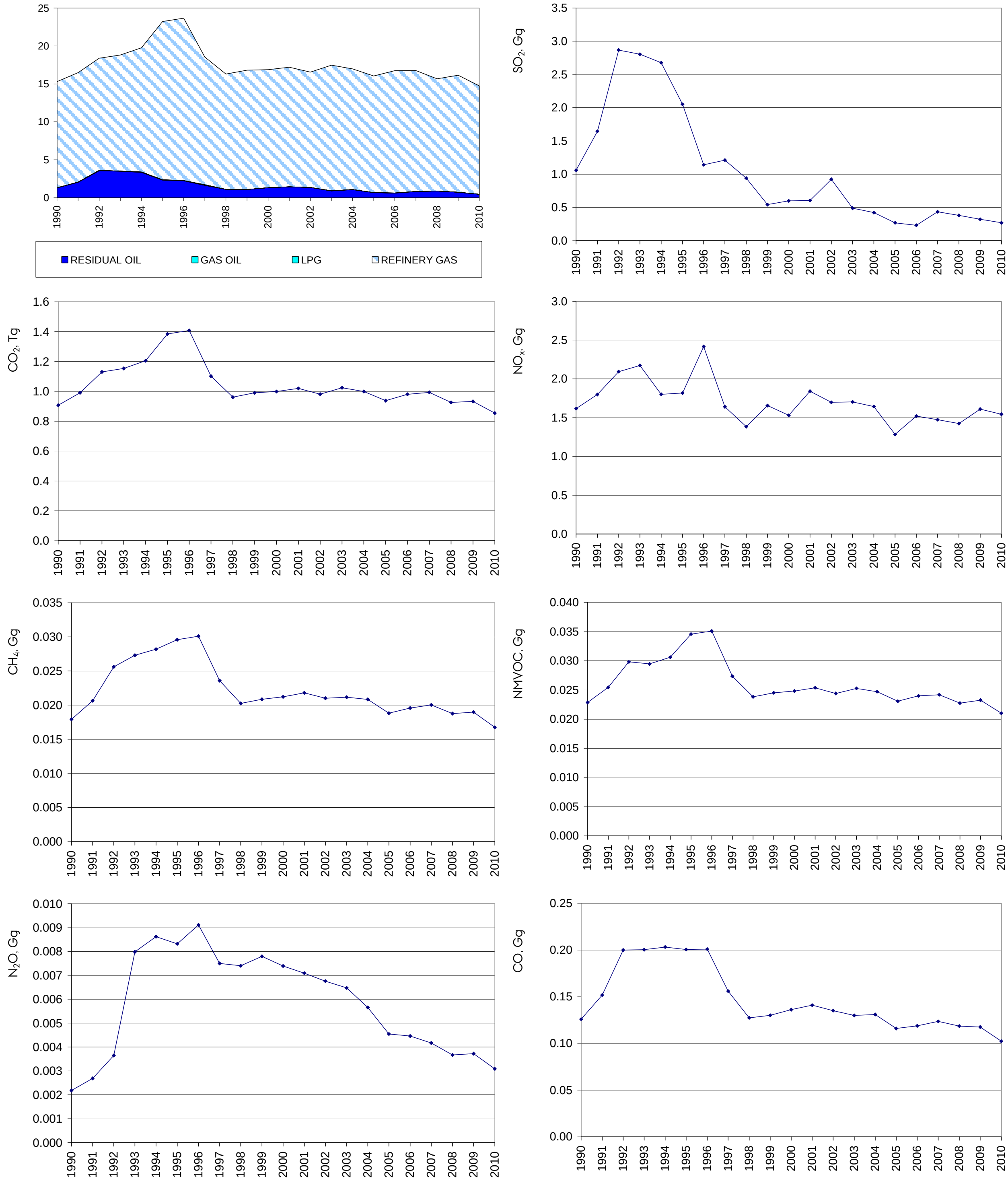


Figure 3.2.27 time series for 1A1b Petroleum refining.

1A1c Other energy industries

The source category *Other energy industries* comprises natural gas consumption in the offshore industry and a natural gas processing plant. Gas turbines are the main plant type. Figure 3.2.28 shows the time series for fuel consumption and emissions.

The fuel consumption in 2010 was 2.7 times the consumption in 1990. The CO_2 emission follows the fuel consumption and the emission in 2010 was also 2.7 times the emission in 1990.

The time series for N_2O is incorrect. The inconsistent emission factors will be corrected in the next inventory.

The emissions from all other pollutants follow the increase of fuel consumption.

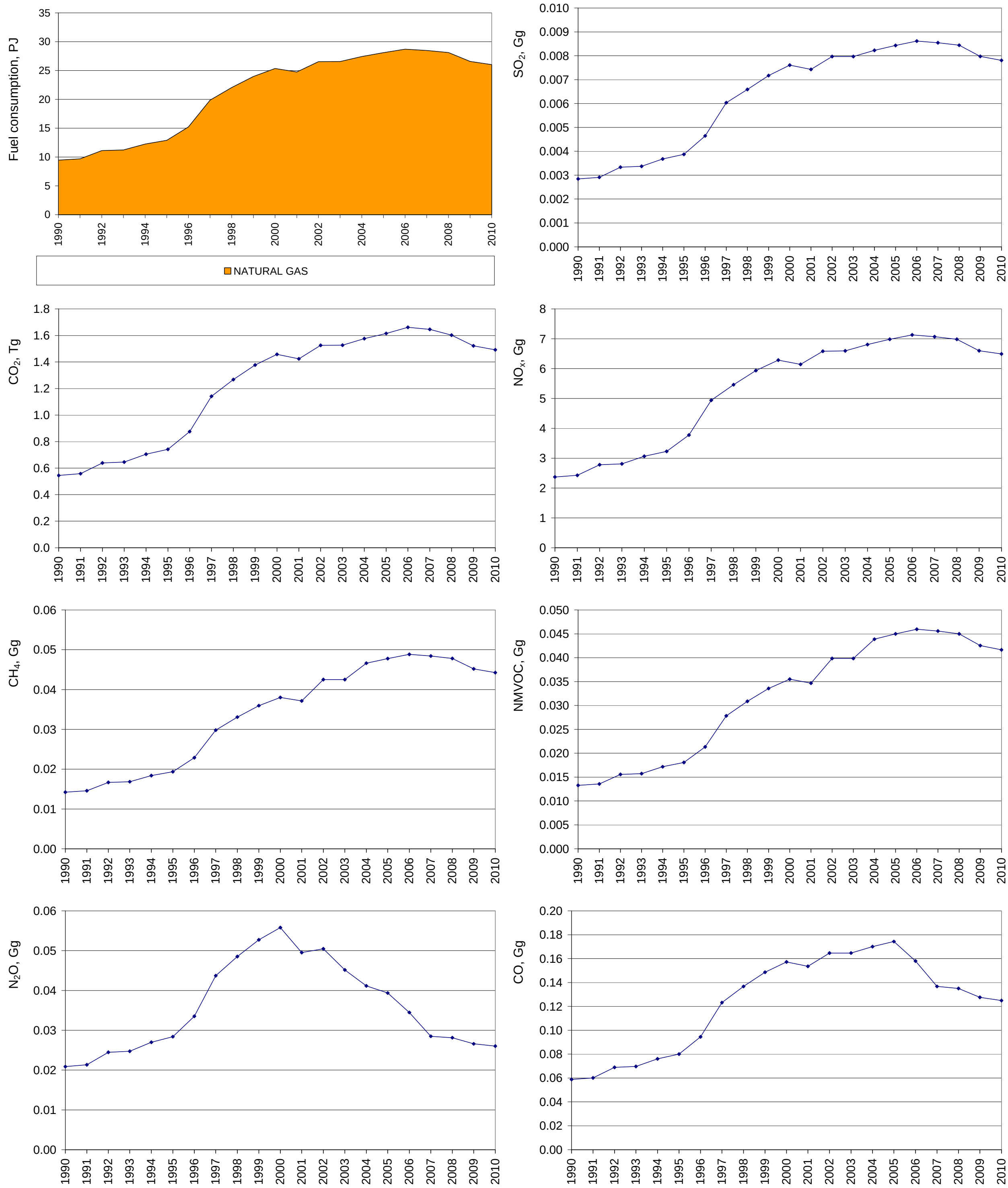


Figure 3.2.28 time series for 1A1c Other energy industries.

1A2 Industry

Manufacturing industries and construction (Industry) consists of both stationary and mobile sources. In this chapter, only stationary sources are included.

The emission source category *1A2 Industry* consists of the subcategories:

- 1A2a Iron and steel
- 1A2b Non-ferrous metals
- 1A2c Chemicals
- 1A2d Pulp, Paper and Print
- 1A2e Food processing, beverages and tobacco
- 1A2f i Industry-Other

Figure 3.2.29-3.2.31 show the time series for fuel consumption and emissions. The subsector *Industry – Other* is the main subsector for fuel consumption and emissions. *Food processing, beverages and tobacco* is also an important subsector.

The total fuel consumption in industrial combustion was 12 % lower in 2010 than in 1990. The fuel consumption has decreased considerably (17 %) since 2006 but however increased since 2009. The consumption of gas has increased since 1990 whereas the consumption of coal has decreased. The consumption of residual oil has decreased, but the consumption of petroleum coke increased. The biomass consumption has increased 27 % since 1990.

The greenhouse gas emission and the CO_2 emission are both rather stable following the small fluctuations in fuel consumption and the decrease since 2006. Due to change of applied fuels, the greenhouse gas and CO_2 emissions have decreased more than the fuel consumption since 1990; both emissions have decreased 26 %.

The CH_4 emission has increased from 1994-2000 and decreased again from 2004 - 2007. In 2010, the emission was 2.0 times the level in 1990. The CH_4 emission follows the consumption of natural gas in gas engines (Figure 3.2.29). Most industrial CHP plants based on gas engines came in operation during 1995 to 1999. The decrease in later years is a result of the liberalisation of the electricity market.

The N_2O emission has decreased 44 % since 1990, mainly due to the decreased residual oil consumption. In recent years, combustion of wood is a considerable emission source.

The SO_2 emission has decreased 79 % since 1990. This is mainly a result of lower consumption of residual oil in the industrial sector. Further, the sulphur content of residual oil and several other fuels has decreased since 1990 due to legislation and tax laws.

The NO_x emission has decreased 56 % since 1990 due to the reduced emission from industrial boilers in general. Cement production is the main emission source accounting for more than 50 % of the emission except in 2010. The NO_x emission from cement production was 67 % of the 1990 emission level whereas the fuel consumption was only 5 % lower. The reduced emission is a result of installation of SCR on all production units in 2004-2007 and improved performance of the SCR units in recent years. In 2010, the declining production rate also contributes to the reduced emission.

The NMVOC emission has decreased 73 % since 1990. The decrease is a mainly result of decreased emission factor for combustion of wood in industrial boilers. The emission from gas engines has however increased considerably after 1995 due to the increased fuel consumption that is a result of the installation of a large number of industrial CHP plants (Figure 3.35). The NMVOC emission factor for gas engines is much higher than for boilers regardless of the fuel.

The CO emission in 2010 was 19 % lower than in 1990. The main source of emission is combustion in *Industry – Other*, primarily in wood and cement production. The CO emission from mineral wool production is included in the industry sector (2A7d).

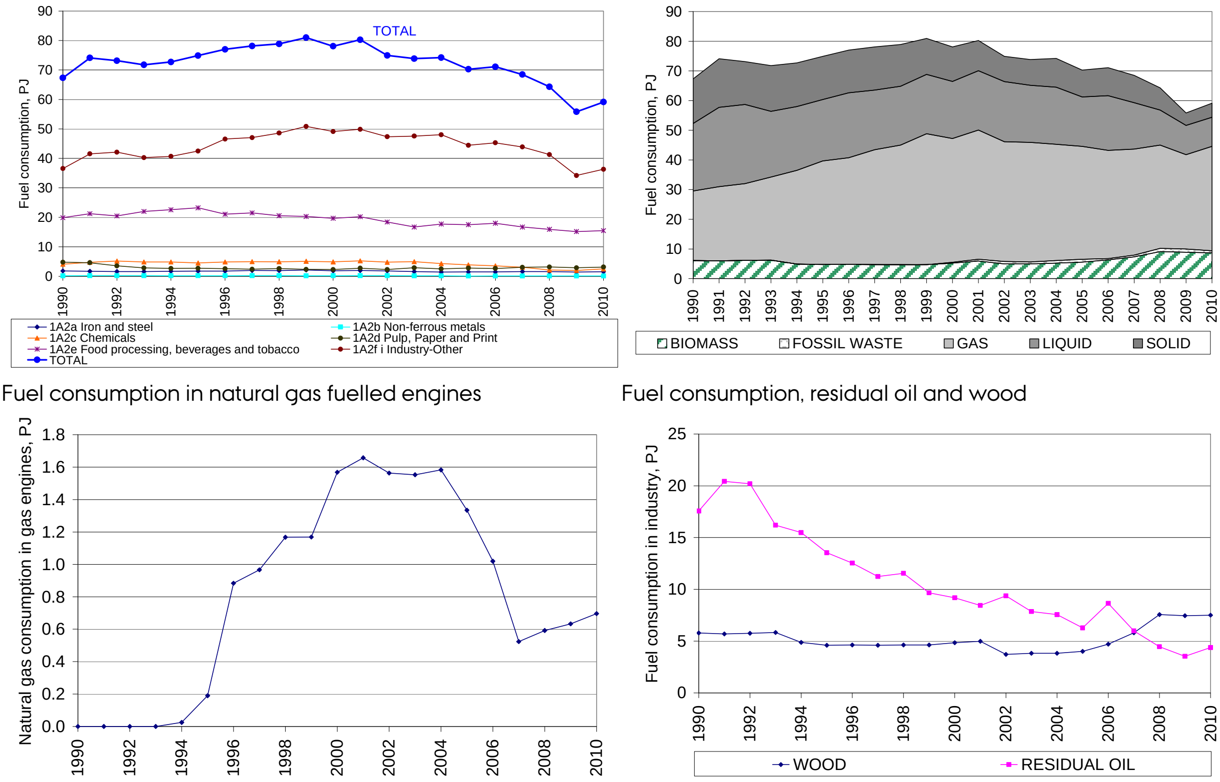


Figure 3.2.29 time series for fuel consumption, 1A2 Industry.

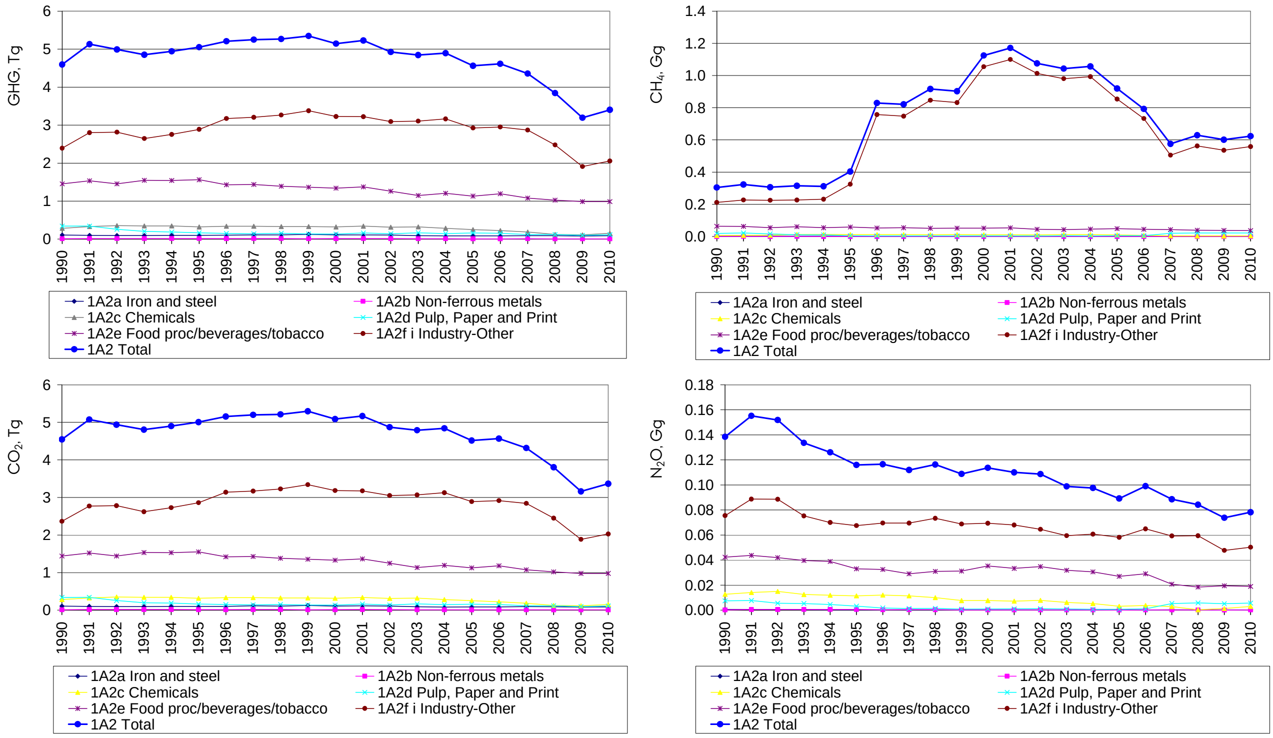


Figure 3.2.30 time series for greenhouse gas emission, 1A2 Industry.

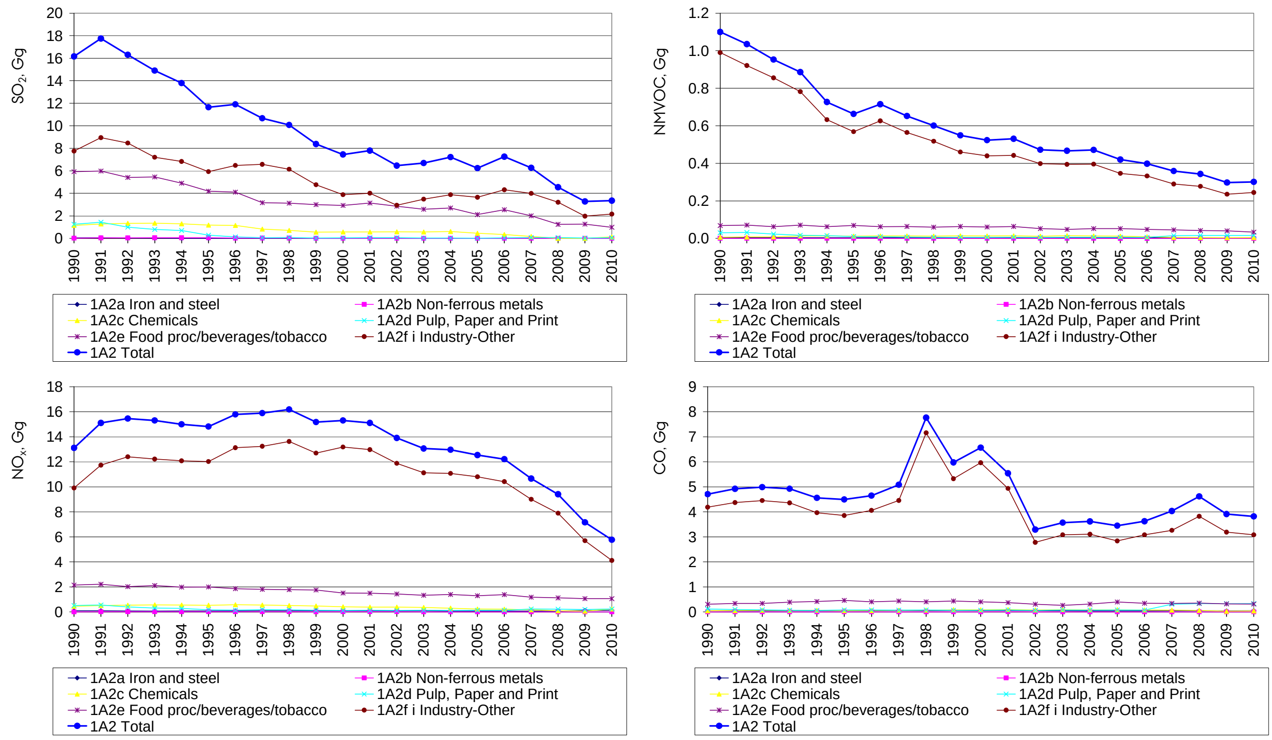


Figure 3.2.31 time series for SO_2, NO_x, NMVOC and CO emission, 1A2 Industry.

1A2a Iron and steel

Iron and steel is a very small emission source category. Figure 3.2.32 shows the time series for fuel consumption and emissions.

Natural gas is the main fuel in the subsector.

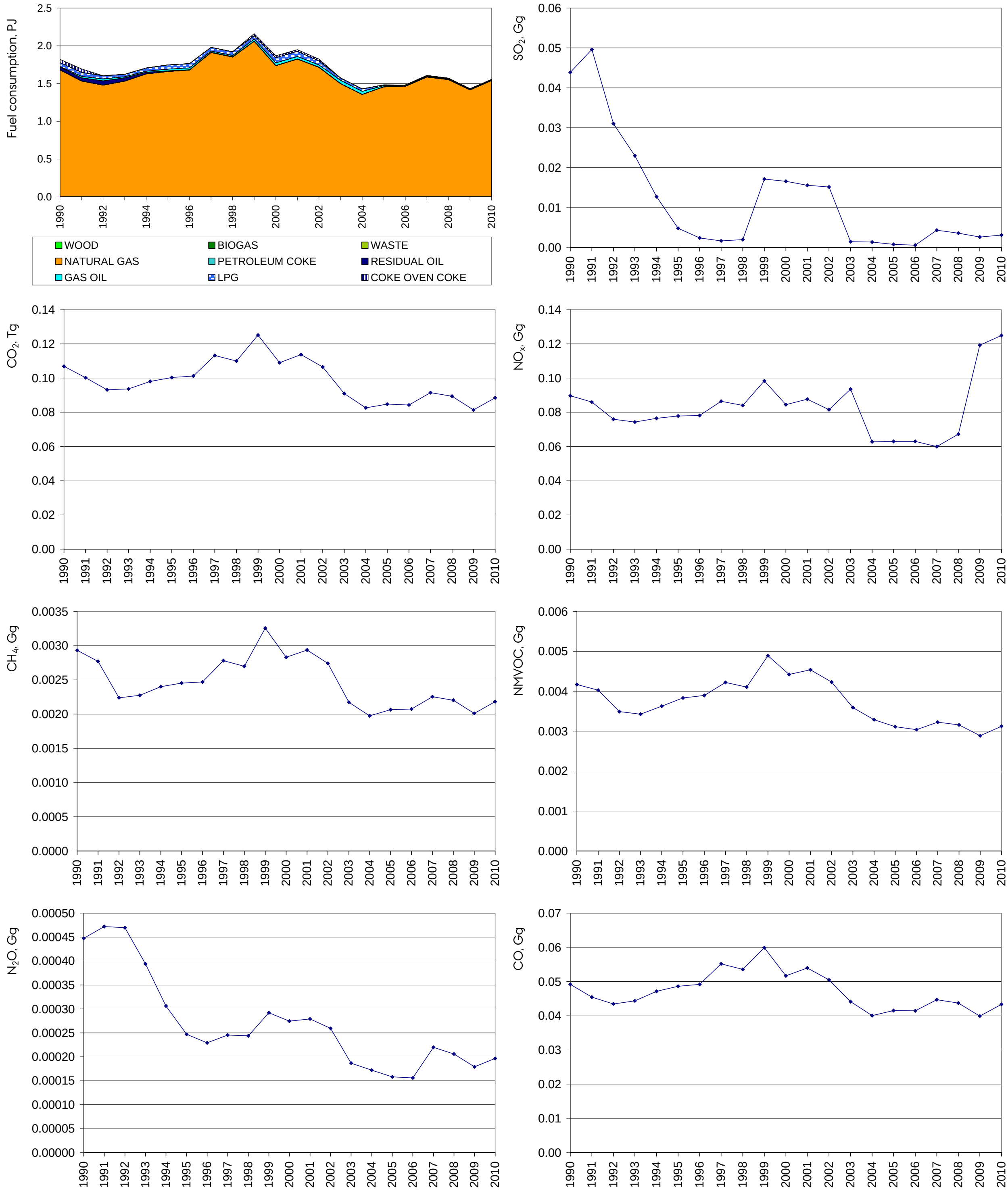


Figure 3.32 time series for 1A2a Iron and steel.

1A2b Non-ferrous metals

Non-ferrous metals is a very small emission source category. Figure 3.33 shows the time series for fuel consumption and emissions.

Natural gas is the main fuel in the subsector. The consumption of residual oil has decreased and the SO_2 emission follows this fuel consumption. The emissions of NO_x, NMVOC and CO follow the fuel consumption.

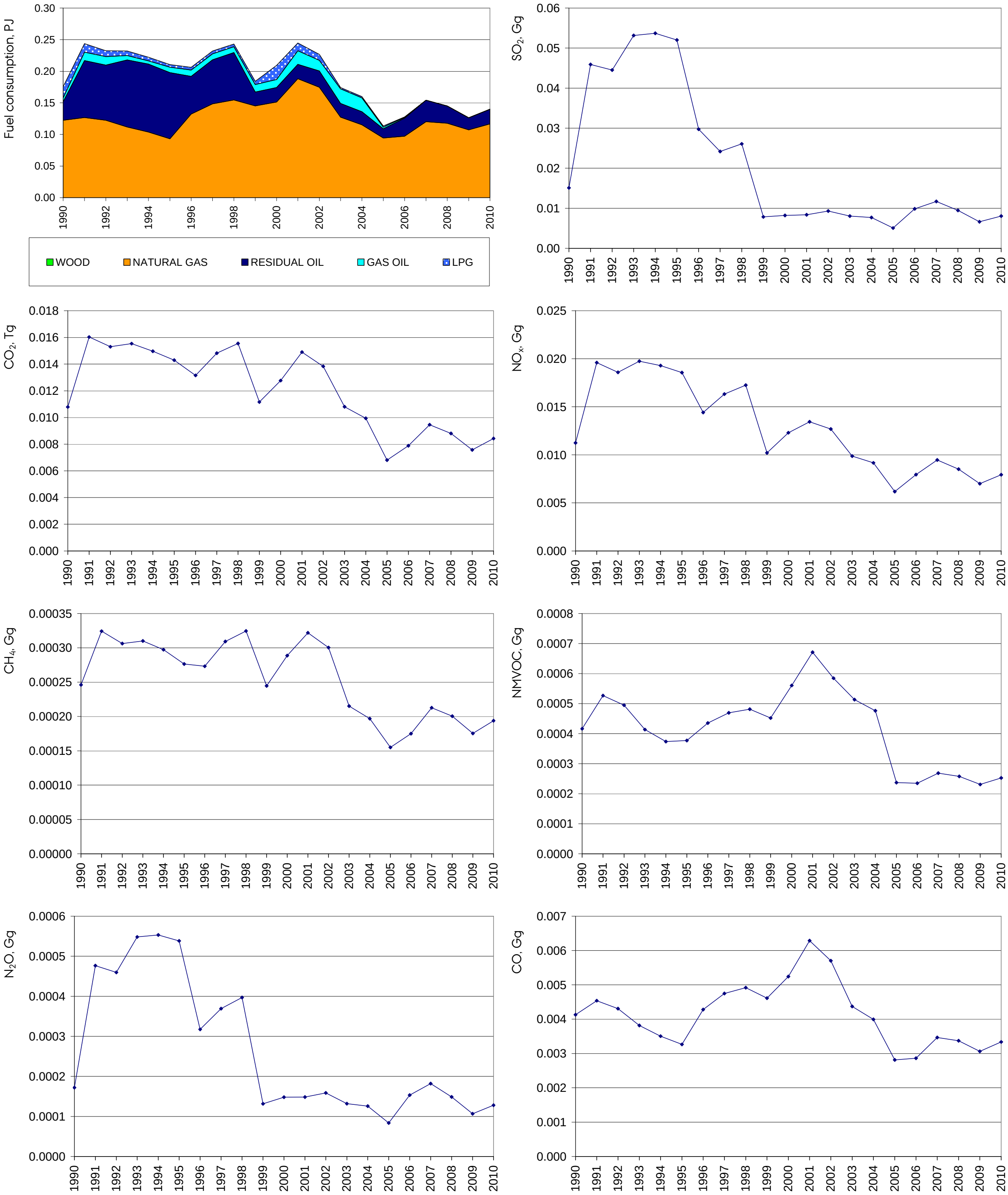


Figure 3.33 time series for 1A2b Non-ferrous metals.

1A2c Chemicals

Chemicals is a minor emission source category. Figure 3.34 shows the time series for fuel consumption and emissions.

Natural gas is the main fuel in this subsector. The consumption residual oil has decreased and the SO_2 emission follows this fuel consumption.

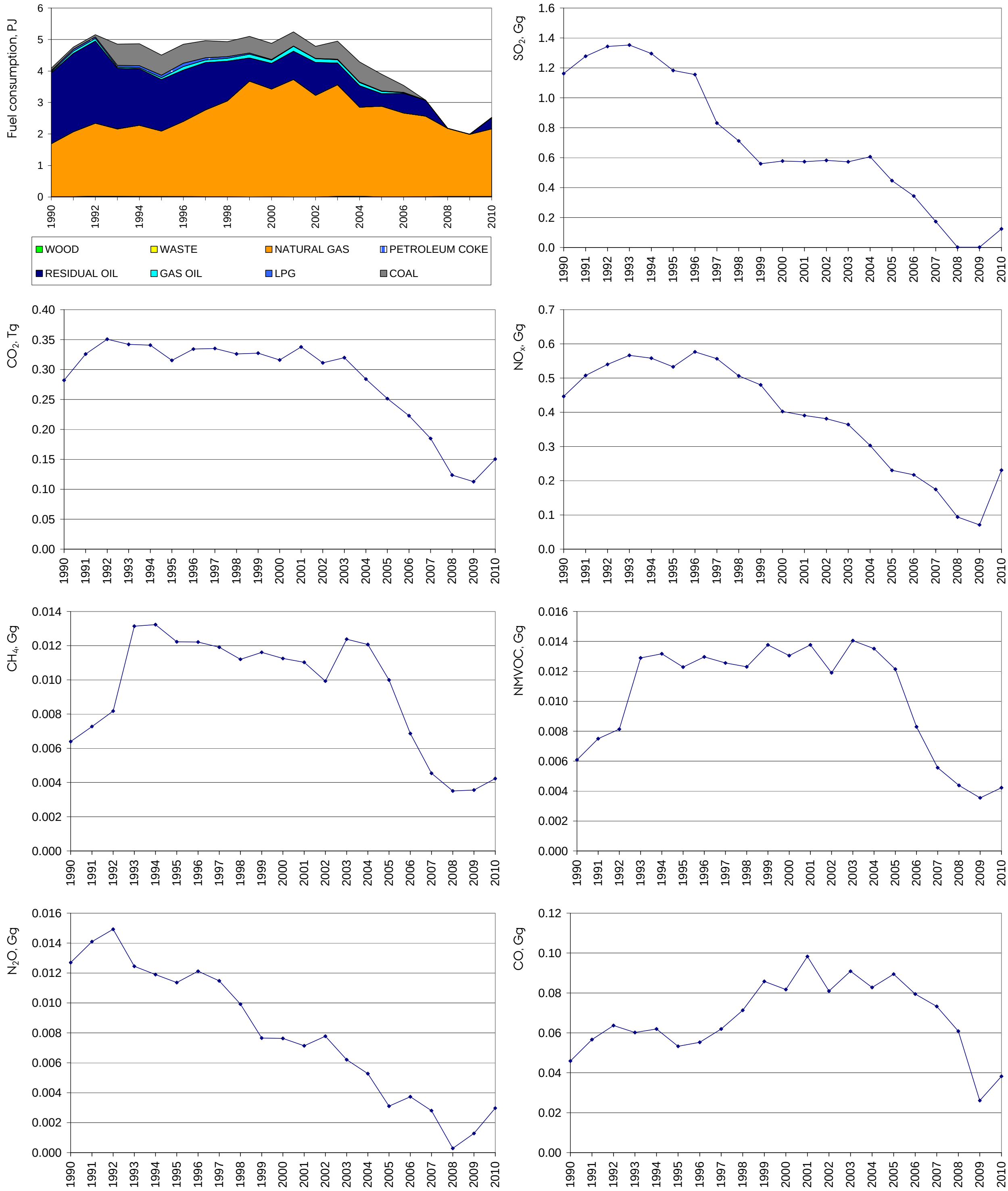


Figure 3.34 time series for 1A2c Chemicals.

1A2d Pulp, paper and print

Pulp, paper and print is a minor emission source category. Figure 3.35 shows the time series for fuel consumption and emissions.

Natural gas and - since 2007 - also wood are the main fuels in the subsector.

The increased consumption of wood in 2007 onwards is reflected in both the CH_4, N_2O, NMVOC and CO emission time series.

The consumption of coal and residual oil has decreased and this is reflected in the SO_2 emission time series.

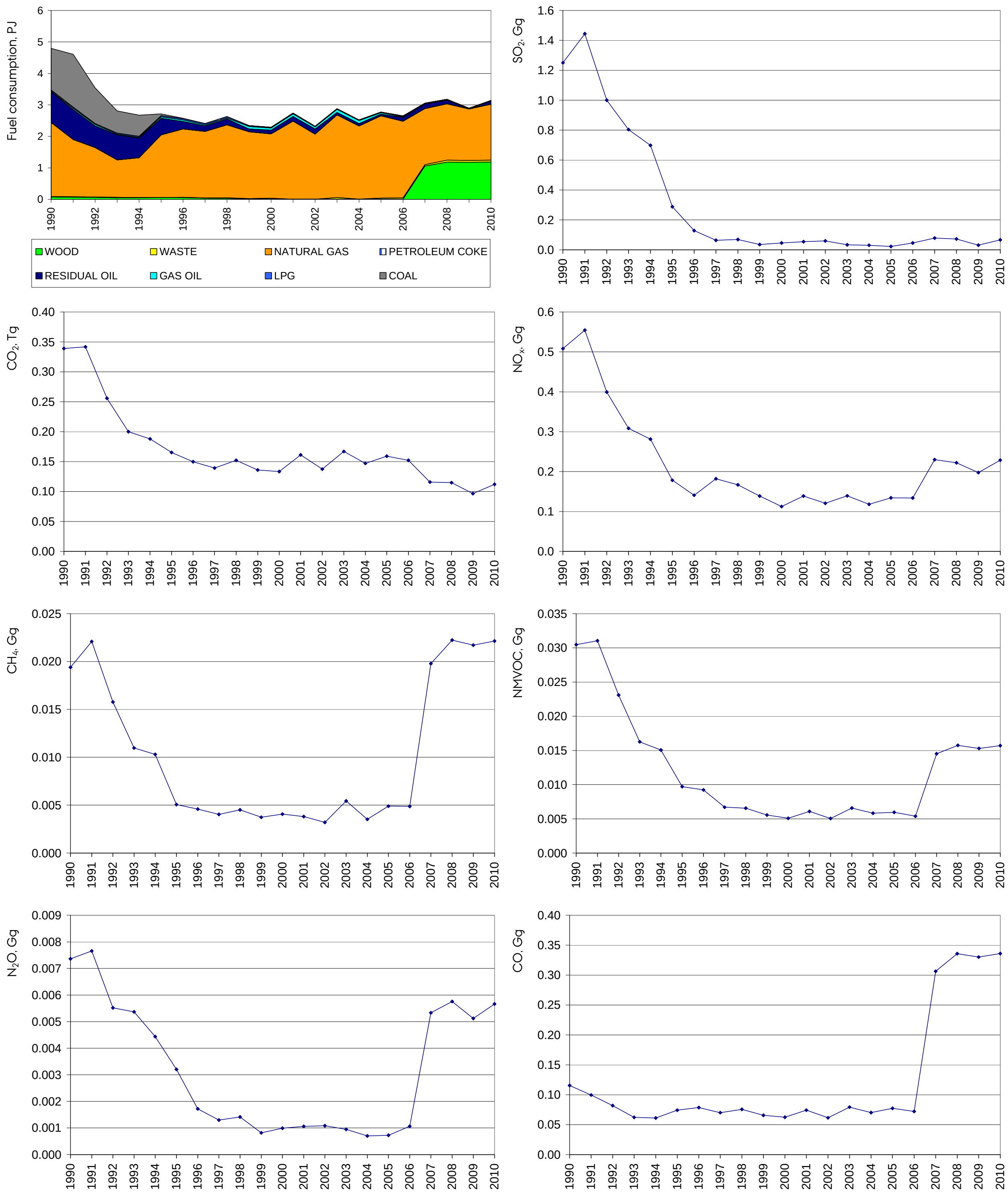


Figure 3.35 time series for 1A2d Pulp, paper and print.

1A2e Food processing, beverages and tobacco

Pulp, paper and print is a considerable industrial subsector. Figure 3.36 shows the time series for fuel consumption and emissions of SO_2, NO_x, NMVOC and CO.

Natural gas, residual oil and coal are the main fuels in the subsector. The consumption of coal and residual oil has decreased whereas the consumption of natural gas has increased. This is reflected in the SO_2 emission time series.

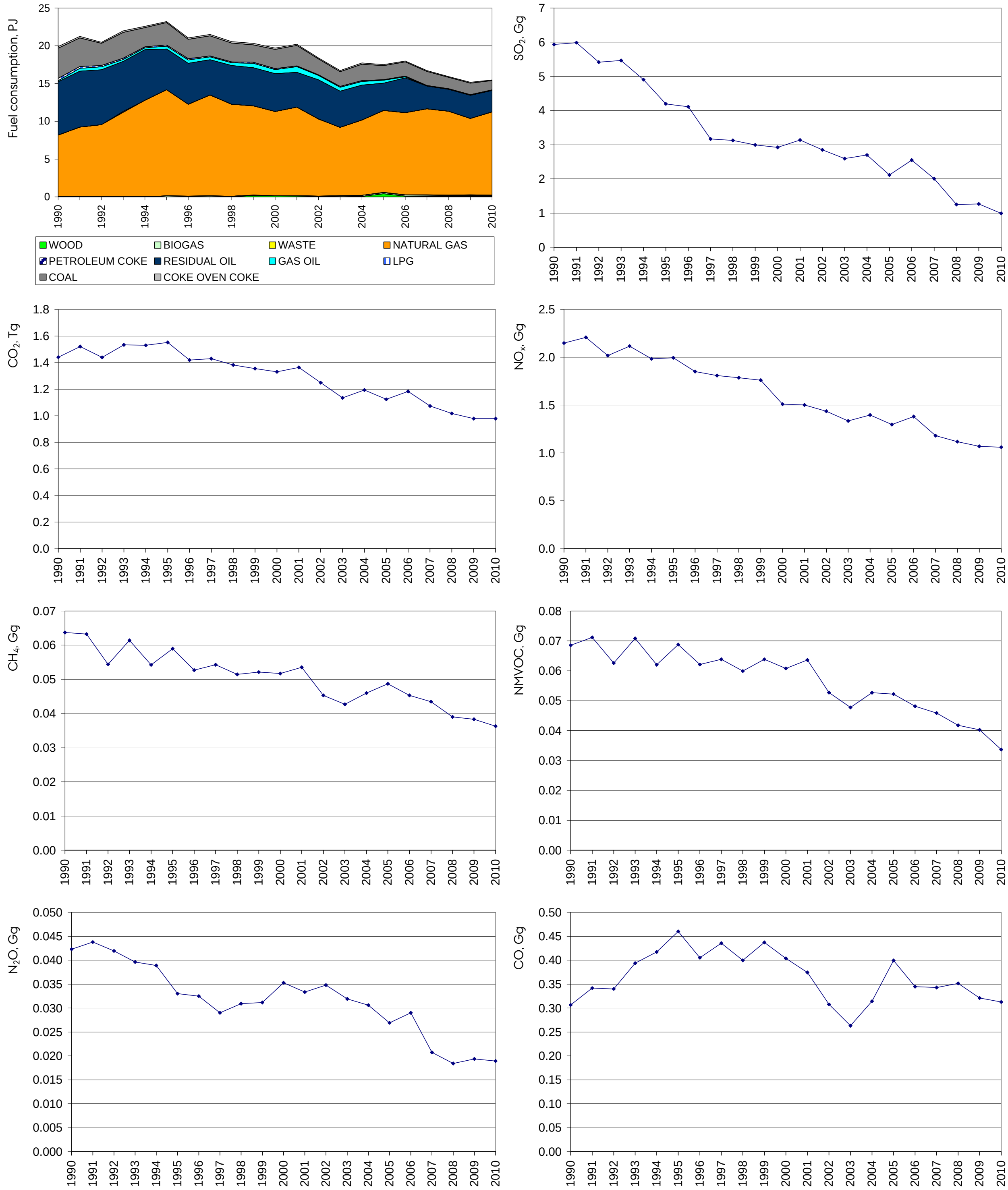


Figure 3.36 time series for 1A2e Food processing, beverages and tobacco.

1A2f Industry – other

Industry - other is a considerable industrial subsector. Figure 3.37 shows the time series for fuel consumption and emissions. The subsector includes cement production that is a major industrial emission source in Denmark.

Natural gas is the main fuels in the subsector in recent years. The consumption of coal and residual oil has decreased.

The NO_x time series is discussed above (page 129).

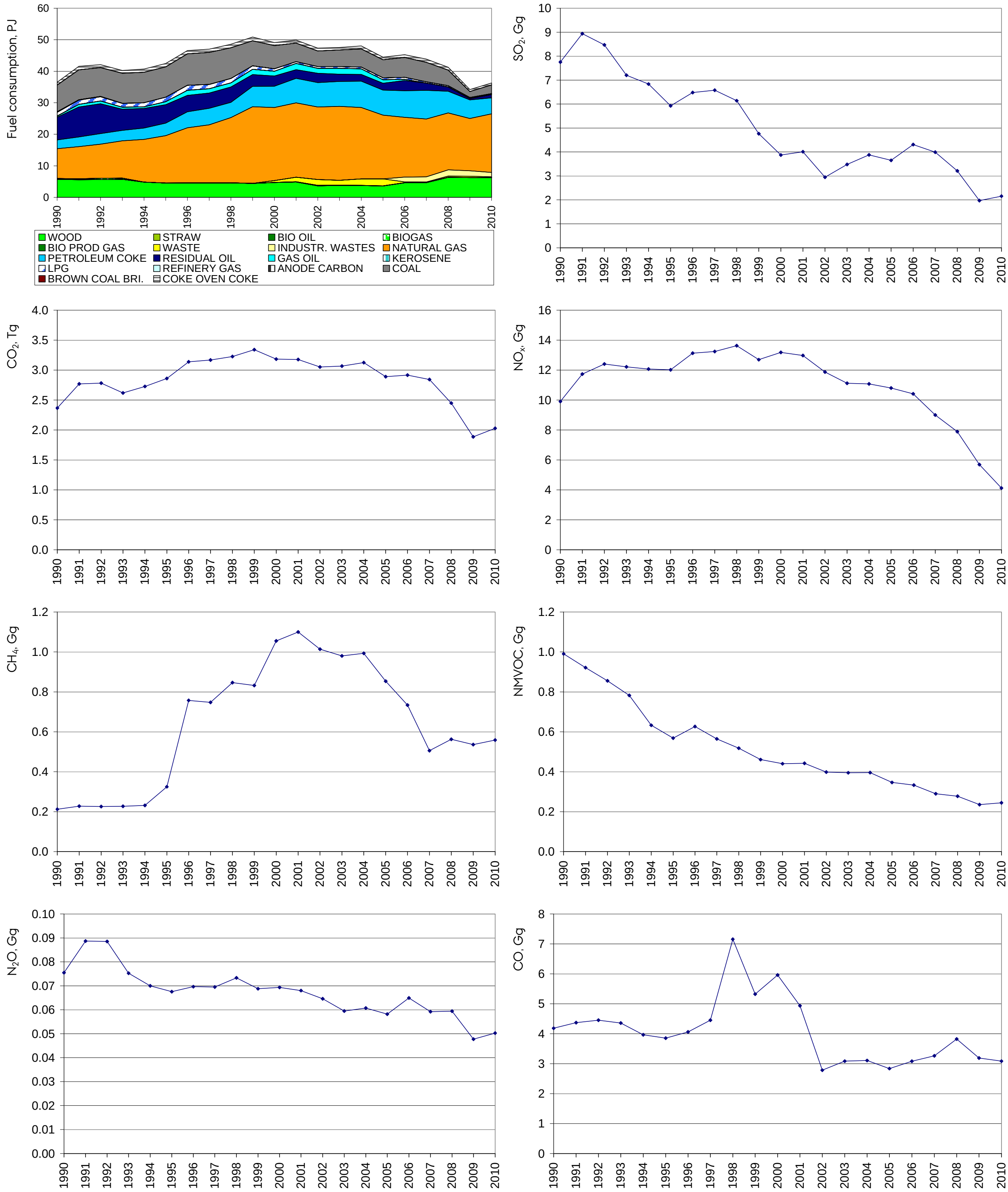


Figure 3.37 time series for 1A2f Industry - other.

1A4 Other Sectors

The emission source category *1A4 Other Sectors* consists of the subcategories:

- 1A4a Commercial/Institutional plants.
- 1A4b Residential plants.
- 1A1c Agriculture/Forestry.

Figure 3.2.38-40 present time series for this emission source category. Residential plants is the dominant subcategory accounting for the largest part of all emissions. time series are discussed below for each subcategory.

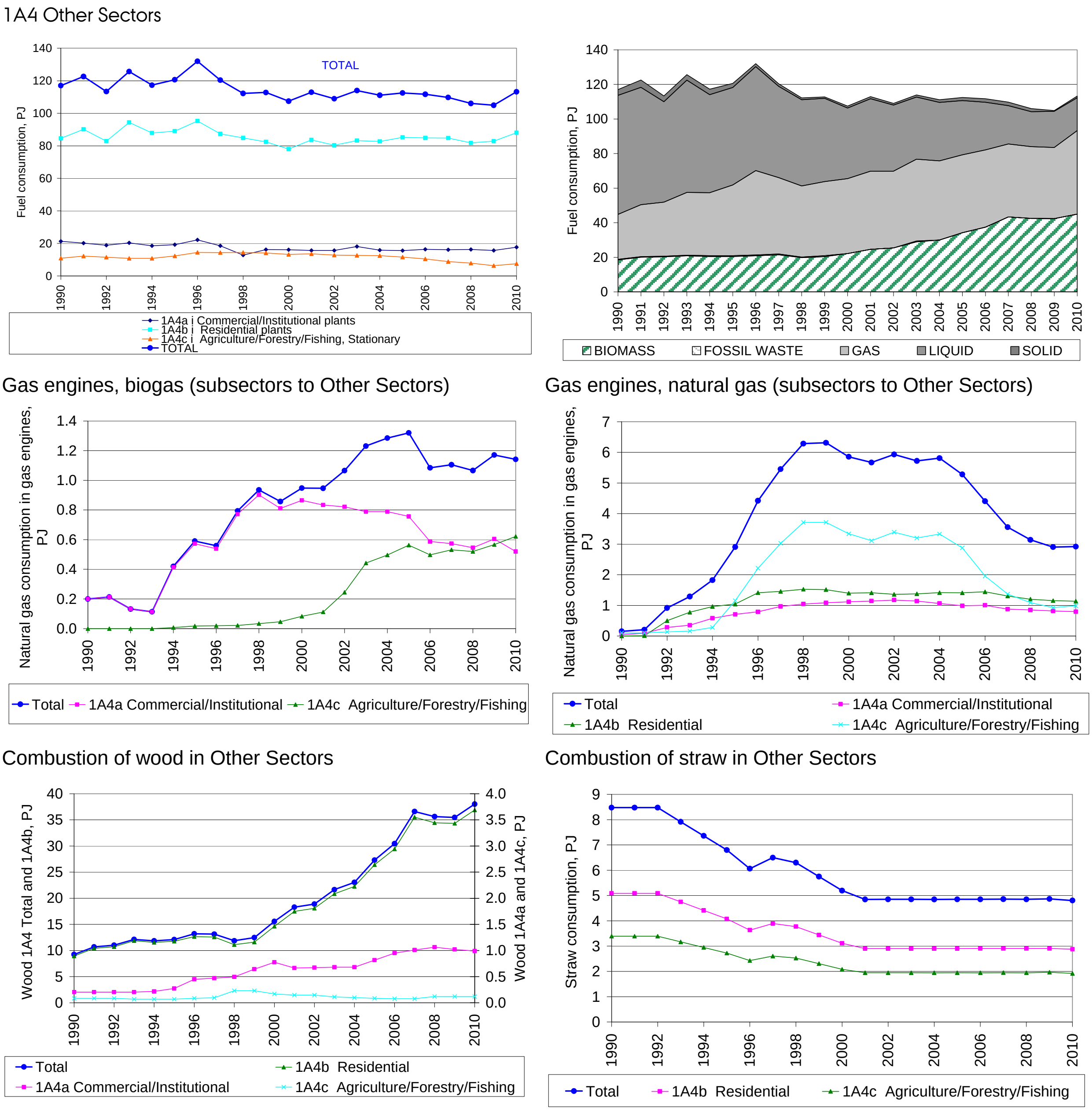


Figure 3.2.38 time series for fuel consumption, 1A4 Other Sectors.

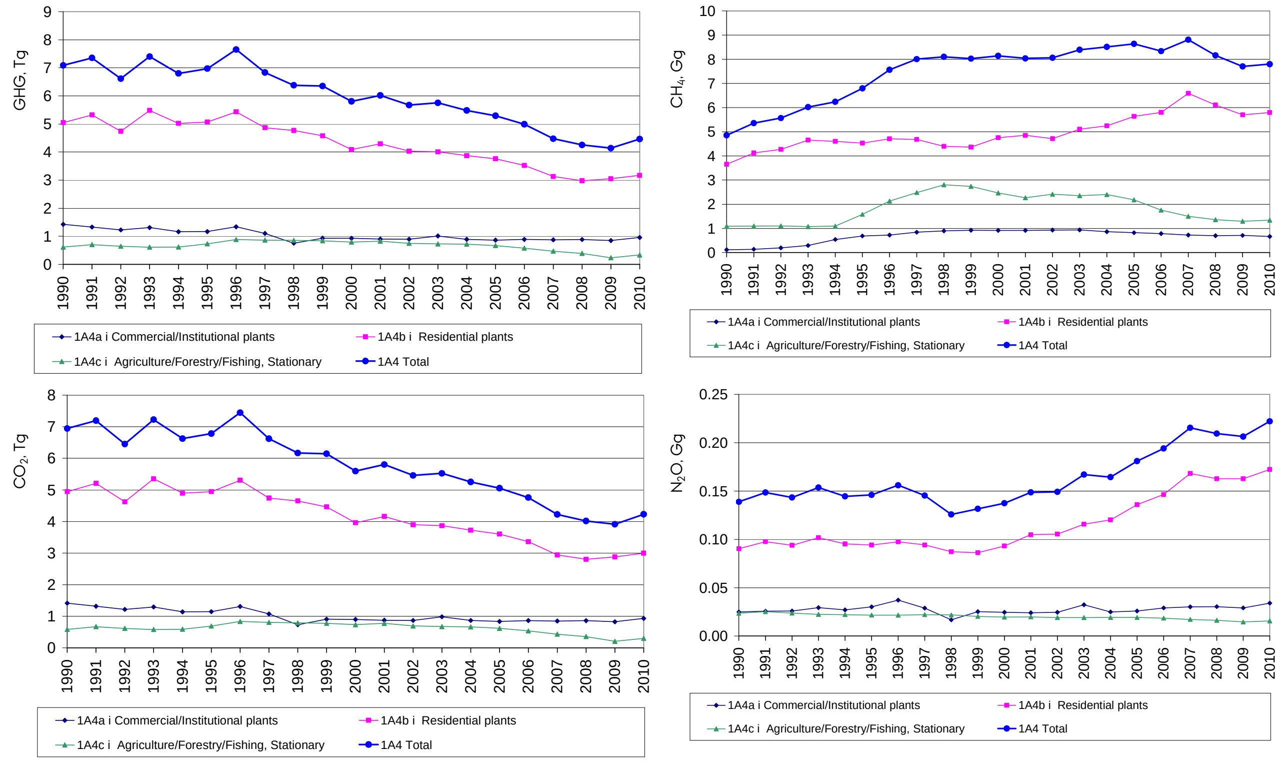


Figure 3.2.39 time series for greenhouse gas emission, 1A4 Other Sectors.

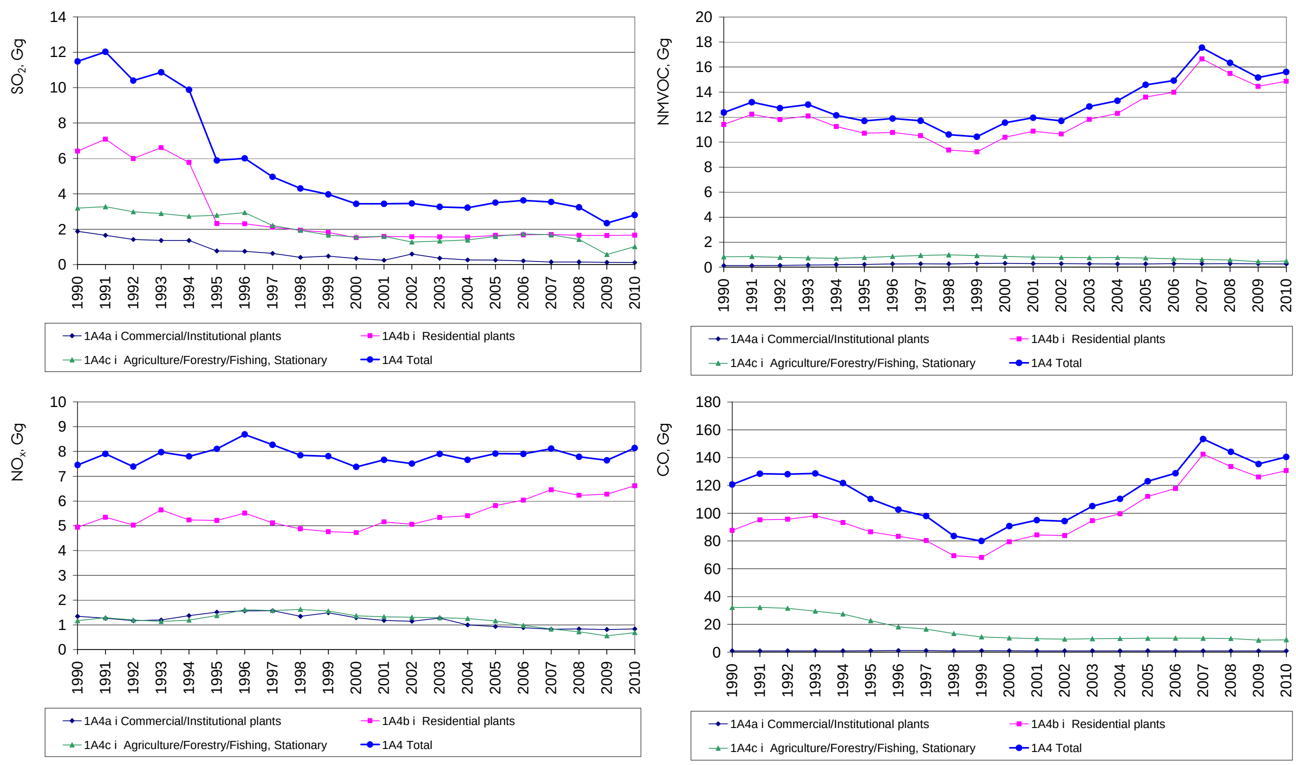


Figure 3.2.40 time series for SO_2, NO_x, NMVOC and CO emission, 1A4 Other Sectors.

1A4a Commercial and institutional plants

The subcategory *Commercial and institutional plants* consists of both stationary and mobile sources. In this chapter, only stationary sources are included. Figure 3.2.41 shows the time series for fuel consumption and emissions.

The subcategory *Commercial and institutional plants* has low fuel consumption and emissions compared to the other stationary combustion emission source categories. Figure 3.2.35 shows the time series for fuel consumption and emissions.

The fuel consumption in commercial/institutional plants has decreased 17 % since 1990 and there has been a change of fuel type. The fuel consumption consists mainly of gas oil and natural gas. The consumption of gas oil has decreased whereas the consumption of natural gas has increased since 1990. The consumption of wood and biogas has also increased. The wood consumption in 2010 was five times the consumption in 1990.

The CO_2 emission has decreased 34 % since 1990. Both the decrease of fuel consumption and the change of fuels – from gas oil to natural gas - contribute to the decreased CO_2 emission.

The CH_4 emission in 2010 was 6 times the 1990 level. The increase is mainly a result of the increased emission from natural gas fuelled engines. The emissions from biogas fuelled engines and from combustion of wood also contribute to the increase. The time series for consumption of natural gas and biogas are shown in Figure 3.2.32.

The N_2O emission in 2010 was 37 % higher than in 1990. This increase is a result of the change of fuel from gas oil to natural gas boilers. The emission from wood combustion has also been increasing. The fluctuations of the N_2O emission follow the fuel consumption.

The SO_2 emission has decreased 93 % since 1990. The decrease is a result of both the change of fuel from gas oil to natural gas and of the lower sulphur content in gas oil and in residual oil. The lower sulphur content (0.05 % for gas oil since 1995 and 0.7 % for residual oil since 1997) is a result of Danish tax laws (DEPA 1998). The high emission in 2002 is a result of installation of new boilers and abatement equipment in a large wastewater treatment plant. The abatement equipment did not perform as expected in the first period, which caused increased SO_2 emission for a period of time.

The NO_x emission was 38 % lower in 2010 than in 1990. The decrease is mainly a result of the lower fuel consumption but also the change from gas oil to natural gas has contributed to the decrease. The emission from gas engines and wood combustion has increased.

The NMVOC emission in 2010 was 2.0 times the 1990 emission level. The large increase is a result of the increased combustion of wood that is the main source of emission. The increased consumption of natural gas in gas engines (Figure 3.2.32) also contribute to the increased NMVOC emission.

The CO emission has decreased 5 % since 1990. The emission, from wood and from natural gas fuelled engines and boilers, has increased whereas the emission from gas oil has decreased. This is a result of the change of fuels applied in the sector.

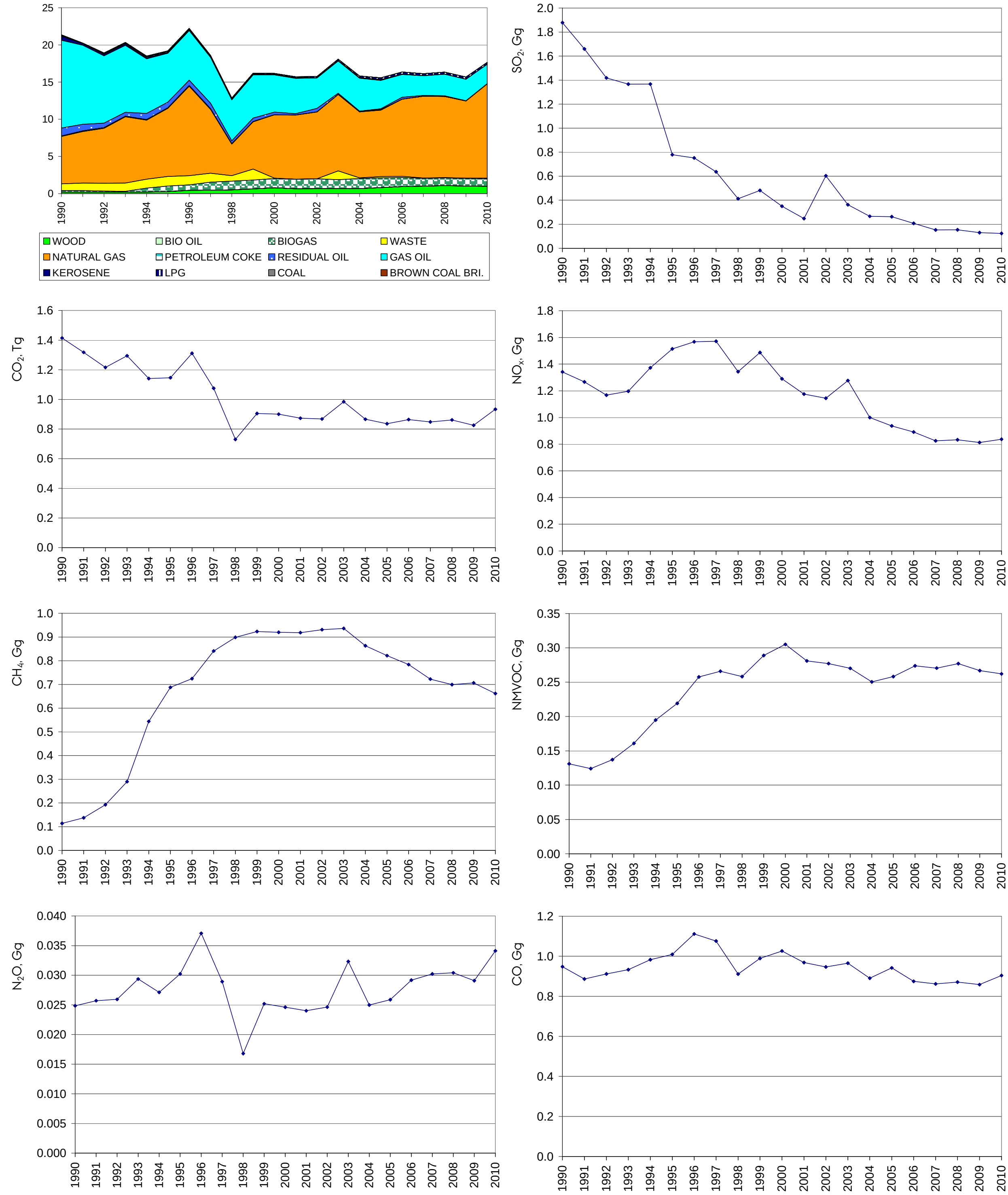


Figure 3.2.41 time series for 1A4a Commercial /institutional.

1A4b Residential plants

The emission source category *Residential plants* consists of both stationary and mobile sources. In this chapter, only stationary sources are included. Figure 3.2.42 shows the time series for fuel consumption and emissions.

For residential plants, the total fuel consumption has been rather stable, and in 2010, the consumption was 4 % higher than in 1990. However, the consumption of gas oil has decreased since 1990 whereas the consumption of wood has increased considerably (4.1 times the 1990 level). The consumption of natural gas has also increased since 1990.

The CO_2 emission has decreased by 39 % since 1990. This decrease is mainly a result of the considerable change in fuels used from gas oil to wood and natural gas.

The CH_4 emission from residential plants has increased 59 % since 1990 due to the increased combustion of wood in residential plants, which is the main source of emission. The increased emission from gas engines also contributes to the increased emission.

The change of fuel from gas oil to wood has resulted in a 91 % increase of N_2O emission since 1990 due to a higher emission factor for wood than for gas oil.

The large decrease (74 %) of SO_2 emission from residential plants is mainly a result of a change of sulphur content in gas oil since 1995. The lower sulphur content (0.05 %) is a result of Danish tax laws (DEPA 1998). In addition, the consumption of gas oil has decreased and the consumption of natural gas that results in very low SO_2 emissions has increased.

The NO_x emission has increased by 34 % since 1990 due to the increased emission from wood combustion. The emission factor for wood is higher than for gas oil.

The emission of NMVOC has increased 30 % since 1990 as a result of the increased combustion of wood. The emission factor for wood has decreased since 2000, due to improved technology, but not as much as the increase in consumption of wood. The emission factor for wood and straw is higher than for liquid or gaseous fuels.

The CO emission has increased 49 % due to the increased use of wood that is the main source of emission. The emission factor for wood has decreased since 2000, due to improved technology, but not as much as the increase in consumption of wood. The emission from combustion of straw has decreased since 1990.

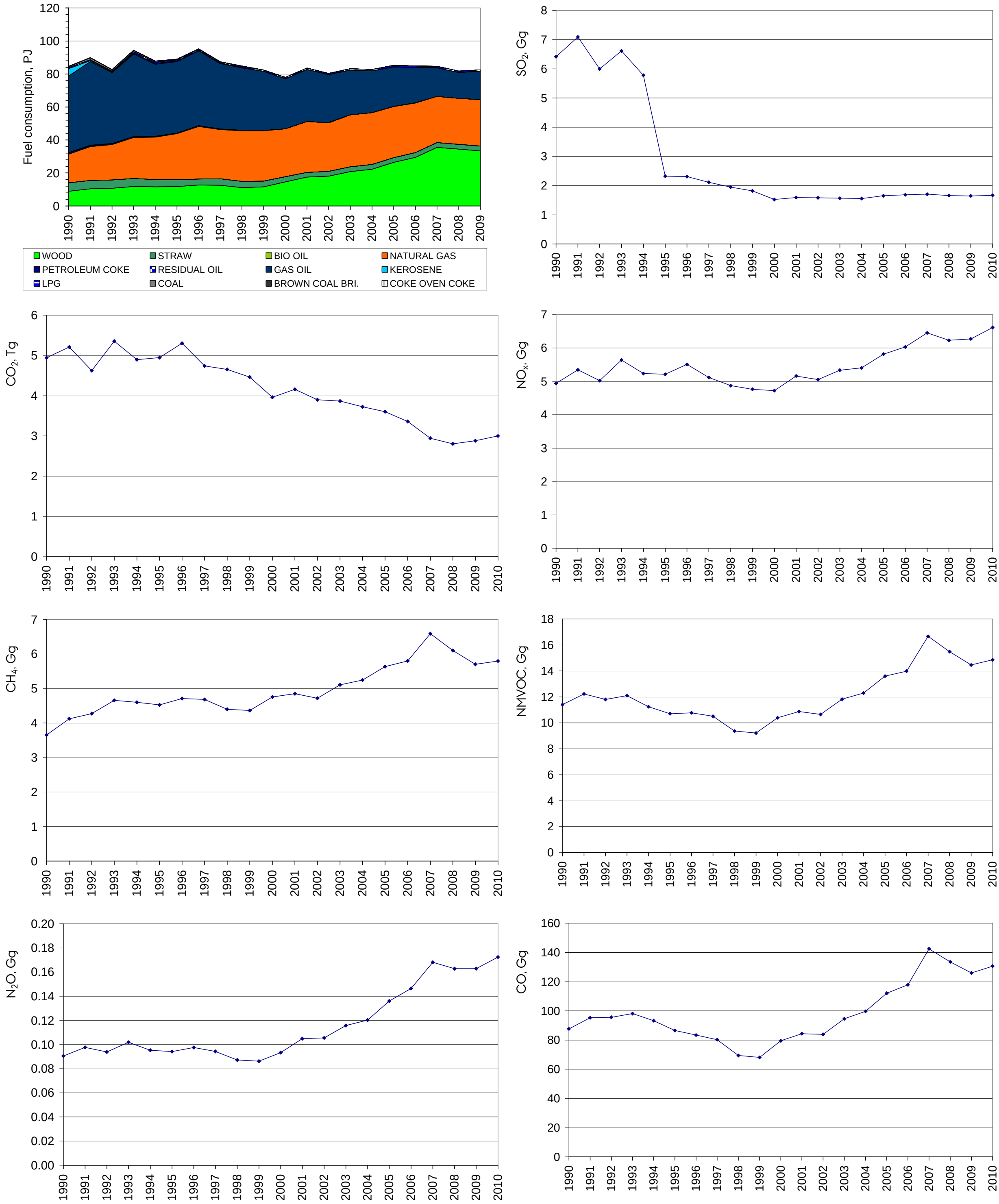


Figure 3.2.42 time series for 1A4b Residential plants.

1A4c Agriculture/forestry

The emission source category *Agriculture/forestry* consists of both stationary and mobile sources. In this chapter, only stationary sources are included. Figure 3.2.43 shows the time series for fuel consumption and emissions.

For plants in agriculture/forestry, the fuel consumption has decreased 31 % since 1990. A considerable decrease in the fuel consumption has taken place since year 2000.

The type of fuel that has been used has changed since 1990. In the years 1995-2005, the consumption of natural gas was high, but in recent years, the consumption decreased again. A large part of the natural gas consumption has been combusted in gas engines (Figure 3.2.32). Most CHP plants in agriculture/forestry based on gas engines came in operation in 1995-1999. The decrease in later years is a result of the liberalisation of the electricity market.

The consumption of straw has decreased since 1990. The consumption of both residual oil and gas oil has increased after 1990 but has decreased again in recent years.

The CO_2 emission in 2010 was 49 % lower than in 1990. The CO_2 emission increased from 1990 to 1996 due to increased fuel consumption. Since 1996, the CO_2 emission has decreased in line with the decrease in fuel consumption.

The CH_4 emission in 2010 was 23 % higher than the emission in 1990. The emission follows the time series for natural gas combusted in gas engines (Figure 3.2.32). The emission from combustion of straw has decreased as a result of the decreasing consumption of straw in the sector.

The emission of N_2O has decreased by 34 % since 1990. The decrease is a result of the lower fuel consumption as well as the change of fuel. The decreasing consumption of straw contributes considerably to the decrease of emission.

The SO_2 emission was 68 % lower in 2010 than in 1990. The emission decreased mainly in the years 1996-2002. The main emission sources are coal, residual oil and straw.

The emission of NO_x was 41 % lower in 2010 than in 1990.

The emission of NMVOC has decreased 41 % since 1990. The major emission source is combustion of straw. The consumption of straw has decreased since 1990. The emission from gas engines has increased mainly due to increased fuel consumption.

The CO emission has decreased 72 % since 1990. The major emission source is combustion of straw. In addition to the decrease of straw consumption, the emission factor for straw has also decreased since 1990.

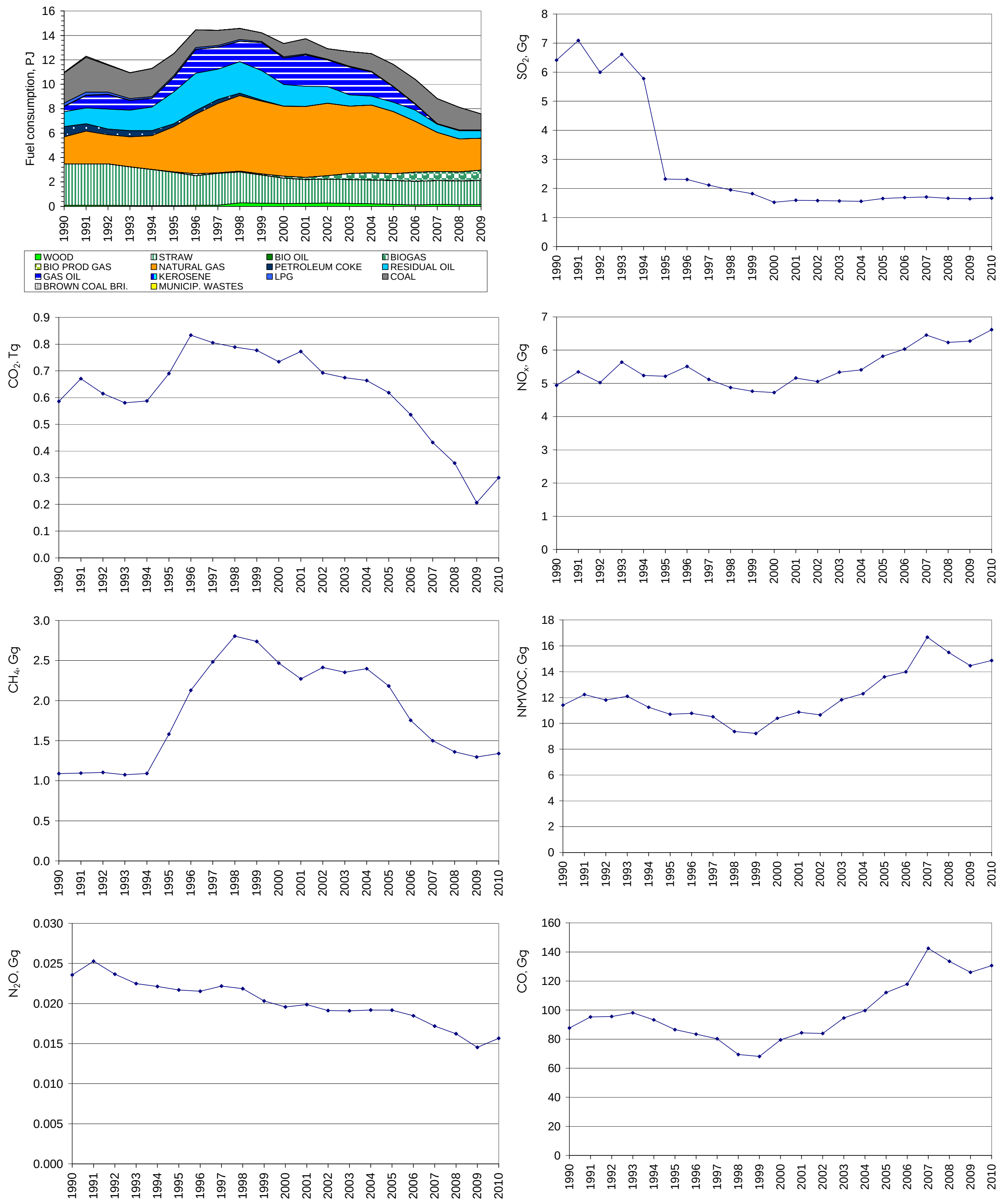


Figure 3.2.43 time series for 1A4c Agriculture/Forestry.

3.2.5 Methodological issues

The Danish emission inventory is based on the CORINAIR (CORe INventory on AIR emissions) system, which is a European program for air emission inventories. CORINAIR includes methodology structure and software for inventories. The methodology is described in the EMEP/CORINAIR Emission Inventory Guidebook 2009 update, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (EEA, 2009). Emission data are stored in an Access database, from which data are transferred to the reporting formats.

In the Danish emission database all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP source categories. Aggregation to the source category codes used in CRF is based on a correspondence list enclosed in Annex 3A-1.

The emission inventory for stationary combustion is based on activity rates from the Danish energy statistics. General emission factors for various fuels, plants and sectors have been determined. Some large plants, such as power plants, are registered individually as large point sources and plant-specific emission data are used.

Tiers

The type of emission factor and the applied tier level for each emission source are shown in Table 3.2.13 below. The tier levels have been determined based on the 1996 Guidebook (IPCC 1997).

The fuel consumption data for transformation are technology specific. For end-use of fuels, the disaggregation to specific technologies is less detailed. However, for residential wood combustion the technology disaggregation is less detailed.

Distinguishing between tier level 2 and tier 3 has been based on the emission factor. The tier levels definitions have been interpreted as follows:

- Tier 1: The emission factor is an IPCC default tier 1 value.
- Tier 2: The emission factors are country specific and based on either a few emission measurements or IPCC tier 2 emission factors.
- Tier 3: Based on plant specific emission data or on a country specific emission factor based on a considerable number of plant specific emission measurements and detailed technology knowledge.

Table 3.2.13 gives an overview of the calculation methods and type of emission factor. The table also shows which of the source categories are key in any of the key source analysis[8] (including LULUCF, tier 1/tier 2, level/trend).

[8] Key category according to the KCA tier 1 or tier 2 for Denmark (excluding Greenland and Faroe Islands), including LULUCF, level 1990/ level 2010/ trend.

Table 3.2.13 Methodology and type of emission factor.

		Tier	EMF 1)	Key category
Stationary Combustion, Coal	CO_2	Tier 3[9] (Tier 3 / Tier 1[10])	PS[2] (CS / D[3])	Yes
Stationary Combustion, BKB	CO_2	Tier 1	D	No
Stationary Combustion, Coke	CO_2	Tier 1	D	No
Stationary Combustion, Fossil waste	CO_2	Tier 3	CS	Yes
Stationary Combustion, Petroleum coke	CO_2	Tier 2	CS	Yes
Stationary Combustion, Residual oil	CO_2	Tier 3 / Tier 3 / Tier 1[4]	PS / CS / D[11]	Yes
Stationary Combustion, Gas oil	CO_2	Tier 2 / Tier 3	CR / PS	Yes
Stationary Combustion, Kerosene	CO_2	Tier 1	D	Yes
Stationary Combustion, LPG	CO_2	Tier 1	D	No
Stationary Combustion, Refinery gas	CO_2	Tier 3	PS / CS	Yes
Stationary Combustion, Natural gas	CO_2	Tier 3	CS / PS[12]	Yes
Stationary Combustion, SOLID	CH_4	Tier 2 / Tier 1	D(2) / D	No
Stationary Combustion, LIQUID	CH_4	Tier 2 / Tier 2 / Tier 1	D(2) / CS / D	No
Stationary Combustion, GAS	CH_4	Tier 2 / Tier 3	D(2) / CS	No
Natural gas fuelled engines, GAS	CH_4	Tier 3	CS	Yes
Stationary Combustion, WASTE	CH_4	Tier 2	CS	No
Stationary Combustion, BIOMASS	CH_4	Tier 2 / Tier 1	D(2) / CS / D	Yes
Biogas fuelled engines, BIOMASS	CH_4	Tier 3	CS	No
Stationary Combustion, SOLID	N_2O	Tier 2 / Tier 1	CS / D	Yes
Stationary Combustion, LIQUID	N_2O	Tier 2 / Tier 1	D(2) / D / CS	Yes
Stationary Combustion, GAS	N_2O	Tier 1 / Tier 2	D / CS / D(2)	Yes
Stationary Combustion, WASTE	N_2O	Tier 2	CS	No
Stationary Combustion, BIOMASS	N_2O	Tier 1 / Tier 2	D / CS / D(2)	Yes

1) D: IPCC tier 1, D(2): IPCC tier 2/3, CR: Corinair default, CS: Country specific, PS: Plant specific.

Large point sources

Large emission sources such as power plants, industrial plants and refineries are included as large point sources in the Danish emission database. Each point source may consist of more than one part, e.g. a power plant with several units. By registering the plants as point sources in the database, it is possible to use plant-specific emission factors.

In the inventory for the year 2010, 77 stationary combustion plants are specified as large point sources. These point sources include:

- Power plants and decentralised CHP plants (combined heat and power plants).
- Waste incineration plants.
- Large industrial combustion plants.
- Petroleum refining plants.

The criteria for selection of point sources consist of the following:

- All centralized power plants, including smaller units.
- All units with a capacity above 25 MW_e.
- All district heating plants with an installed effect of 50 MW_{th} or above and significant fuel consumption.
- All waste incineration plants obligated to report environmental data annually according to Danish law (DEPA, 2010).
- Industrial plants,
  - with an installed effect of 50 MW_{th} or above and significant fuel consumption.

[9] For 2006 onwards. Country specific emission factors and tier 2 have been applied for 1990-2005.
[10] For coal combustion in other source sectors than 1A1a corresponding to 3 % of the coal consumption in 2010.
[11] Residual oil not applied in source category 1A1a
[12] Off shore gas turbines and a few power plants

– with a significant process related emission.

The fuel consumption of stationary combustion plants registered as large point sources in the 2010 inventory was 325 PJ. This corresponds to 59 % of the overall fuel consumption for stationary combustion.

A list of the large point sources for 2010 and the fuel consumption rates is provided in Annex 3A-5. The number of large point sources registered in the databases increased from 1990 to 2010.

The emissions from a point source are based either on plant specific emission data or, if plant specific data are not available, on fuel consumption data and the general Danish emission factors. Annex 3A-5 shows which of the emission data for large point sources are plant-specific and the corresponding share of the emission from stationary combustion.

CO_2 emission factors are plant specific for the major power plants, refineries and for cement production. SO_2 and NO_x emissions from large point sources are often plant-specific based on emission measurements. Emissions of CO and NMVOC are also plant-specific for some plants. Plant-specific emission data are obtained from:

- CO_2 data reported under the EU Emission Trading Scheme (ETS).
- Annual environmental reports / environmental reporting available on the Danish EPA home page[13]
- Annual plant-specific reporting of SO_2 and NO_x from power plants >25MW$_e$ prepared for the Danish Energy Agency and Energinet.dk.
- Emission data reported by DONG Energy and Vattenfall, the two major electricity suppliers.
- Emission data reported from industrial plants.

The EU ETS data are discussed in the chapter Emission factors (see page 153).

Annual environmental reports for the plants include a considerable number of emission data sets. Emission data from annual environmental reports are, in general, based on emission measurements, but some emissions have potentially been calculated from general emission factors.

If plant-specific emission factors are not available, general area source emission factors are used.

Emissions of the greenhouse gases CH_4 and N_2O from the large point sources are all based on the area source emission factors.

Area sources

Fuels not combusted in large point sources are included as source category specific area sources in the emission database. Plants such as residential boilers, small district heating plants, small CHP plants and some industrial boilers are defined as area sources. Emissions from area sources are based on fuel consumption data and emission factors. Further information on emission factors is provided below in the chapter Emission factors (see page 153).

[13] http://www3.mst.dk/Miljoeoplysninger/PrtrPublicering/Index

Activity rates, fuel consumption

The fuel consumption rates are based on the official Danish energy statistics prepared by the Danish Energy Agency (DEA). DCE aggregates fuel consumption rates to SNAP categories. Some fuel types in the official Danish energy statistics are added to obtain a less detailed fuel aggregation level cf. Annex 3A-3. The calorific values on which the energy statistics are based are also enclosed in Annex 3A-3. The correspondence list between the energy statistics and SNAP categories is enclosed in Annex 3A-9.

The fuel consumption of the NFR category *Manufacturing industries and construction* (corresponding to SNAP category 03) is disaggregated into industrial subsectors based on the data DEA data set aggregated for the Eurostat reporting (DEA 2011d). This is an improved methodology implemented this year.

The fuel consumption data flow is shown in Figure 3.2.44.

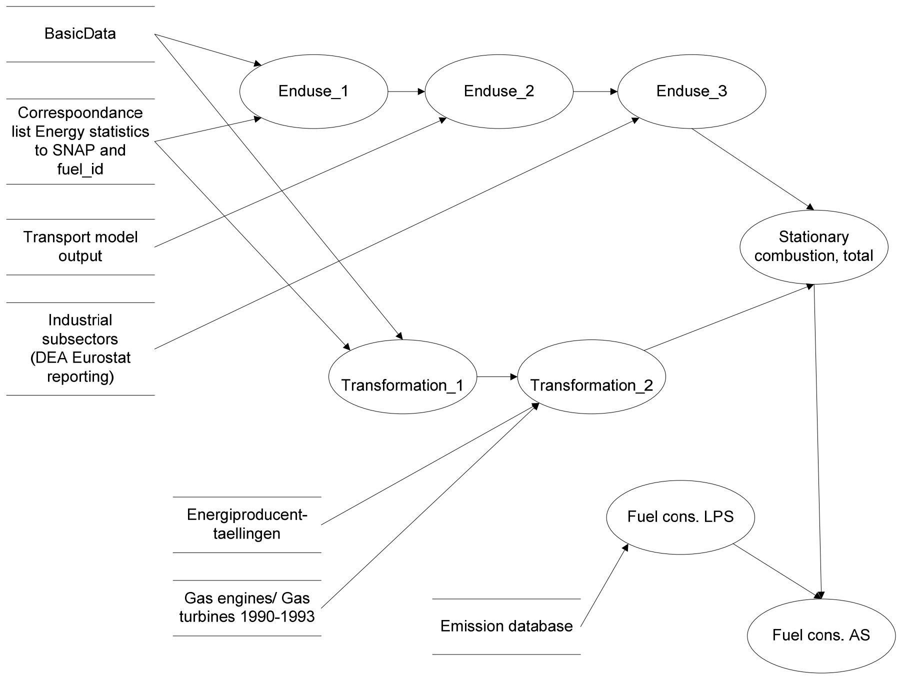


Figure 3.2.44. Fuel consumption data flow.

Both traded and non-traded fuels are included in the Danish energy statistics. Thus, for example, estimation of the annual consumption of non-traded wood is included.

Petroleum coke purchased abroad and combusted in Danish residential plants (border trade of 628 TJ in 2010) is not included in the Danish inventory. This is in agreement with the IPCC Guidelines (1996).

The fuel consumption data for large point sources refer to the EU Emission Trading Scheme (EU ETS) data for plants for which the CO_2 emission also refer to EU ETS, see page 153.

For all other large point sources, the fuel consumption refers to a DEA database (DEA 2010c). The DEA compiles a database for the fuel consumption of each district heating and power-producing plant, based on data reported by plant operators. The consistency between EU ETS reporting and the DEA database (DEA, 2010c) is checked by the DEA and any discrepancies are corrected prior to the use in the emission inventory.

The fuel consumption of area sources is calculated as total fuel consumption in the energy statistics minus fuel consumption of large point sources.

The Danish national energy statistics includes three fuels used for non-energy purposes; bitumen, white spirit and lubricants. The total consumption for non-energy purposes is relatively low, e.g. 10.6 PJ in 2010. The use of white spirit is included in the inventory in *Solvent and other product use*. The emissions associated with the use of bitumen and lubricants are included in *Industrial Processes.* The non-energy use of fuels is included in the reference approach for Climate Convention reporting and appropriately corrected in line with the Revised 1996 IPCC Guidelines (IPCC, 1997).

In Denmark all waste incineration are utilised for heat and power production. Thus, incineration of waste is included as stationary combustion in the source category *Fuel combustion* (subcategories *1A1*, *1A2* and *1A4)*.

Fuel consumption data are presented in Chapter 3.2.2.

Town gas

Town gas has been included in the fuel category natural gas. The consumption of town gas in Denmark is very low, e.g. 0.5 PJ in 2010. In 1990, the town gas consumption was 1.5 PJ and the consumption has been steadily decreasing throughout the time series.

In Denmark, town gas is produced based on natural gas. The use of coal for town gas production ceased in the early 1980s.

An indicative composition of town gas according to the largest supplier of town gas in Denmark is shown in Table 3.2.14 (KE, 2009).

Table 3.2.14 Composition of town gas 2009 (KE, 2009).

Component	Town gas, % (mol.)
Methane	43.9
Ethane	2.9
Propane	1.1
Butane	0.5
Carbon dioxide	0.4
Nitrogen	40.5
Oxygen	10.7

The lower heating value of the town gas currently used is 19.3 MJ per Nm^3 and the CO_2 emission factor 56.4 kg per GJ. This is very close to the emission factor used for natural gas of 56.74 kg per GJ. According to the supplier, both the composition and heating value will change during the year. It has not been possible to obtain a yearly average.

In earlier years, the composition of town gas was somewhat different. Table 3.2.15 shows data for town gas composition in 2000-2005. These data are constructed with the input from Københavns Energi (KE) (Copenhagen Energy) and Danish Gas Technology Centre (DGC), (Jeppesen, 2008; Kristensen, 2007). The data refer to three measurements performed several years apart; the first in 2000 and the latest in 2005.

Table 3.2.15 Composition of town gas, information from the period 2000-2005.

Component	Town gas, % (mol.)
Methane	22.3-27.8
Ethane	1.2-1.8
Propane	0.5-0.9
Butane	0.13-0.2
Higher hydrocarbons	0-0.6
Carbon dioxide	8-11.6
Nitrogen	15.6-20.9
Oxygen	2.3-3.2
Hydrogen	35.4-40.5
Carbon monoxide	2.6-2.8

The lower calorific value has been between 15.6 and 17.8 MJ per Nm^3. The CO_2 emission factors - derived from the few available measurements - are in the range of 52-57 kg per GJ.

The Danish approach includes town gas as part of the fuel category natural gas and thus indirectly assumes the same CO_2 emission factor. This is a conservative approach ensuring that the CO_2 emissions are not underestimated.

Due to the scarce data available and the very low consumption of town gas compared to consumption of natural gas (< 0.5 %), the methodology will be applied unchanged in future inventories.

Waste

All waste incineration in Denmark is utilised for heat and/or power production and thus included in the energy sector. The waste incinerated in Denmark for energy production consists of the waste fractions shown in Figure 3.2.45. In 2009, 3 % of the incinerated waste was hazardous waste[14].

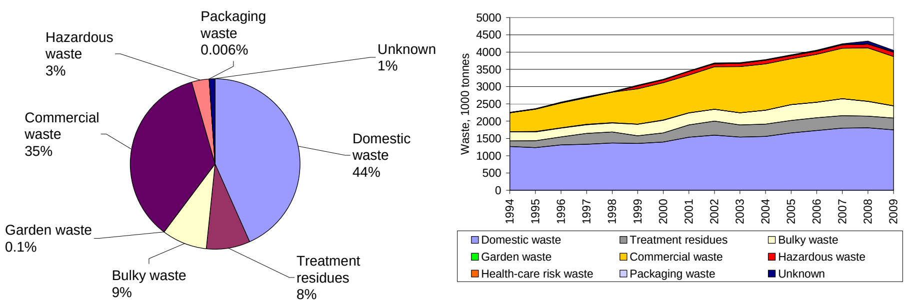


Figure 3.2.45 Waste fractions (weight) for incinerated waste in 2009 and the corresponding time series 1994-2009 (ISAG, 2011).

In connection to the project estimating an improved CO_2 emission factor for waste (Astrup et al. 2012), the fossil energy fraction have been recalculated. The fossil fraction was not measured/estimated as part of the project, but the flue gas measurements combined with data from Fellner & Rechberger (2011) indicated a fossil energy part of 45 %. The energy statistics was reported prior to the recalculation of the fossil energy part and thus this year DCE and DEA do not apply the same fossil fraction for waste. However, the fossil energy fraction will be coordinated between DEA and DCE before the emission inventory reported in 2013.

[14] In 2001 onwards, health-care risk waste is included in hazardous waste in the ISAG database.

Biogas

Biogas includes landfill gas, sludge gas and manure/organic waste gas[15]. The Danish energy statistics specifies production and consumption of each of the biogas types. In 2010, 72 % of the applied biogas was manure /organic waste gas.

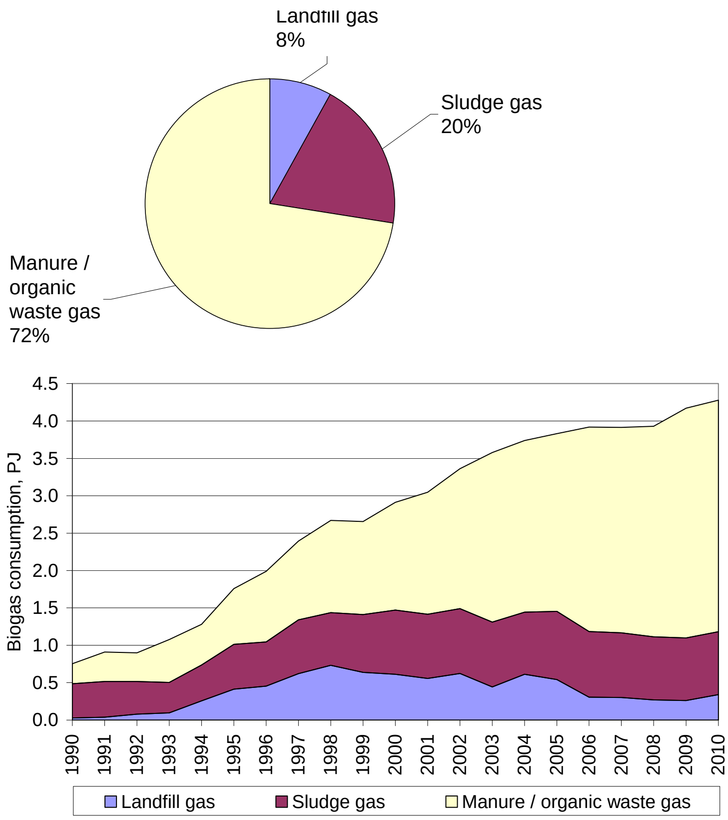


Figure 3.2.46 Biogas types 2010 and the corresponding time series 1990-2010 (DEA, 2011a).

Emission factors

For each fuel and SNAP category (sector and e.g. type of plant) a set of general area source emission factors has been determined. The emission factors are either nationally referenced or based on the international guidebooks: EMEP/EEA Guidebook (EEA 2009)[16] and IPCC Reference Manual (IPCC 1997).

An overview of the type of emission factor is shown in Table 3.2.13. A complete list, of emission factors including time series and references, is provided in Annex 3A-4.

CO_2, use of EU ETS data

The CO_2 emission factors for some large power plants and for combustion in the cement industry and refineries are plant specific and based on the reporting to the EU Emission Trading Scheme (EU ETS). In addition, emission factors for offshore gas turbines and refinery gas is based on EU ETS data[17]. The EU ETS data have been applied for the years 2006 - 2010.

The EU ETS data are also applied for other source categories and are further discussed in Chapter 1.4.10.

[15] Based on manure with addition of other organic waste.
[16] And former editions of the EMEP/Corinair Guidebook.
[17] See page 134 and 134.

Methodology, criteria for implementation and QA/QC

The Danish emission inventory for stationary combustion only includes data from plants using higher tier methods as defined in the EU decision (EU Commission, 2007), where the specific methods for determining carbon contents, oxidation factor and calorific value are specified. The EU decision includes rules for measuring, reporting and verification.

For each of the plants included individually in the Danish inventory all applied methodologies are specified in individual monitoring plans that are approved by Danish authorities (DEA) prior to the reporting of the emissions. The plants/fuels included individually in the Danish inventory all apply the Tier 3 methodology for calculating the CO_2 emission factor. This selection criteria results in a dataset for which the emission factor values are based on fuel quality measurements[18], not default values from the Danish UNFCCC reporting. All fuel analyses are performed according to ISO 17025.

The power plants/fuels selected based on emission factor methodology apply the tiers for activity data, net calorific value (NCV), emission factor and oxidation factor listed below.

Coal

The CO_2 emission factor for coal is based on analysis of C content of the coal (g C per kg) and coal weight measurements. However, NCV values are also measured according to high tier methods in spite of the fact that this value is not input data for the calculation of total CO_2 emission.

- Fuel flow: Tier 4 methodology (± 1.5 %). For coal, the activity data (weight) is based on measurements on belt conveyor scale. The uncertainty is below the required ± 1.5 %.
- NCV: Tier 3 methodology. Data are based on measurements according to ISO 13909 / ISO 18283 (sampling) and ISO 1928 (NCV). The uncertainty for data is below ± 0.5 %.
- Emission factor: The emission factor is C-content of the coal. Tier 3 methodology (± 0.5 %) is applied and the measurements are performed according to ISO 13909 (sampling) and ISO/TS 12902 (C-content).
- Oxidation factor: Based on Tier 3 methodology except for one plant that applies Tier 1 methodology[19]. The Tier 3 methodology is based on measurements of C-content in bottom ash and fly ash according to ISO/TS 12902 or on burning loss measurements according to ISO 1171. The uncertainty has been estimated to 0.5 %. For Tier 1 the oxidation factor is assumed to be 1.

Residual oil

- Fuel flow: Tier 4 methodology (± 1.5 %) for most plants. However, a few of the included plants apply Tier 3 methodology (± 2.5 %).
- NCV: Tier 3 methodology. Data are based on sampling according to API Manual of Petroleum Measurement Standards / ASTM D 270 and fuel analysis (NCV) according to ASTM D 240 / ISO 1928 / data stated by the fuel supplier.
- Emission factor: Tier 3 methodology according to API Manual of Petroleum Measurement Standards / ASTM D 4057 (sampling) and ISO 12902 / ASTM D 5291 (C-content).

[18] Applying specific methods defined in the EU decision
[19] In addition DCE have assumed the oxidation factor to be 1 for a plant for which the stated oxidation factor was rejected in the QC work.

- Oxidation factor: Based on Tier 2 or Tier 3 methodology, both resulting in the oxidation factor 1 with an uncertainty of 0.8 %.

For coal and residual oil fuel analyses are required for each 20,000 tonnes or at least six times each year. The fuel analyses are performed by accredited laboratories[20].

QC of EU ETS data

DCE performs QC checks on the reported emission data, see Chapter 1.4.10. Based on the QC checking DCE excluded the oxidation factor for coal for one stationary combustion plant for 2010.

Additional data analysis performed as a result of the former review will result in exclusion of one dataset for 2008, two datasets for 2007 and one dataset for 2006. The oxidation factors for these datasets are outliers. This will be corrected in the reporting in 2013.

Data presentation

The EU ETS data for power plants include plant specific emission factors for coal, residual oil, gas oil, natural gas and petroleum coke. The EU ETS data for power plants account for 55 % of the CO_2 emission from stationary combustion.

Power plants, coal

EU ETS data for 2010 were available from 14 coal fired power plant units. The plant specific information accounts for 97 %[21] of the Danish coal consumption and 47 % of the total (fossil) CO_2 emission from stationary combustion plants. The average CO_2 emission factor for coal for these 14 units was 93.6 kg per GJ (Table 3.2.16). The plants all apply bituminous coal.

Table 3.2.16 EU ETS data for 14 coal fired power plant units, 2010.

	Average	Min	Max
Heating value, GJ per tonne[22]	24.4	23.8	25.0
CO_2 implied emission factor, kg per GJ[1)]	93.6	91.5	95.4
Oxidation factor	0.994	0.987	1.000

1) Including oxidation factor

Table 3.2.17 CO_2 implied emission factor time series for coal fired power plant units based on EU ETS data.

Year	CO_2 implied emission factor, kg per GJ[1)]
2006	94.4
2007	94.3
2008	94.0
2009	93.6
2010	93.6

1) Including oxidation factor

Power plants, residual oil

EU ETS data for 2010 based on higher tier methodologies were available from 8 units combusting residual oil. Aggregated data and time series are

[20] EN ISO 17025.
[21] Including EU ETS data for cement production: 98 %.
[22] One data set has been excluded as part of the QC work.

shown in Table 3.2.18 and Table 3.2.19. The EU ETS data accounts for 34 %[23] of the residual oil consumption in stationary combustion.

Table 3.2.18 EU ETS data for 8 power plant units combusting residual oil.

	Average	Min	Max
Heating value, GJ per tonne	40.5	39.7	40.8
CO_2 implied emission factor, kg per GJ	79.2	78.6	80.5
Oxidation factor	1.00	1.00	1.00

Table 3.2.19 CO_2 implied emission factor time series for residual oil fired power plant units based on EU ETS data.

Year	CO_2 implied emission factor, kg per GJ[1)]
2006	78.2
2007	78.1
2008	78.5
2009	78.9
2010	79.2

1) Including oxidation factor

Power plants, gas oil

EU ETS data for 2010 based on higher tier methodologies were available from 3 plants combusting gas oil. Aggregated data and time series are shown in Table 3.2.20 and Table 3.2.21. The EU ETS data accounts for 5 % of the gas oil consumption in stationary combustion.

Table 3.2.20 EU ETS data for 3 power plant units combusting gas oil.

	Average	Min	Max
CO_2 implied emission factor, kg per GJ	74.8	74.7	75.2
Oxidation factor	1.00	1.00	1.00

Table 3.2.21 CO_2 implied emission factor time series for gas oil fired power plant units based on EU ETS data.

Year	CO_2 implied emission factor, kg per GJ[1)]
2006	75.1
2007	74.9
2008	73.7
2009	75.1
2010	74.8

1) Including oxidation factor

Industrial plants

Plant specific CO_2 emission factors from EU ETS have also been applied for the cement production plants, sugar production plants and vegetable oil production plants, that are part of source category 1A2 Industry. The EU ETS data includes CO_2 emission factors for coal, petroleum coke, residual oil, gas oil and waste.

Offshore gas turbines

Individual EU ETS data are not applied for each of the offshore gas turbines, but EU ETS data have been applied to estimate an average CO_2 emission factor for this source category, see page 161.

Refinery gas

EU ETS data are also applied for the two refineries in Denmark. The emission factor for refinery gas is based on EU ETS data, see page 161.

[23] 73 % including EU ETS data for cement industry.

CO_2, other emission factors

The CO_2 emission factors that are not included in EU ETS data or that are included but based on lower tier methodologies are not plant specific in the Danish inventory. The emission factors that are not plant specific accounts for 45 % of the fossil CO_2 emission.

The CO_2 emission factors applied for 2010 are presented in Table 3.2.22. time series have been estimated for:

- Coal applied in source category 1A1a
- Residual oil in source category 1A1a
- Refinery gas
- Natural gas applied in off shore gas turbines
- Natural gas, other

For all other fuels, the same emission factor has been applied for 1990-2010.

In the reporting to the UNFCCC, the CO_2 emission is aggregated to five fuel types: Solid fuels, Liquid fuels, Gaseous fuels, Biomass and Other fuels. The correspondence list between the DCE fuel categories and the IPCC fuel categories is also provided in Table 3.2.22.

Only emissions from fossil fuels are included in the total national CO_2 emission. The biomass emission factors are also included in the table, because emissions from biomass are reported to the UNFCCC as a memo item.

The CO_2 emission from incineration of waste (37 + 75.1 kg per GJ) is divided into two parts: The emission from combustion of the fossil content of the waste, which is included in the national total, and the emission from combustion of the rest of the waste – the biomass part, which is reported as a memo item. In the IPCC reporting, the fuel consumption and emissions from the fossil content of the waste is reported in the fuel category, *Other fuels*.

Table 3.2.22 CO_2 emission factors, 2010.

Fuel	Emission factor kg per GJ		Reference type	IPCC fuel category
	Biomass	Fossil fuel		
Coal, source category 1A1a Public electricity and heat production		93.6 [1)]	Country specific	Solid
Coal, Other source categories		94.6 [3)]	IPCC 1997	Solid
Brown coal briquettes		94.6	IPCC 1997	Solid
Coke oven coke		108	IPCC 1997	Solid
Anodic carbon		108 [1)]	IPCC 1997	Solid
Petroleum coke		92 [3)]	Country specific	Liquid
Residual oil, source category 1A1a Public electricity and heat production		79.2 [1)]	Country specific	Liquid
Residual oil, other source categories		77.4 [3)]	IPCC 1997	Liquid
Gas oil		74 [1) 3)]	EEA 2007	Liquid
Kerosene		71.9	IPCC 1997	Liquid
Orimulsion		80 [2)]	Country specific	Liquid
LPG		63.1	IPCC 1997	Liquid
Refinery gas		57.134	Country specific	Liquid
Natural gas, off shore gas turbines		57.314	Country specific	Gas
Natural gas, other		56.74	Country specific	Gas
Waste	75.1 [3)4)]	+ 37 [3)4)]	Country specific	Biomass and Other fuels
Straw	110		IPCC 1997	Biomass
Wood	110		IPCC 1997	Biomass
Bio oil	74		Country specific	Biomass
Biogas	83.6		Country specific	Biomass
Biomass producer gas	142.9 [5)]		Country specific	Biomass

1) Plant specific data from EU ETS incorporated for individual plants.

2) Not applied in 2010. Orimulsion was applied in Denmark in 1995 – 2004.

3) Plant specific data from EU ETS incorporated for cement production.

4) The emission factor for waste is (37+75.1) kg CO_2 per GJ waste. The fuel consumption and the CO_2 emission have been disaggregated to the two IPCC fuel categories *Biomass* and *Other fuels* in CRF. The IEF[24] for CO_2, Other fuels is 82.22 kg CO_2 per GJ fossil waste.

5) Includes a high content of CO_2 in the gas.

Coal

As mentioned above[25], EU ETS data have been utilised for the years 2006 - 2010 in the emission inventory. In 2010, the implied emission factor (including oxidation factor) for the power plants using coal was 93.6 kg per GJ. The implied emission factor values were between 91.5 and 95.4 kg per GJ.

In 2010, only 2 % of the CO_2 emission from coal consumption was based on the emission factor, whereas 98 % of the coal consumption was covered by EU ETS data[26]. All coal applied in Denmark is bituminous coal (DEA, 2011d).

The emission factors for coal combustion in source category *1A1a Public electricity and heat production* in the years 2006-2010 refer to the implied emission factors of the EU ETS data estimated for each year. For the years 1990-2005, the emission factor for coal in source category *1A1a Public electricity and heat production* refer to the average IEF for 2006-2009.

[24] Not including cement production.
[25] CO_2, use of EU ETS data
[26] Including EU ETS data for cement production.

time series for net calorific value (NCV) of coal are available in the Danish energy statistics. NCV for *Electricity plant coal* fluctuates in the interval 24.3-25.8 GJ per tonne.

The correlation between NCV and CO_2 IEF (including the oxidation factor) in the EU ETS data (2006-2009) have been analysed and the results are shown in Annex 3A-10. However, a significant correlation between NCV and IEF have not been found in the dataset and thus an emission factor time series based on the NCV time series was not relevant. In addition, the correlation of NCV and CO_2 emission factors has been analysed. This analysis is also shown in Annex 3A-10. As expected, the correlation was better in this dataset, but still insufficient for estimating a time series for the CO_2 emission factor based on the NCV time series.

As mentioned above all coal applied in Denmark is bituminous coal and within the range of coal qualities applied in the plants reporting data to EU ETS a correlation could not be documented.

For other sectors apart from 1A1a, the applied emission factor 94.6 kg per GJ refers to IPCC Guidelines (IPCC, 1997). This emission factor has been applied for all years.

time series for the CO_2 emission factor are shown in Table 3.2.23.

Table 3.2.23 CO_2 emission factors for coal, time series.

Year	1A1a Public electricity and heat production kg per GJ	Other source categories kg per GJ
1990-2005	94.0	94.6
2006	94.4	94.6
2007	94.3	94.6
2008	94.0	94.6
2009	93.6	94.6
2010	93.6	94.6

Brown coal briquettes

The emission factor for brown coal briquettes, 94.6 kg per GJ, is based on a default value from the IPCC Guidelines (IPCC, 1997) assuming full oxidation. The default value in the IPCC Guidelines is 25.8 t C per TJ, corresponding to $25.8 \cdot (12+2 \cdot 16)/12 = 94.6$ kg CO_2 per GJ assuming full oxidation. The same emission factor has been applied for 1990-2010.

Coke oven coke

The emission factor for coke oven coke, 108 kg per GJ, is based on a default value from the IPCC Guidelines (IPCC, 1997) assuming full oxidation. The default value in the IPCC guidelines is 29.5 t C per TJ, corresponding to $29.5 \cdot (12+2 \cdot 16)/12 = 108$ kg CO_2 per GJ assuming full oxidation. The same emission factor has been applied for 1990-2010.

Anodic carbon

Anodic carbon has been applied in Denmark in 2009-2010 in two mineral wood production units. EU ETS data are available for both plants and thus the area source emission factor have not been applied.

Petroleum coke

The emission factor for petroleum coke, 92 kg per GJ, has been estimated by SK Energy (a former major power plant operator in eastern Denmark) in 1999 based on a fuel analysis carried out by dk-Teknik in 1993 (Bech, 1999).

The emission factor level was confirmed by a new fuel analysis, which, however, is considered confidential. The same emission factor has been applied for 1990-2010.

Plant specific EU ETS data have been utilised for the cement production for the years 2006 - 2010. This consumption represents more than 99 % of the consumption of petroleum coke in Denmark.

Plant specific emission factors from EU ETS data are now available for one power plant and the cement production plant. Both plants state emission factors that are higher than 92 kg/GJ. Thus, the area source emission factor 93 kg/GJ that is based on EU ETS data for 2006-2010 will be applied in the next inventory for all years. Due to the fact that in 2010 less than 0.2 % of the CO_2 emission from petroleum coke consumption was based on the area source emission factor the error is very low[27].

Residual oil

As mentioned above[28] EU ETS data have been utilised for the 2006 - 2010 emission inventories. In 2010, the implied emission factor (including oxidation factor) for the power plants combusting residual oil was 79.2 kg per GJ. The implied emission factor values were between 78.6 and 80.5 kg per GJ.

In 2010, 63 % of the CO_2 emission from residual oil consumption was based on the emission factor, whereas 37 % of the residual oil consumption was covered by EU ETS data[29].

The emission factors for residual oil combustion in source category *1A1a Public electricity and heat production* in the years 2006-2010 refer to the implied emission factors of the EU ETS data estimated for each year. For the years 1990-2005, the emission factor for residual oil in source category *1A1a Public electricity and heat production* refer to the average IEF for 2006-2009.

For other source categories apart from 1A1a, the applied emission factor 77.4 kg per GJ refers to the IPCC Guidelines (IPCC, 1997). This emission factor has been applied for all years.

time series for the CO_2 emission factor are shown in Table 3.2.24.

Table 3.2.24 CO_2 emission factors for residual oil, time series.

Year	Source category 1A1a Public electricity and heat production kg per GJ	Other source categories kg per GJ
1990-2005	78.4	77.4
2006	78.2	77.4
2007	78.1	77.4
2008	78.5	77.4
2009	78.9	77.4
2010	79.2	77.4

Gas oil

The emission factor for gas oil, 74 kg per GJ, refers to EEA (2007). The emission factor is consistent with the IPCC default emission factor for gas oil (74.1 kg per GJ assuming full oxidation). The CO_2 emission factor has been confirmed by the two major power plant operators in 1996 (Christiansen,

[27] The total consumption of petroleum coke was 5 PJ in 2010.
[28] CO_2, use of EU ETS data
[29] Including EU ETS data for cement production.

1996 and Andersen, 1996). The same emission factor has been applied for 1990-2010.

Plant specific EU ETS data have been utilised for power plant units in the 2006 - 2010 emission inventories. In 2010, the implied emission factor for the power plants using gas oil was 74.8 kg per GJ. The EU ETS CO_2 emission factors for power plants were in the interval 74.7 - 75.2 kg per GJ. In 2010, 6 % of the CO_2 emission from gas oil consumption was based on EU ETS data[30].

Kerosene

The emission factor for kerosene, 71.9 kg per GJ, refers to IPCC Guidelines (IPCC, 1997). The same emission factor has been applied for 1990-2010.

Orimulsion

The emission factor for orimulsion, 80 kg per GJ, refers to the Danish Energy Agency (DEA, 2010b). The IPCC default emission factor is almost the same: 80.7 kg per GJ assuming full oxidation. The CO_2 emission factor has been confirmed by the only major power plant operator using orimulsion (Andersen, 1996). The same emission factor has been applied for all years. Orimulsion has not been used in Denmark in 1995-2004.

LPG

The emission factor for LPG, 63.1 kg per GJ, refers to IPCC Guidelines (IPCC, 1997). The same emission factor has been applied for 1990-2010.

Refinery gas

The emission factor applied for refinery gas refers to EU ETS data for the two refineries in operation in Denmark. Implied emission factors for Denmark have been estimated annually based on the EU ETS data since 2006. The average implied emission factor (57.6 kg per GJ) for 2006-2009 have been applied for the years 1990-2005. This emission factor is consistent to the emission factor stated in the 2006 IPCC Guidelines (IPCC, 2006). The time series is shown in Table 3.2.25.

Table 3.2.25 CO_2 emission factors for refinery gas, time series.

Year	CO_2 emission factor, kg per GJ
1990-2005	57.6
2006	57.812
2007	57.848
2008	57.948
2009	56.814
2010	57.134

Natural gas, offshore gas turbines

EU ETS data for the fuel consumption and CO_2 emission for offshore gas turbines are available for the years 2006-2010. Based on data for each oilfield implied emission factors have been estimated for 2006-2010. The average value for 2006-2009 has been applied for the years 1990-2005. The time series is shown in Table 3.2.26.

[30] Including EU ETS data for cement production.

Table 3.2.26 CO_2 emission factors for offshore gas turbines, time series.

Year	CO_2 emission factor, kg per GJ
1990-2005	57.469
2006	57.879
2007	57.784
2008	56.959
2009	57.254
2010	57.314

Natural gas, other source categories

The emission factor for natural gas is estimated by the Danish gas transmission company, Energinet.dk[31]. The calculation is based on gas analysis carried out daily by Energinet.dk at Egtved.

In 2010, there was a 5.7 PJ import of natural gas in Denmark, a 132 PJ export and a consumption that added up to 187 PJ. In former years only natural gas from the Danish gas fields have been utilised in Denmark. If the import of natural gas increases further, the methodology for estimating the CO_2 emission factor might be revised based on an ongoing dialog with the Danish Energy Agency and Energinet.dk. However, Energinet.dk have stated that the difference between the emission factor based on measurements at Egtved and the average value at Froeslev very close to the border differs less than 0.3 % for 2010.

Energinet.dk and the Danish Gas Technology Centre have calculated emission factors for 2000-2010. The emission factor applied for 1990-1999 refers to Fenhann & Kilde (1994). This emission factor was confirmed by the two major power plant operators in 1996 (Christiansen, 1996 and Andersen, 1996). The time series for the CO_2 emission factor is provided in Table 3.2.27.

Table 3.2.27 CO_2 emission factor time series for natural gas.

Year	CO_2 emission factor, kg per GJ
1990-1999	56.9
2000	57.1
2001	57.25
2002	57.28
2003	57.19
2004	57.12
2005	56.96
2006	56.78
2007	56.78
2008	56.77
2009	56.69
2010	56.74

Waste

The CO_2 emission from incineration of waste is divided into two parts: The emission from combustion of the fossil content of the waste, which is included in the national total, and the emission from combustion of the rest of the waste – the biomass part, which is reported as a memo item.

The CO_2 emission factor has been recalculated this year implementing results from an ongoing project, *Biogenic carbon in Danish combustible waste* including emission measurements from five Danish waste incineration plants (Astrup et al. 2012). The average fossil emission factors for waste have estimated to be 37 kg/GJ waste and the interval for the five plants was 25 – 51

[31] Former Gastra and before that part of DONG. Historical data refer to these companies.

kg/GJ. The five plants represent 44 % of the incinerated waste in 2010. The emission factor 37 kg/ GJ waste corresponds to 82.22 kg/GJ fossil waste.

The total CO_2 emission factor for waste refers to a Danish study (Jørgensen & Johansen, 2003). Based on emission measurements on five waste incineration plants the total CO_2 emission factor for waste incineration has been determined to 112.1 kg per GJ. Thus, the biomass emission factor has been determined to 75.1 kg/GJ waste.

Plant specific EU ETS data have been utilised for cement production in the 2006 - 2010 emission inventories.

Wood

The emission factor for wood, 110 kg per GJ, refers IPCC (1997). The same emission factor has been applied for 1990-2010.

Straw

The emission factor for wood, 110 kg per GJ, refers IPCC (1997). The same emission factor has been applied for 1990-2010.

Bio oil

The emission factor is assumed to be the same as for gas oil – 74 kg per GJ. The consumption of bio oil is below 2 PJ.

Biogas

In Denmark 3 different types of biogas is applied: Manure/organic waste based biogas, landfill based biogas and wastewater treatment biogas (sludge gas). Manure / organic waste based biogas represent more than 70 % of the consumption, see page 153.

The emission factor for biogas, 83.6 kg per GJ, is based on a biogas with 65 % (vol.) CH_4 and 35 % (vol.) CO_2. Danish Gas Technology Centre has stated that this is a typical manure-based biogas as utilised in stationary combustion plants (Kristensen, 2001). The same emission factor has been applied for 1990-2010.

Biomass producer gas

Biomass producer gas applied in Denmark is based on wood. The gas composition is known for three different plants and the applied emission factor have been estimated by Danish Gas Technology Centre (Kristensen, 2010) based on the gas composition measured on the plant that with the highest consumption.

The consumption of biomass producer gas is below 0.3 PJ for all years.

CH_4

The CH_4 emission factors applied for 2010 are presented in Table 3.2.28. In general, the same emission factors have been applied for 1990-2010. However, time series have been estimated for both natural gas fuelled engines and biogas fuelled engines, residential wood combustion, natural gas fuelled gas turbines[32] and waste incineration plants[32].

Emission factors for CHP plants < 25 MW_e refer to emission measurements carried out on Danish plants (Nielsen et al., 2010; Nielsen & Illerup, 2003;

[32] A minor emission source.

Nielsen et al., 2009). The emission factors for residential wood combustion are based on technology dependent data.

Emission factors that are not nationally referenced all refer to the IPCC Guidelines (IPCC, 1997).

Gas engines combusting natural gas or biogas account for more than half the CH_4 emission from stationary combustion plants. The relatively high emission factor for gas engines is well-documented and further discussed below.

Table 3.2.28 CH_4 emission factors 2010.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
SOLID	COAL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
				010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
				010104	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
		1A2 e-f	Industry - other	all	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
		1A4c i	Agriculture/ Forestry	020300	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.[1)]
	BROWN COAL BRI.	1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
	COKE OVEN COKE	1A2 e-f	Industry	all	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
	ANODIC CARBON	1A2f i	Industry - other	032000	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
LIQUID	PETROLEUM COKE	1A1a	Commercial/ Institutional	020100	3	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.
		1A2f	Industry – other	all	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil.
		1A4b	Residential	020200	10	IPCC (1997), Tier 1, Table 1-7, Residential, oil.
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
				010102	1.3	Nielsen et al. (2010)
				010103	1.3	Nielsen et al. (2010)
				010104	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
				010202	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
				010203	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
		1A1b	Petroleum refining	010306	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
		1A2 a-f	Industry	all	1.3	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil.
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 2, Table 1-18, Residential, residual fuel oil.
		1A4c i	Agriculture/ Forestry	020300	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil[1)].
				020302	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil[1)].
				020304	4	IPCC (1997), Tier 2, Table 1-15, Utility, Large diesel engines.
	GAS OIL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010103	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010104	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
				010105	24	Nielsen et al. (2010)
				010202	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010203	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
		1A1b	Petroleum refining	010306	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
		1A2 c-f	Industry	Other	0.2	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil.
				Turbines	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil.
				Engines	24	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
				020103	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
				020105	24	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residential, distillate fuel oil.
				020204	24	Nielsen et al. (2010)
		1A4c	Agriculture/ Forestry	020302	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
	KEROSENE	1A2 f	Industry	all	0.2	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil.
		1A4a	Commercial/ Institutional	020100	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residential, distillate fuel oil.
		1A4c i	Agriculture/ Forestry	020300	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil[1)].
	LPG	1A1a	Electricity and heat production	010101	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
				010102	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
				010103	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
Continued						
				010203	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
		1A2 a-f	Industry	all	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil
		1A4a	Commercial/ Institutional	020100	10	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.
				020105	10	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.
		1A4b i	Residential	020200	1.1	IPCC (1997), Tier 2, Table 1-18, Residential propane/butane furnaces.
		1A4c i	Agriculture/ Forestry	020300	10	IPCC (1997), Tier 1, Table 1-7, Agriculture, oil.
	REFINERY GAS	1A1b	Petroleum refining	010304	1.7	Assumed equal to natural gas fuelled gas turbines. Nielsen et al. (2010)
				010306	1	Assumed equal to natural gas fuelled plants. IPCC (1997), Tier 1, Table 1-7, Natural gas
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010102	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010103	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010104	1.7	Nielsen et al. (2010)
				010105	481	Nielsen et al. (2010)
				010202	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010203	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
		1A1c	Other energy industries	010504	1.7	Nielsen et al. (2010)
		1A2 a-f	Industry	Other	1.4	IPCC (1997), Tier 2, Table 1-16, Industry, natural gas boilers.
				Gas turbines	1.7	Nielsen et al. (2010)
				Engines	481	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers.
				020103	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers.
				020105	481	Nielsen et al. (2010)
		1A4b i	Residential	020200	5	IPCC (1997), Tier 1, Table 1-7, Residential, natural gas.
				020202	5	IPCC (1997), Tier 1, Table 1-7, Residential, natural gas.
				020204	481	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers[1)].
				020304	481	Nielsen et al. (2010)
WASTE	WASTE	1A1a	Electricity and heat production	010101	0.34	Nielsen et al. (2010)
				010102	0.34	Nielsen et al. (2010)
				010103	0.34	Nielsen et al. (2010)
				010203	0.34	Nielsen et al. (2010)
		1A2a-f	Industry	all	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
		1A4a	Commercial/ Institutional	020103	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
	INDUSTRIAL WASTE	1A2f	Industry	031600	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
BIOMASS	WOOD	1A1a	Electricity and heat production	010101	3.1	Nielsen et al. (2010)
				010102	3.1	Nielsen et al. (2010)
				010103	3.1	Nielsen et al. (2010)
				010104	3.1	Nielsen et al. (2010)
				010203	30	IPCC (1997), Tier 1, Table 1-7, Energy industries, wood
		1A2 d-f	Industry	all	15	IPCC (1997), Tier 2, Table 1-16, Industry, wood stoker boilers.
		1A4a	Commercial/ Institutional	020100	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2)].
				020105	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2)].
		1A4b i	Residential	020200	114	DCE estimate based on technology distribution [3)]
				020202	114	DCE estimate based on technology distribution [3)]
				020204	114	DCE estimate based on technology distribution [3)]
		1A4c i	Agriculture/ Forestry	020300	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2)].
				020303	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2)].
	STRAW	1A1a	Electricity and heat production	010101	0.47	Nielsen et al. (2010)
				010102	0.47	Nielsen et al. (2010)
				010103	0.47	Nielsen et al. (2010)
				010104	0.47	Nielsen et al. (2010)
				010203	30	IPCC (1997), Tier 1, Table 1-7, Energy industries, other biomass
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, other biomass.
		1A4c i	Agriculture/ Forestry	020300	300	IPCC (1997), Tier 1, Table 1-7, Agriculture, other biomass.
	BIO OIL	1A1a	Electricity and heat production	010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010105	24	Nielsen et al. (2010) assumed same emission factor as for gas oil fuelled engines.
				010202	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
Continued						
				010203	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
		1A2	Industry	030105	24	Nielsen et al. (2010) assumed same emission factor as for gas oil fuelled engines.
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residential, distillate fuel oil.
	BIOGAS	1A1a	Electricity and heat production	010101	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural gas. Assumed similar to natural gas (DCE assumption).
				010102	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural gas. Assumed similar to natural gas (DCE assumption).
				010105	434	Nielsen et al. (2010)
				010203	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural gas. Assumed similar to natural gas (DCE assumption).
		1A2 e-f	Industry	Other	5	IPCC (1997), Tier 1, Table 1-7, Industry, natural gas. Assumed similar to natural gas (DCE assumption).
				En-gines	434	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	5	IPCC (1997), Tier 1, Table 1-7, Commercial, natural gas. Assumed similar to natural gas (DCE assumption).
				020103	5	IPCC (1997), Tier 1, Table 1-7, Commercial, natural gas. Assumed similar to natural gas (DCE assumption).
				020105	434	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	5	IPCC (1997), Tier 1, Table 1-7, Agriculture, natural gas. Assumed similar to natural gas (DCE assumption).
				020304	434	Nielsen et al. (2010)
	BIO PROD GAS	1A1a	Electricity and heat production	010105	13	Nielsen et al. (2010)
		1A2	Industry	030105	13	Nielsen et al. (2010)

1) Assumed same emission factors as for commercial plants. Plant capacity and technology are similar for Danish plants.

2) Assumed same emission factor as for industrial plants. Plant capacity and technology is similar to industrial plants rather than to residential plants.

3) Aggregated emission factor based on the technology distribution in the sector (Nielsen et Hessberg 2011) and technology specific emission factors.

CHP plants

A considerable part of the electricity production in Denmark is based on decentralised CHP plants, and well-documented emission factors for these plants are, therefore, of importance. In a project carried out for the electricity transmission company, Energinet.dk, emission factors for CHP plants <25MW_e have been estimated. The work was reported in 2010 (Nielsen et al., 2010).

The work included waste incineration plants, CHP plants combusting wood and straw, natural gas and biogas-fuelled (reciprocating) engines, natural gas fuelled gas turbines, gas oil fuelled engines, gas oil fuelled gas turbines, steam turbines fuelled by residual oil and engines fuelled by biomass producer gas. CH_4 emission factors for these plants all refer to Nielsen et al. (2010). The estimated emission factors were based on existing emission measurements as well as on emission measurements carried out within the project. The number of emission data sets was comprehensive. Emission factors for subgroups of each plant type were estimated, e.g. the CH_4 emission factor for different gas engine types has been determined.

time series for the CH_4 emission factors are based on a similar project estimating emission factors for year 2000 (Nielsen & Illerup, 2003).

Natural gas, gas engines

SNAP 010105, 030105, 020105, 020204 and 020304

The emission factor for natural gas engines refers to the Nielsen et al. (2010). The emission factor includes the increased emission during start/stop of the engines estimated by Nielsen et al. (2008). Emission factor time series for the years 1990-2007 have been estimated based on Nielsen & Illerup (2003). These three references are discussed below.

Nielsen et al. (2010):

> CH_4 emission factors for gas engines were estimated for 2003-2006 and for 2007-2010. The dataset was split in two due to new emission limits for the engines from October 2006. The emission factors were based on emission measurements from 366 (2003-2006) and 157 (2007-2010) engines respectively. The engines from which emission measurements were available for 2007-2010 represent 38 % of the gas consumption. The emission factors were estimated based on fuel consumption for each gas engine type and the emission factor for each engine type. The majority of emission measurements that were not performed within the project related solely to the emission of total unburned hydrocarbon (CH_4 + NMVOC). A constant disaggregation factor was estimated based on 9 emission measurements including both CH_4 and NMVOC.

Nielsen & Illerup (2003):

> The emission factor for natural gas engines was based on 291 emission measurements in 114 different plants. The plants from which emission measurements were available represented 44 % of the total gas consumption in gas engines in year 2000.

Nielsen et al. (2008):

> This study calculated a start/stop correction factor. This factor was applied to the time series estimated in Nielsen & Illerup (2003). Further, the correction factors were applied in Nielsen et al. (2010).

The emission factor for lean-burn gas engines is relatively high, especially for pre-chamber engines, which account for more than half the gas consumption in Danish gas engines. However, the emission factors for different pre-chamber engine types differ considerably.

The installation of natural gas engines in decentralised CHP plants in Denmark has taken place since 1990. The first engines installed were relatively small open-chamber engines but later mainly pre-chamber engines were installed. As mentioned above, pre-chamber engines have a higher emission factor than open-chamber engines; therefore, the emission factor has increased during the period 1990-1995. After that technical improvements of the engines have been implemented as a result of upcoming emission limits that most installed gas engines had to meet in late 2006 (DEPA, 2005).

The time series were based on:

- Full load emission factors for different engine types in year 2000 (Nielsen & Illerup, 2003), 2003-2006 and 2007-2010 (Nielsen et al., 2010).
- Data for year of installation for each engine and fuel consumption of each engine 1994-2002 from the Danish Energy Agency (DEA, 2003).
- Research concerning the CH_4 emission from gas engines carried out in 1997 (Nielsen & Wit, 1997).
- Correction factors including increased emission during start/stop of the engines (Nielsen et al., 2010).

Table 3.2.29 time series for the CH_4 emission factor for natural gas fuelled engines.

Year	Emission factor, g per GJ
1990	266
1991	309
1992	359
1993	562
1994	623
1995	632
1996	616
1997	551
1998	542
1999	541
2000	537
2001	522
2002	508
2003	494
2004	479
2005	465
2006	473
2007	481
2008	481
2009	481
2010	481

Gas engines, biogas

SNAP 010105, 030105, 020105 and 020304

The emission factor for biogas engines was estimated to 434 g per GJ in 2010. The emission factor is lower than the factor for natural gas, mainly because most engines are lean-burn open-chamber engines - not prechamber engines.

time series for the emission factor have been estimated. The emission factors for biogas engines were based on Nielsen et al. (2010) and Nielsen & Illerup (2003). The two references are discussed below. The time series are shown in Table 3.2.30.

Nielsen et al. (2010):

> CH_4 emission factors for gas engines were estimated for 2006 based on emission measurements performed in 2003-2010. The emission factor was based on emission measurements from 10 engines. The engines from which emission measurements were available represent 8 % of the gas consumption. The emission factor was estimated based on fuel consumption for each gas engine type and the emission factor for each engine type. The majority of emission measurements that were not performed within the project related solely to the emission of total unburned hydrocarbon (CH_4 + NMVOC). A constant disaggregation factor was estimated based on 3 emission measurements including both CH_4 and NMVOC.

Nielsen & Illerup (2003):

> The emission factor for natural gas engines was based on 18 emission measurements from 13 different engines. The engines from which emission measurements were available represented 18 % of the total biogas consumption in gas engines in year 2000.

Table 3.2.30 time series for the CH_4 emission factor for biogas fuelled engines.

Year	Emission factor, g per GJ
1990	239
1991	251
1992	264
1993	276
1994	289
1995	301
1996	305
1997	310
1998	314
1999	318
2000	323
2001	342
2002	360
2003	379
2004	397
2005	416
2006	434
2007	434
2008	434
2009	434
2010	434

Gas turbines, natural gas

SNAP 010104, 010504 and 030104

The emission factor for gas turbines was estimated to be below 1.7 g per GJ in 2005 (Nielsen et al., 2010). The emission factor was based on emission measurements on five plants. The emission factor in year 2000 was 1.5 g per GJ (Nielsen & Illerup, 2003). A time series have been estimated.

CHP, wood

SNAP 010102 and, 010103 and 010104

The emission factor for CHP plants combusting wood was estimated to be below 3.1 g per GJ (Nielsen et al., 2010) and the emission factor 3.1 g per GJ has been applied for all years. The emission factor was based on emission measurements on two plants.

CHP, straw

SNAP 010101, 010102, 010103 and 010104

The emission factor for CHP plants combusting straw was estimated to be below 0.47 g per GJ (Nielsen et al., 2010) and the emission factor 0.47 g per GJ has been applied for all years. The emission factor was based on emission measurements on four plants.

CHP, waste

SNAP 010101, 010102 and 010103

The emission factor for CHP plants combusting waste was estimated to be below 0.34 g per GJ in 2006 (Nielsen et al., 2010) and 0.59 g per GJ in year 2000 (Nielsen & Illerup, 2003). A time series have been estimated. The emission factor was based on emission measurements on nine plants.

The emission factor has also been applied for district heating plants.

Residential wood combustion

The emission factor for residential wood combustion is based on technology specific data. The emission factor time series is shown in Table 3.2.31.

Table 3.2.31 CH_4 emission factor time series for residential wood combustion.

Year	Emission factor, g per GJ
1990-2000	198.0
2001	175.0
2002	165.1
2003	161.8
2004	158.2
2005	149.2
2006	138.8
2007	139.1
2008	130.7
2009	120.1
2010	114.0

The emission factors for each technology and the corresponding reference are shown in Table 3.2.32. The emission factor time series are estimated based on time series (2000-2010) for wood consumption in each technology (Nielsen & Hessberg, 2011). The time series for wood consumption in the ten different technologies are illustrated in Figure 3.2.47. The consumption in pellet boilers and new stoves has increased.

Table 3.2.32 Technology specific CH_4 emission factors for residential wood combustion.

Technology	Emission factor, g pr GJ	Reference
Old stoves	430	Paulrud et al. (2005)
New stoves	350	NERI assumption (2011).
Modern stoves	50	Assumed equal to modern manually fed boilers.
Eco labelled stove	2	Olsson & Kjällstrand (2005)
Other stoves	430	Assumed equal to old iron stoves
Old manually fed boilers with accumulator tank	211	Paulrud et al. (2005)
Old manually fed boilers without accumulator tank	256	Paulrud et al. (2005)
Modern manually fed boilers with accumulator tank	50	Johansson et al (2004)
Modern manually fed boilers without accumulator tank	50	Johansson et al (2004)
Pellet boilers	3	Paulrud et al. (2005)
Other boilers	430	Assumed equal to old iron stoves

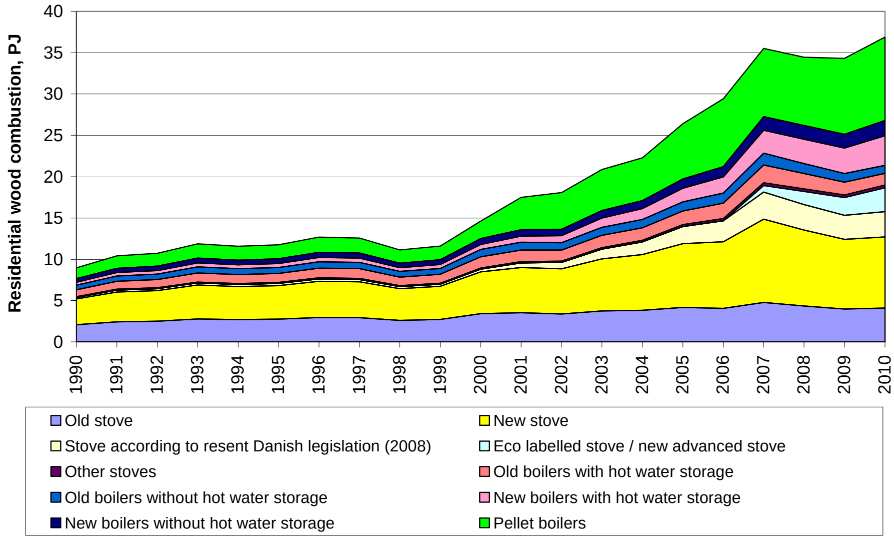


Figure 3.2.47 Technology specific wood consumption in residential plants.

Other stationary combustion plants

Emission factors for other plants refer to the IPCC Guidelines (IPCC, 1997).

N_2O

The N_2O emission factors applied for the 2010 inventory are listed in Table 3.2.33. time series have been estimated for natural gas fuelled gas turbines and refinery fuelled turbines. All other emission factors have been applied unchanged for 1990-2010.

Emission factors for natural gas fuelled reciprocating engines, natural gas fuelled gas turbines, CHP plants < 300 MW combusting wood, straw or residual oil, waste incineration plants, engines fuelled by gas oil and gas engines fuelled by biomass producer gas all refer to emission measurements carried out on Danish plants, Nielsen et al. (2010).

The emission factor for coal-powered plants in public power plants refers to research conducted by Elsam (now part of DONG Energy). The emission factor for offshore gas turbines refers to the Danish study concerning CHP plants (Nielsen & Illerup, 2003).

The emission factor for natural gas has been applied for refinery gas. Denmark uses two different N_2O emission factors for refinery gas, one when the gas is utilised in gas turbines and one for use in boilers. The emission factor for gas turbines is nationally referenced while the emission factor for boilers is based on the Revised 1996 IPCC Guidelines (IPCC 1997). Refinery gas has similar properties as natural gas, i.e. similar nitrogen content in the fuel, which means that N_2O formation will be similar under similar combustion conditions. This is the reasoning behind choosing the emission factor for natural gas rather than for liquid fuel for both turbines and boilers.

All emission factors that are not nationally referenced refer to the IPCC Guidelines (IPCC, 1997).

Table 3.2.33 N_2O emission factors 2010.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
SOLID	COAL	1A1a	Electricity and heat production	010101	0.8	Elsam (2005)
				010102	0.8	Elsam (2005)
				010204	0.8	Elsam (2005)
		1A2 e-f	Industry	all	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
		1A4c i	Agriculture/ Forestry	020300	1.4	IPCC (1997), Tier 1, Table 1-8, Commercial, coal
	BROWN COAL BRI.	1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
	COKE OVEN COKE	1A2 e-f	Industry	all	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
	ANODIC CARBON	1A2f	Industry - other	032000	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
LIQUID	PETROLEUM COKE	1A2f	Industry – other	all	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
		1A4b	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential oil
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
				010102	5	Nielsen et al. (2010)
				010103	5	Nielsen et al. (2010)
				010104	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010105	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010202	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
				010203	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
		1A1b	Petroleum refining	010306	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 a-f	Industry	all	5	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
				020302	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
				020304	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
	GAS OIL	1A1a	Electricity and heat production	010101	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010102	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010103	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010104	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010105	2.1	Nielsen et al. (2010)
				010202	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010203	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
		1A1b	Petroleum refining	010306	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 c-f	Industry	Other	0.4	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil boilers
				Turbines	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
				Engines	2.1	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
				020103	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
				020105	2.1	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
				020204	2.1	Nielsen et al. (2010)
		1A4c	Agriculture/ Forestry	020302	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
	KEROSENE	1A2	Industry	all	0.4	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil boilers
		1A4a	Commercial/ Institutional	020100	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil[1)]
	LPG	1A1a	Electricity and heat production	010101	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010102	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010203	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 a-f	Industry	all	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
		1A4a	Commercial/ Institutional	020100	0.6	IPCC (1997), Tier 1, Table 1-8, Commercial, oil
				020105	0.6	IPCC (1997), Tier 1, Table 1-8, Commercial, oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.6	IPCC (1997), Tier 1, Table 1-8, Agriculture, oil
	REFINERY GAS	1A1b	Petroleum refining	010304	1	Assumed equal to natural gas fuelled turbines. Based on Nielsen et al. (2010).
				010306	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010102	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010103	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010104	1	Nielsen et al. (2010)
				010105	0.58	Nielsen et al. (2010)
				010202	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010203	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
		1A1c	Other energy industries	010504	2.2	Nielsen & Illerup (2003) [2)]
		1A2 a-f	Industry	other	0.1	IPCC (1997), Tier 1, Table 1-8, Industry, natural gas
				Gas turbines	1	Nielsen et al. (2010)
				Engines	0.58	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers
				020103	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers
				020105	0.58	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.1	IPCC (1997), Tier 1, Table 1-8, Residential, natural gas
				020202	0.1	IPCC (1997), Tier 1, Table 1-8, Residential, natural gas

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
Continued						
				020204	0.58	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers[1)]
				020304	0.58	Nielsen et al. (2010)
WASTE	WASTE	1A1a	Electricity and heat production	010102	1.2	Nielsen et al. (2010)
				010103	1.2	Nielsen et al. (2010)
				010104	1.2	Nielsen et al. (2010)
				010203	1.2	Nielsen et al. (2010)
		1A2 c-f	Industry	all	4	IPCC (1997), Tier 1, Table 1-8, Industry, wastes
		1A4a	Commercial/ Institutional	020103	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wastes
	INDUSTR. WASTE	1A2f	Industry - other	031600	4	IPCC (1997), Tier 1, Table 1-8, Industry, wastes
BIO-MASS	WOOD	1A1a	Electricity and heat production	010101	0.8	Nielsen et al. (2010)
				010102	0.8	Nielsen et al. (2010)
				010103	0.8	Nielsen et al. (2010)
				010104	0.8	Nielsen et al. (2010)
				010203	4	IPCC (1997), Tier 1, Table 1-8, Energy industries, wood
		1A2 d-f	Industry	all	4	IPCC (1997), Tier 1, Table 1-8, Industry, wood
		1A4a	Commercial/ Institutional	020100	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wood
				020105	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wood
		1A4b i	Residential	020200	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
				020202	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
				020204	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
		1A4c i	Agriculture/ Forestry	020300	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, wood
				020303	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, wood
	STRAW	1A1a	Electricity and heat production	010101	1.1	Nielsen et al. (2010)
				010102	1.1	Nielsen et al. (2010)
				010103	1.1	Nielsen et al. (2010)
				010104	1.1	Nielsen et al. (2010)
				010203	4	IPCC (1997), Tier 1, Table 1-8, Energy industries, other bio-mass
		1A4b i	Residential	020200	4	IPCC (1997), Tier 1, Table 1-8, Residential, other biomass
		1A4c i	Agriculture/ Forestry	020300	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, other biomass
	BIO OIL	1A1a	Electricity and heat production	010102	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010105	2.1	Assumed equal to gas oil. Based on Nielsen et al. (2010)
				010202	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010203	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
		1A2	Industry	030105	2.1	Assumed equal to gas oil. Based on Nielsen et al. (2010)
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
	BIOGAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010102	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010105	1.6	Nielsen et al. (2010)
				010203	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
		1A2 e-f	Industry	Other	0.1	IPCC (1997), Tier 1, Table 1-8, Industry, natural gas
				Engines	1.6	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.1	IPCC (1997), Tier 1, Table 1-8, Commercial, natural gas
				020103	0.1	IPCC (1997), Tier 1, Table 1-8, Commercial, natural gas
				020105	1.6	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	0.1	IPCC (1997), Tier 1, Table 1-8, Agriculture, natural gas
				020304	1.6	Nielsen et al. (2010)
	BIO PROD GAS	1A1a	Electricity and heat production	010105	2.7	Nielsen et al. (2010)
		1A2	Industry	030105	2.7	Nielsen et al. (2010)

1) In Denmark, plants in Agriculture/Forestry are similar to Commercial plants.

SO_2, NO_x, NMVOC and CO

Emission factors for SO_2, NO_x, NMVOC and CO are listed in Annex 3A-4. The appendix includes references and time series.

The emission factors refer to:

- The EMEP/CORINAIR Guidebook (EEA, 2007 and EEA, 2009).
- The IPCC Guidelines, Reference Manual (IPCC, 1996).
- Danish legislation:
  - DEPA, 2001.
  - DEPA, 1990.
  - DEPA, 2003.
- Danish research reports including:
  - Two emission measurement programs for decentralised CHP plants (Nielsen et al. 2010; Nielsen & Illerup, 2003).
  - Research and emission measurements programs for biomass fuels:

        - Nikolaisen et al. (1998).
        - Jensen & Nielsen (1990).
        - Serup et al. (1999).
        - Christiansen et al. (1997).
    - Research and environmental data from the gas sector:
        - Gruijthuijsen & Jensen (2000).
        - Danish Gas Technology Centre (DGC) (2001).
        - Wit & Andersen (2003).
- Aggregated emission factors for residential wood combustion based on technology distribution (Nielsen et Hessberg 2011) and technology specific emission factors (EEA 2009; DEPA 2010). For NMVOC the emission factors also refer to Pettersson et al. (2011).
- Calculations based on plant-specific emissions from a considerable number of power plants.
- Calculations based on plant-specific emission data from a considerable number of waste incineration plants. These data refer to annual environmental reports published by plant operators.
- Sulphur content data from oil companies and the Danish gas transmission company, Energinet.dk.
- Additional personal communication.

The emission factors for NMVOC that are not nationally referenced all refer to EEA (2009).

Emission factor time series have been estimated for a considerable number of the emission factors. These are provided in Annex 3A-4.

3.2.6 Uncertainty

Uncertainty estimates include uncertainty with regard to the total emission inventory as well as uncertainty with regard to trends.

Methodology

Greenhouse gases

The uncertainty for greenhouse gas emissions have been estimated according to the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty has been estimated by two approaches; tier 1 and tier 2. Both approaches are further described in Chapter 1.7.

The **tier 1** approach is based on a normal distribution and a confidence interval of 95 %.

The input data for the tier 1 approach are:

- Emission data for the base year and the latest year.
- Uncertainties for emission factors
- Uncertainty for fuel consumption rates.

The emission source categories applied are listed in Table 3.2.34.

The **tier 2** approach is a Monte Carlo approach based on a lognormal distribution. The input data for the model is also based on 95 % confidence interval. The input data for the tier 2 approach are:

- Fuel consumption data for the base year and the latest year.

- Emission factors or implied emission factors (IEF) for the base year and the latest year
- Uncertainties for emission factors for the base year and the latest year. If the same uncertainty is applied for both years, the data can be indicated as statistically dependent or independent.
- Uncertainties for fuel consumption rates in the base year and the latest year. If the same uncertainty is applied for both years, the data can be indicated as statistically dependent or independent.

The same emission source categories and emission data have been applied for both approaches. The separate uncertainty estimation for gas engine CH_4 emission and CH_4 emission from other plants does not follow the recommendations in the IPCC Good Practice Guidance. Disaggregation is applied, because in Denmark, the CH_4 emission from gas engines is much larger than the emission from other stationary combustion plants, and the CH_4 emission factor for gas engines is estimated with a much smaller uncertainty level than for other stationary combustion plants.

In general, the same uncertainty levels have been applied for both approaches. However, the tier 2 approach allows different uncertainty levels for 1990 and 2010 and this is relevant to a few uncertainties as discussed below. The 2010 uncertainty levels have been applied in the tier 1 approach.

Most of the applied uncertainty estimates for activity rates and emission factors are default values from the IPCC Reference Manual or aggregated by DCE based on the default values. Some of the uncertainty estimates are, however, based on national estimates.

In general, the uncertainty of the fuel consumption data has been assumed to be the same in 1990 and 2010 and the uncertainty has been assumed to be statistically independent. However, a considerable part of the residential wood consumption is non-traded and the uncertainty of biomass consumption has been assumed statistically dependent.

Fuel consumption data for waste are more uncertain for 1990 than for 2010.

For coal and refinery gas combustion, the uncertainty of the CO_2 emission factor is lower in 2010 than in 1990 due to availability of EU ETS data. Further, the CO_2 emission factor for the fossil part of waste is less uncertain for 2010 than for 1990.

The uncertainty of the CH_4 emission factors for gas engines have been assumed higher in 1990 than in 2010 due to the emission measurement programmes on which the emission factors in later years are based.

All other uncertainty levels for emission factors have been assumed equal in 1990 and 2010 and statistically dependent.

Table 3.2.34 Uncertainty rates for fuel consumption and emission factors, 2010.

IPCC Source category	Gas	Fuel consumption uncertainty, %		Emission factor uncertainty, %	
		1990	2010	1990	2010
Stationary Combustion, Coal, CO_2	CO_2	0.9%[2]	0.9%[7]	4[10]	0.5[7]
Stationary Combustion, BKB, CO_2	CO_2	2.9%[2]	3.0%[2]	5[1]	
Stationary Combustion, Coke[33], CO_2	CO_2	1.9%[2]	1.9%[2]	5[1]	
Stationary Combustion, Fossil waste, CO_2	CO_2	10.0%[2]	5.0%[2]	20[5]	10[5]
Stationary Combustion, Petroleum coke, CO_2	CO_2	3.3%[2]	5.0%[2]	5[1]	
Stationary Combustion, Residual oil, CO_2	CO_2	1.2%[2]	1.0%[2]	2[4]	2[7]
Stationary Combustion, Gas oil, CO_2	CO_2	2.9%[2]	2.4%[2]	4[10]	
Stationary Combustion, Kerosene, CO_2	CO_2	3.0%[2]	2.8%[2]	5[1]	
Stationary Combustion, LPG, CO_2	CO_2	1.7%[2]	2.2%[2]	5[1]	
Stationary Combustion, Refinery gas, CO_2	CO_2	1.0%[2]	1.0%[2]	5[1]	2[12]
Stationary Combustion, Natural gas, CO_2	CO_2	1.2%[2]	1.0%[2]	0.4[8]	
Stationary Combustion, SOLID, CH_4	CH_4	0.9%[2]	1.0%[2]	100[1]	
Stationary Combustion, LIQUID, CH_4	CH_4	1.5%[2]	1.1%[2]	100[1]	
Stationary Combustion, GAS, CH_4	CH_4	1.0%[8]	1.0%[8]	100[1]	
Natural gas fuelled engines, GAS, CH_4	CH_4	1.0%[9]	1.0%[9]	10[11]	2[3]
Stationary Combustion, WASTE, CH_4	CH_4	10.0%[5]	5.0%[5]	100[1]	
Stationary Combustion, BIOMASS, CH_4	CH_4	10.6%[2]	12.8%[2]	100[1]	
Biogas fuelled engines, BIOMASS, CH_4	CH_4	6.8%[2]	3.8%[2]	20[11]	10[11]
Stationary Combustion, SOLID, N_2O	N_2O	0.9%[2]	1.0%[2]	400[6) 13]	
Stationary Combustion, LIQUID, N_2O	N_2O	1.5%[2]	1.1%[2]	1000[1) 13]	
Stationary Combustion, GAS, N_2O	N_2O	1.0%[8]	1.0%[8]	750[6) 13]	
Stationary Combustion, WASTE, N_2O	N_2O	10.0%[5]	5.0%[5]	400[6) 13]	
Stationary Combustion, BIOMASS, N_2O	N_2O	10.6%[2]	12.6%[2]	400[6) 13]	

1) IPCC Good Practice Guidance, default value (IPCC, 2000).
2) Estimated by DCE based on default uncertainty levels in IPCC Good Practice Guidance, Table 2.6 (IPCC, 2000).
3) Jørgensen et al. (2010). Uncertainty data for NMVOC + CH_4.
4) Jensen & Lindroth (2002).
5) Estimated by DCE based on ongoing work, biogenic carbon in waste (Nielsen, 2010). A new improved emission factor has been applied this year.
6) DCE, rough estimate based on a default value of 400 % when the emission factor is based on emission measurements from plants in Denmark.
7) Emission data based on EU ETS data.
8) Lindgren (2010). Personal communication, Tine Lindgren, Energinet.dk, e-mail 2010-03-16.
9) Equal to natural gas total. DCE assumption.
10) DCE assumption based on EU ETS data interval and IPCC Guidelines (IPCC, 1997) data interval.
11) NERI estimate based on Nielsen et al. (2010).
12) DCE assumption based on the fact that data are based on EU ETS data.
13) With a truncation of twice the uncertainty rate. The truncation is relevant for the very large uncertainty rates for N_2O emission factors due to the log-normal distribution applied in the tier 2 model.

Other pollutants

With regard to other pollutants, IPCC methodologies for uncertainty estimates have been adopted for the LRTAP Convention reporting activities (Pulles & Aardenne, 2003). The Danish uncertainty estimates are based on the simple Tier 1 approach.

The uncertainty estimates are based on emission data for the base year and year 2010 as well as on uncertainties for fuel consumption and emission factors for each of the main SNAP source categories. The applied uncertainties for activity rates and emission factors are default values referring to Pulles & Aardenne (2003). The default uncertainties for emission factors are given in letter codes representing an uncertainty range. It has been assumed that the uncertainties were in the lower end of the range for all sources and pollutants. The applied uncertainties for emission factors are listed in Table 3.2.35.

33 Including anodic carbon.

The uncertainty for fuel consumption in stationary combustion plants is assumed to be 2 %.

Table 3.2.35 Uncertainty rates for emission factors, %.

SNAP source category	SO_2	NO_x	NMVOC	CO
01	10	20	50	20
02	20	50	50	50
03	10	20	50	20

Results

The tier 1 uncertainty estimates for stationary combustion emission inventories are shown in Table 3.2.36. Detailed calculation sheets are provided in Annex 3A-7. The tier 2 uncertainty estimates are shown in Table 3.2.37 and detailed results are provided in Annex 3A-7.

The tier 1 uncertainty interval for greenhouse gas is estimated to be ±1.9 % and trend in greenhouse gas emission is -16.2 % ± 1.3 %-age points. The main sources of uncertainty for greenhouse gas emission 2010 are the N_2O emission from combustion of biomass, gaseous and liquid fuels. The main sources of uncertainty in the trend in greenhouse gas emission are the CO_2 emission from coal combustion and the N_2O emission from combustion of biomass and liquid fuels.

The total emission uncertainty is 7.6 % for SO_2, 17 % for NO_x, 43 % for NMVOC and 45 % for CO.

The tier 2 approach points out N_2O emission from combustion of biomass and gaseous fuels and CO_2 from coal combustion as the main contributors to the total uncertainty for greenhouse gas emission from stationary combustion.

Table 3.2.36 Danish uncertainty estimates, tier 1 approach, 2010.

Pollutant	Uncertainty Total emission, %	Trend 1990-2010, %	Uncertainty trend, %-age points
GHG	±1.9	-16.2	±1.3
CO_2	±0.9	-17.2	±0.8
CH_4	±33	+233	±158
N_2O	±256	+16	±265
SO_2	±7.6	-93	±0.4
NO_x	±17	-65	±2.7
NMVOC	±43	+32	±8.6
CO	±45	+17	±3.0

Table 3.2.37 Danish uncertainty estimates, tier 2 approach, 2010.

Pollutant	Uncertainty of total emission, %		Trend 1990-2010, %	Uncertainty of trend, %-age points	
GHG	-1.2%	+2.0%	-16.1%	-2.8%	+2.8%
CO_2	-0.8%	+0.9%	-17.2%	-2.7%	+2.6%
CH_4	-20%	+51%	233%	-21%	+47%
N_2O	-74%	+196%	11.1%	-147%	+127%

The results are illustrated and compared in figure 3.2.48. The uncertainties are in the same level for each pollutant. The emission data shown for the tier

1 approach are the CRF emission data. The tier 2 emission levels are median values based on the Monte Carlo approach.

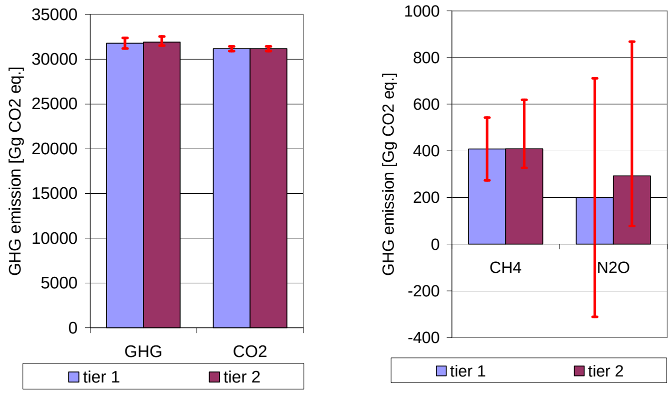


Figure 3.2.48 Uncertainty level, the two approaches are compared for 2010.

3.2.7 Source specific QA/QC and verification

A QA/QC plan for the Danish emission inventories has been implemented. The quality manual (Sørensen et al. 2005) describes the concepts of quality work and definitions of sufficient quality, critical control points and a list of Point for Measuring (PM).

Documentation concerning verification of the Danish emission inventories has been published by Fauser et al. (2007). The reference approach for the energy sector is shown in Chapter 3.4.

Former editions of the sector report for stationary combustion (Nielsen et al. 2010) has been reviewed by external experts in 2004, 2006 and 2009 (Nielsen et al. 2004, Nielsen et al. 2006 and Nielsen et al. 2009). This forms a vital part of the QA activities for stationary combustion.

Information on the Danish QA/QC plan is included in Chapter 1.6. Source specific QA/QC and PM's are shown below.

Data storage, level 1

Table 3.2.38 lists the sectoral PM's for data storage level 1.

Table 3.2.38 List of PM, data storage level 1.

Level	CCP	Id	Description	Sectoral/general	Stationary combustion
Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values.	Sectoral	Uncertainties are estimated and references given in NIR chapter 3.2.5.
	2. Comparability	DS1.2.1	Comparability of the emission factors/calculation parameters with data from international guidelines, and evaluation of major discrepancies.	Sectoral	In general if national referenced emission factors differ considerably from IPCC Guideline/EEA Guidebook values this is discussed in NIR chapter 3.2.4. This documentation is improved annually based on reviews. At CRF level, a project has been carried out comparing the Danish inventories with those of other countries (Fauser et al. 2007).
	3.Completeness	DS.1.3.1	Ensuring that the best possible national data for all sources are included, by setting down the reasoning behind the selection of datasets.	Sectoral	A list of external data are shown and discussed below.
	4.Consistency	DS.1.4.1	The original external data has to be archived with proper reference.	Sectoral	It is ensured that all external data are archived at DCE. Subsequent data processing takes place in other spreadsheets or databases. The datasets are archived annually in order to ensure that the basic data for a given report are always available in their original form.
	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and DCE about the conditions of delivery	Sectoral	For stationary combustion, a data delivery agreement is made with the DEA. NERI (now DCE) and DEA have renewed the data delivery agreement in 2011. Most of the other external data sources are available due to legislatory requirements. See Table 3.2.39.
	7.Transparency	DS.1.7.1	Listing of all archived datasets and external contacts.	Sectoral	A list of external datasets and external contacts is shown in Table 3.2.39 below.

Table 3.2.39 List of external data sources.

Dataset	Description	AD or Emf.	Reference	Contact(s)	Data agreement/ Comment
Energiproducenttællingen.xls	Data set for all electricity and heat producing plants.	Activity data	The Danish Energy Agency (DEA)	Kaj Stærkind	Data agreement in place
Gas consumption for gas engines and gas turbines 1990-1994	Historical data set for gas engines and gas turbines.	Activity data	The Danish Energy Agency (DEA)	Peter Dal	No data agreement. Historical data
Basic data (Grunddata.xls)	The Danish energy statistics. Data set applied for both the reference approach and the national approach.	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Data agreement in place. However, the data set is also published as part of national energy statistics
Energy statistics for industrial subsectors	Disaggregation of the industrial fuel consumption. The data set have been applied for the first time in the inventory reported in 2012.	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Only informal data delivery agreement. The data set will be included in the next update of the data delivery agreement with DEA.
SO_2 & NO_x data, plants>25 MW_e	Annual emission data for all power plants > 25 MW_e. Includes information on methodology: measurements or emission factor.	Emissions	Energinet.dk	Christian F.B. Nielsen	No data agreement in place
Emission factors	Emission factors stems from a large number of sources.	Emission factors	See chapter regarding emission factors		Some of the annually updated CO_2 emission factors are based on EU ETS data, see below. For the other emission factors no formal data delivery agreement.
Annual environmental reports / environmental data	Emissions from plants defined as large point sources	Emissions	Various plants		No data agreement necessary. Plants are obligated by law and data published on the Danish EPA homepage.
EU ETS data	Plant specific CO_2 emission factors	Emission factors and fuel consumption	The Danish Energy Agency (DEA)	Dorte Maimann Helen Falster	Plants are obligated by law. The availability of detailed information is part of the renewed data agreement with DEA.

Energiproducenttaellingen - statistic on fuel consumption from district heating and power plants (DEA)
The data set includes all plants producing power or district heating. The spreadsheet from DEA is listing fuel consumption of all plants included as large point sources in the emission inventory. The statistic on fuel consumption from district heating and power plants is regarded as complete and with no significant uncertainty since the plants are bound by law to report their fuel consumption and other information.

Gas consumption for gas engines and gas turbines 1990-1994 (DEA)
For the years 1990-1994, DEA has estimated consumption of natural gas and biogas in gas engines and gas turbines. DCE assesses that the estimation by the DEA are the best available data.

Basic data (DEA)
The Danish energy statistics. The spreadsheet from DEA is used for the CO_2 emission calculation in accordance with the IPCC reference approach and is also the first data set applied in the national approach. The data set is included in the data delivery agreement with DEA, but it is also published annually on DEA's homepage.

Energy statistics for industrial subsectors (DEA)
This data set has been applied for the first time in the inventory reported in 2012. The data includes disaggregation of the fuel consumption for industrial plants. The data set is estimated for the reporting to Eurostat. The data delivery agreement is informal at this time, but the dataset will be included in the next update of the agreement with DEA.

SO_2 and NO_x emission data from electricity producing plants > 25MW$_e$ (Energinet.dk)
Plants larger than 25 MW$_e$ are obligated to report emission data for SO_2 and NO_x to the DEA annually. Data are on production unit level and classified. The data on plant level are part of the plants annually environmental reports. DCE's QC of the data consists of a comparison with data from previous years and with data from the plants' annual environmental reports.

Emission factors
For specific references, see the chapter regarding emission factors. Some of the annually updated CO_2 emission factors are based on EU ETS data, se below.

Annual environmental reports (DEPA)
A large number of plants are obligated by law to report annual environmental data including emission data. DCE compares the data with those from previous years and large discrepancies are checked.

EU ETS data (DEA)
EU ETS data are information on fuel consumption, heating values, carbon content of fuel, oxidation factor and CO_2 emissions. DCE receives the verified reports for all plants which utilises a detailed estimation methodology. DCE's QC of the received data consists of comparing to calculation using standard emission factors as well as comparing reported values with those for previous years.

Data processing, level 1

Table 3.2.40 lists the sectoral PM's for data processing level 1.

Table 3.2.40 List of PM, data processing level 1.

Level	CCP	Id	Description	Sectoral / general	Stationary combustion
Data Pro-cessing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source not part of DS.1.1.1 as input to Data Storage level 2 in relation to type and scale of variability.	Sectoral	Uncertainties are estimated and references given in NIR chapter 3.2.5.
	2.Comparability	DP.1.2.1	The methodologies have to follow the international guidelines suggested by UNFCCC and IPCC.	Sectoral	The methodological approach is consistent with international guidelines. An overview of tiers is given in NIR Chapter 3.2.5
	3.Completeness	DP.1.3.1	Identification of data gaps with regard to data sources that could improve quantitative knowledge.	Sectoral	The energy statistics is considered complete.
	4.Consistency	DP.1.4.1	Documentation and reasoning of methodological changes during the time series and the qualitative assessment of the impact on time series consistency.	Sectoral	The two main methodological changes in the time series; implementation of Energiproducenttaellingen (plant specific fuel consumption data) from 1994 onwards and implementation of EU ETS data from 2006 onwards is discussed in NIR chapter 3.2.
	5.Correctness	DP.1.5.2	Verification of calculation results using time series	Sectoral	time series for activity data on SNAP and CRF source category level are used to identify possible errors. time series for emission factors and the emission from CRF subcategories are also examined.
		DP.1.5.3	Verification of calculation results using other measures	Sectoral	The IPCC reference approach validates the fuel consumption rates and CO_2 emission. Both differ less than 2.0 % (1990-2010). The reference approach is further discussed in NIR Chapter 3.4.
	7.Transparency	DP.1.7.1	The calculation principle, the equations used and the assumptions made must be described.	Sectoral	This is included in NIR chapter 3.2.5.
		DP.1.7.2	Clear reference to dataset at Data Storage level 1	Sectoral	This is included in NIR chapter 3.2.5.
		DP.1.7.3	A manual log to collect information about recalculations.	Sectoral	-

Data storage, level 2

Table 3.2.41 lists the sectoral PM's for data storage level 2.

Table 3.2.41 List of PM, data storage level 2.

Level	**CCP**	**Id**	**Description**	**Sectoral / general**	**Stationary combustion**
Data Storage level 2	5.Correctness	DS.2.5.1	Check if a correct data import to level 2 has been made	Sectoral	To ensure a correct connection between data on level 2 and level 1 different controls are in place, e.g. control of sums and random tests.

Data storage level 4

Table 3.2.42 lists the sectoral PM's for data storage level 4.

Table 3.2.42 List of PM, data storage level 4.

Level	CCP	Id	Description	Sectoral / general	Stationary combustion
Data Storage level 4	4. Consistency	DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.	Sectoral	Large dips/jumps in time series are discussed and explained in NIR chapter 3.2.

Other QC procedures

The emission from each large point source is compared with the emission reported the previous year.

Some automated checks have been prepared for the emission databases:

- Check of units for fuel rate, emission factors and plant-specific emissions.
- Check of emission factors for large point sources. Emission factors for pollutants that are not plant-specific should be the same as those defined for area sources.
- Additional checks on database consistency.
- Emission factor references are included in this report (Chapter 3.2.5 and Appendix 3A-4).
- Annual environmental reports are kept for subsequent control of plant-specific emission data.
- QC checks of the country-specific emission factors have not been performed, but most factors are based on input from companies that have implemented some QA/QC work. The major power plant owner/operators in Denmark, DONG Energy and Vattenfall have obtained the ISO 14001 certification for an environmental management system. The Danish Gas Technology Centre and Force Technology both run accredited laboratories for emission measurements.

National external review

The 2005, 2007 and 2010 updates of the sector report for stationary Former editions of the sector report for stationary combustion (Nielsen et al. 2010) has been reviewed by external experts in 2004, 2006 and 2009 (Nielsen et al. 2004, Nielsen et al. 2006 and Nielsen et al. 2009). This forms a vital part of the QA activities for stationary combustion.

3.2.8 Source specific recalculations and improvements

Recalculations for stationary combustion 2009 are shown in Table 3.2.43. The main calculations are discussed below.

Table 3.2.43 Recalculations for stationary combustion, 2009.

	CO_2, Gg CO_2	CH_4, Gg CO_2 eqv.	N_2O Gg CO_2 eqv.	CO_2, %	CH_4, %	N_2O %
1.A.1. Energy Industries	**133.98**	**1.33**	**-10.00**	**1**	**1**	**-9**
Liquid Fuels	-20.91	0.31	-0.03	-1	61	0
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-14.90	-0.21	-10.13	0	0	-34
Biomass	146.99	1.22	-0.38	2	5	-1
Other Fuels	169.79	0.01	0.54	14	10	10
a. Public Electricity and Heat Production	154.13	1.02	0.13	1	1	0
Liquid Fuels	-20.91	-0.01	-0.03	-2	-1	-1
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	5.24	-0.20	0.00	0	0	0
Biomass	146.99	1.22	-0.38	2	5	-1
Other Fuels	169.79	0.01	0.54	14	10	10
b. Petroleum Refining	0.00	0.32	0.00	0	412	0
Liquid Fuels	0.00	0.32	0.00	0	412	0
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	0.00	0.00	0.00	0	0	0
Biomass	0.00	0.00	0.00	0	0	0
Other Fuels	0.00	0.00	0.00	0	0	0
c. Manufacture of Solid Fuels and Other Energy Industries	-20.14	-0.01	-10.13	-1	-1	-55
Liquid Fuels	0.00	0.00	0.00	0	0	0
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-20.14	-0.01	-10.13	-1	-1	-55
Biomass	0.00	0.00	0.00	0	0	0
Other Fuels	0.00	0.00	0.00	0	0	0
1.A.2 Manufacturing Industries and Construction	**65.83**	**-1.01**	**3.31**	**2**	**-7**	**11**
Liquid Fuels	0.09	0.00	0.37	0	0	2
Solid Fuels	63.53	0.26	0.53	18	34	34
Gaseous Fuels	-25.88	0.00	0.28	-1	0	14
Biomass	175.86	-1.50	1.66	22	-31	18
Other Fuels	28.09	0.24	0.48	42	54	54
a. Iron and Steel	-7.45	-0.31	-0.08	-8	-88	-57
Liquid Fuels	-0.78	0.00	-0.02	-42	-18	-66
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-6.68	-0.31	-0.05	-8	-88	-54
Biomass	0.00	0.00	0.00	0	0	0
Other Fuels	0.00	0.00	0.00	0	0	0
b. Non-Ferrous Metals	-0.24	-0.02	0.00	-3	-86	11
Liquid Fuels	0.27	0.00	0.01	22	15	32
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-0.51	-0.02	0.00	-8	-88	-54
Biomass	0.00	0.00	0.00	0	0	0
Other Fuels	0.00	0.00	0.00	0	0	0
c. Chemicals	-159.71	-0.97	-0.27	-59	-93	-41
Liquid Fuels	-18.76	-0.01	-0.35	-98	-98	-100
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-141.50	-0.95	0.10	-56	-94	35
Biomass	-2.04	-0.01	-0.03	-64	-74	-72
Other Fuels	0.00	0.00	0.00	0	0	0
d. Pulp, Paper and Print	-59.24	-0.17	1.22	-38	-27	336
Liquid Fuels	-6.55	0.00	-0.14	-81	-67	-97
Solid Fuels	0.00	0.00	0.00	0	0	0
Gaseous Fuels	-54.77	-0.54	-0.11	-37	-92	-69
Biomass	129.43	0.36	1.45	2842	1263	2724
Other Fuels	0.00	0.00	0.00	0	0	0
e. Food Processing, Beverages and Tobacco	55.36	-2.82	2.37	6	-78	65
Liquid Fuels	158.62	0.05	3.20	185	170	203
Solid Fuels	51.62	0.12	0.25	49	54	54
Gaseous Fuels	-157.58	-2.64	-0.43	-22	-90	-53
Biomass	-45.71	-0.37	-0.69	-67	-87	-87

	CO_2, Gg CO_2	CH_4, Gg CO_2 eqv.	N_2O Gg CO_2 eqv.	CO_2, %	CH_4, %	N_2O %
Continued						
Other Fuels	0.00	0.00	0.00	0	0	0
f. Other (please specify)(4)	237.12	3.27	0.07	10	37	0%
Cement production	0.00	0.00	0.00	0%	0%	0%
Liquid Fuels	0.00	0.00	0.36	0%	-1%	32%
Solid Fuels	0.00	0.00	0.00	0%	0%	0%
Gaseous Fuels	0.00	0.00	0.00	0%	0%	0%
Biomass	-33.20	-0.09	-0.17	-26%	-13%	-13%
Other Fuels	7.75	0.09	0.17	11%	19%	19%
Non-road machinery	0.00	0.00	0.00	0%	0%	0%
Liquid Fuels	-1.55	0.00	0.00	0%	0%	0%
Solid Fuels	0.00	0.00	0.00	0%	0%	0%
Gaseous Fuels	0.00	0.00	0.00	0%	0%	0%
Biomass	0.00	0.00	0.00	0%	0%	0%
Other Fuels	0.00	0.00	0.00	0%	0%	0%
Other non-specified	0.00	0.00	0.00	0%	0%	0%
Liquid Fuels	-131.16	-0.04	-2.68	-79%	-72%	-88%
Solid Fuels	11.91	0.14	0.28	9%	48%	48%
Gaseous Fuels	335.16	4.46	0.78	55%	184%	117%
Biomass	127.38	-1.39	1.10	21%	-37%	16%
Other Fuels	0.00	0.00	0.00	0%	0%	0%
1.A.4 Other Sectors	**-147.57**	**-18.39**	**0.79**	**-2%**	**-10%**	**1%**
Liquid Fuels	-83.47	-0.03	-0.23	-2%	0%	-1%
Solid Fuels	-84.93	-0.19	-0.39	-67%	-46%	-67%
Gaseous Fuels	20.60	0.08	0.25	1%	0%	3%
Biomass	419.53	-18.24	1.15	10%	-12%	2%
Other Fuels	0.23	0.00	0.00	14%	9%	9%
a. Commercial/Institutional	19.43	-0.47	0.16	2%	-2%	2%
Liquid Fuels	3.91	0.00	0.01	1%	0%	1%
Solid Fuels	0.00	0.00	0.00	0%	0%	0%
Gaseous Fuels	15.29	-0.32	0.21	3%	-4%	3%
Biomass	1.82	-0.15	-0.06	1%	-2%	-4%
Other Fuels	0.23	0.00	0.00	14%	9%	9%
b. Residential	-43.83	-21.41	1.04	-1%	-15%	2%
Liquid Fuels	-43.98	-0.01	-0.11	-3%	-1%	-3%
Solid Fuels	-0.05	0.00	0.00	-2%	-2%	-2%
Gaseous Fuels	0.20	0.03	0.00	0%	0%	0%
Biomass	392.68	-21.42	1.15	11%	-17%	3%
Other Fuels	0.00	0.00	0.00	0%	0%	0%
c. Agriculture/Forestry/Fisheries	-123.17	3.49	-0.41	-6%	13%	-1%
Liquid Fuels	-43.40	-0.02	-0.13	-2%	-1%	0%
Solid Fuels	-84.89	-0.19	-0.39	-68%	-68%	-68%
Gaseous Fuels	5.11	0.37	0.04	3%	4%	3%
Biomass	25.03	3.33	0.06	9%	23%	2%
Other Fuels	0.00	0.00	0.00	0%	0%	0%

For stationary combustion plants, the emission estimates for the years 1990-2009 have been updated according to the latest energy statistics published by the Danish Energy Agency. The update included both end use and transformation sectors as well as a source category update.

The relatively large recalculations for CO_2 emission from the fuel category "Other fuels" is a result a revised CO_2 emission factor fossil waste incineration. This emission factor has been recalculated based on a large number of measurements performed at Danish plants in 2010-2011. The CO_2 emission factor is 14 % higher than the emission factor applied last year. The estimated emission from fuel category Other fuels in 1A1a Public electricity and Heat production in 2009 has increased 14 % corresponding to 170 Gg CO_2.

The disaggregation of emissions in 1A2 Manufacturing industries and construction has been recalculated based on a new improved methodology. Thus, relatively large recalculations occur for the industrial subsectors, but the changes for the aggregated sector 1A2 are lower.

The recalculations in CO_2 emission from biomass (+147 Gg CO_2 for 1A1, +176 Gg CO_2 for 1A2 and +420 Gg for sector 1A4) are a result of revised CO_2 emission factors for wood and straw. Both emission factors now refer to the IPCC Guidelines, 1997.

The CH_4 emission from residential wood combustion has been recalculated based on improved technology disaggregation data. This has resulted in a 21 Gg CO_2 eq. lower emission in 2009 than reported last year.

The CH_4 emission factor for refineries have been included or revised for several years. This results in improved time series but also in large relative changes for some years. However, the emission level is low and the recalculation for 2009 is below 0.5 Gg CO_2 eq.

The N_2O emission from gaseous fuels in sector 1A1c has been recalculated resulting in a decrease of 10 Gg CO_2 eq. The N_2O emission factor for off shore gas turbines now follows emission factor for on shore gas turbines.

Finally, emission data for associated CO_2 emission for non-energy use of fuels have been implemented in CRF table 1.A(d). This information has been implemented as a result of a review comment. Data have been implemented in NIR Chapter 3.4 this year.

3.2.9 Source specific planned improvements

A number of improvements are planned for the stationary combustion emission inventories:

- The reporting of, and references for, the applied emission factors will be further developed in future inventories.
- Analysis of EU ETS data for residual oil similar to the analysis for coal (Annex 3A-10) will be included next year as recommended in the latest review.
- Additional analysis of the time series for industrial subsectors in Chapter 3.2.4.
- The Danish energy statistics was reported prior to the recalculation of the fossil energy part and thus this year DCE and DEA do not apply the same fossil fraction for waste. However, the fossil energy fraction will be coordinated between DEA and DCE before the emission inventory reported in 2013.
- Four data sets from EU ETS (2006-2008) will be excluded based on the QC work.

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3.3 Transport and other mobile sources (CRF sector 1A2, 1A3, 1A4 and 1A5)

The emission inventory basis for mobile sources is fuel consumption information from the Danish energy statistics. In addition, background data for road transport (fleet and mileage), air traffic (aircraft type, flight numbers, origin and destination airports), national sea transport (fuel surveys, ferry technical data, number of return trips, sailing time) and non-road machinery (engine no., engine size, load factor and annual working hours) are used to make the emission estimates sufficiently detailed. Emission data mainly comes from the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009). However, for railways, measurements specific to Denmark are used.

In the Danish emissions database, all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according to the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP sectors. The aggregation to the sector codes used for both the UNFCCC and UNECE Conventions is based on a correspondence list between SNAP and IPCC classification codes (CRF), shown in Table 3.3.1 (mobile sources only).

Table 3.3.1 SNAP – CRF correspondence table for transport.

SNAP classification	CRF/NFR classification
07 Road transport	1A3b Transport-Road
0801 Military	1A5 Other
0802 Railways	1A3c Railways
0803 Inland waterways	1A3d Transport-Navigation
080402 National sea traffic	1A3d Transport-Navigation
080403 National fishing	1A4c Agriculture/forestry/fisheries
080404 International sea traffic	1A3d Transport-Navigation (international)
080501 Dom. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation
080502 Int. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation (international)
080503 Dom. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation
080504 Int. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation (international)
0806 Agriculture	1A4c Agriculture/forestry/fisheries
0807 Forestry	1A4c Agriculture/forestry/fisheries
0808 Industry	1A2f Industry-Other
0809 Household and gardening	1A4b Residential
0811 Commercial and institutional	1A4a Commercial and institutional

Military transport activities (land and air) refer to the CRF/NFR sector Other (1A5), while the Transport-Navigation sector (1A3d) comprises national sea transport (ship movements between two Danish ports) and recreational craft (SNAP code 0803).

For aviation, LTO (Landing and Take Off)[1] refers to the part of flying which is below 1000 m. This part of the aviation emissions (SNAP codes 080501 and 080502) are included in the national emissions total as prescribed by the UNECE reporting rules. According to UNFCCC the national emissions for

[1] A LTO cycle consists of the flying modes approach/descent, taxiing, take off and climb out. In principle the actual times-in-modes rely on the actual traffic circumstances, the airport configuration, and the aircraft type in question.

aviation comprise the emissions from domestic LTO (0805010) and domestic cruise (080503). The fuel consumption and emission development explained in the following are based on these latter results.

The working machinery and equipment in industry (SNAP code 0808) is grouped in Industry-Other (1A2f), while agricultural and forestry non-road machinery (SNAP codes 0806 and 0807) is accounted for in the Agriculture/forestry/fisheries (1A4c) sector together with fishing activities.

For mobile sources, internal database models for road transport, air traffic, sea transport and non road machinery have been set up at Department of Environmental Science (ENVS)/Danish Centre for Environment and Energy (DCE), Aarhus University (former NERI), in order to produce the emission inventories. The output results from the DCE models are calculated in a SNAP format, as activity rates (fuel consumption) and emission factors, which are then exported directly to the central Danish CollectER database.

Apart from national inventories, the DCE models are used also as a calculation tool in research projects, environmental impact assessment studies, and to produce basic emission information which requires various aggregation levels.

3.3.1 Source category description

The following description of source categories explains the development in fuel consumption and emissions for road transport and other mobile sources.

Fuel consumption

Table 3.3.2 Fuel consumption (PJ) for domestic transport in 2010 in CRF sectors.

CRF ID	Fuel consumption (PJ)
Industry-Other (1A2f)	14.2
Civil Aviation (1A3a)	2.2
Road (1A3b)	165.6
Railways (1A3c)	3.3
Navigation (1A3d)	7.9
Comm./Inst. (1A4a)	2.4
Residential (1A4b)	0.9
Agri./for./fish. (1A4c)	25.2
Military (1A5)	1.5
Total	223.0

Table 3.3.2 shows the fuel consumption for domestic transport based on DEA statistics for 2010 in CRF sectors. The fuel consumption figures in time series 1990-2010 are given in Annex 3.B.16 (CRF format) and are shown for 1990 and 2010 in Annex 3.B.15 (CollectER format). Road transport has a major share of the fuel consumption for domestic transport. In 2010 this sector's fuel consumption share is 74 %, while the fuel consumption shares for Agriculture/forestry/fisheries and Industry-Other are 11 and 6 %, respectively. For the remaining sectors the total fuel consumption share is 9 %.

From 1990 to 2010, the diesel and gasoline fuel consumption have changed by 42 % and -2 %, respectively, and in 2010 the fuel consumption shares for diesel and gasoline were 67 % and 31 %, respectively (Figures 3.3.1 and

3.3.2). Other fuels only have a 2 % share of the domestic transport total. Almost all gasoline is used in road transportation vehicles. Gardening machinery and recreational craft are merely small consumers. Regarding diesel, there is considerable fuel consumption in most of the domestic transport categories, whereas a more limited use of residual oil and jet fuel is being used in the navigation sector and by aviation (civil and military flights), respectively.

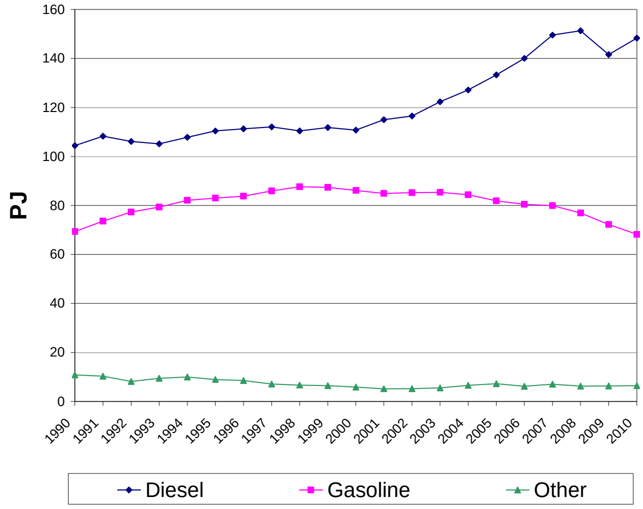


Figure 3.3.1 Fuel consumption pr fuel type for domestic transport 1990-2010.

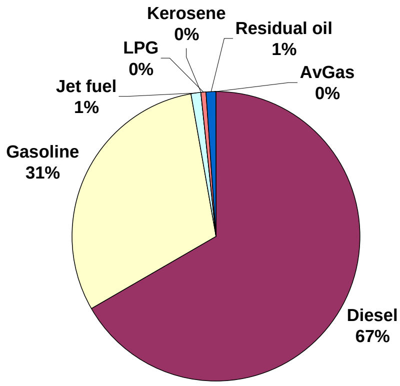


Figure 3.3.2 Fuel consumption share pr fuel type for domestic transport in 2010.

Road transport

As shown in Figure 3.3.3, the energy use for road transport[2] has generally increased until 2007, except from a small fuel consumption decline noted in 2000. The impact of the global financial crisis on fuel consumption for road transport becomes visible for 2008 and 2009. The fuel consumption development is due to a slight decreasing trend in the use of gasoline fuels from 1999 onwards combined with a steady growth in the use of diesel until 2007. Within sub-sectors, passenger cars represent the most fuel-consuming vehicle category, followed by heavy-duty vehicles, light duty vehicles and 2-wheelers, in decreasing order (Figure 3.3.4).

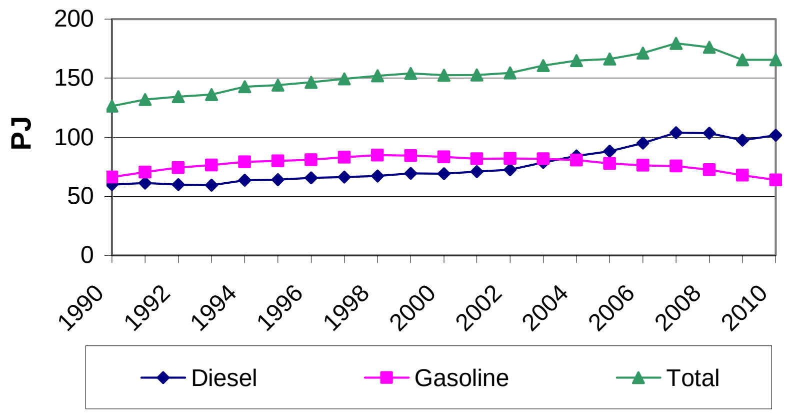


Figure 3.3.3 Fuel consumption pr fuel type and as totals for road transport 1990-2010.

[2] The gasoline and diesel fuel sums include small amounts of bio ethanol and bio diesel; 1.7 % and 0.02 %, respectively in 2010.

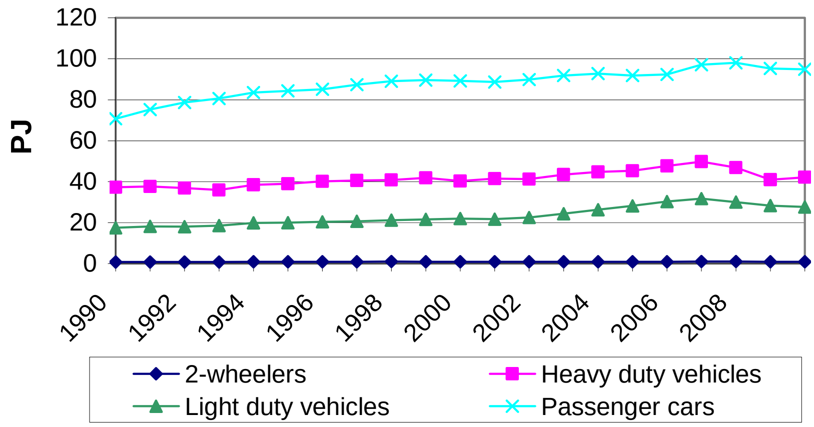


Figure 3.3.4 Total fuel consumption pr vehicle type for road transport 1990-2010.

As shown in Figure 3.3.5, fuel consumption for gasoline passenger cars dominates the overall gasoline consumption trend. The development in diesel fuel consumption in recent years (Figure 3.3.6) is characterised by increasing fuel consumption for diesel passenger cars, while declines in the fuel consumption for trucks and buses (heavy-duty vehicles) and light duty vehicles are noted for 2008 and 2009.

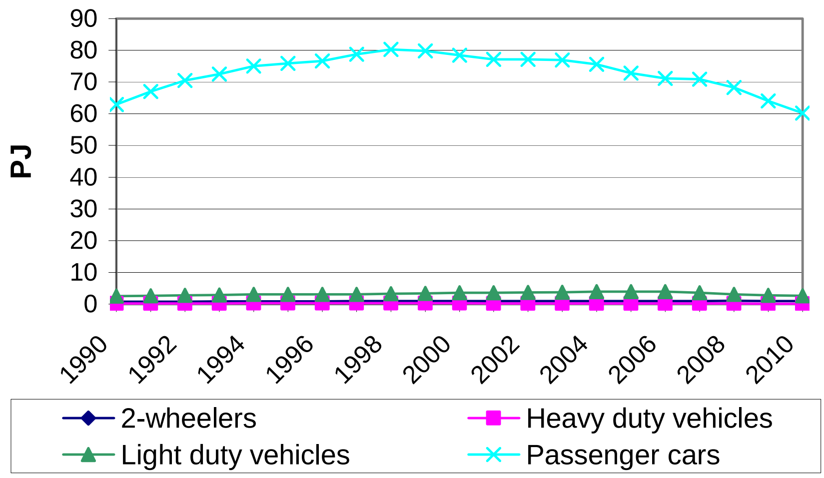


Figure 3.3.5 Gasoline fuel consumption pr vehicle type for road transport 1990-2010.

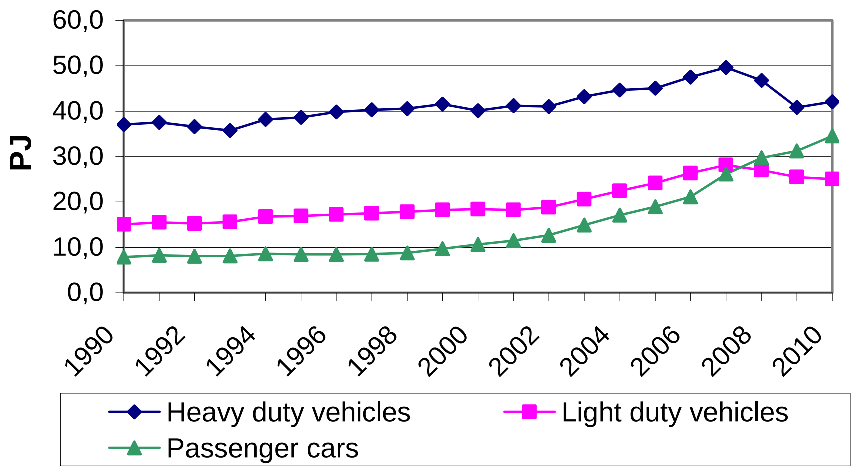


Figure 3.3.6 Diesel fuel consumption pr vehicle type for road transport 1990-2010.

In 2010, fuel consumption shares for gasoline passenger cars, heavy-duty vehicles, diesel passenger cars, diesel light duty vehicles and gasoline light duty vehicles were 36, 25, 21, 15 and 2 %, respectively (Figure 3.3.7).

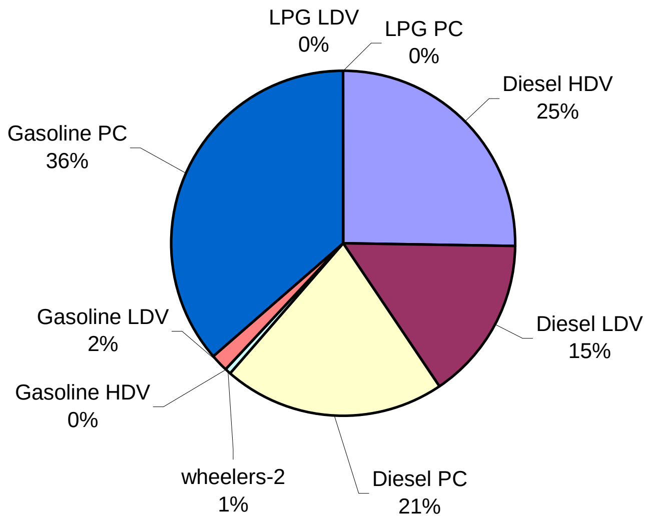


Figure 3.3.7 Fuel consumption share (PJ) pr vehicle type for road transport in 2010.

Other mobile sources

It must be noted that the fuel consumption figures behind the Danish inventory for mobile equipment in the agriculture, forestry, industry, household and gardening (residential), and inland waterways (part of navigation) sectors, are less certain than for other mobile sectors. For these types of machinery, the DEA statistical figures do not directly provide fuel consumption information, and fuel consumption totals are subsequently estimated from activity data and fuel consumption factors. For recreational craft the latest historical year is 2004.

As seen in Figure 3.3.8, classified according to CRF the most important sectors are Agriculture/forestry/fisheries (1A4c), Industry-other (mobile machinery part of 1A2f) and Navigation (1A3d). Minor fuel consuming sectors are Civil Aviation (1A3a), Railways (1A3c), Other (military mobile fuel consumption: 1A5), Commercial/institutional (1A4a) and Residential (1A4b).

The 1990-2010 time series are shown pr fuel type in Figures 3.3.9-3.3.12 for diesel, gasoline and jet fuel, respectively.

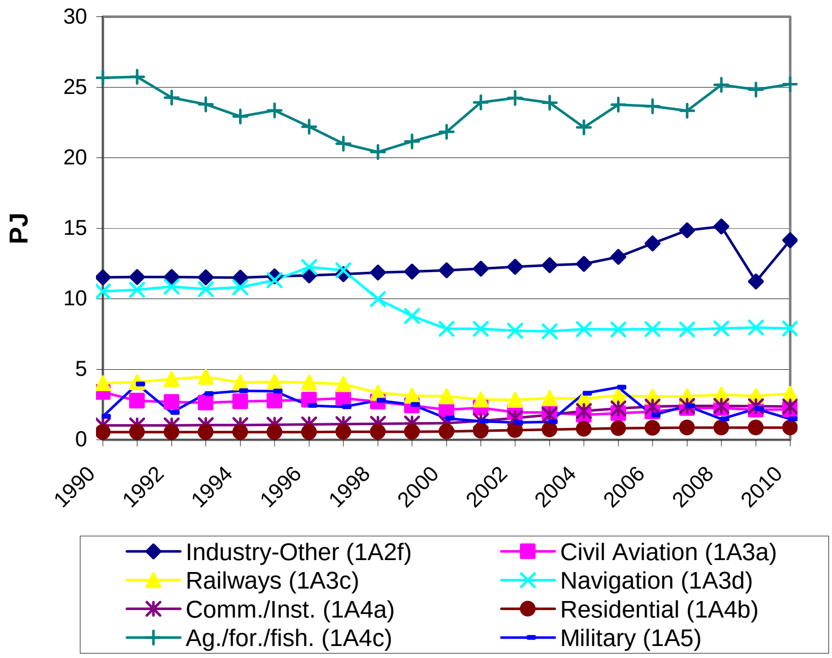


Figure 3.3.8 Total fuel consumption in CRF sectors for other mobile sources 1990-2010.

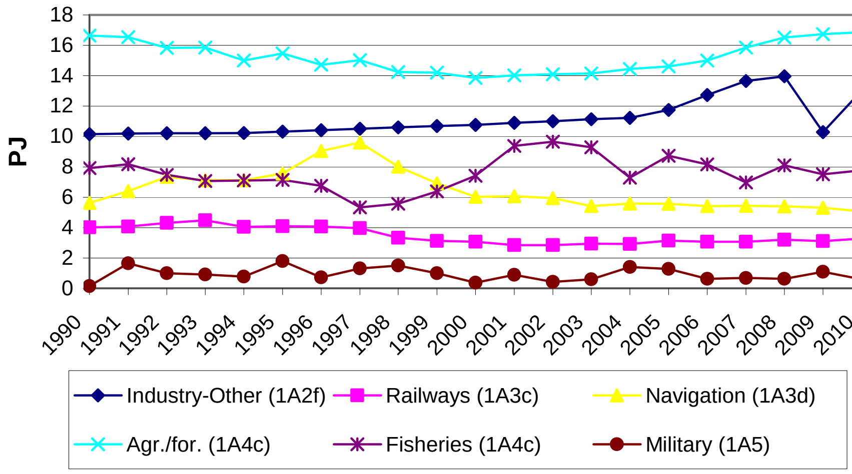


Figure 3.3.9 Diesel fuel consumption in CRF sectors for other mobile sources 1990-2010.

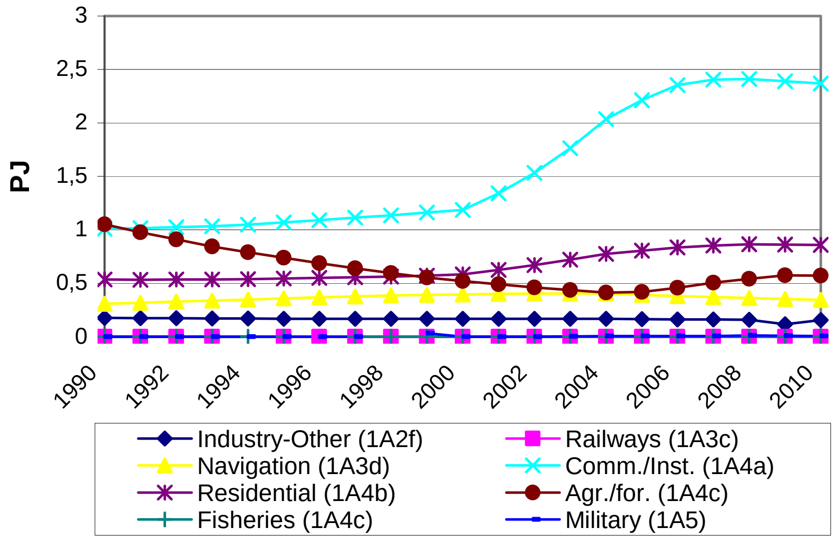


Figure 3.3.10 Gasoline fuel consumption in CRF sectors for other mobile source 1990-2010.

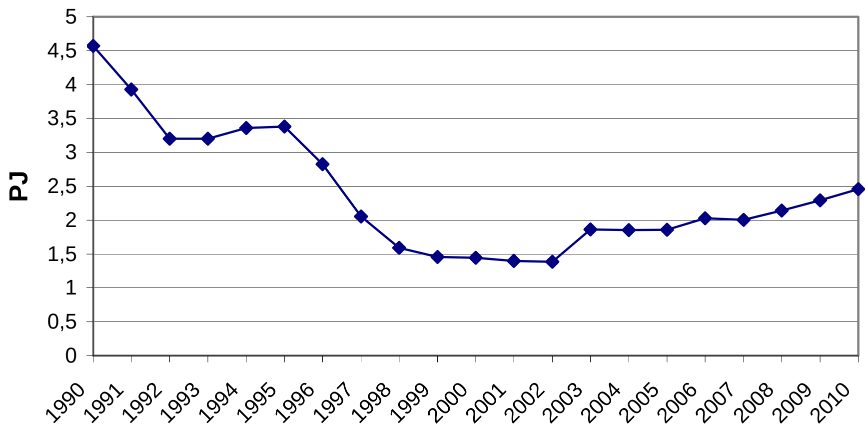


Figure 3.3.11 Residual oil fuel consumption in CRF sectors for other mobile sources 1990-2010.

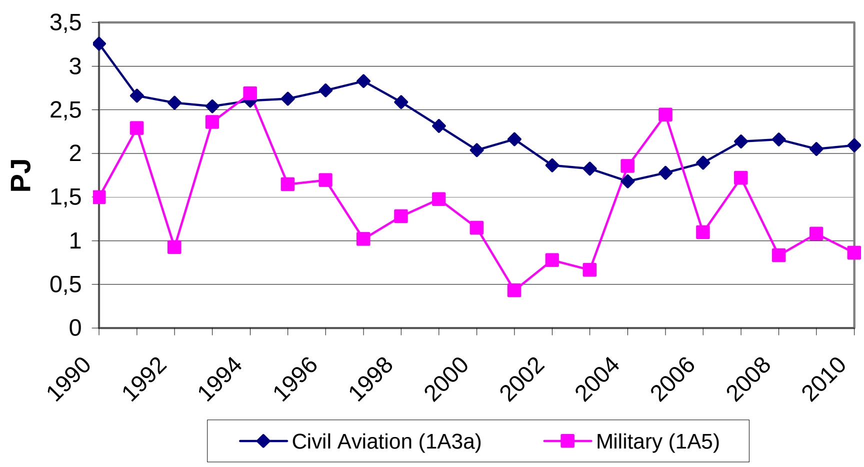


Figure 3.3.12 Jet fuel consumption in CRF sectors for other mobile sources 1990-2010.

In terms of diesel, the fuel consumption decreases for agricultural machines until 2000, due to fewer numbers of tractors and harvesters. After that, the increase in the engine sizes of new sold machines has more than outbalanced the trend towards smaller total stock numbers. The fuel consumption for industry has increased from the beginning of the 1990's, due to an increase in the activities for construction machinery. The fuel consumption increase has been very pronounced in 2005-2008, for 2009, however, the global financial crisis has a significant impact on the building and construction activities. For fisheries, the development in fuel consumption reflects the activities in this sector.

The Navigation sector comprises national sea transport (fuel consumption between two Danish ports including sea travel directly between Denmark and Greenland/Faroe Islands) and recreational craft. For the latter category, fuel consumption has increased significantly from 1990 to 2004 due to the rising number diesel-fuelled private boats. For national sea transport, the diesel fuel consumption curve reflects the combination of traffic and ferries in use for regional ferries. From 1998 to 2000, a significant decline in fuel consumption is apparent. The most important explanation here is the closing of ferry service routes in connection with the opening of the Great Belt Bridge in 1997. For railways, the gradual shift towards electrification explains the lowering trend in diesel fuel consumption and the emissions for this transport sector. The fuel consumed (and associated emissions) to produce electricity is accounted for in the stationary combustion part of the Danish inventories.

The largest gasoline fuel consumption is found for household and gardening machinery in the Commercial/Institutional (1A4a) and Residential (1A4b) sectors. Especially from 2001-2006, a significant fuel consumption increase is apparent due to considerable growth in the machinery stock. The decline in gasoline fuel consumption for Agriculture/forestry/fisheries (1A4c) is due to the gradual phasing out of gasoline-fuelled agricultural tractors.

In terms of residual oil there has been a substantial decrease in the fuel consumption for regional ferries. The fuel consumption decline is most significant from 1990-1992 and from 1997-1999.

The considerable variations from one year to another in military jet fuel consumption are due to planning and budgetary reasons, and the passing demand for flying activities. Consequently, for some years, a certain amount of jet fuel stock-building might disturb the real picture of aircraft fuel consumption. Civil aviation has decreased until 2004, since the opening of the Great Belt Bridge in 1997, both in terms of number of flights and total jet fuel consumption. After 2004 an increase in the consumption of jet fuel is noted until 2007/2008.

Bunkers

The residual oil and diesel oil fuel consumption fluctuations reflect the quantity of fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, tank vessels and foreign fishing boats. For jet petrol, the sudden fuel consumption drop in 2002 is explained by the recession in the air traffic sector due to the events of September 11, 2001 and structural changes in the aviation business. In 2009, the impact of the global financial crisis on flying activities becomes very visible.

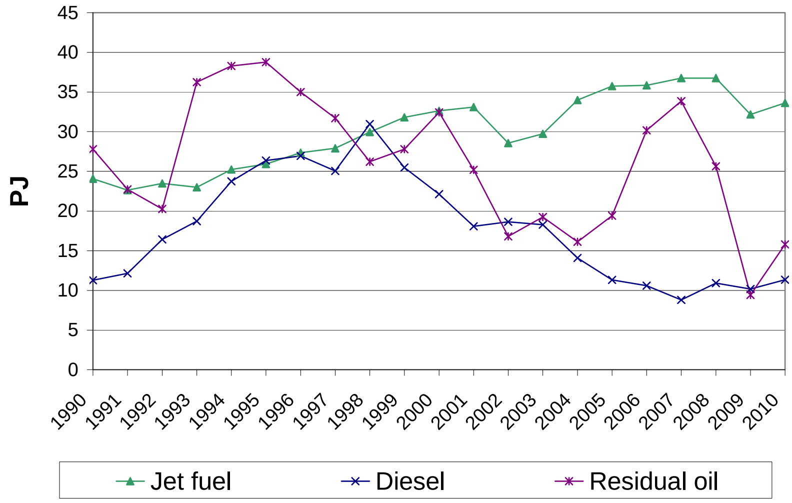


Figure 3.3.13 Bunker fuel consumption 1990-2010.

Emissions of CO_2, CH_4 and N_2O

In Table 3.3.3 the CO_2, CH_4 and N_2O emissions for road transport and other mobile sources are shown for 2010 in CRF sectors. The emission figures in time series 1990-2010 are given in Annex 3.B.16 (CRF format) and are shown for 1990 and 2010 in Annex 3.B.15 (CollectER format).

From 1990 to 2010 the road transport emissions of CO_2 and N_2O have increased by 30 and 24 %, respectively, whereas the emissions of CH_4 have decreased by 74 % (from Figures 3.3.14 - 3.3.16). From 1990 to 2010 the other mobile CO_2 emissions have decreased by 2 %, (from Figures 3.3.18 - 3.3.20).

Table 3.3.3 Emissions of CO_2, CH_4 and N_2O in 2010 for road transport and other mobile sources.

CRF Sector	CH_4	CO_2	N_2O
	tonnes	tonnes	Tonnes
Industry-Other (1A2f)	37	1 037	44
Civil Aviation (1A3a)	4	156	8
Railways (1A3c)	7	242	7
Navigation (1A3d)	35	593	35
Comm./Inst. (1A4a)	160	173	3
Residential (1A4b)	65	63	1
Ag./for./fish. (1A4c)	113	1 865	91
Military (1A5)	4	107	4
Total other mobile	425	4 235	192
Road (1A3b)	644	12 108	385
Total mobile	1 069	16 343	577

Road transport

CO_2 emissions are directly fuel consumption dependent and, in this way, the development in the emission reflects the trend in fuel consumption. As shown in Figure 3.3.14, the most important emission source for road transport is passenger cars, followed by heavy-duty vehicles, light-duty vehicles and 2-wheelers in decreasing order. In 2010, the respective emission shares were 56, 26, 17 and 1 %, respectively (Figure 3.3.17).

The majority of CH_4 emissions from road transport come from gasoline passenger cars (Figure 3.3.15). The emission drop from 1992 onwards is explained by the penetration of catalyst cars into the Danish fleet. The 2010 emission shares for CH_4 were 53, 24, 19 and 4 % for passenger cars, heavy-duty vehicles, 2-wheelers and light-duty vehicles, respectively (Figure 3.3.17).

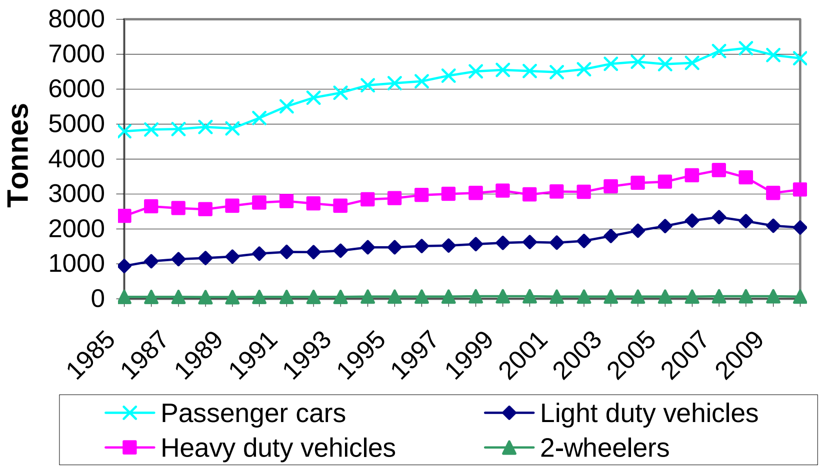


Figure 3.3.14 CO_2 emissions (k-tonnes) pr vehicle type for road transport 1990-2010.

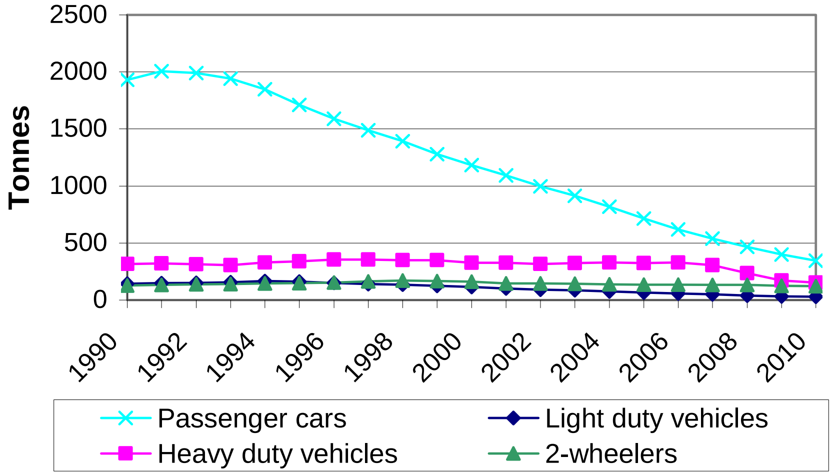


Figure 3.3.15 CH_4 emissions (tonnes) pr vehicle type for road transport 1990-2010.

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of N_2O from the first generation of catalyst cars (Euro 1) compared to conventional cars. The emission factors for later catalytic converter technologies are considerably lower than the ones for Euro 1, thus causing the emissions to decrease from 1998 onwards (Figure 3.3.16). In 2010, emission shares for passenger cars, heavy and light-duty vehicles were 52, 31 and 17 %, of the total road transport N_2O, respectively (Figure 3.3.17).

Referring to the second IPCC assessment report, 1 g CH_4 and 1 g N_2O has the greenhouse effect of 21 and 310 g CO_2, respectively. In spite of the relatively large CH_4 and N_2O global warming potentials, the largest contribution to the total CO_2 emission equivalents for road transport comes from CO_2, and the CO_2 emission equivalent shares pr vehicle category are almost the same as the CO_2 shares.

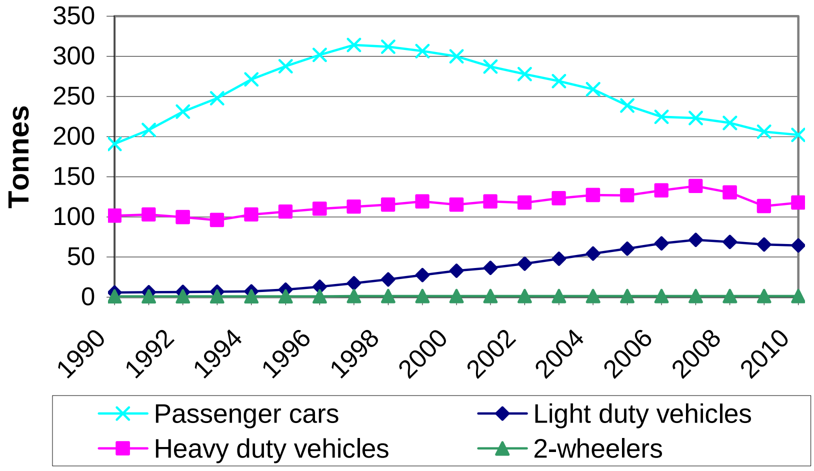


Figure 3.3.16 N_2O emissions (tonnes) pr vehicle type for road transport 1990-2010.

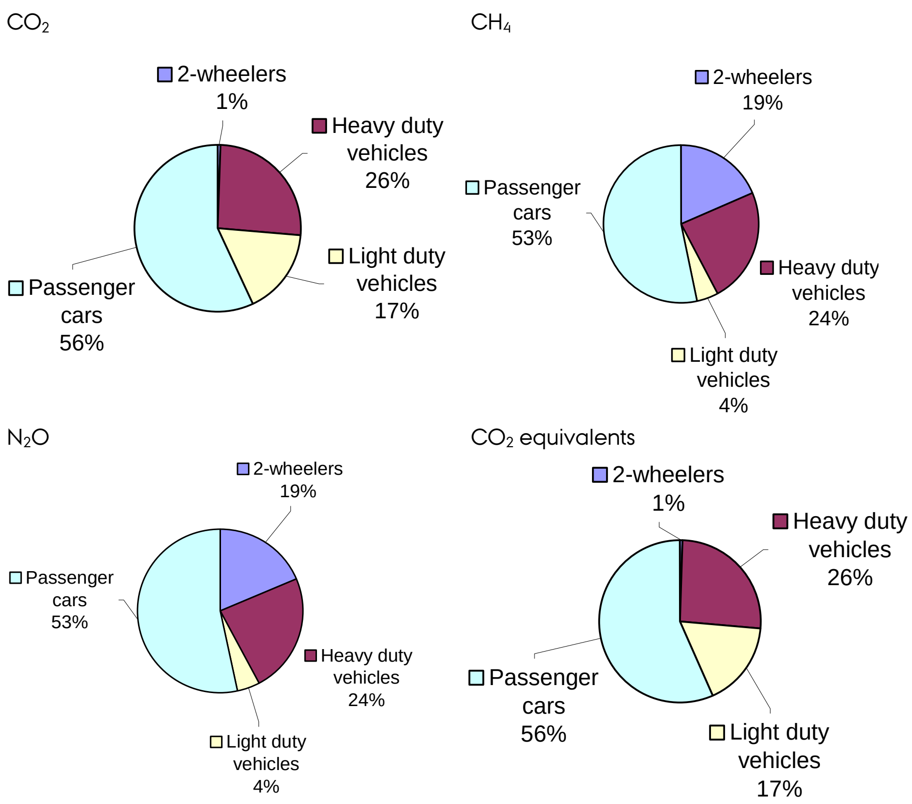


Figure 3.3.17 CO_2, CH_4 and N_2O emission shares and GHG equivalent emission distribution for road transport in 2010.

Other mobile sources

For other mobile sources, the highest CO_2 emissions in 2010 come from Agriculture/forestry/fisheries (1A4c), Industry-other (1A2f) and Navigation (1A3d), with shares of 44, 24 and 14 %, respectively (Figure 3.3.21). The 1990-2010 emission trend is directly related to the fuel consumption development in the same time-period. Minor CO_2 emission contributors are sectors such as Commercial/Institutional (1A4a), Residential (1A4b), Railways (1A3c), Civil Aviation (1A3a) and Military (1A5).

For CH_4, far the most important sources are the gasoline fuelled gardening machinery in the Commercial/Institutional (1A4a) and Residential (1A4b) sectors, see Figure 3.3.21. The emission shares are 38 % and 15 %, respectively in 2010. The 2010 emission shares for Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d) are 26, 9 and 8 %, respectively, whereas the remaining sectors have emission shares of 2 % or less.

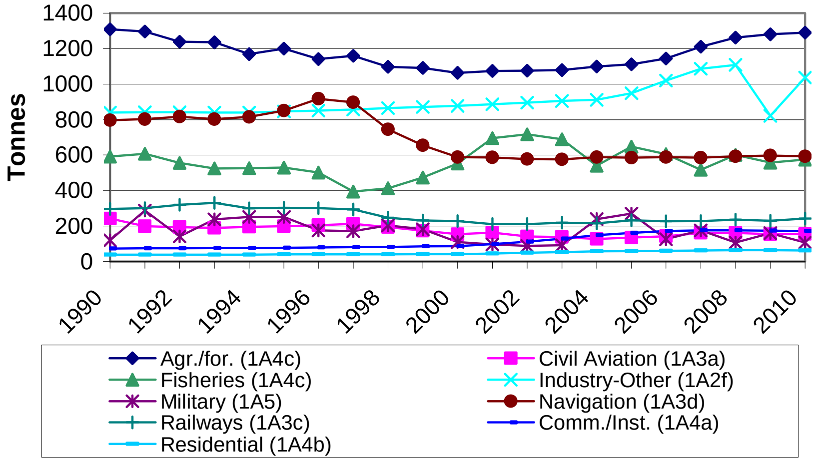


Figure 3.3.18 CO_2 emissions (ktonnes) in CRF sectors for other mobile sources 1990-2010.

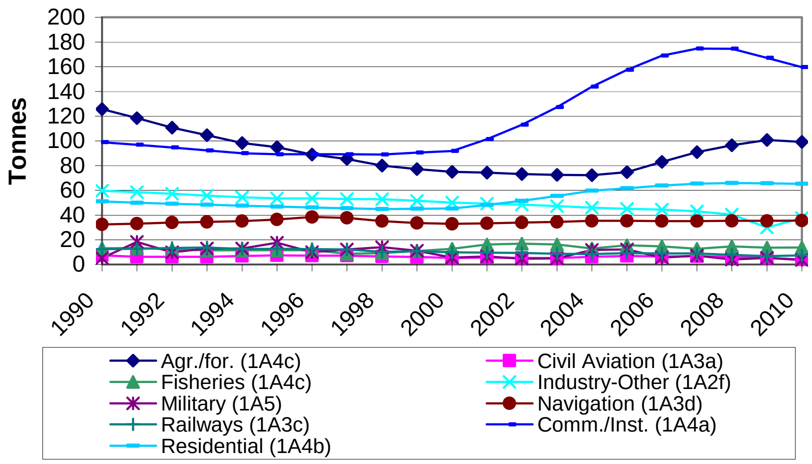


Figure 3.3.19 CH_4 emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

For N_2O, the emission trend in sub-sectors is the same as for fuel consumption and CO_2 emissions (Figure 3.3.20).

As for road transport, CO_2 alone contributes with by far the most CO_2 emission equivalents in the case of other mobile sources, and pr sector the CO_2 emission equivalent shares are almost the same as those for CO_2, itself (Figure 3.3.21).

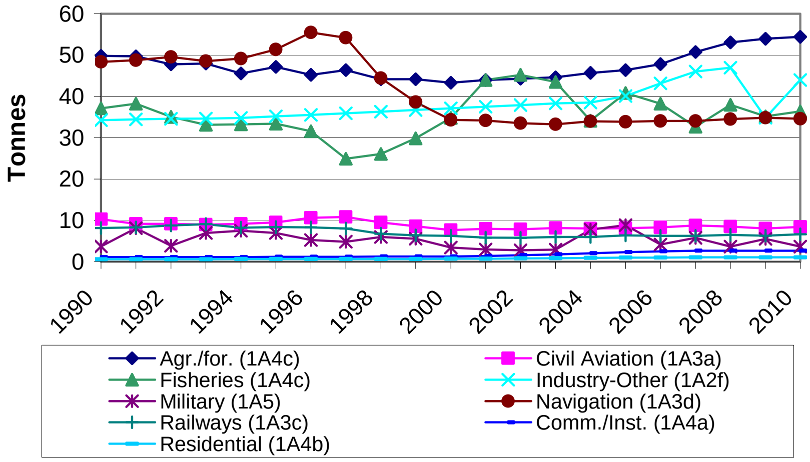


Figure 3.3.20 N_2O emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

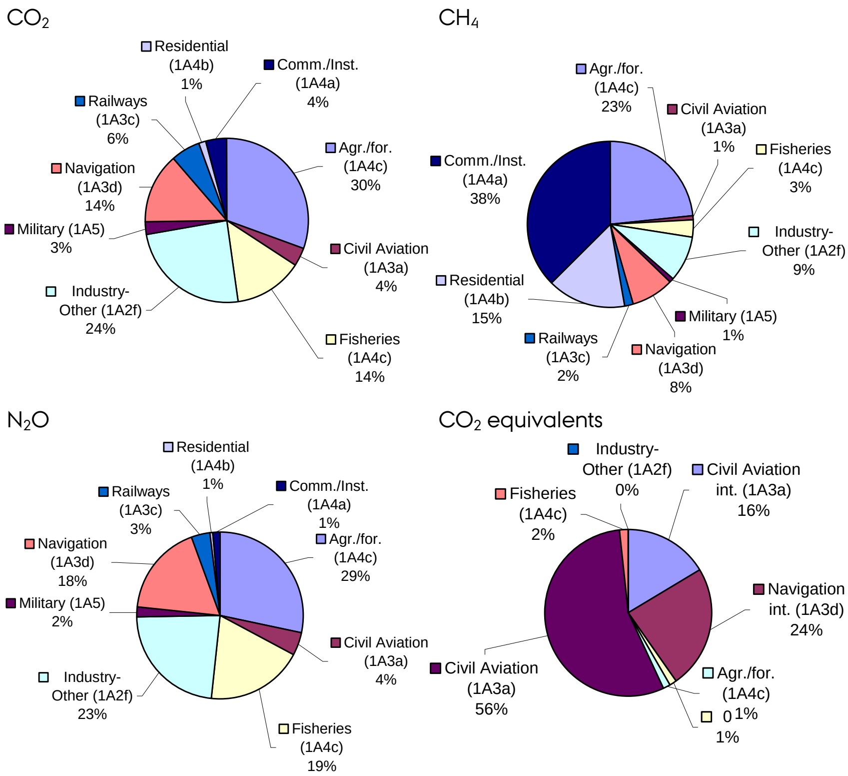


Figure 3.3.21 CO_2, CH_4 and N_2O emission shares and GHG equivalent emission distribution for other mobile sources in 2010.

Emissions of SO_2, NO_X, NMVOC and CO

In Table 3.3.4 the SO_2, NO_X, NMVOC and CO emissions for road transport and other mobile sources are shown for 2010 in CRF sectors. The emission figures in the time series 1990-2010 are given in Annex 3.B.16 (CRF format) and are shown for 1990 and 2010 in Annex 3.B.15 (CollectER format).

From 1990 to 2010, the road transport emissions of NMVOC, CO and NO_X emissions have decreased by 84, 77 and 56 %, respectively (Figures 3.3.23-3.3.25).

For other mobile sources, the emissions of NO_X decreased by 24 % from 1990 to 2010 and for SO_2 the emission drop is as much as 81 %. In the same period, the emissions of NMVOC have declined by 24 %, whereas the CO emissions have increased by 12 % (Figures 3.3.27-3.3.30).

Table 3.3.20 Emissions of SO_2, NO_X, NMVOC and CO in 2010 for road transport and other mobile sources.

CRF ID	SO_2	NO_x	NMVOC	CO
	tonnes	tonnes	tonnes	tonnes
Industry-Other (1A2f)	31	8 540	1 173	6 446
Civil Aviation (1A3a)	50	623	109	688
Railways (1A3c)	2	2 818	189	481
Navigation (1A3d)	1 440	9 582	937	5 841
Comm./Inst. (1A4a)	1	217	4 423	72 338
Residential (1A4b)	0	87	2 032	25 616
Ag./for./fish. (1A4c)	404	20 770	2 374	19 380
Military (1A5)	20	438	41	309
Total other mobile	1 947	43 075	11 279	131 100
Road (1A3b)	76	44 159	12 514	105 972
Total mobile	2 023	87 235	23 793	237 072

Road transport

The step-wise lowering of the sulphur content in diesel fuel has given rise to a substantial decrease in the road transport emissions of SO_2 (Figure 3.3.22). In 1999, the sulphur content was reduced from 500 ppm to 50 ppm (reaching gasoline levels), and for both gasoline and diesel the sulphur content was reduced to 10 ppm in 2005. Since Danish diesel and gasoline fuels have the same sulphur percentages, at present, the 2010 shares for SO_2 emissions and fuel consumption for passenger cars, heavy-duty vehicles, light-duty vehicles and 2-wheelers are the same in each case: 56, 26, 17 and 1 %, respectively (Figure 3.3.26).

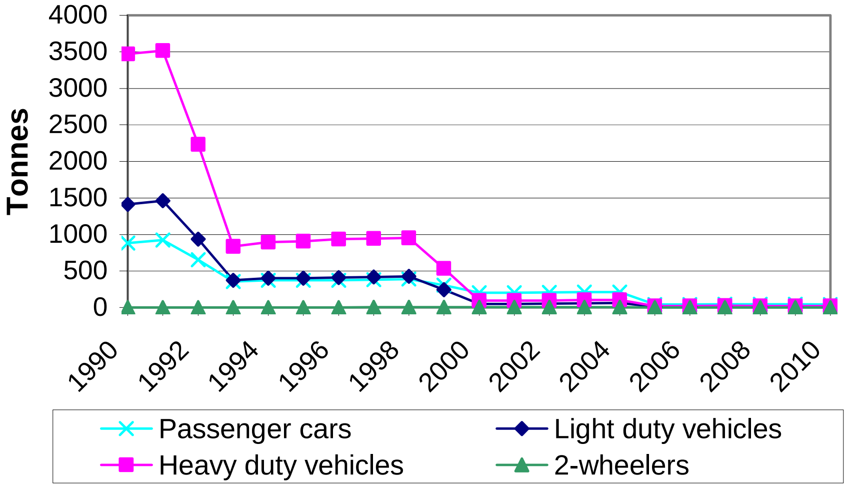


Figure 3.3.22 SO_2 emissions (tonnes) pr vehicle type for road transport 1990-2010.

Historically, the emission totals of NMVOC and CO have been very dominated by the contributions coming from private cars, as shown in Figures 3.3.24-3.3.25. However, the NMVOC and CO (and NO_x) emissions from this vehicle type have shown a steady decreasing tendency since the introduction of private catalyst cars in 1990 (EURO I) and the introduction of even more emission-efficient EURO II, III and IV private cars (introduced in 1997, 2001 and 2006, respectively).

In the case of NO_x, the real traffic emissions for heavy duty vehicles do not decline as intended by the EU emission legislation. This is due to the so-called engine cycle-beating effect. Outside the legislative test cycle stationary measurement points, the electronic engine control for heavy duty Euro II and III engines switches to a fuel efficient engine running mode, thus leading to increasing NO_x emissions. However, the reduction in transport activities due to the global financial crisis causes the NO_x emissions for heavy duty vehicles to decrease significantly in 2008 and 2009.

The 2010 emission shares for heavy-duty vehicles, passenger cars, light-duty vehicles and 2-wheelers for NO_x (52, 35, 13 and 0 %), NMVOC (5, 58, 8 and 18 %) and CO (6, 77, 7, 10 %) are also shown in Figure 3.3.26.

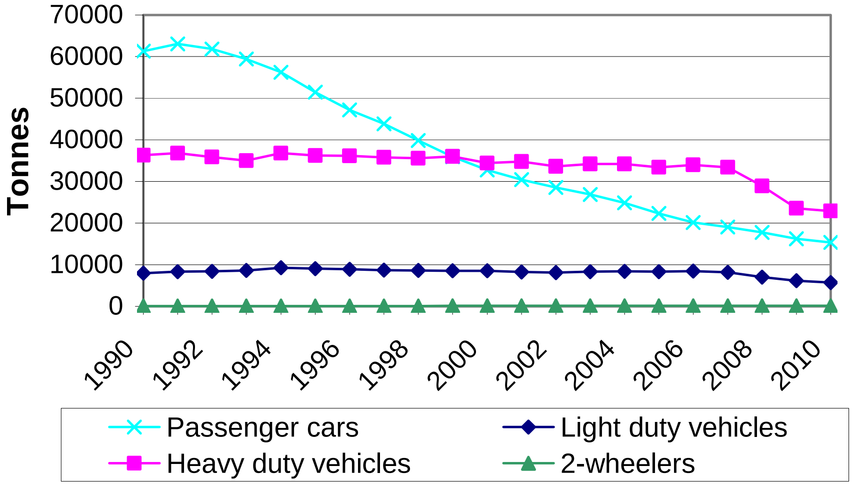


Figure 3.3.23 NO_X emissions (tonnes) pr vehicle type for road transport 1990-2010.

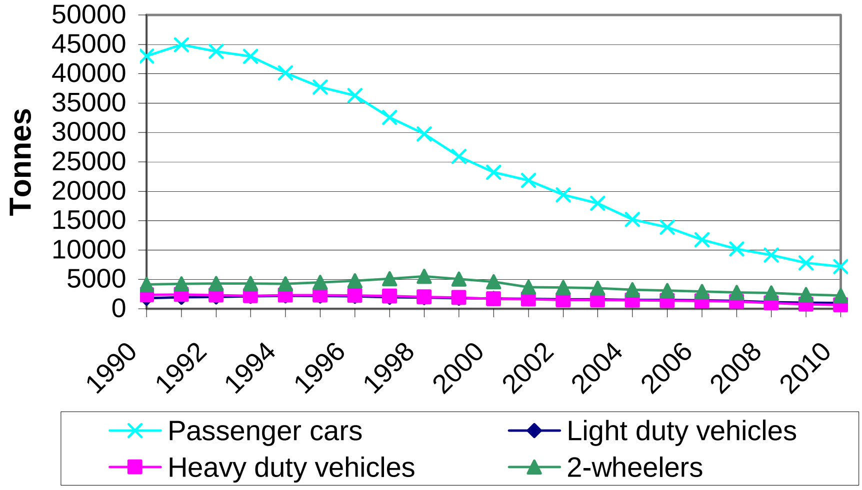


Figure 3.3.24 NMVOC emissions (tonnes) pr vehicle type for road transport 1990-2010

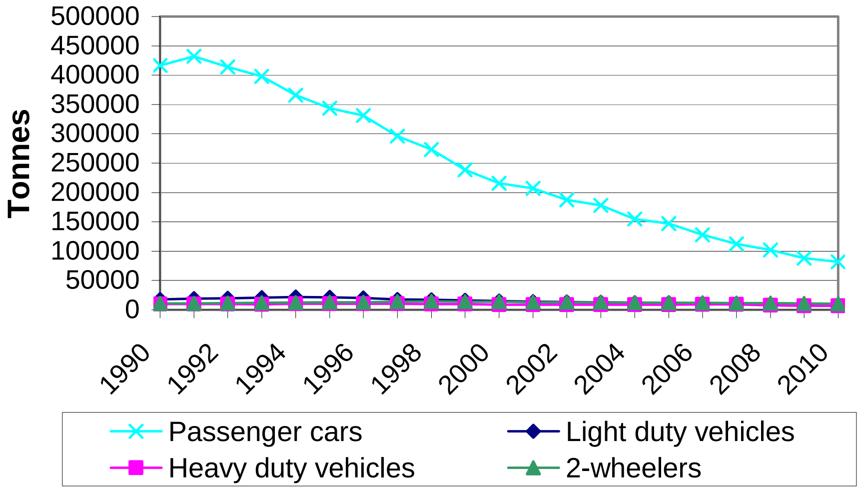


Figure 3.3.25 CO emissions (tonnes) pr vehicle type for road transport 1990-2010.

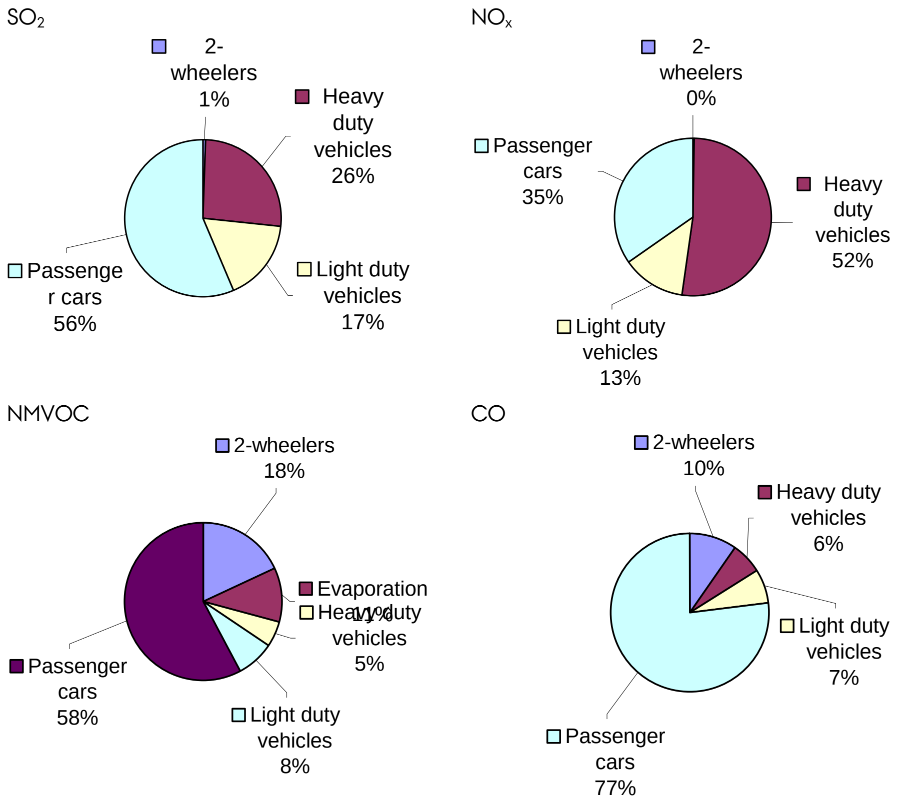


Figure 3.3.26 SO_2, NO_X, NMVOC and CO emission shares pr vehicle type for road transport in 2010

Other mobile sources

For SO_2 the trends in the Navigation (1A3d) emissions shown in Figure 3.3.27 mainly follow the development of the heavy fuel oil consumption (Figure 3.25). Though, from 1993 to 1995 relatively higher contents of sulphur in the fuel (estimated from sales) cause a significant increase in the emissions of SO_2. The SO_2 emissions for Fisheries (1A4c) correspond with the development in the consumption of marine gas oil. The main explanation for the development of the SO_2 emission curves for Railways (1A3c) and non-road machinery in Agriculture/forestry (1A4c) and Industry (1A2f), are the stepwise sulphur content reductions for diesel used by machinery in these sectors.

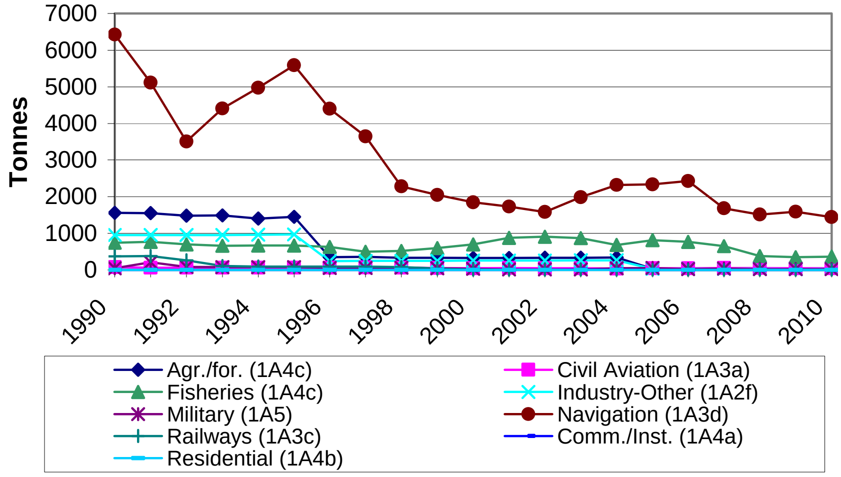


Figure 3.3.27 SO_2 emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

In general, the emissions of NO_X, NMVOC and CO from diesel-fuelled working equipment and machinery in agriculture, forestry and industry have decreased slightly since the end of the 1990s due to gradually strengthened emission standards given by the EU emission legislation directives. For industry, the emission impact from the global financial crisis becomes very visible for 2009.

NO_X emissions mainly come from diesel machinery, and the most important sources are Agriculture/forestry/fisheries (1A4c), Navigation (1A3d), Industry (1A2f) and Railways (1A3c), as shown in Figure 3.3.20. The 2010 emission shares are 48, 22, 20 and 7 %, respectively (Figure 3.3.23). Minor emissions come from the sectors, Civil Aviation (1A3a), Military (1A5) and Residential (1A4b).

The NO_X emission trend for Navigation, Fisheries and Agriculture is determined by fuel consumption fluctuations for these sectors, and the development of emission factors. For ship engines the emission factors tend to increase for new engines until mid-1990s. After that, the emission factors gradually reduce until 2000, bringing them to a level comparable with the emission limits for new engines in this year. For agricultural machines, there have been somewhat higher NO_x emission factors for 1991-stage I machinery, and an improved emission performance for stage I and II machinery since the late 1990s.

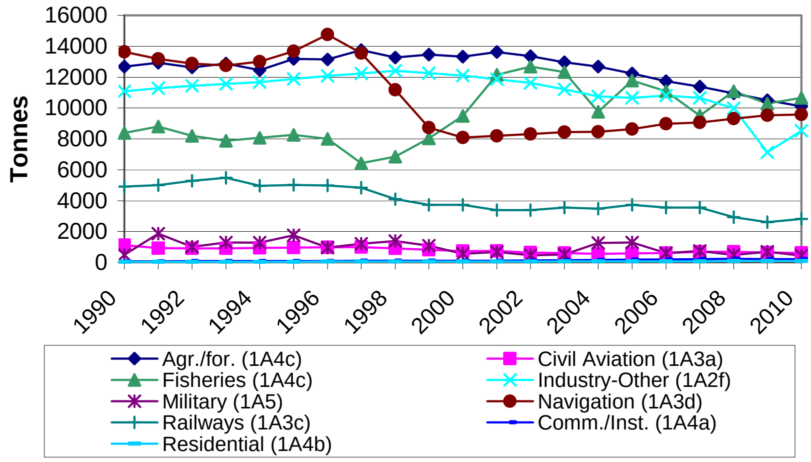


Figure 3.3.28 NO_X emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

The emission development for industry NO_x is the product of a fuel consumption increase from 1985 to 2008, most pronounced from 2005-2008, and a development in emission factors as explained for agricultural machinery. For railways, the gradual shift towards electrification explains the declining trend in diesel fuel consumption and NO_X emissions for this transport sector until 2001.

The 1990-2010 time series of NMVOC and CO emissions are shown in Figures 3.3.29 and 3.3.30 for other mobile sources. The 2010 sector emission shares are shown in Figure 3.3.31. For NMVOC, the most important sectors are Commercial/Institutional (1A4a), Agriculture/forestry/-fisheries (1A4c), Residential (1A4b), Industry (1A2f) and Navigation (1A3d) with 2010 emission shares of 40, 21, 18, 10 and 8 %, respectively. The same five sectors also contribute with most of the CO emissions. For Commercial/Institutional (1A4a), Residential (1A4b), Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d) the emission shares are 55, 20, 15, 5 and 4 %, respectively. Minor NMVOC and CO emissions come from Railways (1A3c), Civil Aviation (1A3a) and Military (1A5).

For NMVOC and CO, the significant emission increases for the comercial/-institutional and residential sectors after 2000 are due to the increased number of gasoline working machines. Improved NMVOC emission factors for diesel machinery in agriculture and gasoline equipment in forestry (chain saws) are the most important explanations for the NMVOC emission decline in the Agriculture/forestry/fisheries sector. This explanation also applies for the industrial sector, which is dominated by diesel-fuelled machinery. From 1997 onwards, the NMVOC emissions from Navigation decrease due to the gradually phase-out of the 2-stroke engine technology for recreational craft. The main reason for the significant 1985-2006 CO emission decrease for Agriculture/forestry-/fisheries is the phasing out of gasoline tractors.

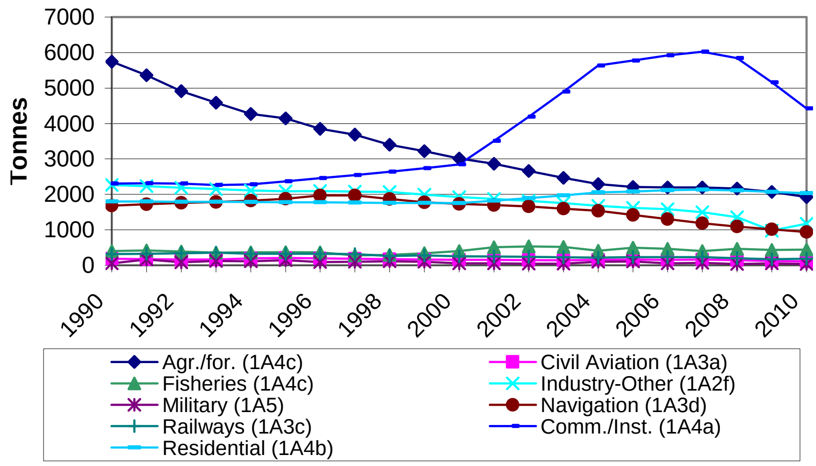


Figure 3.3.29 NMVOC emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

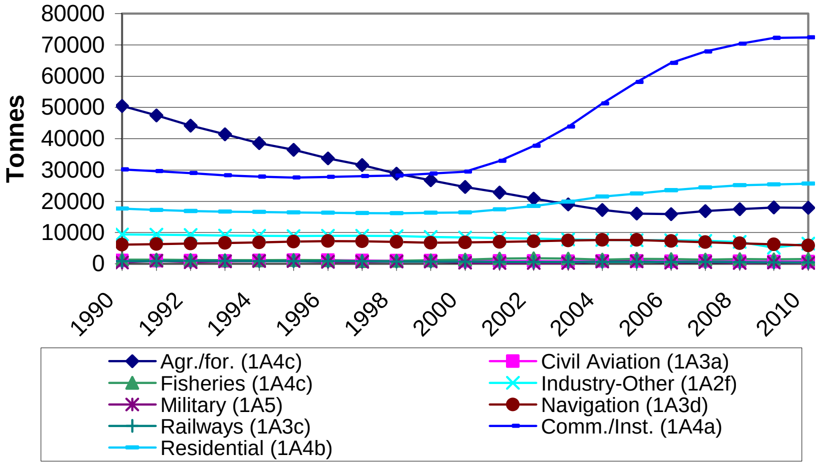


Figure 3.3.30 CO emissions (tonnes) in CRF sectors for other mobile sources 1990-2010.

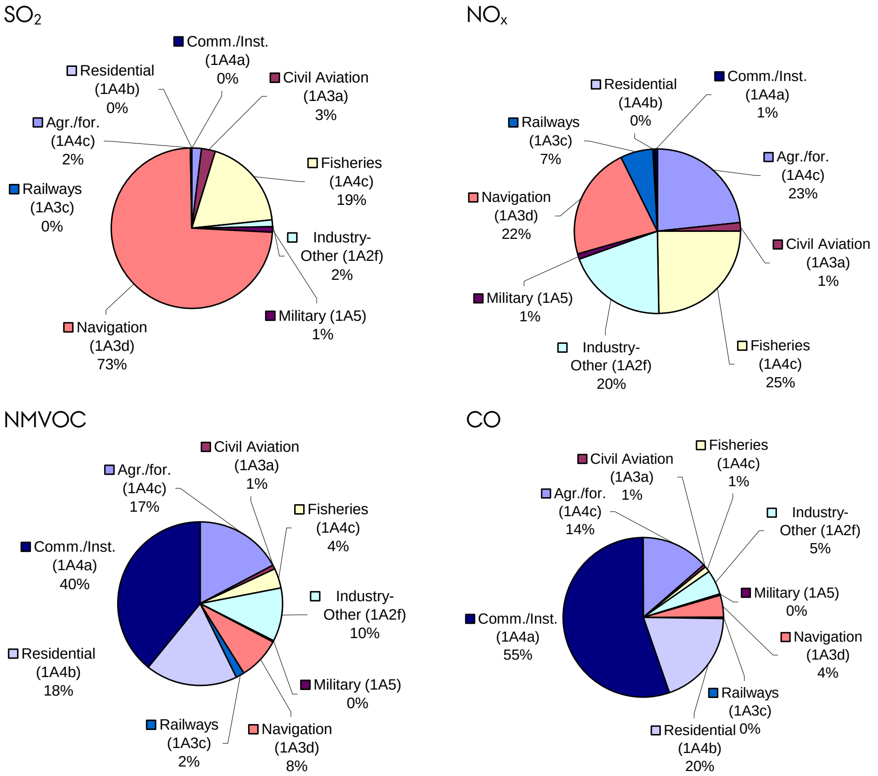


Figure 3.3.31 SO_2, NO_X, NMVOC and CO emission shares pr vehicle type for other mobile sources in 2010.

Bunkers

The most important emissions from bunker fuel consumption (fuel consumption for international transport) are SO_2, NO_X and CO_2 (and TSP, not shown). However, compared with the Danish national emission total (all sources), the greenhouse gas emissions from bunkers are small. The bunker emission totals are shown in Figure 3.3.7 for 2010, split into sea transport and civil aviation. All emission figures in the 1990-2010 time series are given in Annex 3.B.16 (CRF format). In Annex 3.B.15, the emissions are also given in CollectER format for the years 1990 and 2010.

Table 3.3.5 Emissions in 2010 for international transport.

CRF sector	SO_2	NO_X	NMVOC	CH_4	CO	CO_2	N_2O
	tonnes	tonnes	tonnes	tonnes	tonnes	k-tonnes	tonnes
Navigation int. (1A3d)	7 383	35 658	1 160	36	3 826	1 487	94
Civil Aviation int. (1A3a)	739	9 854	503	53	1 791	2 314	79
International total	8 122	45 512	1 663	89	5 617	3 800	173

The differences in emissions between navigation and civil aviation are much larger than the differences in fuel consumption (and derived CO_2 emissions), and display a poor emission performance for international sea transport. In broad terms, the emission trends shown in Figure 3.3.32 are similar to the fuel consumption development.

However, for navigation minor differences occur for the emissions of SO_2, NO_X and CO_2 due to varying amounts of marine gas oil and residual oil, and for SO_2 and NO_X the development in the emission factors also have an impact on the emission trends. For civil aviation, apart from the annual consumption of jet fuel, the development of the NO_X emissions is also due to yearly variations in LTO/aircraft type (earlier than 2001) and city-pair statistics (2001 onwards).

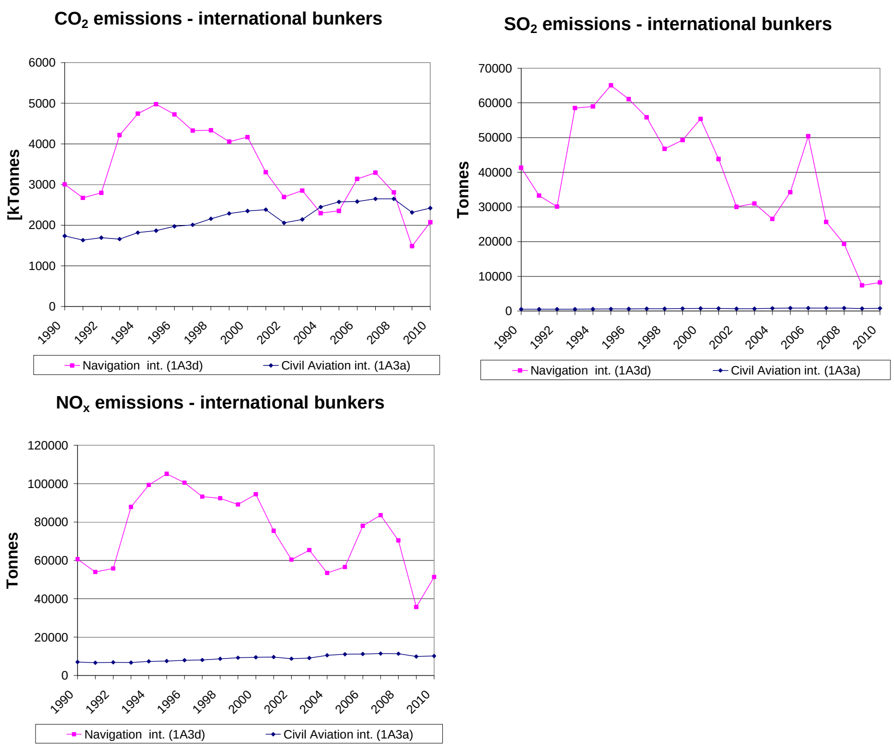


Figure 3.3.32 CO_2, SO_2 and NO_X emissions for international transport 1990-2010.

3.3.2 Methodological issues

The description of methodologies and references for the transport part of the Danish inventory is given in two sections: one for road transport and one for the other mobile sources.

Methodology and references for Road Transport

For road transport, the detailed methodology is used to make annual estimates of the Danish emissions, as described in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009). The actual calculations are made with a model developed by DCE, using the European COPERT IV model methodology explained by (EMEP/EEA, 2009). In COPERT, fuel consumption and emission simulations can be made for operationally hot engines, taking into account gradually stricter emission standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated.

Vehicle fleet and mileage data

Corresponding to the COPERT IV fleet classification, all present and future vehicles in the Danish fleet are grouped into vehicle classes, sub-classes and layers. The layer classification is a further division of vehicle sub-classes into groups of vehicles with the same average fuel consumption and emission behaviour, according to EU emission legislation levels. Table 3.3.6 gives an overview of the different model classes and sub-classes, and the layer level with implementation years are shown in Annex 3.B.1.

Table 3.3.6 Model vehicle classes and sub-classes and trip speeds.

			Trip speed [km pr h]		
Vehicle classes	Fuel type	Engine size/weight	Urban	Rural	Highway
PC	Gasoline	< 1.4 l.	40	70	100
PC	Gasoline	1.4 – 2 l.	40	70	100
PC	Gasoline	> 2 l.	40	70	100
PC	Diesel	< 2 l.	40	70	100
PC	Diesel	> 2 l.	40	70	100
PC	LPG		40	70	100
PC	2-stroke		40	70	100
LDV	Gasoline		40	65	80
LDV	Diesel		40	65	80
LDV	LPG		40	65	80
Trucks	Gasoline		35	60	80
Trucks	Diesel	Rigid 3,5 - 7,5t	35	60	80
Trucks	Diesel	Rigid 7,5 - 12t	35	60	80
Trucks	Diesel	Rigid 12 - 14 t	35	60	80
Trucks	Diesel	Rigid 14 - 20t	35	60	80
Trucks	Diesel	Rigid 20 - 26t	35	60	80
Trucks	Diesel	Rigid 26 - 28t	35	60	80
Trucks	Diesel	Rigid 28 - 32t	35	60	80
Trucks	Diesel	Rigid >32t	35	60	80
Trucks	Diesel	TT/AT 14 - 20t	35	60	80
Trucks	Diesel	TT/AT 20 - 28t	35	60	80
Trucks	Diesel	TT/AT 28 - 34t	35	60	80
Trucks	Diesel	TT/AT 34 - 40t	35	60	80
Trucks	Diesel	TT/AT 40 - 50t	35	60	80
Trucks	Diesel	TT/AT 50 - 60t	35	60	80
Trucks	Diesel	TT/AT >60t	35	60	80
Urban buses	Gasoline		30	50	70
Urban buses	Diesel	< 15 tonnes	30	50	70
Urban buses	Diesel	15-18 tonnes	30	50	70
Urban buses	Diesel	> 18 tonnes	30	50	70
Coaches	Gasoline		35	60	80
Coaches	Diesel	< 15 tonnes	35	60	80
Coaches	Diesel	15-18 tonnes	35	60	80
Coaches	Diesel	> 18 tonnes	35	60	80
Mopeds	Gasoline		30	30	-
Motorcycles	Gasoline	2 stroke	40	70	100
Motorcycles	Gasoline	< 250 cc.	40	70	100
Motorcycles	Gasoline	250 – 750 cc.	40	70	100
Motorcycles	Gasoline	> 750 cc.	40	70	100

To support the emission calculations a project has been carried out by DTU Transport, in order to provide fleet and annual mileage data for the vehicle categories present in COPERT IV (Jensen, 2011). The latter source also provides information of the mileage split between urban, rural and highway driving. The respective average speeds come from The Danish Road Directorate (Ekman, 2005). Additional data for the moped fleet and motorcycle fleet disaggregation information is given by The National Motorcycle Association (Markamp, 2011).

In addition data from a survey made by the Danish Road Directorate (Hansen, 2010) has given information of the total mileage driven by foreign trucks on Danish roads in 2009. This mileage contribution has been added to the total mileage for Danish trucks on Danish roads, for trucks > 16 tonnes of gross vehicle weight. The data has been further processed by DTU Transport; by using appropriate assumptions the mileage have been backcasted to 1985 and forecasted to 2010.

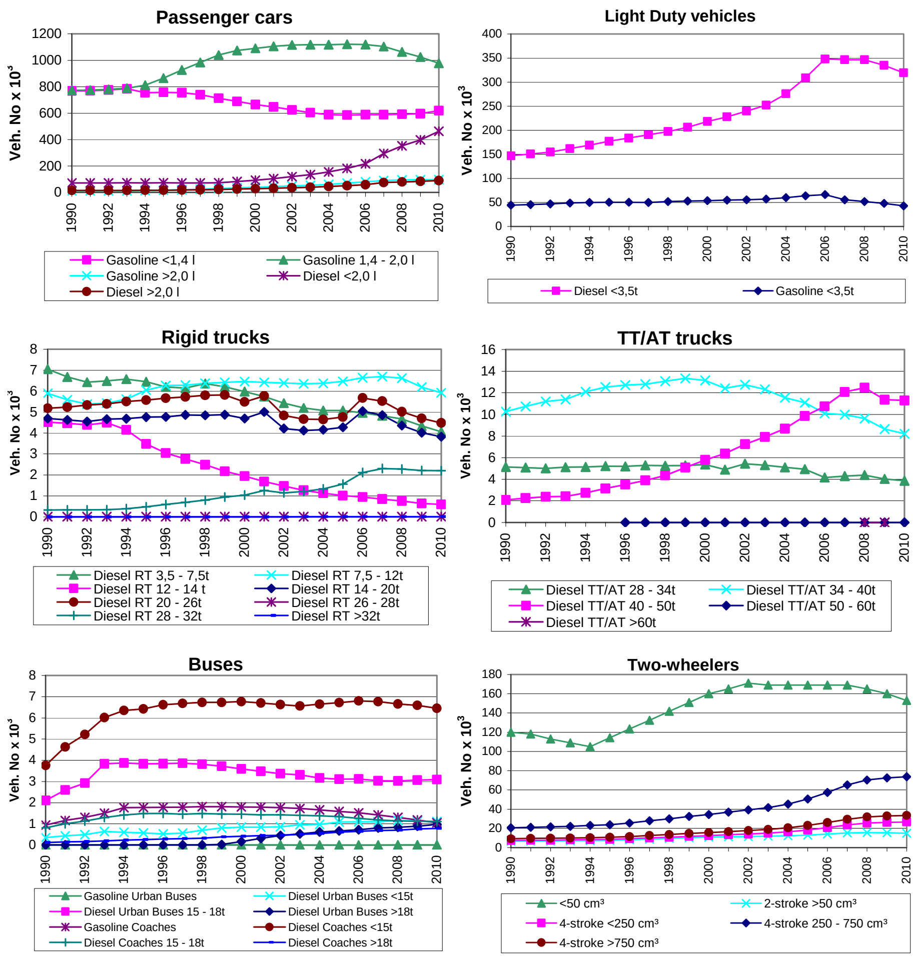


Figure 3.3.33 Number of vehicles in sub-classes in 1990-2010.

For passenger cars, the engine size differentiation is less certain for the years before 2005. The increase in the total number of passenger cars is mostly due to a growth in the number of gasoline cars with engine sizes between 1.4 and 2 litres (from 1990-2002) and an increase in the number of gasoline cars (>2 litres) and diesel cars (< 2 litres). Until 2005, there has been a decrease in the number of cars with an engine size smaller than 1.4 litres.

There has been a considerable growth in the number of diesel light-duty vehicles from 1985 to 2006, the number of vehicles has however decreased somewhat after 2006.

For the truck-trailer and articulated truck combinations there is a tendency towards the use of increasingly larger trucks throughout the time period. The decline in fleet numbers for many of the truck categories in 2007/2008 and until 2009, is caused by the impact of the global financial crisis and the reflagging of Danish commercial trucks to companies based in the neighbouring countries.

The number of urban buses has been almost constant between 1985 and 2008. The sudden change in the level of coach numbers from 1994 to 1995 is due to uncertain fleet data.

The reason for the significant growth in the number of mopeds from 1994 to 2002 is the introduction of the so-called Moped 45 vehicle type. For motorcycles, the number of vehicles has grown in general throughout the entire 1985-2010 period. The increase is, however, most visible from the mid-1990s and onwards.

The vehicle numbers are summed up in EU emission layers for each year (Figure 3.3.34) by using the correspondence between layers and first year of registration:

$$N_{j,y} = \sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \qquad (1)$$

Where N = number of vehicles, j = layer, y = year, i = first year of registration.

Weighted annual mileages pr layer are calculated as the sum of all mileage driven pr first registration year divided by the total number of vehicles in the specific layer.

$$M_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y}} \qquad (2)$$

Since 2006 economical incitements have been given to private vehicle owners to buy Euro 5 diesel passenger cars and vans in order to bring down the particulate emissions from diesel vehicles. The estimated sales between 2006 and 2010 have been examined by the Danish EPA and are included in the fleet data behind the Danish inventory (Winther, 2011).

For heavy duty trucks, there is a slight deviation from the strict correspondence between EU emission layers and first registration year.

In this case, specific Euro class information for most of the vehicles from 2001 onwards is incorporated into the fleet and mileage data model developed by Jensen et al. (2011). For inventory years before 2001, and for vehicles with no Euro information the normal correspondence between layers and first year of registration is used.

Vehicle numbers and weighted annual mileages pr layer are shown in Annex 3.B.1 and 3.B.2 for 1990-2010. The trends in vehicle numbers pr layer are also shown in Figure 3.3.34. The latter figure shows how vehicles complying with the gradually stricter EU emission levels (EURO I, II, III etc.) have been introduced into the Danish motor fleet.

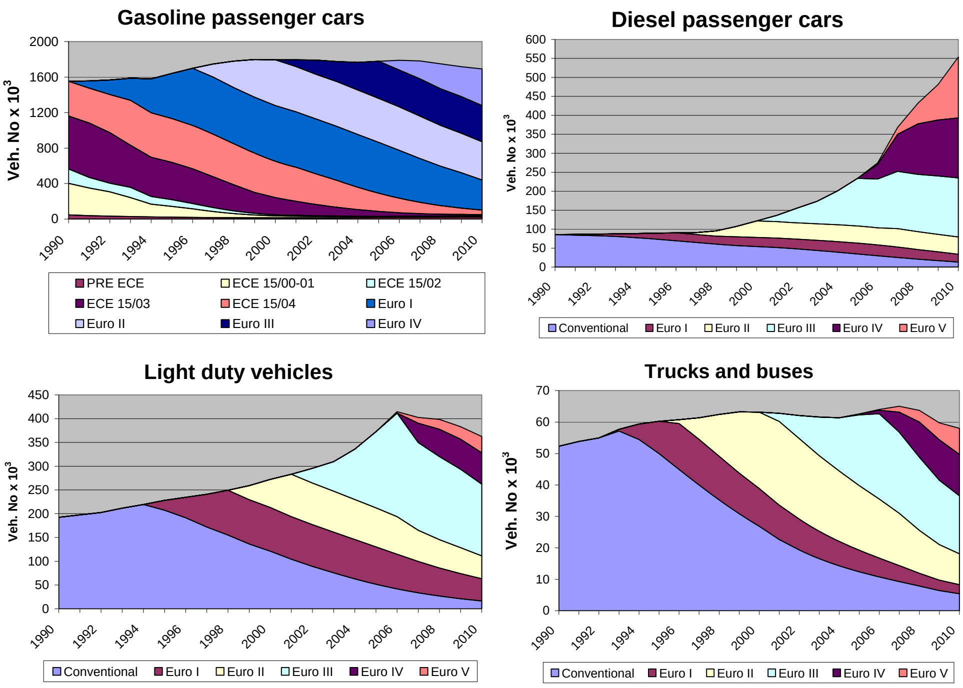


Figure 3.3.34 Layer distribution of vehicle numbers pr vehicle type in 1990-2010.

Emission legislation

The EU 443/2009 regulation sets new emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles. Some key elements of the adopted text are as follows:

- **Limit value curve**: the fleet average to be achieved by all cars registered in the EU is 130 grams pr kilometre (g pr km). A so-called limit value curve implies that heavier cars are allowed higher emissions than lighter cars while preserving the overall fleet average.
- **Further reduction:** A further reduction of 10 g CO2 pr km, or equivalent if technically necessary, will be delivered by other technological improvements and by an increased use of sustainable biofuels.
- **Phasing-in of requirements**: in 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards.
- **Lower penalty payments for small excess emissions** until 2018: If the average CO2 emissions of a manufacturer's fleet exceed its limit value in any year from 2012, the manufacturer has to pay an excess emissions premium for each car registered. This premium amounts to €5 for the first g pr km of exceedance, €15 for the second g pr km, €25 for the third g pr km, and €95 for each subsequent g pr km. From 2019, already the first g pr km of exceedance will cost €95.
- **Long-term target**: a target of 95g pr km is specified for the year 2020. The modalities for reaching this target and the aspects of its implementation including the excess emissions premium will have to be defined in a review to be completed no later than the beginning of 2013.

- **Eco-innovations**: because the test procedure used for vehicle type approval is outdated, certain innovative technologies cannot demonstrate their CO2-reducing effects under the type approval test. As an interim procedure until the test procedure is reviewed by 2014, manufacturers can be granted a maximum of 7g pr km of emission credits on average for their fleet if they equip vehicles with innovative technologies, based on independently verified data.

On 28 October 2009 the European Commission adopted a new legislative proposal to reduce CO2 emissions from light commercial vehicles (vans). The main content of the proposal is given below in bullet points:

- **Target dates:** the EU fleet average for all new light commercial vehicles (vans) of 175 g pr km will apply as of 2014. The requirement will be phased-in as of 2014 when 75% of each manufacturer's newly registered vans must comply on average with the limit value curve set by the legislation. This will rise to 80 % in 2015, and 100% from 2016 onwards.
- **Limit value curve:** emissions limits are set according to the mass of vehicle, using a limit value curve. The curve is set in such a way that a fleet average of 175 grams of CO_2 pr kilometre is achieved. A so-called limit value curve of 100% implies that heavier vans are allowed higher emissions than lighter vans while preserving the overall fleet average. Only the fleet average is regulated, so manufacturers will still be able to make vehicles with emissions above the limit value curve provided these are balanced by other vehicles which are below the curve.
- **Vehicles affected:** the vehicles affected by the legislation are vans, which account for around 12% of the market for light-duty vehicles. This includes vehicles used to carry goods weighing up to 3.5t (vans and car-derived vans, known as N1) and which weigh less than 2610 kg when empty.
- **Long-term target:** a target of 135g pr km is specified for the year 2020. Confirmation of the target with the updated impact assessment, the modalities for reaching this target, and the aspects of its implementation, including the excess emissions premium, will have to be defined in a review to be completed no later than the beginning of 2013.
- **Excess emissions premium for small excess emissions until 2018:** if the average CO_2 emissions of a manufacturer's fleet exceed its limit value in any year from 2014, the manufacturer has to pay an excess emissions premium for each van registered. This premium amounts to €5 for the first g pr km of exceedance, €15 for the second g pr km, €25 for the third g pr km, and €120 for each subsequent g pr km. From 2019, already the first g pr km of exceedance will cost €120. This value is higher than the one for cars (€95) because of the differences in compliance costs.
- **Super-credits:** vehicles with extremely low emissions (below 50g pr km) will be given additional incentives whereby 1 low-emitting van will be counted as 2.5 vehicles in 2014, as 1.5 vehicles in 2015, and 1 vehicle from 2016.
- **Eco-innovations:** because the test procedure used for vehicle type approval is outdated, certain innovative technologies cannot demonstrate their CO_2-reducing effects under the type approval test. As an interim procedure until the test procedure is reviewed by 2014, manufacturers can be granted a maximum of 7g pr km of emission credits on average for their fleet if they equip vehicles with innovative technologies, based on independently verified data.
- **Other flexibilities:** manufacturers may group together to form a pool and act jointly in meeting the specific emissions targets. Independent

manufacturers who sell fewer than 22,000 vehicles pr year can also apply to the Commission for an individual target instead.

For Euro 1-4 passenger cars and light duty trucks, the chassis dynamometer test cycle used in the EU for measuring fuel is the NEDC (New European Driving Cycle), see Nørgaard and Hansen (2004). The test cycle is also used also for emissions testing. The NEDC cycle consists of two parts, the first part being a 4-time repetition (driving length: 4 km) of the ECE test cycle. The latter test cycle is the so-called urban driving cycle3 (average speed: 19 km pr h). The second part of the test is the run-through of the EUDC (Extra Urban Driving Cycle) test driving segment, simulating the fuel consumption under rural and highway driving conditions. The driving length of EUDC is seven km at an average speed of 63 km pr h. More information regarding the fuel measurement procedure can be found in the EU-directive 80/1268/EØF.

For NO_X, VOC (NMVOC + CH_4), CO and PM, the emissions from road transport vehicles have to comply with the different EU directives listed in Table 3.3.7. The emission directives distinguish between three vehicle classes according to vehicle reference mass[4]: Passenger cars and light duty trucks (<1305 kg), light duty trucks (1305-1760 kg) and light duty trucks (>1760 kg).The specific emission limits are shown in Annex 3.B.3.

[3] For Euro 3 and on, the emission approval test procedure was slightly changed. The 40 s engine warm up phase before start of the urban driving cycle was removed.

[4] Reference mass: net vehicle weight + mass of fuel and other liquids + 100 kg.

Table 3.3.7 Overview of the existing EU emission directives for road transport vehicles.

Vehicle category	Emission layer	EU directive	First reg. date
Passenger cars (gasoline)	PRE ECE	-	-
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1.10.1990[e]
	Euro II	94/12	1.1.1997
	Euro III	98/69	1.1.2001
	Euro IV	98/69	1.1.2006
	Euro V	715/2007	1.1.2011
	Euro VI	715/2007	1.9.2015
Passenger cars (diesel and LPG)	Conventional	-	-
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1.10.1990[e]
	Euro II	94/12	1.1.1997
	Euro III	98/69	1.1.2001
	Euro IV	98/69	1.1.2006
	Euro V	715/2007	1.1.2011
	Euro VI	715/2007	1.9.2015
Light duty trucks (gasoline and diesel)	Conventional	-	-
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	93/59	1.10.1994
	Euro II	96/69	1.10.1998
	Euro III	98/69	1.1.2002
	Euro IV	98/69	1.1.2007
	Euro V	715/2007	1.1.2012
	Euro VI	715/2007	1.9.2016
Heavy duty vehicles	Euro 0	88/77	1.10.1990
	Euro I	91/542	1.10.1993
	Euro II	91/542	1.10.1996
	Euro III	1999/96	1.10.2001
	Euro IV	1999/96	1.10.2006
	Euro V	1999/96	1.10.2009
	Euro VI	595/2009	1.10.2013
Mopeds	Conventional	-	-
	Euro I	97/24	2000
	Euro II	2002/51	2004
Motor cycles	Conventional	-	-
	Euro I	97/24	2000
	Euro II	2002/51	2004
	Euro III	2002/51	2007

a,b,c,d: Expert judgement suggest that Danish vehicles enter into the traffic before EU directive first registration dates. The effective inventory starting years are a: 1970; b: 1979; c: 1981; d: 1986.
e: The directive came into force in Denmark in 1991 (EU starting year: 1993).

In practice, the emissions from vehicles in traffic are different from the legislation limit values and, therefore, the latter figures are considered to be too inaccurate for total emission calculations. A major constraint is that the emission approval test conditions reflect only to a small degree the large variety of emission influencing factors in the real traffic situation, such as cumulated mileage driven, engine and exhaust after treatment maintenance levels and driving behaviour.

Therefore, in order to represent the Danish fleet and to support average national emission estimates, emission factors must be chosen which derive from numerous emissions measurements, using a broad range of real world driving patterns and a sufficient number of test vehicles. It is similar important to have separate fuel consumption and emission data for cold-start emission calculations and gasoline evaporation (hydrocarbons).

For heavy-duty vehicles (trucks and buses), the emission limits are given in g pr kWh and the measurements are carried out for engines in a test bench, using the EU ESC (European Stationary Cycle) and ETC (European Transient Cycle) test cycles, depending on the Euro norm and exhaust gas after-treatment system installed. A description of the test cycles is given by Nørgaard and Hansen, 2004). Measurement results in g pr kWh from emission approval tests cannot be directly used for inventory work. Instead, emission factors used for national estimates must be transformed into g pr km, and derived from a sufficient number of measurements which represent the different vehicle size classes, Euro engine levels and real world variations in driving behaviour.

Fuel consumption and emission factors

Trip-speed dependent basis factors for fuel consumption and emissions are taken from the COPERT model using trip speeds as shown in Table 3.3.6. The factors are listed in Annex 3.B.4. For EU emission levels not represented by actual data, the emission factors are scaled according to the reduction factors given in Annex 3.B.5.

The fuel consumption and emission factors used in the Danish inventory come from the COPERT IV model. The source for these data is various European measurement programmes. In general the COPERT data are transformed into trip-speed dependent fuel consumption and emission factors for all vehicle categories and layers.

For passenger cars, real measurement results are behind the emission factors for Euro 1-4 vehicles, and those earlier. For light duty trucks the measurements represent Euro 1 and prior vehicle technologies. For mopeds and motorcycles, updated fuel consumption and emission figures are behind the conventional and Euro 1-3 technologies.

In order to account for the trend towards more fuel efficient vehicles being sold in Denmark in the later years, fuel consumption factors for Euro 5 and Euro 6 passenger cars are estimated in the following way.

An aggregated CO_2 emission factor (g/km) for new registered passenger cars in the years 2009 and 2010 have been calculated from 1) type approval fuel economy values incorporated in the DTU Transport fleet and mileage statistics and 2) fuel specific CO_2 emission factors. The aggregated CO_2 emission factor for 2010 is used in combination with the overall EU target of 130 g CO_2/km in 2015 and 95 g CO_2/km in 2020 in order to calculate an interpolated time series of type approval related CO_2 emission factors for the years 2011-2014 and 2016-2019 (year specific CO_2 emission factors).

By assuming that the fuel type/engine size specific COPERT IV fuel consumption factors for Euro 4 cars relate to cars from 2009, Euro 5 and 6 COPERT corresponding factors for each fuel type/engine size combination are calculated for each year in the forecast period by multiplying the Euro 4 factor with the ratio between the year specific aggregated CO_2 emission factor and the aggregated CO_2 emission factor for 2009.

The experimental basis for heavy-duty trucks and buses is computer simulated emission factors for Euro 0-V engines.

In COPERT IV updated emission factors have recently been made available for Euro V heavy duty vehicles using EGR and SCR exhaust emission after-treatment systems, respectively. The estimated new sales of Euro V diesel trucks equipped with EGR and SCR during the 2006-2010 time periods has been examined by Hjelgaard and Winther (2011). These inventory fleet data are used in the Danish inventory to calculate weighted emission factors for Euro V trucks in different size categories.

During the 2000's urban environmental zones have been established in Danish cities in order to bring down the particulate emissions from diesel fuelled heavy duty vehicles. Driving in these environmental zones prescribe the use of diesel particulate filters. The Danish EPA has provided the estimated number of Euro I-III urban buses and Euro II-III trucks and tourist buses which have been retrofitted with filters during the 2000's. These retrofit data are included in the Danish inventory by assuming that particulate emissions are lowered by 80 % compared with the emissions from the same Euro technology with no filter installed (Winther, 2011).

For all vehicle categories/technology levels not represented by measurements, the emission factors are produced by using reduction factors. The latter factors are determined by assessing the EU emission limits and the relevant emission approval test conditions, for each vehicle type and Euro class.

Deterioration factors

For three-way catalyst cars the emissions of NO_X, NMVOC and CO gradually increase due to catalyst wear and are, therefore, modified as a function of total mileage by the so-called deterioration factors. Even though the emission curves may be serrated for the individual vehicles, on average, the emissions from catalyst cars stabilise after a given cut-off mileage is reached due to OBD (On Board Diagnostics) and the Danish inspection and maintenance programme.

For each year, the deterioration factors are calculated pr first registration year by using deterioration coefficients and cut-off mileages, as given in EMEP/EEA (2009), for the corresponding layer. The deterioration coefficients are given for the two driving cycles: "Urban Driving Cycle" (UDF) and "Extra Urban Driving Cycle" (EUDF: urban and rural), with trip speeds of 19 and 63 km pr h, respectively.

Firstly, the deterioration factors are calculated for the corresponding trip speeds of 19 and 63 km pr h in each case determined by the total cumulated mileage less than or exceeding the cut-off mileage. The Formulas 3 and 4 show the calculations for the "Urban Driving Cycle":

$$UDF = U_A \cdot MTC + U_B \text{, MTC} < \text{U}_{\text{MAX}} \quad (3)$$

$$UDF = U_A \cdot U_{MAX} + U_B \text{, MTC >= } U_{MAX} \tag{4}$$

where UDF is the urban deterioration factor, U_A and U_B the urban deterioration coefficients, MTC = total cumulated mileage and U_{MAX} urban cut-off mileage.

In the case of trip speeds below 19 km pr h the deterioration factor, DF, equals UDF, whereas for trip speeds exceeding 63 km pr h, DF=EUDF. For trip speeds between 19 and 63 km pr h the deterioration factor, DF, is found as an interpolation between UDF and EUDF. Secondly, the deterioration factors, one for each of the three road types, are aggregated into layers by taking into account vehicle numbers and annual mileage levels pr first registration year:

$$DF_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y}} \tag{5}$$

where DF is the deterioration factor.

For N_2O and NH_3, COPERT IV takes into account deterioration as a linear function of mileage for gasoline fuelled EURO 1-4 passenger cars and light duty vehicles. The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/EEA (2009), for the corresponding layer. A cut-off mileage of 120 000 km (pers. comm. Ntziachristos, 2007) is behind the calculation of the modified emission factors, and for the Danish situation the low sulphur level interval is assumed to be most representative.

Emissions and fuel consumption for hot engines

Emissions and fuel consumption results for operationally hot engines are calculated for each year and for layer and road type. The procedure is to combine fuel consumption and emission factors (and deterioration factors for catalyst vehicles), number of vehicles, annual mileage levels and the relevant road-type shares given in Table 3.3.7. For non-catalyst vehicles this yields:

$$E_{j,k,y} = EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \tag{6}$$

Here E = fuel consumption/emission, EF = fuel consumption/emission factor, S = road type share and k = road type.

For catalyst vehicles the calculation becomes:

$$E_{j,k,y} = DF_{j,k,y} \cdot EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \tag{7}$$

Extra emissions and fuel consumption for cold engines

Extra emissions of NO_X, VOC, CH_4, CO, PM, N_2O, NH_3 and fuel consumption from cold start are simulated separately. For SO_2 and CO_2, the extra emissions are derived from the cold start fuel consumption results.

Each trip is associated with a certain cold-start emission level and is assumed to take place under urban driving conditions. The number of trips is distributed evenly across the months. First, cold emission factors are calculated as the hot emission factor times the cold:hot emission ratio. Secondly, the extra emission factor during cold start is found by subtracting the hot emission factor from the cold emission factor. Finally, this extra factor is applied on the fraction of the total mileage driven with a cold engine (the β-factor) for all vehicles in the specific layer.

The cold:hot ratios depend on the average trip length and the monthly ambient temperature distribution. The Danish temperatures for 2010 are given in Cappelen et al. (2011). For previous years, temperature data are taken from similar reports available from The Danish Meteorological Institute (www.dmi.dk). The cold:hot ratios are equivalent for gasoline fuelled conventional passenger cars and vans and for diesel passenger cars and vans, respectively, see EMEP/EEA (2009). For conventional gasoline and all diesel vehicles the extra emissions become:

$$CE_{j,y} = \beta \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr - 1) \tag{8}$$

Where CE is the cold extra emissions, β = cold driven fraction, CEr = Cold:Hot ratio.

For catalyst cars, the cold:hot ratio is also trip speed dependent. The ratio is, however, unaffected by catalyst wear. The Euro I cold:hot ratio is used for all future catalyst technologies. However, in order to comply with gradually stricter emission standards, the catalyst light-off temperature must be reached in even shorter periods of time for future EURO standards. Correspondingly, the β-factor for gasoline vehicles is reduced step-wise for Euro II vehicles and their successors.

For catalyst vehicles the cold extra emissions are found from:

$$CE_{j,y} = \beta_{red} \cdot \beta_{EUROI} \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr_{EUROI} - 1) \tag{9}$$

where β_{red} = the β reduction factor.

For CH_4, specific emission factors for cold driven vehicles are included in COPERT IV. The β and β_{red} factors for VOC are used to calculate the cold driven fraction for each relevant vehicle layer. The NMVOC emissions during cold start are found as the difference between the calculated results for VOC and CH_4.

For N_2O and NH_3, specific cold start emission factors are also proposed by COPERT IV. For catalyst vehicles, however, just like in the case of hot emission factors, the emission factors for cold start are functions of cumulated mileage (emission deterioration). The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/EEA (2009), for the corresponding layer. For cold start, the cut-off mileage and sulphur level interval for hot engines are used, as described in the deterioration factors paragraph.

Evaporative emissions from gasoline vehicles

For each year, evaporative emissions of hydrocarbons are simulated in the forecast model as hot and warm running losses, hot and warm soak loss and diurnal emissions. The calculation approach is the same as in COPERT III. All emission types depend on RVP (Reid Vapour Pressure) and ambient temperature. The emission factors are shown in EMEP/EEA (2009).

Running loss emissions originate from vapour generated in the fuel tank while the vehicle is running. The distinction between hot and warm running loss emissions depends on engine temperature. In the model, hot and warm running losses occur for hot and cold engines, respectively. The emissions are calculated as annual mileage (broken down into cold and hot mileage totals using the β-factor) times the respective emission factors. For vehicles equipped with evaporation control (catalyst cars), the emission factors are only one tenth of the uncontrolled factors used for conventional gasoline vehicles.

$$R_{j,y} = N_{j,y} \cdot M_{j,y} \cdot ((1-\beta) \cdot HR + \beta \cdot WR) \tag{10}$$

where R is running loss emissions and HR and WR are the hot and warm running loss emission factors, respectively.

In the model, hot and warm soak emissions for carburettor vehicles also occur for hot and cold engines, respectively. These emissions are calculated as number of trips (broken down into cold and hot trip numbers using the β-factor) times respective emission factors:

$$S_{j,y}{}^{C} = N_{j,y} \cdot \frac{M_{j,y}}{l_{trip}} \cdot ((1-\beta) \cdot HS + \beta \cdot WS) \tag{11}$$

where S^C is the soak emission, l_{trip} = the average trip length, and HS and WS are the hot and warm soak emission factors, respectively. Since all catalyst vehicles are assumed to be carbon canister controlled, no soak emissions are estimated for this vehicle type. Average maximum and minimum temperatures pr month are used in combination with diurnal emission factors to estimate the diurnal emissions from uncontrolled vehicles $E^d(U)$:

$$E_{j,y}{}^{d}(U) = 365 \cdot N_{j,y} \cdot e^{d}(U) \tag{12}$$

Each year's total is the sum of each layer's running loss, soak loss and diurnal emissions.

Fuel use balance

The calculated fuel consumption in COPERT IV must equal the statistical fuel sale totals according to the UNFCCC and UNECE emissions reporting format. The statistical fuel sales for road transport are derived from the Danish Energy Agency data (see DEA, 2011). The DEA data are further processed for gasoline in order to account for e.g. non road and recreational craft fuel consumption, which are not directly stated in the statistics, please refer to paragraph 1.1.4 for further information regarding the transformation of DEA fuel data.

The standard approach to achieve a fuel balance in annual emission inventories is to multiply the annual mileage with a fuel balance factor derived as the ratio between simulated and statistical fuel figures for gasoline and diesel, respectively. This method is also used in the present model.

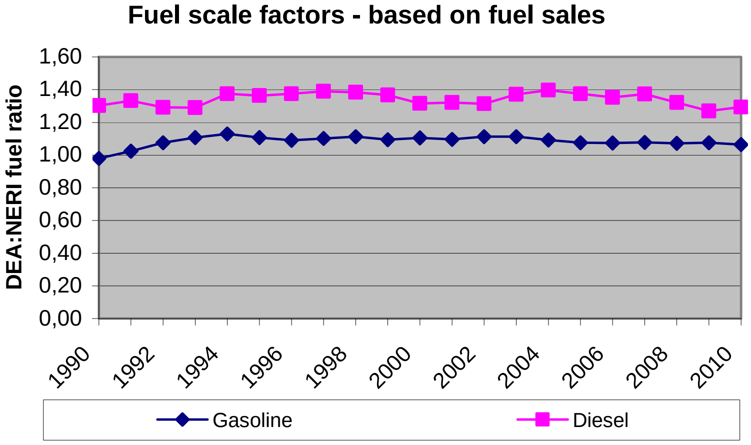


Figure 3.3.35 DEA:DCE Fuel ratios and diesel mileage adjustment factor based on DEA fuel sales data and DCE fuel consumption estimates.

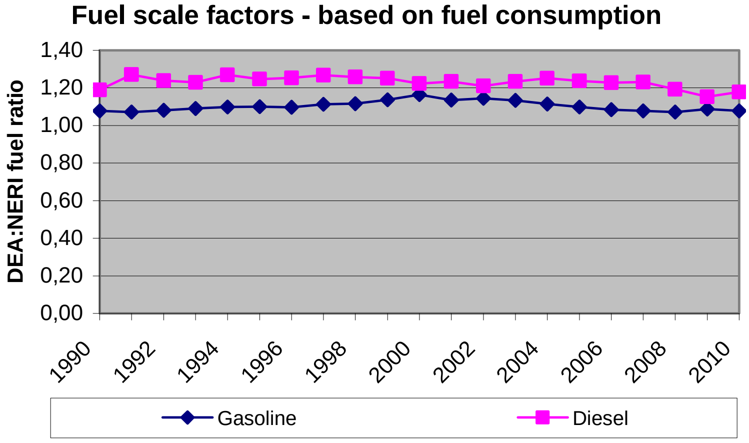


Figure 3.3.36 DEA:DCE Fuel ratios and diesel mileage adjustment factor based on DEA fuel consumption data and DCE fuel consumption estimates.

In Figure 3.3.35 and Figure 3.3.36 the COPERT IV:DEA gasoline and diesel fuel consumption ratios are shown for fuel sales and fuel consumption from 1990-2010. The data behind the figures are also listed in Annex 3.B.8. The fuel consumption figures are related to the traffic on Danish roads.

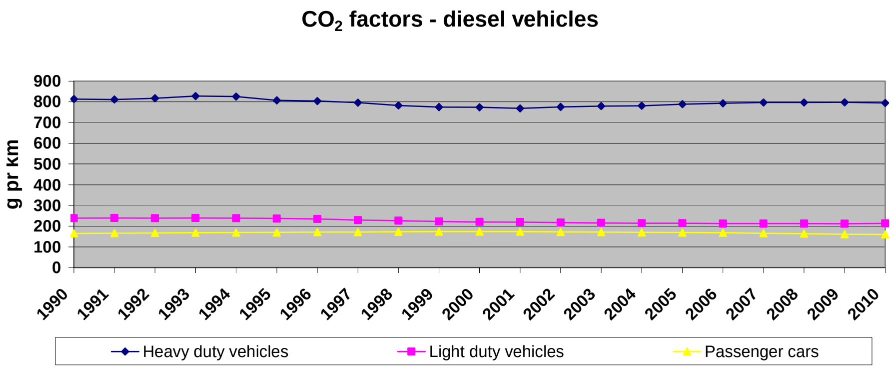
Pr fuel type, all mileage numbers are equally scaled in order to obtain fuel equilibrium, and hence the mileage factors used are the reciprocal values of the COPERT IV:DEA fuel consumption: fuel sales ratio.

The reasons for the differences between DEA sales figures and bottom-up fuel estimates are mostly due to a combination of the uncertainties related to COPERT IV fuel consumption factors, allocation of vehicle numbers in sub-categories, annual mileage, trip speeds and mileage splits for urban, rural and highway driving conditions.

The final fuel consumption and emission factors pr vehicle type are shown in Annex 3.B.7 for 1990-2010. The total fuel consumption and emissions are shown in Annex 3.B.8, pr vehicle category and as grand totals, for 1990-2010 (and CRF format in Annex 3.B.16). In Annex 3.B.15, fuel consumption and emission factors as well as total emissions are given in CollectER format for 1990 and 2010.

In the following Figures 3.3.37 - 3.3.40, the fuel and km related emission factors for CO_2 (km related only), CH_4 and N_2O are shown pr vehicle type for the Danish road transport (from 1990-2010). For CO_2 the emission factors are country specific values, and come from the DEA. From 2006 and 2008, respectively, bio ethanol and biodiesel has become available from a limited number of gas filling stations in Denmark. Following the IPCC guideline definitions, bio ethanol is regarded as CO_2 neutral for the transport sector as such. The sulphur content for bio ethanol/biodiesel is assumed to be zero, and hence, the aggregated CO_2 (and SO_2) factors for gasoline/diesel have been adjusted, on the basis of the energy content of pure gasoline/diesel and bio ethanol/biodiesel.

A literature review carried out in the Danish research project REBECA revealed no significant changes in emission factors between neat gasoline and E5 gasoline-ethanol blends for the combustion related emission components (Winther, 2010). Hence, no modifications of the neat gasoline based COPERT emission factors are made in the inventories in order to account for E5 usage. However, adjustment of the emission factors will be made, if new information becomes available which justify such changes. The CO_2 factors are shown pr fuel type in Table 3.3.8.



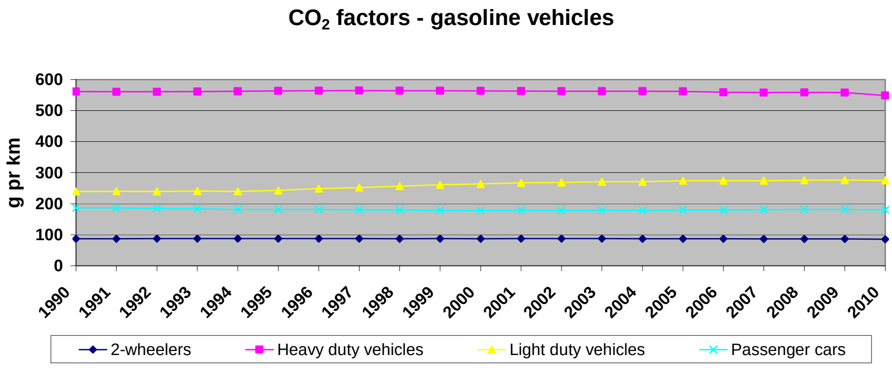
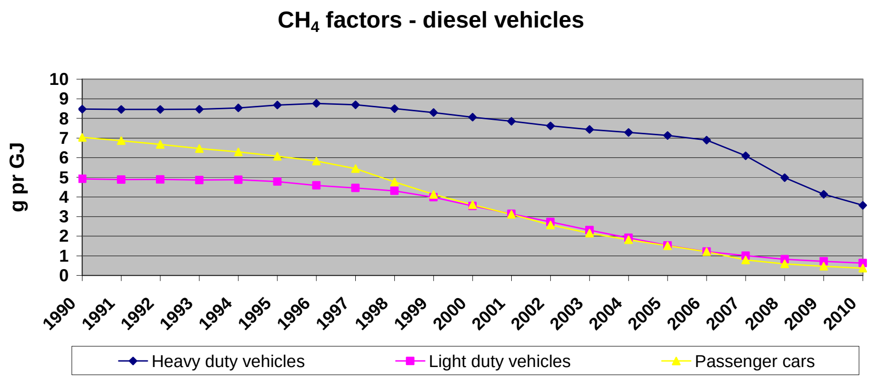
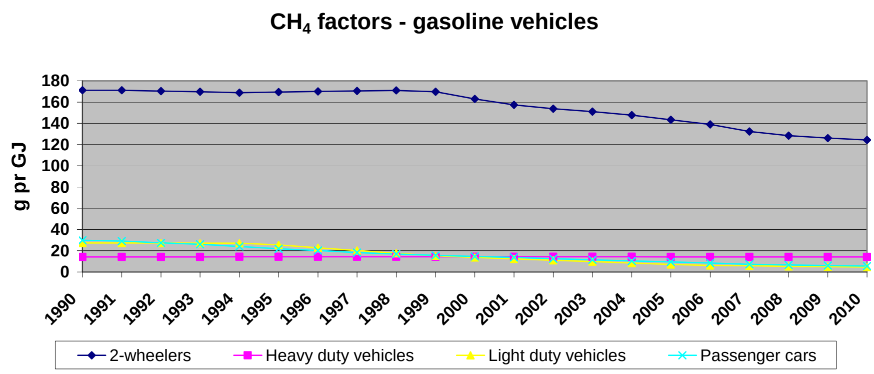


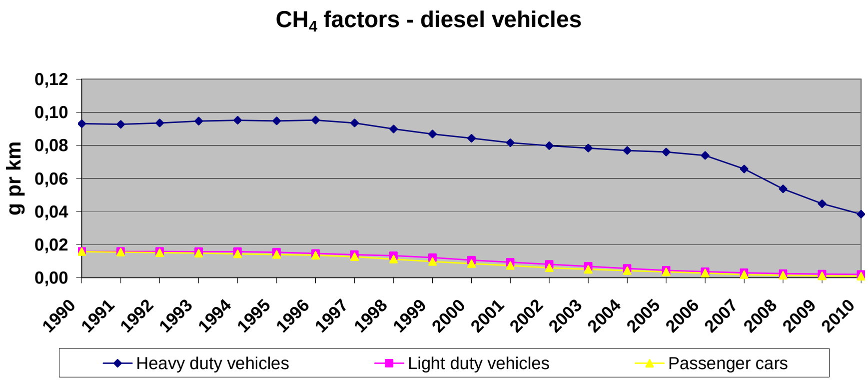
Figure 3.3.37 Km related CO_2 emission factors pr vehicle type for Danish road transport (1990-2010).

Table 3.3.8 Fuel-specific emission factors for CO_2 (kg pr GJ) for road transport in Denmark.

Fuel type	1990-2005	2006	2007	2008	2009	2010
Neat gasoline	73	73	73	73	73	73
Neat diesel	74	74	74	74	74	74
Bio ethanol	0	0	0	0	0	0
Biodiesel	0	0	0	0	0	0
Gasoline	73	72.9	72.8	72.8	72.8	71.7
Diesel	74	74	74	74	73.9	74
LPG	63.1	63.1	63.1	63.1	63.1	63.1







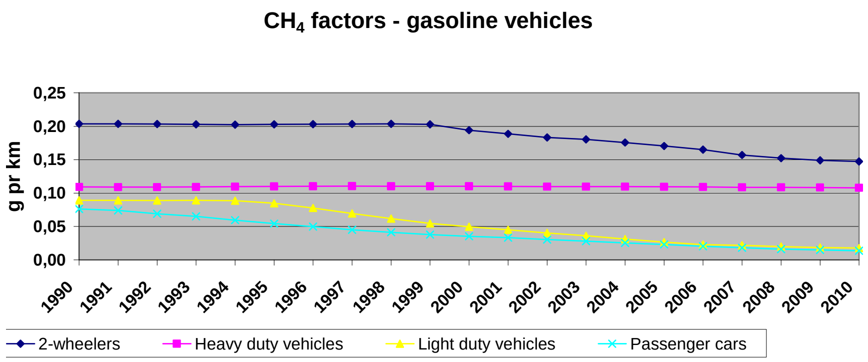


Figure 3.3.38 Fuel and km related CH_4 emission factors pr vehicle type for Danish road transport (1990-2010).

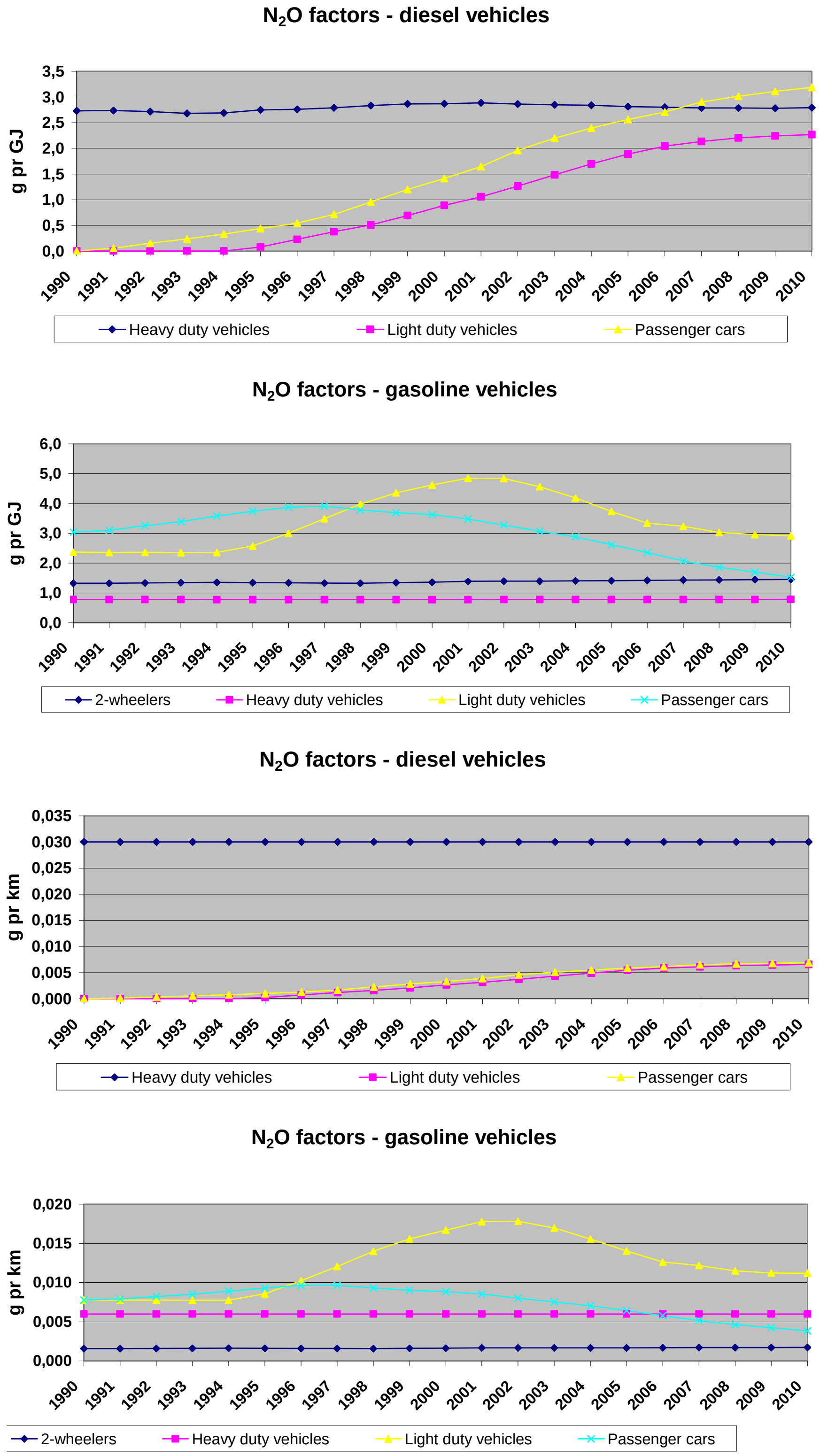


Figure 3.3.39 Fuel and km related N_2O emission factors pr vehicle type for Danish road transport (1990-2010).

Methodologies and references for other mobile sources

Other mobile sources are divided into several sub-sectors: sea transport, fishery, air traffic, railways, military, and working machinery and equipment in the sectors agriculture, forestry, industry and residential. The emission calculations are made using the detailed method as described in the EMEP/EEA air pollutant emission inventory guidebook (EMEP/EEA, 2009) for air traffic, off-road working machinery and equipment, and ferries, while for the remaining sectors the simple method is used.

3.3.3 Activity data

Air traffic

The activity data for air traffic consists of air traffic statistics provided by the Danish Civil Aviation Agency (CAA-DK) and Copenhagen Airport. Fuel statistics for jet fuel consumption and aviation gasoline are obtained from the Danish energy statistics (DEA, 2011).

For 2001 onwards, pr flight records are provided by CAA-DK as data codes for aircraft type, and origin and destination airports (city-pairs).

Subsequently the aircraft types are separated by DCE into larger aircraft using jet fuel (jet engines, turbo props, helicopters) and small aircraft types with piston engines using aviation gasoline. This is done by using different aircraft dictionaries, internet look-ups and by communication with the CAA-DK. Each of the larger aircraft type is then matched with a representative type for which fuel consumption and emission data are available from the EMEP/EEA databank. Relevant for this selection is aircraft maximum take off mass, engine types, and number of engines. A more thorough explanation is given in Winther (2001a, b).

In the later years many flights in Denmark are being made by the new aircraft types CRJ9, E70, E170 and E175. These aircraft types are not represented by data in the EMEP/EEA databank. Instead new fuel consumption and emission factors have been calculated using fuel consumption and emission indexes from the ICAO Engine Exhaust Emission Database (www.caa.co.uk) for the CFM34-8C5 engine type which is installed in CRJ9, E70, E170 and E175. For LTO the fuel consumption and emission indexes are directly available from the ICAO database. For cruise, distance related indexes are calculated by weighting the baseline CFM34-8C5 indexes with the development in distance related emission indexes for the B737 400 representative aircraft type taken from the EMEP/EEA database.

The ideal flying distance (great circle distance) between the city-pairs is calculated by DCE in a separate database. The calculation algorithm uses a global latitude/altitude coordinate table for airports. In cases when airport coordinates are not present in the DCE database, these are looked up on the internet and entered into the database accordingly.

For inventory years prior to 2001, detailed LTO/aircraft type statistics are obtained from Copenhagen Airport (for this airport only), while information of total take-off numbers for other Danish airports is provided by CAA-DK. The assignment of representative aircraft types for Copenhagen Airport is done as described above. For the remaining Danish airports representative aircraft types are not directly assigned. Instead appropriate average assumptions are made relating to the fuel consumption and emission data part.

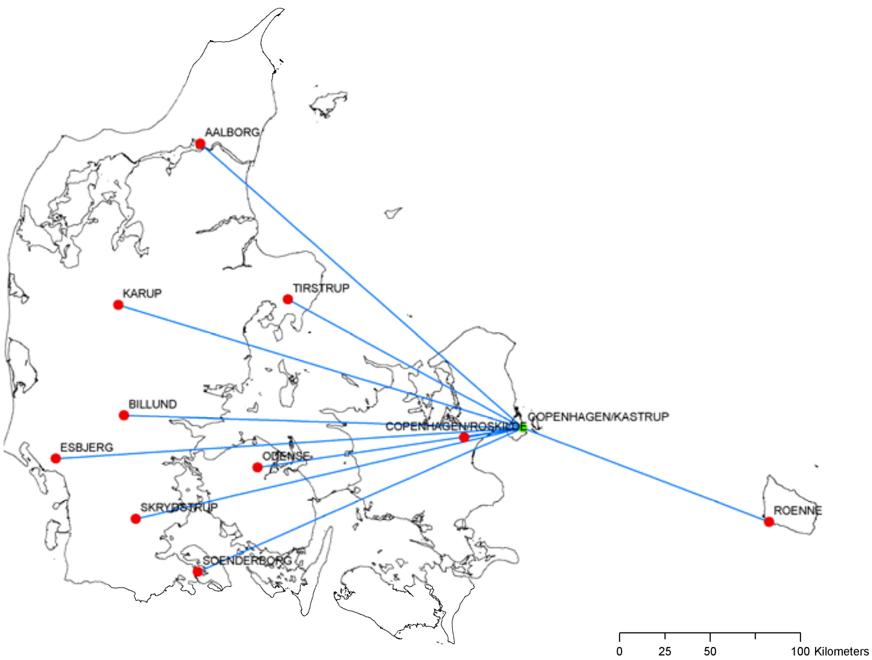


Figure 3.3.40 Most frequent domestic flying routes for large aircraft in Denmark.

Copenhagen Airport is the starting or end point for most of the domestic aviation made by large aircraft in Denmark (Figure 3.3.40; routes to Greenland/Faroe Islands are not shown). Even though many domestic flights not touching Copenhagen Airport are also reported in the flight statistics kept by CAA-DK, these flights, however, are predominantly made with small piston engine aircraft using aviation gasoline. Hence, the consumption of jet fuel by flights not using Copenhagen is merely marginal.

Non-road working machinery and equipment

Non-road working machinery and equipment are used in agriculture, forestry and industry, for household/gardening purposes and in inland waterways (recreational craft). Information on the number of different types of machines, their respective load factors, engine sizes and annual working hours has been provided by Winther et al. (2006). The stock development from 1990-2010 for the most important types of machinery are shown in Figures 3.3.41 - 3.3.48. The stock data are also listed in Annex 3.B.11, together with figures for load factors, engine sizes and annual working hours. As regards stock data for the remaining machinery types, please refer to (Winther et al., 2006).

It is important to note that from key experts in the field of industrial non road activities a significant decrease in the activities is assumed for 2009 due to the global financial crisis. This reduction is in the order of 25 % for 2009 for industrial non road in general (pers. comm. Per Stjernqvist, Volvo Construction Equipment 2010). For fork lifts, 5 % and 20 % reductions are assumed for 2008 and 2009, respectively (pers. comm. Peter H. Møller, Rocla A/S).

For agriculture, the total number of agricultural tractors and harvesters per year are shown in the Figures 3.3.41 - 3.3.42, respectively. The figures clearly show a decrease in the number of small machines, these being replaced by machines in the large engine-size ranges.

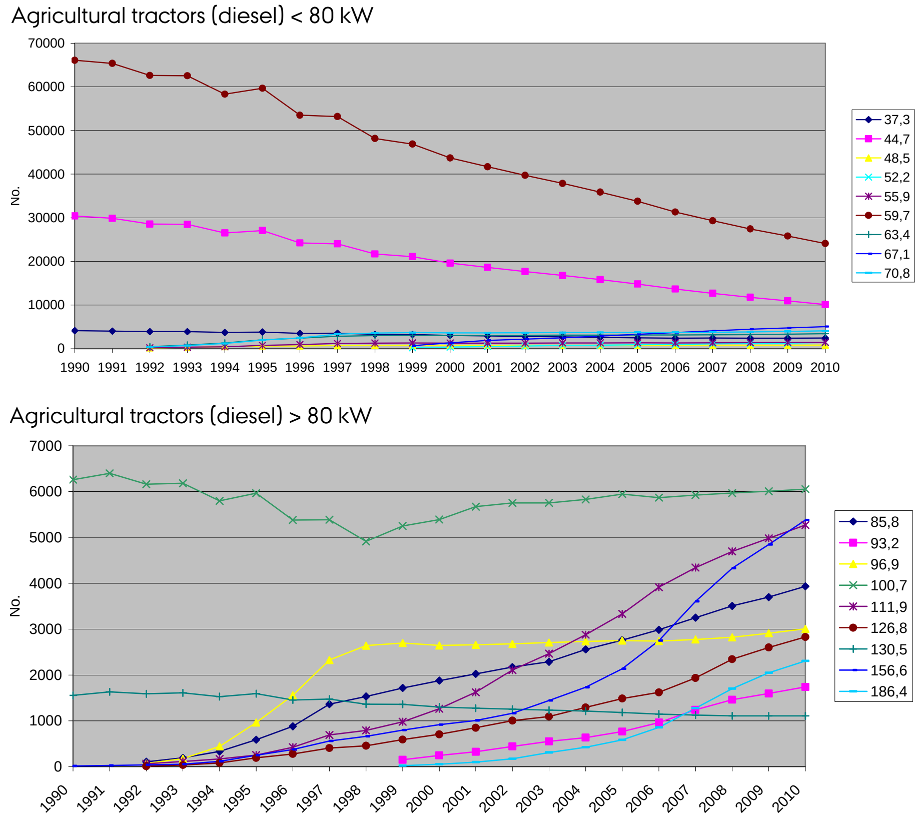


Figure 3.3.41 Total numbers in kW classes for tractors from 1990 to 2010.

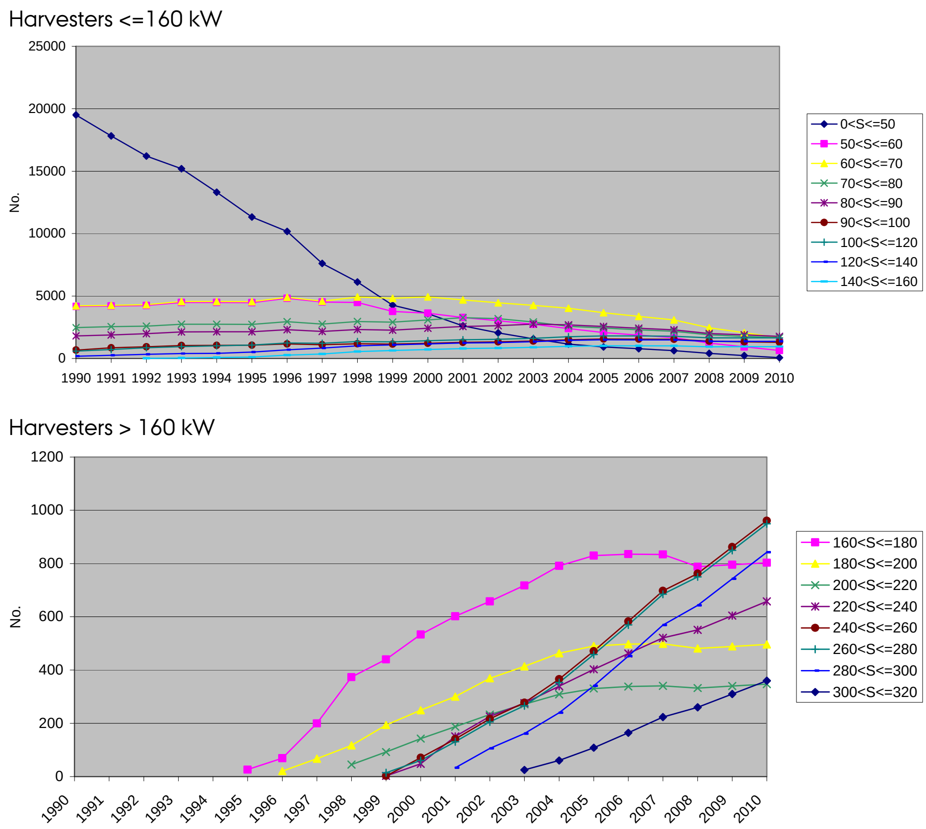
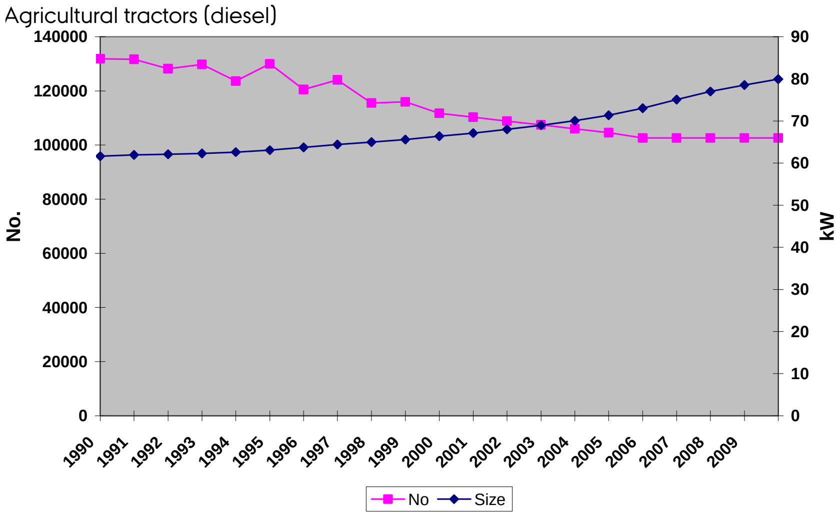


Figure 3.3.42 Total numbers in kW classes for harvesters from 1990 to 2010.

The tractor and harvester developments towards fewer vehicles and larger engines, shown in Figure 3.3.43, are very clear. From 1990 to 2010, tractor and harvester numbers decrease by around 22 % and 51 %, respectively, whereas the average increase in engine size for tractors is 30 % and 145 % for harvesters, in the same time period.



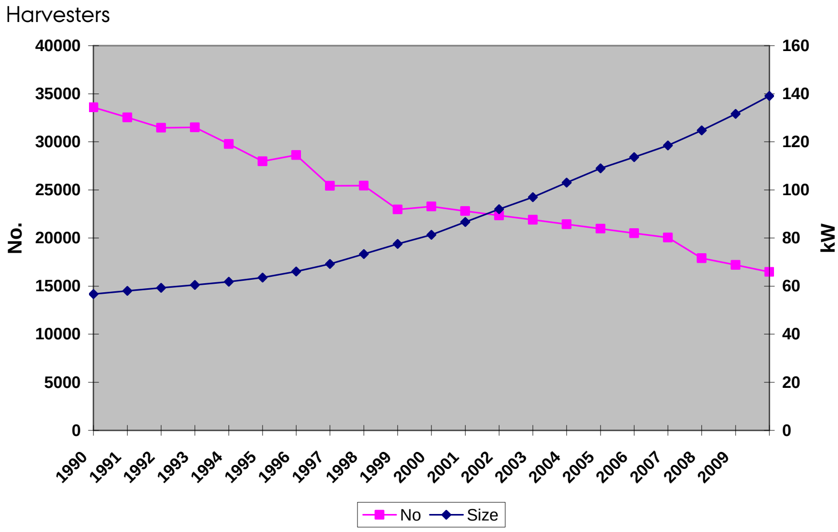
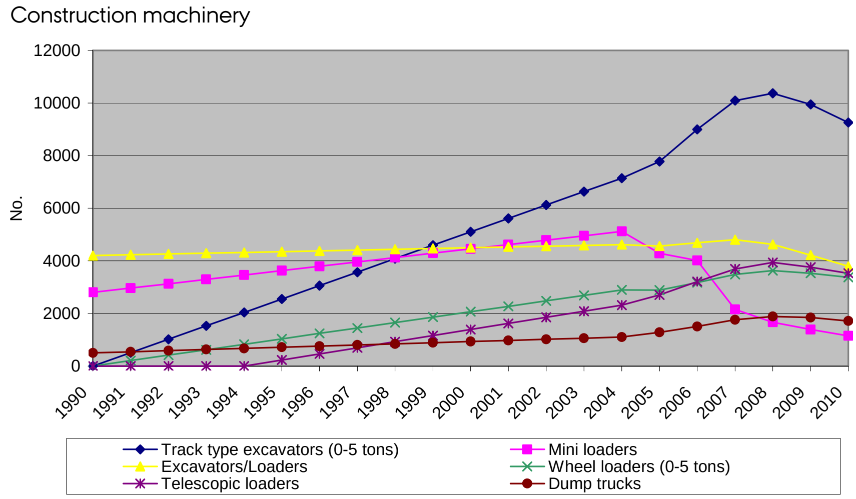


Figure 3.3.43 Total numbers and average engine size for tractors and harvesters (1990 to 2010).

The most important machinery types for industrial use are different types of construction machinery and fork lifts. The Figures 3.3.44 and 3.3.45 show the 1990-2010 stock development for specific types of construction machinery and diesel fork lifts. For most of the machinery types there is an increase in machinery numbers from 1990 onwards, due to increased construction activities. It is assumed that track type excavators/wheel type loaders (0-5 tonnes), and telescopic loaders first enter into use in 1991 and 1995, respectively.



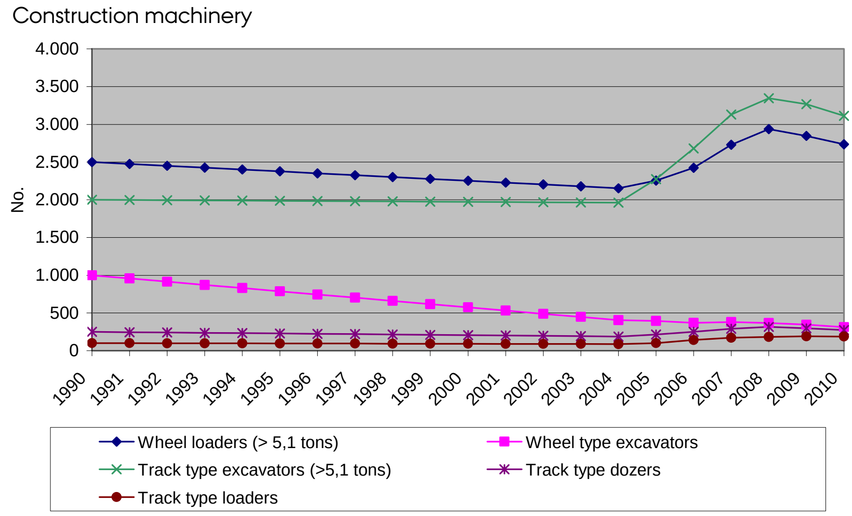


Figure 3.3.44 1990-2010 stock development for specific types of construction machinery.

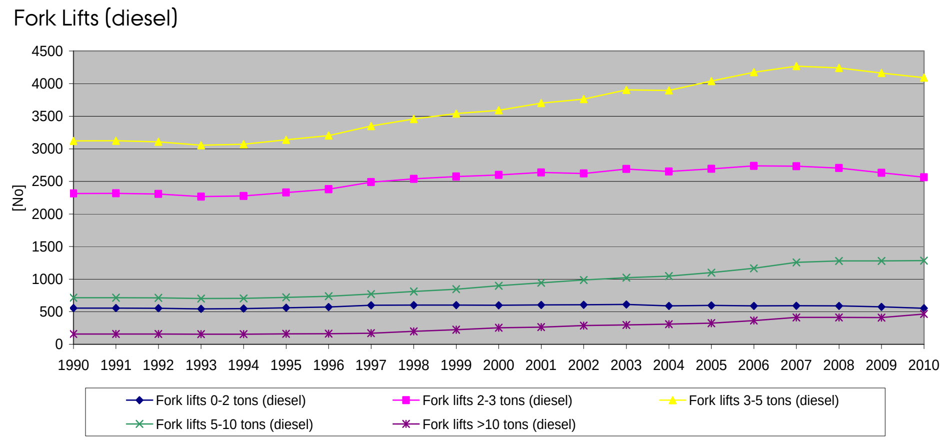


Figure 3.3.45 Total numbers of diesel fork lifts in kW classes from 1990 to 2010.

The emission level shares for tractors, harvesters, construction machinery and diesel fork lifts are shown in Figure 3.3.46, and present an overview of the penetration of the different pre-Euro engine classes, and engine stages complying with the gradually stricter EU stage I and II emission limits. The average lifetimes of 30, 25, 20 and 10 years for tractors, harvesters, fork lifts and construction machinery, respectively, influence the individual engine technology turn-over speeds.

The EU emission directive Stage I and II implementation years relate to engine size, and for all four machinery groups the emission level shares for the specific size segments will differ slightly from the picture shown in Figure 3.3.46. Due to scarce data for construction machinery, the emission level penetration rates are assumed to be linear and the general technology turnover pattern is as shown in Figure 3.3.46.

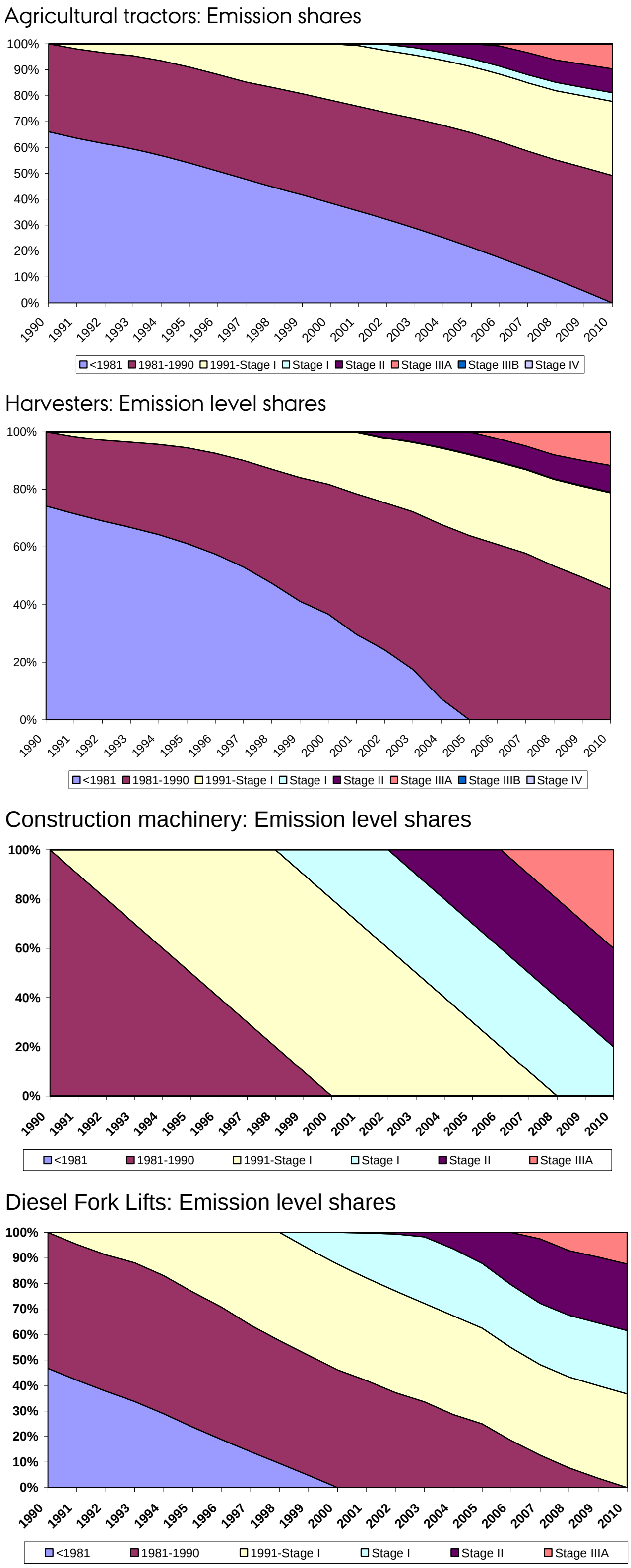


Figure 3.3.46 Emission level shares for tractors, harvesters, construction machinery and diesel fork lifts (1990 to 2010).

The 1990-2010 stock development for the most important household and gardening machinery types is shown in Figure 3.3.47.

For lawn movers and cultivators, the machinery stock remains approximately the same for all years. The stock figures for chain saws, shrub clearers, trimmers and hedge cutters increase from 1990 until 2004, and for riders this increase continues also after 2004. The yearly stock increases, in most cases, become larger after 2000. The lifetimes for gasoline machinery are short and, therefore, there new emission levels (not shown) penetrate rapidly.

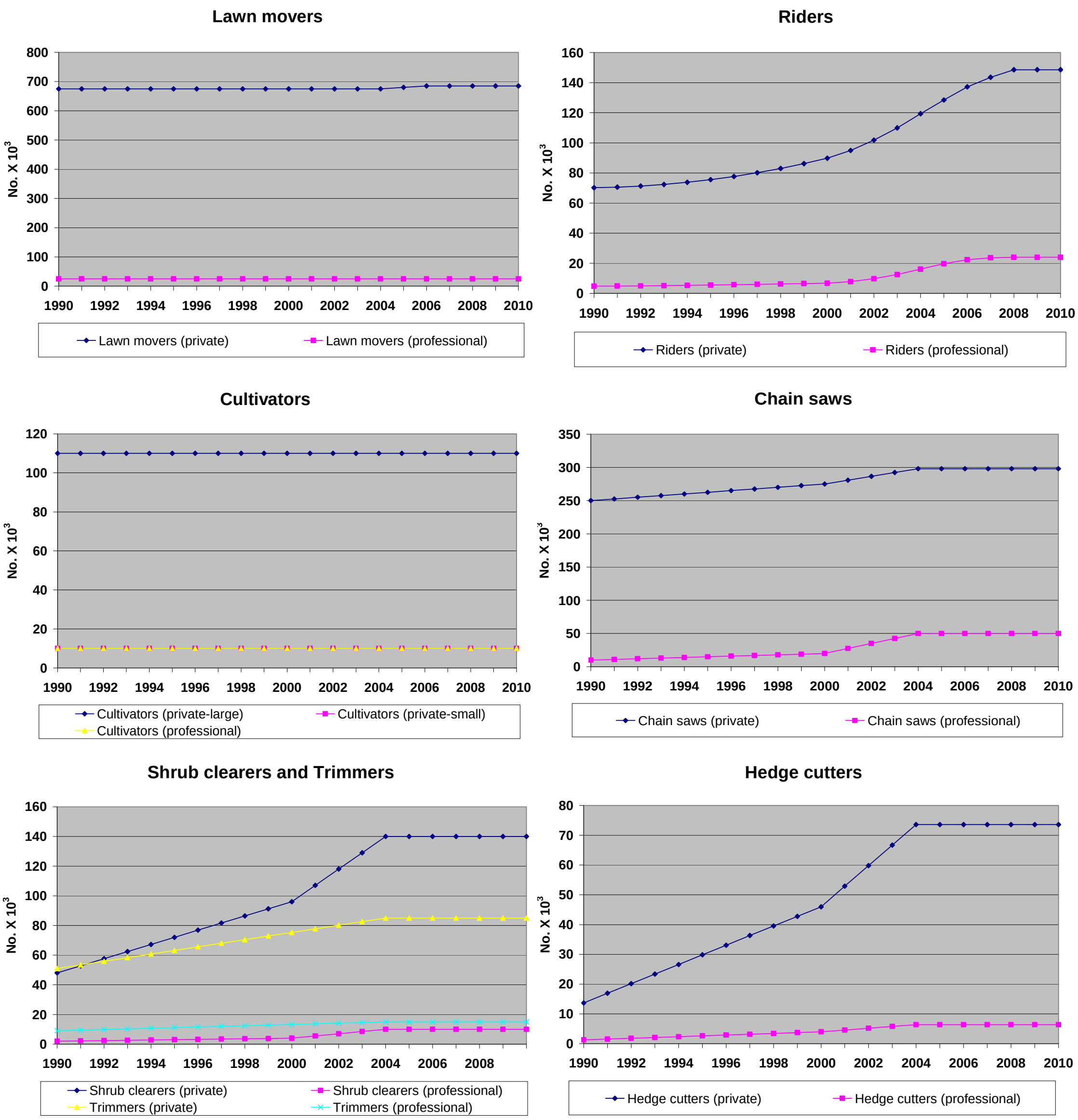


Figure 3.3.47 Stock development 1990-2010 for the most important household and gardening machinery types.

Figure 3.3.48 shows the development in numbers of different recreational craft from 1990-2010. The 2004 stock data for recreational craft are repeated for 2005+, since no new fleet information has been obtained.

For diesel boats, increases in stock and engine size are expected during the whole period, except for the number of motor boats (< 27 ft.) and the engine sizes for sailing boats (<26 ft.), where the figures remain unchanged. A decrease in the total stock of sailing boats (<26 ft.) by 21 % and increases in the total stock of yawls/cabin boats and other boats (<20 ft.) by around 25 % are expected. Due to a lack of information specific to Denmark, the shifting rate from 2-stroke to 4-stroke gasoline engines is based on a German non-road study (IFEU, 2004).

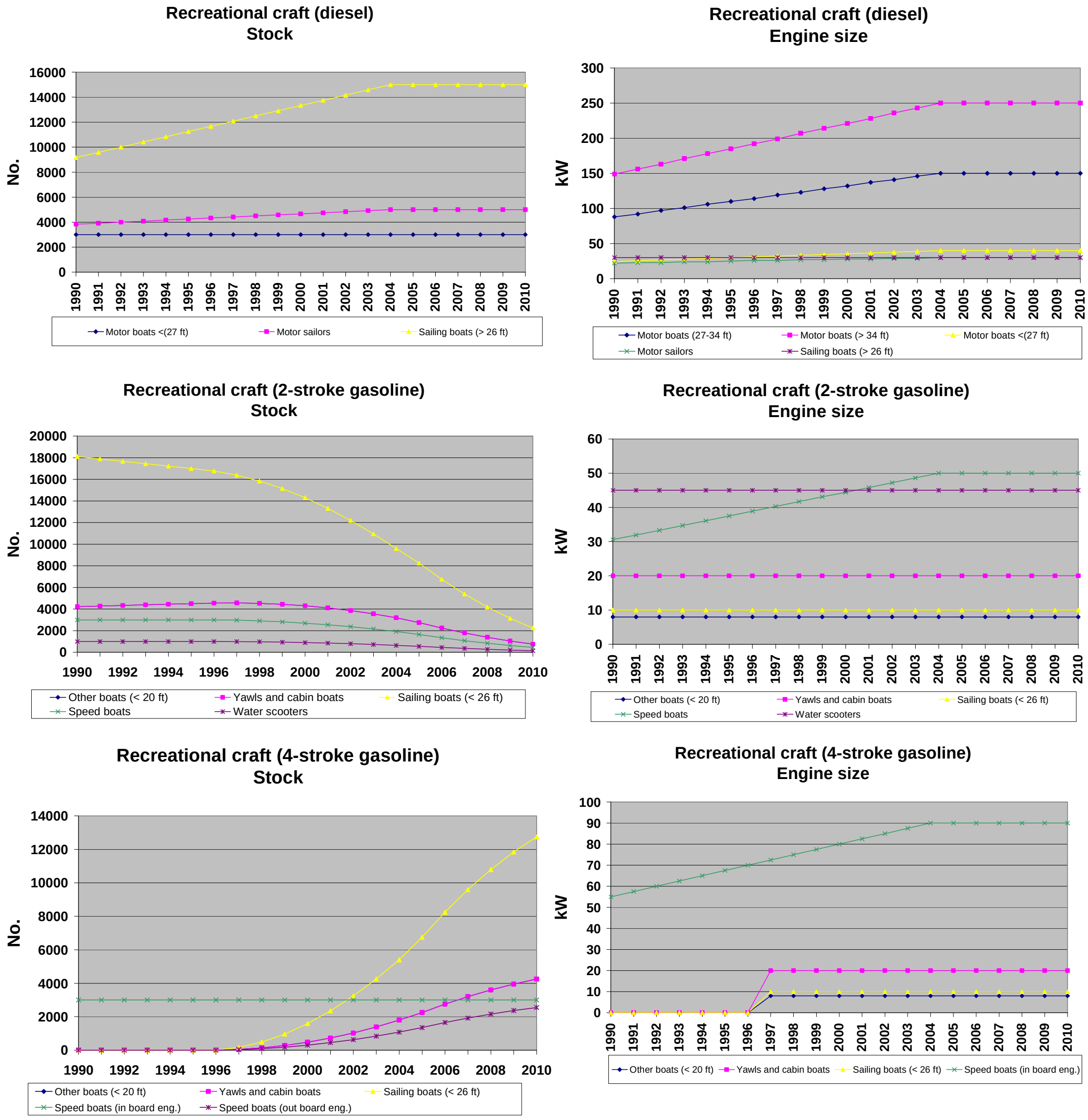


Figure 3.3.48 1990-2010 Stock and engine size development for recreational craft.

National sea transport

A detailed methodology is used to estimate the fuel consumption figures for national sea transport, based on fleet activity estimates for regional ferries, local ferries and other national sea transport (Winther, 2008a).

Table 3.3.9 lists the most important domestic ferry routes in Denmark in the period 1990-2010. For these ferry routes and the years 1990-2005, the following detailed traffic and technical data have been gathered by Winther (2008a): Ferry name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxiliary engine size and sailing time (single trip).

For 2006-2010, the above mentioned traffic and technical data for specific ferries have been provided by Kristensen (2011) in the case of Mols-Linien (Sjællands Odde-Ebeltoft, Sjællands Odde-Århus, Kalundborg-Århus), by Hjortberg (2011) for Bornholmstrafikken (Køge-Rønne) and by Simonsen (2011) for Langelandstrafikken A/S (Tårs-Spodsbjerg). For Esbjerg/Hanstholm/Hirtshals-Torshavn traffic and technical data have been provided by Dávastovu (2011).

Table 3.3.9 Domestic ferry routes comprised in the Danish inventory.

Ferry service	Service period
Esbjerg-Torshavn	1990-1995, 2009+
Halsskov-Knudshoved	1990-1999
Hanstholm-Torshavn	1991-1992, 1999+
Hirtshals-Torshavn	2010
Hundested-Grenaa	1990-1996
Kalundborg-Juelsminde	1990-1996
Kalundborg-Samsø	1990+
Kalundborg-Århus	1990+
Korsør-Nyborg, DSB	1990-1997
Korsør-Nyborg, Vognmandsruten	1990-1999
København-Rønne	1990-2004
Køge-Rønne	2004+
Sjællands Odde-Ebeltoft	1990+
Sjællands Odde-Århus	1999+
Tårs-Spodsbjerg	1990+

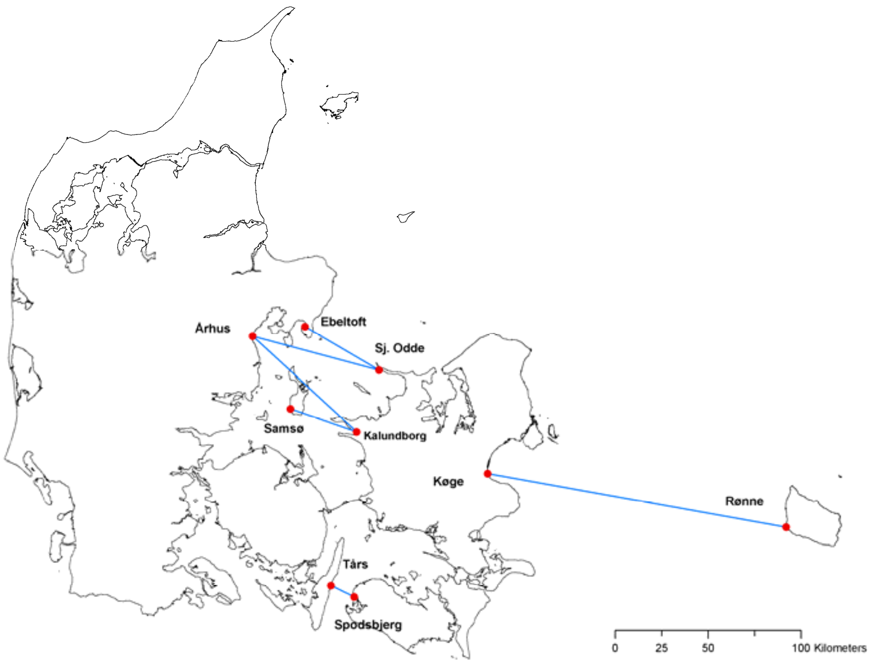
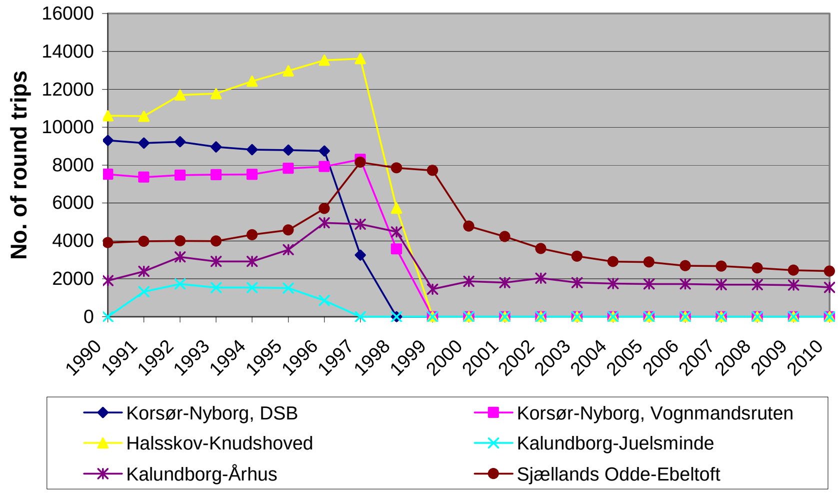


Figure 3.3.50 Domestic regional ferry routes in Denmark (2010).

The number of round trips pr ferry route from 1990 to 2010 is provided by Statistics Denmark (2011), see Figure 3.3.50 (Esbjerg/Hanstholm/Hirtshals-Torshavn not shown). The traffic data are also listed in Annex 3.B.12, together with different ferry specific technical and operational data.

For each ferry, Annex 3.B.12 lists the relevant information as regards ferry route, name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxiliary engine size and sailing time (single trip).



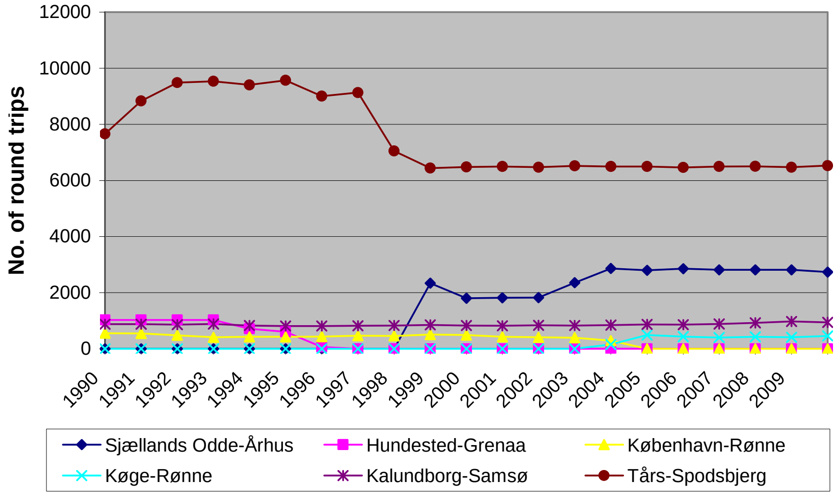


Figure 3.3.51 No. of round trips for the most important ferry routes in Denmark 1990-2010.

It is seen from Table 3.3.9 (and Figure 3.3.51) that several ferry routes were closed in the time period from 1996-1998, mainly due to the opening of the Great Belt Bridge (connecting Zealand and Funen) in 1997. Hundested-Grenaa and Kalundborg-Juelsminde was closed in 1996, Korsør-Nyborg (DSB) closed in 1997, and Halsskov-Knudshoved and Korsør-Nyborg (Vognmandsruten) was closed in 1998. The ferry line København-Rønne was replaced by Køge-Rønne in 2004 and from 1999 a new ferry connection was opened between Sjællands Odde and Århus.

For the local ferries, a bottom-up estimate of fuel consumption for 1996 has been taken from the Danish work in Wismann (2001). The latter project calculated fuel consumption and emissions for all sea transport in Danish waters in 1995/1996 and 1999/2000. In order to cover the entire 1990-2010 inventory period, the fuel figure for 1996 has been adjusted according to the developments in local ferry route traffic shown in Annex 3.B.12.

Fuel sold for freight transport by Royal Arctic Line between Aalborg (Denmark) and Greenland and by Eim Skip - East route between Aarhus (Denmark) and Torshavn (Faroe Islands) are included under other national sea transport in the Danish inventories. In both cases all fuel is being bought in Denmark (Rasmussen, 2011 and Thorarensen, 2011).

For the remaining part of the traffic between two Danish ports, other national sea transport, bottom-up estimates for fuel consumption have been calculated for the years 1995 and 1999 by Wismann (2007). These fuel consumption estimates are used as activity data for the inventory years until 1995 and 1999 onwards. Interpolated figures are used for the inventory years 1996-1998.

The calculations use the database set up for Denmark in the Wismann (2001) study, with actual traffic data from the Lloyd's LMIS database (not including ferries). The database was split into three vessel types: bulk carriers, container ships, and general cargo ships; and five size classes: 0-1000, 1000-3000, 3000-10000, 10000-20000 and >20000 DTW. The calculations assume that bulk carriers and container ships use heavy fuel oil, and that general cargo ships use gas oil. For further information regarding activity data for local ferries and other national sea transport, please refer to Winther (2008a).

The fleet activity data for regional ferries, and the fleet activity based fuel consumption estimates for local ferries and other national sea transport replace the fuel based activity data which originated directly from the DEA statistics.

Other sectors

The activity data for military, railways, international sea transport and fishery consists of fuel consumption information from DEA (2011). For international sea transport, the basis is fuel sold in Danish ports for vessels with a foreign destination, as prescribed by the IPCC guidelines.

However, it must be noted that fuel sold for sailing activities between Denmark and Greenland/Faroe Islands are reported as international in the DEA energy statistics. Hence, for inventory purposes in order to follow the IPCC guidelines the bottom-up fuel estimates for the ferry routes Esbjerg/Hanstholm-Torshavn, and fuel reports from Royal Arctic Line and Eim Skip is being subtracted from the fuel sales figures for international sea transport prior to inventory fuel input.

For fisheries, the calculation methodology described by Winther (2008a) remains fuel based. However, the input fuel data differ from the fuel sales figures previously used. The changes are the result of further data processing of the DEA reported gas oil sales for national sea transport and fisheries, prior to inventory input. For years when the fleet activity estimates of fuel consumption for national sea transport (not including trips to Greenland/Faroe Islands) are smaller than DEA reported fuel sold for national sea transport, fuel is added to fisheries in the inventory. In the opposite case, fuel is being subtracted from the original DEA fisheries fuel sales figure in order to make up the final fuel consumption input for fisheries in the inventories.

The updated fuel consumption time series for national sea transport lead, in turn, to changes in the energy statistics for fisheries (gas oil) and industry (heavy fuel oil), so the national energy balance can remain unchanged.

For all sectors, fuel consumption figures are given in Annex 3.B.15 for the years 1990 and 2010 in CollectER format.

Emission legislation

For the engines used by other mobile sources, no legislative limits exist for specific fuel consumption. And no legislative limits exist for the emissions of CO_2 which are directly fuel dependent. The engines, however, do have to comply with the emission legislation limits agreed by the EU and, except for ships, the VOC emission limits influence the emissions of CH_4, these forming part of total VOC.

For non-road working machinery and equipment, and recreational craft and railway locomotives/motor cars, the emission directives list specific emission limit values (g pr kWh) for CO, VOC, NO_x (or VOC + NO_x) and TSP, depending on engine size (kW for diesel, ccm for gasoline) and date of implementation (referring to engine market date).

For diesel, the directives 97/68 and 2004/26 relate to non-road machinery other than agricultural and forestry tractors, and the directives have different implementation dates for machinery operating under transient and constant loads. The latter directive also comprises emission limits for railway machinery. For tractors the relevant directives are 2000/25 and 2005/13. For gasoline, the directive 2002/88 distinguishes between hand-held (SH) and not hand-held (NS) types of machinery.

For engine type approval, the emissions (and fuel consumption) are measured using various test cycles (ISO 8178). Each test cycle consists of a number of measurement points for specific engine loads during constant operation. The specific test cycle used depends on the machinery type in question and the test cycles are described in more details in the directives.

Table 3.3.10 Overview of EU emission directives relevant for diesel fuelled non-road machinery.

Stage/ Engine size [kW]	CO	VOC	NO_X	VOC+NO_X	PM	Diesel machinery			Tractors	
							Implement. date		EU	Implement.
	[g pr kWh]					EU Directive	Transient	Constant	directive	date
Stage I										
37<=P<75	6.5	1.3	9.2	-	0.85	97/68	1/4 1999	-	2000/25	1/7 2001
Stage II										
130<=P<560	3.5	1	6	-	0.2	97/68	1/1 2002	1/1 2007	2000/25	1/7 2002
75<=P<130	5	1	6	-	0.3		1/1 2003	1/1 2007		1/7 2003
37<=P<75	5	1.3	7	-	0.4		1/1 2004	1/1 2007		1/1 2004
18<=P<37	5.5	1.5	8	-	0.8		1/1 2001	1/1 2007		1/1 2002
Stage IIIA										
130<=P<560	3.5	-	-	4	0.2	2004/26	1/1 2006	1/1 2011	2005/13	1/1 2006
75<=P<130	5	-	-	4	0.3		1/1 2007	1/1 2011		1/1 2007
37<=P<75	5	-	-	4.7	0.4		1/1 2008	1/1 2012		1/1 2008
19<=P<37	5.5	-	-	7.5	0.6		1/1 2007	1/1 2011		1/1 2007
Stage IIIB										
130<=P<560	3.5	0.19	2	-	0.025	2004/26	1/1 2011	-	2005/13	1/1 2011
75<=P<130	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
56<=P<75	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
37<=P<56	5	-	-	4.7	0.025		1/1 2013	-		1/1 2013
Stage IV										
130<=P<560	3.5	0.19	0.4	-	0.025	2004/26	1/1 2014		2005/13	1/1 2014
56<=P<130	5	0.19	0.4	-	0.025		1/10 2014			1/10 2014

Table 3.3.11 Overview of the EU Emission Directive 2002/88 for gasoline fuelled non-road machinery.

	Category	Engine size [ccm]	CO [g pr kWh]	HC [g pr kWh]	NO_X [g pr kWh]	HC+NO_X [g pr kWh]	Implementation date
	Stage I						
Hand held	SH1	S<20	805	295	5.36	-	1/2 2005
	SH2	20=<S<50	805	241	5.36	-	1/2 2005
	SH3	50=<S	603	161	5.36	-	1/2 2005
Not hand held	SN3	100=<S<225	519	-	-	16.1	1/2 2005
	SN4	225=<S	519	-	-	13.4	1/2 2005
	Stage II						
Hand held	SH1	S<20	805	-	-	50	1/2 2008
	SH2	20=<S<50	805	-	-	50	1/2 2008
	SH3	50=<S	603	-	-	72	1/2 2009
Not hand held	SN1	S<66	610	-	-	50	1/2 2005
	SN2	66=<S<100	610	-	-	40	1/2 2005
	SN3	100=<S<225	610	-	-	16.1	1/2 2008
	SN4	225=<S	610	-	-	12.1	1/2 2007

For recreational craft, Directive 2003/44 comprises the emission legislation limits for diesel engines, and for 2-stroke and 4-stroke gasoline engines, respectively. The CO and VOC emission limits depend on engine size (kW) and the inserted parameters presented in the calculation formulas in Table 3.3.12. For NO_X, a constant limit value is given for each of the three engine types. For TSP, the constant emission limit regards diesel engines only.

Table 3.3.12 Overview of the EU Emission Directive 2003/44 for recreational craft.

Engine type	Impl. date	CO=A+B/P^n			HC=A+B/P^n			NO_X	TSP
		A	B	n	A	B	n		
2-stroke gasoline	1/1 2007	150.0	600.0	1.0	30.0	100.0	0.75	10.0	-
4-stroke gasoline	1/1 2006	150.0	600.0	1.0	6.0	50.0	0.75	15.0	-
Diesel	1/1 2006	5.0	0.0	0	1.5	2.0	0.5	9.8	1.0

Table 3.2.13 Overview of the EU Emission Directive 2004/26 for railway locomotives and motorcars.

	Engine size [kW]		CO [g pr kWh]	HC [g pr kWh]	NO_x [g pr kWh]	HC+NOX [g pr kWh]	PM [g pr kWh]	Implement. date
Locomotives	Stage IIIA							
	130<=P<560	RL A	3.5	-	-	4	0.2	1/1 2007
	560<P	RH A	3.5	0.5	6	-	0.2	1/1 2009
	2000<=P and piston displacement >= 5 l/cyl.	RH A	3.5	0.4	7.4	-	0.2	1/1 2009
	Stage IIIB	RB	3.5	-	-	4	0.025	1/1 2012
Motor cars	Stage IIIA							
	130<P	RC A	3.5	-	-	4	0.2	1/1 2006
	Stage IIIB							
	130<P	RC B	3.5	0.19	2	-	0.025	1/1 2012

Aircraft engine emissions of NO_x, CO, VOC and smoke are regulated by ICAO (International Civil Aviation Organization). The engine emission certification standards are contained in Annex 16 — Environmental Protection, Volume II — Aircraft Engine Emissions to the Convention on International Civil Aviation (ICAO Annex 16, 1993). The emission standards relate to the total emissions (in grams) from the so-called LTO (Landing and Take Off) cycle divided by the rated engine thrust (kN). The ICAO LTO cycle contains the idealised aircraft movements below 3000 ft (915 m) during approach, landing, airport taxiing, take off and climb out.

For smoke all aircraft engines manufactured from 1 January 1983 have to meet the emission limits agreed by ICAO. For NO_x, CO, VOC The emission legislation is relevant for aircraft engines with a rated engine thrust larger than 26.7 kN. In the case of CO and VOC, the ICAO regulations apply for engines manufactured from from 1 January 1983.

For NO_x, the emission regulations fall in four categories:

a) For engines of a type or model for which the date of manufacture of the first individual production model is on or before 31 December 1995, and for which the production date of the individual engine is on or before 31 December 1999.
b) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 1995, or for individual engines with a production date after 31 December 1999.
c) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 2003.
d) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 2007.

The regulations published by ICAO are given in the form of the total quantity of pollutants (D_p) emitted in the LTO cycle divided by the maximum sea level thrust (F_{oo}) and plotted against engine pressure ratio at maximum sea level thrust.

The limit values for NO_x are given by the formular in Table 3.3.14.

Table 3.3.14 Current certification limits for NO_x for turbo jet and turbo fan engines.

	Engines first produced before 31.12.1995 & for engines manufactured up to 31.12.1999	Engines first produced after 31.12.1995 & for engines manufactured after 31.12.1999	Engines for which the date of manufacture of the first individual production model was after 31 December 2003	Engines for which the date of manufacture of the first individual production model was after 31 December 2007
Applies to engines >26.7 kN	$Dp/F_{oo} = 40 + 2\pi_{oo}$	$Dp/F_{oo} = 32 + 1.6\pi_{oo}$		
Engines of pressure ratio less than 30				
Thrust more than 89 kN			$Dp/F_{oo} = 19 + 1.6\pi_{oo}$	$Dp/F_{oo} = 16.72 + 1.4080\pi_{oo}$
Thrust between 26.7 kN and not more than 89 kN			$Dp/F_{oo} = 37.572 + 1.6\pi_{oo} - 0.208F_{oo}$	$Dp/F_{oo} = 38.54862 + (1.6823\pi_{oo}) - (0.2453F_{oo}) - (0.00308\pi_{oo}F_{oo})$
Engines of pressure ratio more than 30 and less than 62.5				
Thrust more than 89 kN			$Dp/F_{oo} = 7+2.0\pi_{oo}$	$Dp/F_{oo} = -1.04+ (2.0*\pi_{oo})$
Thrust between 26.7 kN and not more than 89 kN			$Dp/F_{oo} = 42.71 +1.4286\pi_{oo} - 0.4013F_{oo} +0.00642\pi_{oo}F_{oo}$	$Dp/F_{oo} = 46.1600 + (1.4286\pi_{oo}) - (0.5303F_{oo}) - (0.00642\pi_{oo}F_{oo})$
Engines with pressure ratio 82.6 or more			$Dp/F_{oo} = 32+1.6\pi_{oo}$	$Dp/F_{oo} = 32+1.6\pi_{oo}$

Source: International Standards and Recommended Practices, Environmental Protection, ICAO Annex 16 Volume II Part III Paragraph 2.3.2, 2nd edition July 1993, plus amendments: Amendment 3 (20 March 1997),Amendment 4 (4 November 1999),Amendment 5 (24 November 2005).

where:

D_p = the sum of emissions in the LTO cycle in g

F_{oo} = thrust at sea level take-off (100 %)

π_{oo} = pressure ratio at sea level take-off thrust point (100 %)

The equivalent limits for HC and CO are D_p/F_{oo} = 19.6 for HC and D_p/F_{oo} = 118 for CO (ICAO Annex 16 Vol. II paragraph 2.2.2). Smoke is limited to a regulatory smoke number = 83 $(F_{oo})^{-0.274}$ or a value of 50, whichever is the lower.

A further description of the technical definitions in relation to engine certification as well as actual engine exhaust emission measurement data can be found in the ICAO Engine Exhaust Emission Database. The latter database is accessible from http://www.caa.co.uk, hosted by the UK Civil Aviation Authority.

For seagoing vessels, NO_x emissions are regulated as explained in Marpol 73/78 Annex VI, formulated by IMO (International Maritime Organisation). The legislation is relevant for diesel engines with a power output higher than 130 kW, which are installed on a ship constructed on or after 1 January 2000 and diesel engines with a power output higher than 130 kW which undergo major conversion on or after 1 January 2000.

The NO_x emission limits for ship engines in relation to their rated engine speed (n) given in RPM (Revolutions Per Minute) are the following:

- 17 g pr kWh, n < 130 RPM.
- 45 x n-0.2 g pr kWh, 130 ≤ n < 2000 RPM.
- 9,8 g pr kWh, n ≥ 2000 RPM.

Further, the Marine Environment Protection Committee (MEPC) of IMO has approved proposed amendments to MARPOL Annex VI to be agreed by IMO in October 2008 in order to strengthen the emission standards for NO_x and the sulphur contents of heavy fuel oil used by ship engines.

For NO_x emission regulations, a three tiered approach is considered, which comprises the following:

- Tier I: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2000 and prior to 1 January 2011.
- Tier II: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2011.
- Tier III[5]: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2016.

As for the existing NO_x emission limits, the new Tier I-III NO_x legislation values rely on the rated engine speeds. The emission limit equations are shown in Table 3.3.15.

Table 3.3.15 Tier I-III NOx emission limits for ship engines (amendments to MARPOL Annex VI).

	NO_x limit	RPM (n)
Tier I	17 g pr kWh	n < 130
	45 x n-0.2 g pr kWh	130 ≤ n < 2000
	9,8 g pr kWh	n ≥ 2000
Tier II	14.4 g pr kWh	n < 130
	44 x n-0.23 g pr kWh	130 ≤ n < 2000
	7.7 g pr kWh	n ≥ 2000
Tier III	3.4 g pr kWh	n < 130
	9 x n-0.2 g pr kWh	130 ≤ n < 2000
	2 g pr kWh	n ≥ 2000

The Tier I emission limits are identical with the existing emission limits from MARPOL Annex VI.

Also to be agreed by IMO in October 2008, the NO_x Tier I limits are to be applied for existing engines with a power output higher than 5000 kW and a displacement pr cylinder at or above 90 litres, installed on a ship constructed on or after 1 January 1990 but prior to 1 January 2000.

In relation to the sulphur content in heavy fuel and marine gas oil used by ship engines, Table 3.3.16 shows the current legislation in force, and the amendment of MARPOL Annex VI to be agreed by IMO in October 2008.

[5] For ships operating in a designated Emission Control Area. Outside a designated Emission Control Area, Tier II limits apply.

Table 3.3.16 Current legislation in relation to marine fuel quality.

Legislation		Heavy fuel oil		Gas oil	
		S- %	Impl. date (day/month/year)	S- %	Impl. date
EU-directive 93/12		None		0.2[1]	1.10.1994
EU-directive 1999/32		None		0.2	1.1.2000
EU-directive 2005/33[2]	SECA - Baltic sea	1.5	11.08.2006	0.1	1.1.2008
	SECA - North sea	1.5	11.08.2007	0.1	1.1.2008
	Outside SECA's	None		0.1	1.1.2008
MARPOL Annex VI	SECA – Baltic sea	1.5	19.05.2006		
	SECA – North sea	1.5	21.11.2007		
	Outside SECA	4.5	19.05.2006		
MARPOL Annex VI amendments	SECA's	1	01.03.2010		
	SECA's	0.1	01.01.2015		
	Outside SECA's	3.5	01.01.2012		
	Outside SECA's	0.5	01.01.2020[3]		

[1] Sulphur content limit for fuel sold inside EU.

[2] From 1.1.2010 fuel with a sulphur content higher than 0.1 % must not be used in EU ports for ships at berth exceeding two hours

[3] Subject to a feasibility review to be completed no later than 2018. If the conclusion of such a review becomes negative the effective date would default 1 January 2025.

For non road machinery, the EU directive 2003/17/EC gives a limit value of 50 ppm sulphur in diesel (from 2005).

Emission factors

The CO_2 emission factors are country-specific and come from the DEA. The N_2O emission factors are taken from the EMEP/EEA guidebook (EMEP/EEA, 2009).

For military ground material, aggregated CH_4 emission factors for gasoline and diesel are derived from the road traffic emission simulations. The CH_4 emission factors for railways are derived from specific Danish VOC measurements from the Danish State Railways (Delvig, 2010) and a NMVOC/CH_4 split, based on expert judgement.

For agriculture, forestry, industry, household gardening and inland waterways, the VOC emission factors are derived from various European measurement programmes and the current EU emission legislation; see IFEU (2004) and Winther et al. (2006). The NMVOC/CH_4 split is taken from USEPA (2004). The baseline emission factors are shown in Annex 3.B.10.

For national sea transport and fisheries, the VOC emission factors come from Trafikministeriet (2000), for the ferries used by Mols Linjen, however, new VOC emission factors are provided by Kristensen (2008). The latter data originate from measurement results by Hansen et al. (2004), Wismann (1999) and PHP (1996).

For ship engines VOC/CH_4 splits are taken from EMEP/EEA (2009), and all emission factors are shown in Annex 3.B.13.

The CH_4 emission factors for domestic aviation come from the EMEP/EEA (2009).

For all sectors, emission factors for the years 1990 and 2009 are given in CollectER format in Annex 3.B.15.

Table 3.3.17 shows the aggregated emission factors for CO_2, CH_4 and N_2O in 2009 used to calculate the emissions from other mobile sources in Denmark.

Table 3.3.17 Fuel-specific emission factors for CO_2, CH_4 and N_2O for other mobile sources in Denmark.

SNAP ID	CRF ID	Category		Fuel type	Emission factors[6] CH_4 g pr GJ	CO_2 g pr GJ	N_2O g pr GJ
080100	1A5	Military		AvGas	21.90	73.00	2.00
080100	1A5	Military		Diesel	1.76	74.00	2.80
080100	1A5	Military		Gasoline	7.28	73.00	1.58
080100	1A5	Military		Jet fuel	2.65	72.00	2.30
080200	1A3c	Railways		Diesel	2.22	74.00	2.04
080300	1A3d	Inland waterways		Diesel	2.61	74.00	2.97
080300	1A3d	Inland waterways		Gasoline	62.64	73.00	1.46
080402	1A3d	National sea traffic		Diesel	1.51	74.00	4.68
080402	1A3d	National sea traffic		LPG	20.26	63.10	0.00
080402	1A3d	National sea traffic		Residual oil	1.93	78.00	4.89
080403	1A4c	Fishing		Diesel	1.78	74.00	4.68
080404	Memo item	International sea traffic		Diesel	1.76	74.00	4.68
080404	Memo item	International sea traffic		Residual oil	1.94	78.00	4.89
080501	1A3a	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	21.90	73.00	2.00
080501	1A3a	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	1.35	72.00	10.60
080502	Memo item	Air traffic, Int. < 3000 ft.	Other airports	AvGas	21.90	73.00	2.00
080502	Memo item	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	2.27	72.00	7.43
080503	1A3a	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	0.90	72.00	2.30
080504	Memo item	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	0.64	72.00	2.30
080600	1A4c	Agriculture		Diesel	0.94	74.00	3.17
080600	1A4c	Agriculture		Gasoline	160.47	73.00	1.72
080700	1A4c	Forestry		Diesel	0.50	74.00	3.21
080700	1A4c	Forestry		Gasoline	40.93	73.00	0.45
080800	1A2f	Industry		Diesel	0.99	74.00	3.10
080800	1A2f	Industry		Gasoline	108.73	73.00	1.48
080800	1A2f	Industry		LPG	7.69	63.10	3.50
080900	1A4b	Household and gardening		Gasoline	75.84	73.00	1.25
081100	1A4a	Commercial and institutional		Gasoline	67.37	73.00	1.12
080501	1A3a	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	21.90	73.00	2.00
080501	1A3a	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	1.55	72.00	7.00
080502	Memo item	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	21.90	73.00	2.00
080502	Memo item	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	3.42	72.00	3.96
080503	1A3a	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	1.23	72.00	2.30
080504	Memo item	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	1.00	72.00	2.30

Factors for deterioration, transient loads and gasoline evaporation for non road machinery

The emission effects of engine wear are taken into account for diesel and gasoline engines by using the so-called deterioration factors. For diesel engines alone, transient factors are used in the calculations, to account for the emission changes caused by varying engine loads. The evaporative emissions of NMVOC are estimated for gasoline fuelling and tank evaporation.

[6] References. CO_2: Country-specific. N_2O: EMEP/EEA. CH_4: Railways: DSB/DCE; Agriculture/Forestry/Industry/Household-Gardening: IFEU/USEPA; National sea traffic/Fishing/International sea traffic: Trafikministeriet/EMEP/EEA; domestic and international aviation: EMEP/EEA.

The factors for deterioration, transient loads and gasoline evaporation are taken from IFEU (2004), and are shown in Annex 3.B.10. For more details regarding the use of these factors, please refer to paragraph 3.1.4 or Winther et al. (2006).

3.3.4 Calculation method

Air traffic

For aviation, the domestic and international estimates are made separately for landing and take-off (LTOs < 3000 ft), and cruising (> 3000 ft).

The fuel consumption for one LTO cycle is calculated according to the following sum formula:

$$FC_{LTO}^{a} = \sum_{m=1}^{4} t_m \cdot ff_{a,m} \quad (13)$$

Where FC = fuel consumption (kg), m = LTO mode (approach/landing, taxiing, take off, climb out), t = times in mode (s), ff = fuel flow (kg pr s), a = representative aircraft type.

The emissions for one LTO cycle are estimated as follows:

$$E_{LTO}^{a} = \sum_{m=1}^{4} FC_{a,m} \cdot EI_{a,m} \quad (14)$$

Due to lack of specific airport data, for approach/descent, take off and climb out, standardised times-in-modes of 4, 0.7 and 2.2 mins are used as defined by ICAO (ICAO, 1995), whereas for taxiing the appropriate time interval is 13 mins in Copenhagen Airport and 5 mins in other airports present in the Danish inventory.

To estimate cruise results, fuel consumption and emissions for standard flying distances from EMEP/EEA (2009) are interpolated or extrapolated – in each case determined by the great circle distance between the origin and the destination airports.

If the great circle distance, y, is smaller than the maximum distance for which fuel consumption and emission data are given in the EMEP/EEA data bank the fuel consumption or emission E (y) becomes:

$$E(y) = E_{x_i} + \frac{(y - x_i)}{x_{i+1} - x_i} \cdot (E_{x_{i+1}} - E_{x_i}) \quad y<x_{max},\ i = 0,1,2\ldots max-1 \quad (15)$$

In (15) x_i and x_{max} denominate the separate distances and the maximum distance, respectively, with known fuel consumption and emissions. If the flight distance y exceeds x_{max} the maximum figures for fuel consumption and emissions must be extrapolated and the equation then becomes:

$$E(y) = E_{x_{max}} + \frac{(y - x_{max})}{x_{max} - x_{max-1}} \cdot (E_{x_{max}} - E_{x_{max-1}}) \quad y>x_{max} \quad (16)$$

Total results are summed up and categorised according to each flight's airport and country codes.

The overall fuel precision in the model is around 0.8, derived as the fuel ratio between model estimates and statistical sales. The fuel difference is accounted for by adjusting cruising fuel consumption and emissions in the model according to domestic and international cruising fuel shares.

Prior to 2001, the calculation procedure was first to estimate each year's fuel consumption and emissions for LTO. Secondly, total cruising fuel consumption was found year by year as the statistical fuel consumption total minus the calculated fuel consumption for LTO. Lastly, the cruising fuel consumption was split into a domestic and international part by using the results from a Danish city-pair emission inventory in 1998 (Winther, 2001a). For more details of this latter fuel allocation procedure, see Winther (2001b).

Non-road working machinery and recreational craft

Prior to adjustments for deterioration effects and transient engine operations, the fuel consumption and emissions in year X, for a given machinery type, engine size and engine age, are calculated as:

$$E_{Basis}(X)_{i,j,k} = N_{i,j,k} \cdot HRS_{i,j,k} \cdot P \cdot LF_i \cdot EF_{y,z} \qquad (17)$$

where E_{Basis} = fuel consumption/emissions in the basic situation, N = number of engines, HRS = annual working hours, P = average rated engine size in kW, LF = load factor, EF = fuel consumption/emission factor in g pr kWh, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level. The basic fuel consumption and emission factors are shown in Annex 2.B.10.

The deterioration factor for a given machinery type, engine size and engine age in year X depends on the engine-size class (only for gasoline), y, and the emission level, z. The deterioration factors for diesel and gasoline 2-stroke engines are found from:

$$DF_{i,j,k}(X) = \frac{K_{i,j,k}}{LT_i} \cdot DF_{y,z} \qquad (18)$$

where DF = deterioration factor, K = engine age, LT = lifetime, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level.

For gasoline 4-stroke engines the deterioration factors are calculated as:

$$DF_{i,j,k}(X) = \sqrt{\frac{K_{i,j,k}}{LT_i}} \cdot DF_{y,z} \qquad (19)$$

The deterioration factors inserted in (18) and (19) are shown in Annex 2.B.10. No deterioration is assumed for fuel consumption (all fuel types) or for LPG engine emissions and, hence, DF = 1 in these situations.

The transient factor for a given machinery type, engine size and engine age in year X, relies only on emission level and load factor, and is denominated as:

$$TF_{i,j,k}(X) = TF_z \tag{20}$$

Where i = machinery type, j = engine size, k = engine age and z = emission level.

The transient factors inserted in (20) are shown in Annex 2.B.10. No transient corrections are made for gasoline and LPG engines and, hence, TF_z = 1 for these fuel types.

The final calculation of fuel consumption and emissions in year X for a given machinery type, engine size and engine age, is the product of the expressions 17-20:

$$E(X)_{i,j,k} = E_{Basis}(X)_{i,j,k} \cdot TF(X)_{i,j,k} \cdot (1 + DF(X)_{i,j,k}) \tag{21}$$

The evaporative hydrocarbon emissions from fuelling are calculated as:

$$E_{Evap,fueling,i} = FC_i \cdot EF_{Evap,fueling} \tag{22}$$

Where $E_{Evap,fueling}$, = hydrocarbon emissions from fuelling, i = machinery type, FC = fuel consumption in kg, $EF_{Evap,fueling}$ = emission factor in g NMVOC pr kg fuel.

For tank evaporation, the hydrocarbon emissions are found from:

$$E_{Evap,\tan k,i} = N_i \cdot EF_{Evap,\tan k,i} \tag{23}$$

Where $E_{Evap,tank,i}$ = hydrocarbon emissions from tank evaporation, N = number of engines, i = machinery type and $EF_{Evap,fueling}$ = emission factor in g NMVOC pr year.

Ferries, other national sea transport and fisheries

The fuel consumption and emissions in year X, for regional ferries are calculated as:

$$E(X) = \sum_i N_i \cdot T_i \cdot S_{i,j} \cdot P_i \cdot LF_j \cdot EF_{k,l,y} \tag{24}$$

Where E = fuel consumption/emissions, N = number of round trips, T = sailing time pr round trip in hours, S = ferry share of ferry service round trips, P = engine size in kW, LF = engine load factor, EF = fuel consumption/emission factor in g pr kWh, i = ferry service, j = ferry, k = fuel type, l = engine type, y = engine year.

For the remaining navigation categories, the emissions are calculated using a simplified approach:

$$E(X) = \sum_i EC_{i,k} EF_{k,l,y} \quad (25)$$

Where E = fuel consumption/emissions, EC = energy consumption, EF = fuel consumption/emission factor in g pr kg fuel, i = category (local ferries, other national sea, fishery, international sea), k = fuel type, l = engine type, y = average engine year.

The emission factor inserted in (25) is found as an average of the emission factors representing the engine ages which are comprised by the average lifetime in a given calculation year, X:

$$EF_{k,l,y} = \frac{\sum_{year=X}^{year=X-LT} EF_{k,l}}{LT_{k,l}} \quad (26)$$

Other sectors

For military and railways, the emissions are estimated with the simple method using fuel-related emission factors and fuel consumption from the DEA:

$$E = FC \cdot EF \quad (27)$$

where E = emission, FC = fuel consumption and EF = emission factor. The calculated emissions for other mobile sources are shown in CollectER format in Annex 3.B.16 for the years 1990 and 2007 and as time series 1990-2007 in Annex 3.B.15 (CRF format).

Energy balance: DEA statistics and DCE estimates

Following convention rules, the DEA statistical fuel sales figures are behind the full Danish inventory. However, in some cases for mobile sources the DEA statistical sectors do not fully match the inventory sectors. This is the case for non road machinery, where relevant DEA statistical sectors also include fuel consumed by stationary sources.

In other situations, fuel consumption figures estimated by DCE from specific bottom-up calculations are regarded as more reliable than DEA reported sales. This is the case for national sea transport.

In the following the transferral of fuel consumption data from DEA statistics into inventory relevant categories is explained for national sea transport and fisheries, non road machinery and recreational craft, and road transport. A full list of all fuel consumption data, DEA figures as well as intermediate fuel consumption data, and final inventory input figures is shown in Annex 3.B.14.

National sea transport and fisheries

For national sea transport in Denmark, the fuel consumption estimates obtained by DCE (see 1.1.3 Activity data – national sea transport) are regarded as much more accurate than the DEA fuel sales data, since the large fluctuations in reported fuel sales cannot be explained by the actual development in the traffic between different national ports. As a consequence, the new bottom-up estimates replace the previous fuel based figures for national sea transport.

There are different potential reasons for the differences between estimated fuel consumption and reported sales for national sea transport in Denmark.

According to the DEA, the latter fuel differences are most likely explained by inaccurate costumer specifications made by the oil suppliers. This inaccuracy can be caused by a sector misallocation in the sales statistics between national sea transport and fisheries for gas oil, and between national sea transport and industry for heavy fuel oil (Peter Dal, DEA, personal communication, 2007). Further, fuel sold for vessels sailing between Denmark and Greenland/Faroe Islands are reported as international in the DEA statistics, and this fuel categorisation is different from the IPCC guideline definitions (see following paragraph "Bunkers").

Following this, for fisheries and industry the updated fuel consumption time series for national sea transport lead, in turn, to changes in the fuel activity data for fisheries (gas oil), industry (heavy fuel oil) and international sea transport, so the national energy balance can remain unchanged.

For fisheries, fuel investigations made prior to the initiation of the work made by Winther (2008a) have actually pointed out a certain area of inaccuracy in the DEA statistics. No engines installed in fishing vessels use heavy fuel oil, even though a certain amount of heavy fuel oil is listed in the DEA numbers for some statistical years (H. Amdissen, Danish Fishermen's Association, personal communication, 2006). Hence, for fisheries small amounts of fuel oil are transferred to national sea transport, and in addition small amounts of gasoline and diesel are transferred to recreational craft.

Non road machinery and recreational craft

For diesel and LPG, the non-road fuel consumption estimated by DCE is partly covered by the fuel consumption amounts in the following DEA sectors: agriculture and forestry, market gardening, and building and construction. The remaining quantity of non-road diesel and LPG is taken from the DEA industry sector.

For gasoline, the DEA residential sector, together with the DEA sectors mentioned for diesel and LPG, contribute to the non-road fuel consumption total. In addition, a certain amount of fuel from road transport is needed to reach the fuel consumption goal.

The amount of diesel and LPG in DEA industry not being used by non-road machinery is included in the sectors, "Combustion in manufacturing industry" (0301) and "Non-industrial combustion plants" (0203) in the Danish emission inventory.

For recreational craft, the calculated fuel consumption totals for diesel and gasoline are subsequently subtracted from the DEA fishery sector. For gasoline, the DEA reported fuel consumption for fisheries is far too small to fill the fuel gap, and hence the missing fuel amount is taken from the DEA road transport sector.

Bunkers

The distinction between domestic and international emissions from aviation and navigation should be in accordance with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For the national emission inventory, this, in principle, means that fuel sold (and associated emissions) for flights/sea transportation starting from a seaport/airport in the Kingdom of Denmark, with destinations inside or outside the Kingdom of Denmark, are regarded as domestic or international, respectively.

Aviation

For aviation, the emissions associated with flights inside the Kingdom of Denmark are counted as domestic. The flights from Denmark to Greenland and the Faroe Islands are classified as domestic flights in the inventory background data. In Greenland and in the Faroe Islands, the jet fuel sold is treated as domestic. This decision becomes reasonable when considering that almost no fuel is bunkered in Greenland/the Faroe Islands by flights other than those going to Denmark.

Navigation

In DEA statistics, the domestic fuel total consists of fuel sold to Danish ferries and other ships sailing between two Danish ports. The DEA international fuel total consists of the fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, transport to Greenland and the Faroe Islands, tank vessels and foreign fishing boats.

In order to follow the IPCC guidelines the bottom-up fuel estimates for the ferry routes between Denmark and the Faroe Islands, and freight transport between Denmark and Greenland/Faroe Islands are being subtracted from the fuel sales figures for international sea transport prior to inventory fuel input.

In Greenland, all marine fuel sales are treated as domestic. In the Faroe Islands, fuel sold in Faroese ports for Faroese fishing vessels and other Faroese ships is treated as domestic. The fuel sold to Faroese ships bunkering outside Faroese waters and the fuel sold to foreign ships in Faroese ports or outside Faroese waters is classified as international (Lastein and Winther, 2003).

Conclusively, the domestic/international fuel split (and associated emissions) for navigation is not determined with the same precision as for aviation. It is considered, however, that the potential of incorrectly allocated fuel quantities is only a small part of the total fuel sold for navigational purposes in the Kingdom of Denmark.

3.3.5 Uncertainties and time series consistency

Uncertainty estimates for greenhouse gases on Tier 1 and Tier 2 levels, are made for road transport and other mobile sources using the guidelines formulated in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). For road transport, railways and fisheries, these guidelines provide uncertainty factors for activity data that are used in the Danish situation. For other sectors, the factors reflect specific national knowledge (Winther et al., 2006 and Winther, 2008a). These sectors are (SNAP categories): Inland Waterways (a part of 1A3d: Navigation), Agriculture and Forestry (parts of 1A4c: Agriculture-/forestry/fisheries), Industry (mobile part of (1A2f: Industry-other), Residential (1A4b) and National sea transport (a part of 1A3d: Navigation).

The activity data uncertainty factor for civil aviation is based on expert judgement.

The calculations for Tier 1 are shown in Annex 3.B.17 for all emission components. Please refer to Chapter 1.7 for further information regarding the calculation procedure for Tier 2 uncertainty calculations.

Table 3.3.18 Tier 1 Uncertainties for activity data, emission factors and total emissions in 2010 and as a trend.

Category	Activity data	CO_2	CH_4	N_2O
	%	%	%	%
Road transport	2	5	40	50
Military	2	5	100	1000
Railways	2	5	100	1000
Navigation (small boats)	41	5	100	1000
Navigation (large vessels)	11	5	100	1000
Fisheries	2	5	100	1000
Agriculture	24	5	100	1000
Forestry	30	5	100	1000
Industry (mobile)	41	5	100	1000
Residential	35	5	100	1000
Commercial/Institutional	35	5	100	1000
Civil aviation	10	5	100	1000
Overall uncertainty in 2010		5.2	27.1	151.5
Trend uncertainty		6.1	5.0	53.8

Table 3.3.19 Tier 2 Uncertainty factors for activity data and emission factors in 2010.

Category	Activity data	CO_2	CH_4	N_2O
	%	%	%	%
Road transport	2	5	40	500
Military	2	5	100	1000
Railways	2	5	100	1000
Pleasure craft	41	5	100	1000
Regional ferries	20	5	100	1000
Local ferries	20	5	100	1000
Fisheries	2	5	100	1000
Greenland & Faroe Islands	20	5	100	1000
Other national sea transport	20	5	100	1000
Civil aviation	10	5	100	1000
Agriculture	24	5	100	1000
Forestry	30	5	100	1000
Industry	41	5	100	1000
Household and gardening	35	5	100	1000
Commercial and institutional	35	5	100	1000

Table 3.3.20 Tier 2 Uncertainty estimates for CO_2, CH_4, N_2O and CO_2-eq. in 2010.

		1990			2010			1990-2010		
		Median	Uncertainty (%)		Median	Uncertainty (%)		Median	Uncertainty (%)	
		Emission	Lower (-)	Upper (+)	Emission	Lower (-)	Upper (+)	Emission	Lower (-)	Upper (+)
CO_2	ktonnes	13622	5	5	16385	5	5	20	7	7
CH_4	tonnes	2981	29	40	1123	26	36	-62	33	47
N_2O	Tonnes	701	46	200	789	43	178	13	207	279
CO_2-eq.	Ktonnes	13931	5	6	16682	5	6	20	7	7

As regards time series consistency, background flight data cannot be made available on a city-pair level prior to 2000. However, aided by LTO/aircraft statistics for these years and the use of proper assumptions, a good level of consistency is, in any case, obtained for this part of the transport inventory.

The time series of emissions for mobile machinery in the agriculture, forestry, industry, household and gardening (residential) and inland waterways (part of navigation) sectors are less certain than time series for other sectors, since DEA statistical figures do not explicitly provide fuel consumption information for working equipment and machinery.

3.3.6 Quality assurance/quality control (QA/QC)

The intention is to publish every second year a sector report for road transport and other mobile sources. The last sector report prepared concerned the 2006 inventory (Winther, 2008b).

The QA/QC descriptions of the Danish emission inventories for transport follow the general QA/QC description for DCE in Section 1.6, based on the prescriptions given in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

An overview diagram of the Danish emission inventory system is presented in Figure 1.2 (Data storage and processing levels), and the exact definitions of Critical Control Points (CCP) and Points of Measurements (PM) are given in Section 1.6. The status for the PMs relevant for the mobile sector are given in the following text and the result of this investigation indicates a need for future QA/QC activities in order to fulfil the QA/QC requirements from the IPCC GPG.

Data storage level 1

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

The following external data sources are used in the mobile part of the Danish emission inventories for activity data and supplementary information:

- Danish Energy Agency: Official Danish energy statistics.
- National sea transport (Royal Arctic Line, Eim Skip): Annual fuel consumption data.
- DTU Transport: Road traffic vehicle fleet and mileage data.
- Civil Aviation Agency of Denmark: Flight statistics.
- Non-road machinery: Information from statistical sources, research organisations, different professional organisations and machinery manufacturers.
- Ferries (Statistics Denmark): Data for annual return trips for Danish ferry routes.
- Ferries (Danish Ferry Historical Society): Detailed technical and operational data for specific ferries.
- Ferries (Mols Linjen, Bornholmstrafikken, Langelandstrafikken, Smyril Line): Detailed technical and operational data for specific ferries.
- Danish Meteorological Institute (DMI): Temperature data.
- The National Motorcycle Association: 2-wheeler data.

The emission factors come from various sources:

- Danish Energy Agency: CO_2 emission factors and lower heating values (all fuel types).
- COPERT IV: Road transport (all exhaust components, except CO_2, SO_2).
- Danish State Railways: Diesel locomotives (NO_X, VOC, CO and TSP).
- EMEP/EEA guidebook: Civil aviation and supplementary.

- Non road machinery: References given in NERI reports.
- National sea transport and fisheries: TEMA2000 (NO_X, VOC, CO and TSP) and MAN Diesel (sfc, NO_X).

Table 3.3.21 to follow contains Id, File/Directory/Report name, Description, Reference and Contacts. As regards File/Directory/Report name, this field refers to a file name for Id when all external data (time series for the existing inventory) are stored in one file. In other cases, a computer directory name is given when the external data used are stored in several files, e.g. each file contains one inventory year's external data or each file contains time series of external data for sub-categories of machinery. A third situation occurs when the external data are published in publicly available reports; here the aim is to obtain electronic copies for internal archiving.

Table 3.3.21 Overview table of external data and contact persons for transport.

Id no	File/-Directory/-Report name	Description	Activity data or emission factor	Reference	Contacts	Data agreement
T1	Transport energy[1]	Dataset for all transport energy use	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Yes
T2	Fleet and mileage data[1]	Road transport fleet and mileage data	Activity data	DTU Transport	Thomas Jensen	Yes
T3	Flight statistics[2]	Data records for all flights	Activity data	Civil Aviation Agency of Denmark	Jess Nørgaard	Yes
T4	Non road machinery[2]	Stock and operational data for non-road machinery	Activity data	Non road Documentation report		No
T5	Emissions from ships[3]	Data for ferry traffic	Activity data	Statistics Denmark	Sonja Merkelsen	No
T6	Emissions from ships[3]	Technical and operational data for Danish ferries	Activity data	Navigation emission documentation report	Hans Otto Kristensen	No
T7	Temperature data[3]	Monthly avg of daily max/min temperatures	Other data	Danish Meteorological Institute	Danish Meteorological Institute	No
T8	Fleet and mileage data[1]	Stock data for mopeds and motorcycles	Activity data	The National Motorcycle Association	Henrik Markamp	No
T9	CO_2 emission factors[1]	DEA CO_2 emission factors (all fuel types)	Emission factor	The Danish Energy Agency (DEA)	Peter Dal	No
T10	COPERT IV emission factors[3]	Road transport emission factors	Emission factor	Laboratory of applied thermodynamics Aristotle University Thessaloniki	Leonidas Ntziachristos	No
T11	Railways emission factors[1]	Emission factors for diesel locomotives	Emission factor	Danish State Railways	Per Delvig	Yes
T12	EMEP/EEA guidebook[3]	Emission factors for navigation, civil aviation and supplementary	Emission factor	European Environment Agency	European Environment Agency	No
T13	Non road emission factors[3]	Emission factors for agriculture, forestry, industry and house-hold/gardening	Emission factor	Non road Documentation report		No
T14	Emissions from ships[3]	Emission factors for national sea transport and fisheries	Emission factor	Navigation emission documentation report		No

1) File name; 2) Directory in the DCE data library structure; 3) Reports available on the internet.

Danish Energy Agency (energy statistics)

The official Danish energy statistics are provided by the Danish Energy Agency (DEA) and are regarded as complete on a national level. For most transport sectors, the DEA subsector classifications fit the SNAP classifications used by DCE.

For non-road machinery, this is however not the case, since DEA do not distinguish between mobile and stationary fuel consumption in the subsectors relevant for non-road mobile fuel consumption.

Here, DCE calculates a bottom-up non-road fuel consumption estimate and for diesel (land based machinery only) and LPG, the residual fuel quantities are allocated to stationary consumption. For gasoline (land-based machinery) the relevant fuel consumption quantities for the DEA are smaller than the DCE estimates, and the amount of fuel consumption missing is subtracted from the DEA road transport total to account for all fuel sold. For recreational craft, no specific DEA category exists and, in this case, the gasoline and diesel fuel consumption is taken from road transport and fisheries, respectively.

In the case of Danish national sea transport, fuel consumption estimates are obtained by DCE (Winther, 2008a), since they are regarded as much more accurate than the DEA fuel sales data. For the latter source, the large fluctuations in reported fuel sales cannot be explained by the actual development in the traffic between different national ports.

In order to maintain the national energy balance, the updated fuel consumption time series for national sea transport lead, in turn, to changes in the fuel activity data for fisheries (gas oil) and industry (heavy fuel oil).

The DCE fuel modifications, thus, give DEA-SNAP differences for road transport, national sea transport and fisheries.

A special note must be made for the DEA civil aviation statistical figures. The domestic/international fuel consumption division derives from bottom-up fuel consumption calculations made by DCE.

DTU Transport

Figures for fleet numbers and mileage data are provided by DTU Transport on behalf of the Danish Ministry of Transport. Following the data deliverance contract between DCE and the Danish Ministry of Transport, it is a basic task for DTU Transport to possess comprehensive information on Danish road traffic. The fleet figures are based on data from the Car Register, kept by Statistics Denmark and are, therefore, regarded as very precise. Annual mileage information comes from the Danish Vehicle Inspection and Maintenance Programme.

Civil Aviation Agency of Denmark

The Civil Aviation Agency of Denmark (CAA-DK) monitors all aircraft movements in Danish airspace and, in this connection, possesses data records for all take-offs and landings at Danish airports. The dataset from 2001 onwards, among others consisting of aircraft type and origin and destination airports for all flights leaving major Danish airports, are, therefore, regarded as very complete. For inventory years before 2001, the most accurate data contain CAA-DK total movements from major Danish airports and detailed aircraft type distributions for aircraft using Copenhagen Airport, provided by the airport itself.

Non-road machinery (stock and operational data)

A great deal of new stock and operational data for non road machinery was obtained in a research project carried out by Winther et al. (2006) for the 2004 inventory. The source for the agricultural machinery stock of tractors and harvesters is Statistics Denmark. Sales figures for tractors, harvesters and construction machinery, together with operational data and supplementary information, are obtained from The Association of Danish Agricultural Machinery Dealers. IFAG (The Association of Producers and Distributors of

Fork Lifts in Denmark) provides fork-lift sale figures, whereas total stock numbers for gasoline equipment are obtained from machinery manufacturers with large Danish market shares, with figures validated through discussions with KVL. Stock information disaggregated into vessel types for recreational craft was obtained from the Danish Sailing Association. A certain part of the operational data comes from previous Danish non-road research projects (Dansk Teknologisk Institut, 1992 and 1993; Bak et al., 2003).

No statistical register exists for non-road machinery types and this affects the accuracy of stock and operational data. For tractors and harvesters, Statistics Denmark provide total stock data based on information from questionnaires and the registers of crop subsidy applications kept by the Ministry of Food, Agriculture and Fishery. In combination with new sales figures pr engine size from The Association of Danish Agricultural Machinery Dealers, the best available stock data are obtained. In addition, using the sources for construction machinery and fork lift sale figures are regarded as the only realistic approach for consolidated stock information for these machinery types. Use of this source-type also applies in the case of machinery types (gasoline equipment, recreational craft) where data is even scarcer.

To support the 2010 inventory, new 2010 stock data for tractors, harvesters, fork lifts and construction machinery was obtained from the same sources as in Winther et al. (2006). For non-road machinery in general, it is, however, uncertain if data in such a level can be provided annually in the future.

Ferries (Statistics Denmark)

Statistics Denmark provides information of annual return trips for all Danish ferry routes from 1990 onwards. The data are based on monthly reports from passenger and ferry shipping companies in terms of transported vehicles passengers and goods. Thus, the data from Statistics Denmark are regarded as complete. Most likely the data can be provided annually in the future.

Ferries (Danish Ferry Historical Society, DFS)

No central registration of technical and operational data for Danish fer-ries and ferry routes is available from official statistics. However, one valuable reference to obtain data and facts about construction and operation of Danish ferries, especially in the recent 20 - 30 years is the archives of Danish Ferry Historical Society. Pure technical data has not only been obtained from this society´s archives, but some of the knowledge has been obtained through the personal insight about ferries from some of the members of the society, which have been directly involved in the ferry business for example consultants, naval architects, marine engineers, captains and superintendents. However, until recently no documentation of the detailed DFS knowledge was established in terms of written reports or a central database system.

To make use of all the ferry specific data for the Danish inventories, DSF made a data documentation for the years 1990-2005 as a specific task of the research project carried out by Winther (2008a).

Ferries (Mols Linjen, Bornholmstrafikken, Langelandstrafikken, Smyril Line)

For the years 2006+, the major Danish ferry companies are contacted each year in order to obtain ferry technical data, relating to specific ferries in service, annual share of total round trips and other technical information. The relevant annual information is given as personal communication, a method which can be repeated in the future.

National sea transport (Royal Arctic Line, Eim Skip)

For the years 2006+, the major shipping companies with frequent sailing activities between Denmark and Greenland/Faroe Islands are contacted each year in order to obtain data for fuel sold in Denmark used for these vessel activities. The relevant annual information is given as personal communication, a method which can be repeated in the future.

Danish Meteorological Institute

The monthly average max/min temperature for Denmark comes from DMI. This source is self explanatory in terms of meteorological data. Data are publicly available for each year on the internet.

The National Motorcycle Association

Road transport: 2-wheeler stock information (The National Motorcycle Association). Given that no consistent national data are available for mopeds in terms of fleet numbers and distributions according to new sales pr year, The National Motorcycle Association is considered to be the professional organisation, where most expert knowledge is available. The relevant annual information is given as personal communication, a method which can be repeated in the future.

Danish Energy Agency (CO_2 emission factors and lower heating values)

The CO_2 emission factors and net calorific values (NCV) are fuel-specific constants. The country-specific values from the DEA are used for all inventory years.

COPERT IV

COPERT IV provides factors for fuel consumption and for all exhaust emission components which are included in the national inventory. For several reasons, COPERT IV is regarded as the most appropriate source of road traffic fuel consumption and emission factors. First of all, very few Danish emission measurements exist, so data are too scarce to support emission calculations on a national level. Secondly, most of the fuel consumption and emission information behind the COPERT model are derived from different large European research activities, and the formulation of fuel consumption and emission factors for all single vehicle categories has been made by a group of road traffic emission experts. A large degree of internal consistency is, therefore, achieved. Finally, the COPERT model is regularly updated with new experimental findings from European research programmes and, apart from updated fuel consumption and emission factors, the use of COPERT IV by many European countries ensures a large degree of cross-national consistency in reported emission results.

Danish State Railways

Aggregated emission factors of NO_x, VOC, CO and TSP for diesel locomotives are provided annually by the Danish State Railways. Taking into account available time resources for subsector emission calculations, the use of data from Danish State Railways is sensible. This operator accounts for around 90 % of all diesel fuel consumed by railway locomotives in Denmark and the remaining diesel fuel is used by various private railways companies. Setting up contacts with the private transport operators is considered to be a rather time consuming experience taking time away from inventory work in areas of greater emission importance.

EMEP/EEA guidebook

Fuel consumption and emission data from the EMEP/EEA guidebook is the prime and basic source for the aviation and navigation part of the Danish emission inventories. For aviation, the guidebook contains the most comprehensive list of representative aircraft types available for city-pair fuel consumption and emission calculations. The data have been evaluated specifically for detailed national inventory use by a group of experts representing civil aviation administration, air traffic management, emission modellers and inventory workers.

In addition, the EMEP/EEA guidebook is the source of non-exhaust TSP, PM_{10} and $PM_{2.5}$ emission factors for road transport, and the primary source of emission factors for some emission components – typically N_2O, NH_3 and PAH – for other mobile sources.

Non-road machinery (fuel consumption and emission factors)

The references for non-road machinery fuel consumption and emission factors are listed in Winther et al. (2006). The fuel consumption and emission data is regarded as the most comprehensive data collection on a European level, having been thoroughly evaluated by German emission measurement and non-road experts within the framework of a German non-road inventory project.

National sea transport and fisheries

Emission factors for NO_X, VOC, CO and TSP are taken from the TEMA2000 model developed for the Ministry of Transport. To a large extent the emission factors originate from the exhaust emission measurement programme carried out by Lloyd's (1995). For NO_X, additional information of emission factors in a time series going back to 1949, and PM_{10} and $PM_{2.5}$ fractions of total TSP was provided by the engine manufacturer MAN Diesel.

Specifically for the ferries used by Mols Linjen new NO_x , VO and CO emission factors are provided by Kristensen (2008), originating from measurement results by Hansen et al. (2004), Wismann (1999) and PHP (1996).

The experimental work by Lloyd's is still regarded as the most comprehensive measurement campaign with results publicly available. The additional NO_X and $PM_{10}/PM_{2.5}$ information comes from the world's largest ship engine manufacturer and data from this source is consistent with data from Lloyd's. Consequently the data used in the Danish inventories for national sea transport is regarded as the best available for emission calculations.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset, including the reasoning for the specific values

The uncertainty involved in the DEA fuel consumption information (except civil aviation) and the CAA-DK flight statistics is negligible, as such, and this is also true for DMI temperature data. For civil aviation, some uncertainty prevails, since the domestic fuel consumption figures originate from a division of total jet-fuel sales figures into domestic and international fuel quantities, derived from bottom-up calculations. A part of the fuel consumption uncertainties for non-road machines is due to the varying levels of stock and operational data uncertainties, as explained in DS 1.3.1. The road transport fleet totals from DTU Transport and The National Motorcycle Association in the main vehicle categories are accurate. Uncertainties, however, are introduced when the stock data are split into vehicle subcategories. The mileage figures from DTU Transport are generally less certain and uncertainties tend to increase for disaggregated mileage figures on subcategory levels.

As regards emission factors, the CO_2 factors (and NCVs) from the DEA are considered to be very precise, since they relate only to fuel. For the remaining emission factor sources, the SO_2 (based on fuel sulphur content), NO_X, NMVOC, CH_4, CO, TSP, PM_{10} and $PM_{2.5}$ emission factors are less accurate. Though many measurements have been made, the experimental data rely on the individual measurement and combustion conditions. The uncertainties for N_2O and NH_3 emission factors increase even further due to the small number of measurements available. For heavy metals and PAH, experimental data are so scarce that uncertainty becomes very high.

A special note, however, must be made for energy. The uncertainties due to the subsequent treatment of DEA data for road transport, national sea transport, fisheries and the non-road relevant sectors, explained in DS 1.3.1, trigger some uncertainties in the fuel consumption figures for these sectors. This point is, though, more relevant for QA/QC description for data processing, Level 1.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the emission factors/calculation parameters with data from international guidelines, and evaluation of major discrepancies.

Work has been carried out to compare Danish figures with corresponding data from other countries in order to evaluate discrepancies. The comparisons have been made on a CRF level, mostly for implied emission factors (Fauser et al., 2007).

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be archived with proper reference.

It is ensured that the original files from external data sources are archived internally at DCE. Subsequent raw data processing is carried out either in the DCE database models or in spreadsheets (data processing level 1).

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and DCE about the condition of delivery

For transport, DCE has made formal agreements with regard to external data deliverance with (Table 3.3.21 external data source Id's in brackets): DEA (T1), CAA-DK (T3), Danish State Railways (T9) and DTU Transport (T2).

Data Storage level 1	7.Transparency	DS.1.7.1	Listing of all archived datasets and external contacts

The listing of all archived datasets and external contact persons are given in Table 3.3.21.

Data Processing Level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source not part of DS.1.1.1 as input to Data Storage level 2 in relation to type and scale of variability.

The general uncertainties of the DEA fuel consumption information, DMI temperature data, road transport stock totals and the CAA-DK flight statistics are zero. For domestic aviation fuel consumption, the uncertainty is based on own judgement. For road transport, military and railways the fuel consumption uncertainties are taken from the IPCC Good Practice Guidance manual. It is noted that for road transport, it is not possible to quantify in-depth the uncertainties (1) of stock distribution into COPERT IV-relevant vehicle subsectors and (2) of the national mileage figures, as such.

In the mobile part of the Danish emission inventories, uncertainty assessments are made at Data Processing Level 1 for non-road machinery, recreational craft and national sea transport. For these types of mobile machinery, the stock and operational data variations are assumed to be normally distributed (Winther et al., 2006; Winther, 2008a). Tier 1 uncertainty calculations produce final fuel consumption uncertainties ready for Data Storage Level 2 (SNAP level 2: Inland waterways, agriculture, forestry, industry and household-gardening). The sizes of the variation intervals are given for activity data and emission factors in the present report.

For non-road machinery stock and operational data, the uncertainty figures are given in Winther et al. (2006). For navigation, the uncertainty figures are given in Winther (2008a).

For emission factors, the uncertainties for mobile sources are determined as suggested in the IPCC and UNECE guidelines. The uncertainty figures are listed in Paragraph 1.1.5 for greenhouse gases, and in Nielsen et al. (2009), Winther et al. (2006) and Winther (2008b) for the remaining emission components.

Data Processing level 1	1. Accuracy	DP.1.2.1	The methodologies have to follow the international guidelines suggested by UNFCCC and IPCC.

An evaluation of the methodological inventory approach has been made, which proves that the emission inventories for transport are made according to the international guidelines (Winther, 2005: Kyoto notat, in Danish). This paper will be translated into English and the conclusions will be implemented in the future national inventory reports.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

It has been checked that the greenhouse gas emission factors used in the Danish inventory are within margin of the IPCC guideline values.

Data Processing level 1	3.Completeness	DP.1.3.1	Identification of data gaps with regard to data sources that could improve quantitative knowledge.

No important areas can be identified.

Data Processing level 1	4.Consistency	DP.1.4.1	Documentation and reasoning of methodological changes during the time series and the qualitative assessment of the impact on time series consistency.

Se DP 1.7.5.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time series

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

For road transport, aviation, navigation and non-road machinery, whether all external data are correctly put into the DCE transport models is checked. This is facilitated by the use of sum queries which sum up stock data (and mileages for road transport) to input aggregation levels. However, spreadsheet or database manipulations of external data are, in some cases, included in a step prior to this check.

This is carried out in order to produce homogenous input tables for the DCE transport models (road, civil aviation, non-road machinery/recreational craft, navigation/fisheries). The sub-routines perform operations, such as the aggregation/disaggregation of data into first sales year (Examples: Fleet numbers and mileage for road transport, stock numbers for tractors, harvesters and fork lifts) or simple lists of total stock pr year (per machinery type for e.g. household equipment and for recreational craft). For civil aviation, additional databases control the allocation of representative aircraft to real aircraft types and the cruise distance between airports. A more formal description of the sub-routines will be made.

Regarding fuel data, it is checked for road transport and civil aviation that DEA totals (modified for road) match the input values in the DCE models. For the transport modes military and railways, the DEA fuel consumption figures go directly into Data Storage Level 2. This is also the case for the railway emission factors obtained from Danish State Railways and, generally, for the emission factors, which are kept constant over the years.

The DCE model simulations of fuel consumption and emission factors for road transport, civil aviation and non-road machinery refer to Data Processing Level 1.

When DCE transport model changes are made relating to fuel consumption, it is checked that the calculated fuel consumption sums correspond to the expected fuel consumption levels in the time series. The fuel consumption check also includes a time series comparison with fuel consumption totals calculated in the previous model version. The checks are performed on a SNAP level and, if appropriate, detailed checks are made for vehicle/machinery technology splits.

As regards model changes in relation to derived emission factors (and calculated emissions), the time series of emission factors (and emissions) are compared to previous model figures. A part of this evaluation includes an assessment, if the development corresponds to the underlying assumptions given by detailed input parameters. Among other things, the latter parameters depend on emission legislation, new technology phase-in, deterioration factors, engine operational conditions/driving modes, gasoline evaporation (hydrocarbons) and cold starts. For methodological issues, please refer to Section 3.3.2.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle, the equations used and the assumptions made must be described

The DCE model calculation principles and basic equations are thoroughly described in the present report, together with the theoretical model reasoning and assumptions. Documentation is also given e.g. in Nielsen et al. (2009), Winther (2001a, 2008b) and Winther et al. (2006). Further formal descriptions of DCE model sub routines are given in internal notes, and flow maps show the interrelations between tables and calculation queries in the models.

During model development it has been checked that all mathematical model relations give exactly the same results as independent calculations.

Data Processing level 1	7.Transparency	DP.1.7.2	Clear reference to dataset at Data Storage level 1.

In the different documentation reports for transport in the Danish emission inventories, there are explicit references for the different external data used.

Data Processing level 1	7.Transparency	DP.1.7.3	A manual log to collect information about recalculations

Recalculation changes in the emission inventories are described in the NIR and IIR reports as a standard. These descriptions take into account changes in emission factors, activity data and calculation methods.

Data Storage Level 2

Data Storage level 2	5.Correctness	DS.2.5.1	Check if a correct data import to level 2 has been made.

At present, a DCE software programme imports data from prepared input data tables (SNAP fuel consumption figures and emission factors) into the CollectER database.

Tables for CollectER fuel consumption and emission results are prepared by a special DCE database (NERIrep.mdb). The results relevant for mobile sources are copied into a database containing all the official inventory results for mobile sources (Data2010 NIR-UNECE.mdb). By the use of database queries, the results from this latter database are aggregated into the same formats as being used by the relevant DCE transport models in their results calculation part. The final comparison between CollectER and DCE transport model results are set up in a spreadsheet.

Data Storage Level 4

Data Storage level 4	4.Consistency	DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.

A spreadsheet "Check CRF 2010.xls" has been set up to check that the fuel consumption and emission totals from CollectER imported in Data2010 NIR-UNECE.mdb are identical to the fuel consumption and emission totals from the CRF.

Suggested QA/QC plan for mobile sources

The following points make up the list of QA/QC tasks to be carried out directly in relation to the mobile part of the Danish emission inventories. The time plan for the individual tasks has not yet been prepared.

Data storage level 1

An elaboration of the PAH part of the inventory for mobile sources. Review of existing emission factors and inclusion of new sources.

3.3.7 Recalculations and improvements

The following recalculations and improvements of the emission inventories have been made since the emission reporting in 2009.

Road transport

The total mileage per vehicle category from 1985-2009 have been updated based on new data prepared by DTU Transport. Important changes are a different split of total mileage between gasoline and diesel passenger cars based on data for the year 2008 from the Danish vehicle inspection and maintenance programme. Also updated mileage for foreign vehicles driven on Danish roads has been included.

The percentage emission change interval and year of largest percentage differences (low %; high %, year) for the different emission components are: CO_2 (0.2 %; 2.6 %, 2009), CH_4 (0.6 %; 1.6 %, 2009) and N_2O (-0.9 %; 4.6 %, 1994).

Agriculture/forestry/fisheries

The sales distribution into engine sizes for harvesters has been updated for the years 2002, 2003 and 2009. The following largest percentage differences (in brackets) for agriculture/forestry/fisheries are noted for: CO_2 (-0.3 %), CH_4 (0 %) and N_2O (-0.2 %).

Military

Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2009. The following largest percentage differences (in brackets) for military are noted for: CO_2 (0 %), CH_4 (0.6 %) and N_2O (0.5 %).

Aviation

Emission changes occur for the years 2007-2009, due to a correction in the representative aircraft type for new aircraft used for flying in Denmark. Due to an error F28 was previously used as a representative aircraft type for the new aircraft types CRJ9, E70, E170 and E175. However, F28 is a very old aircraft which cannot represent these new aircraft types. Instead new fuel consumption and emission factors have been calculated for the CRJ9, E70, E170 and E175 jets. The following largest percentage differences (in brackets) are noted for the year 2009: CO_2 (-1.7 %), CH_4 (-46.3 %), N_2O (-0.6 %).

3.3.8 Planned improvements

The ongoing aspiration is to fulfil the requirements from UNECE and UNFCCC for good practice in inventory preparation for transport. A study has been completed for transport, reviewing the different issues of choices relating to methods (methods used, emission factors, activity data, completeness, time series consistency, uncertainty assessment) reporting and documentation, and inventory quality assurance/quality control. This work and the overall priorities of DCE, taking into account emission source importance (from the Danish 2009 key source analysis), background data available and time resources, lay down the following list of improvements to be made in future.

Emission factors

Fuel consumption factors for road transport vehicles will be updated by the time when new data becomes available from COPERT model updates.

Aviation

On the basis of the Report of the individual review of the annual submission of Denmark submitted in 2011, next years NIR report will include information of the number of domestic LTO's per representative aircraft type for each of the Danish airports. Average LTO fuel consumption and emission factors per representative aircraft type will also be shown together with the correspondence table between actual aircraft and representative aircraft. To improve the inventory description for North Atlantic flights between Denmark and Greenland/Faroe Islands LTO numbers and LTO emission factors per representative aircraft type will also be shown in next years NIR report for these movements.

QA/QC

Future improvements regarding this issue are dealt with in Section 3.1.4.

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3.4 Additional information (CRF sector 1A Fuel combustion)

3.4.1 Reference approach, feedstocks and non-energy use of fuels

In addition to the sector specific CO_2 emission inventories (the national approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference Manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the national approach.

Data for import, export and stock change used in the reference approach originate from the annual "basic data" table prepared by the Danish Energy Agency (DEA) and published on their home page (DEA 2011b). The fraction of carbon oxidised has been assumed to be 1.00. The carbon emission factors are default factors originating from the IPCC Reference Manual (IPCC, 1997). The country-specific emission factors are not used in the reference approach, the approach being for the purposes of verification. The emission factor for fossil waste is, however, based on the emission factor applied in the national approach[1].

The Climate Convention reporting tables include a comparison of the national approach and the reference approach estimates. To make results comparable, the incineration of fossil waste and the corresponding CO_2 emission have been added in the reference approach. Furthermore, consumption for non-energy purposes is subtracted in the reference approach, because non-energy use of fuels is included in other sectors (Industrial processes and solvent use) in the Danish national approach.

Three fuels are used for non-energy purposes: lubricants, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 11.1 PJ in 2010.

The CO_2 emission from lube oil was 33 Gg in 2010 corresponding to 20 % of the CO_2 emission from lube oil consumption assuming full oxidation. This is in agreement with the IPCC Guideline methodology for lube oil emissions. Methodology and emission data for lube oil is shown in NIR chapter 4.8.

The CO_2 emission from white spirit was 17 Gg in 2010 corresponding to 60 % of the CO_2 emission from white spirit assuming full oxidation. The CO_2 emission data for white spirit is shown in NIR chapter 5, Table 5.4.

The CO_2 emission from bitumen is included as part of the emission from the source sectors *2A5 Asphalt roofing* and *2A6 Road paving with asphalt*.

According to IPCC Good Practice Guidance (IPCC, 2000) the difference should be within 2 %. A comparison of the national approach and the reference approach is illustrated in Figure 3.4.1.

[1] This emission factor have however not been updated this year. This will be corrected in the next inventory.

In 2010, the fuel consumption rates in the two approaches differ by 0.69 % and the CO_2 emission differs by 0.75 %. In the period 1990-2010, both the fuel consumption and the CO_2 emission differ by less than 2.0 %. The differences are below 1% for all years except 1998, 2000 and 2001. In the 2011 reporting the difference for 2009 was also above 1 %. However, improvements of the Danish energy statistics resulting in a lower statistical difference have lead to a difference between reference approach and national approach below 1% for 2009.

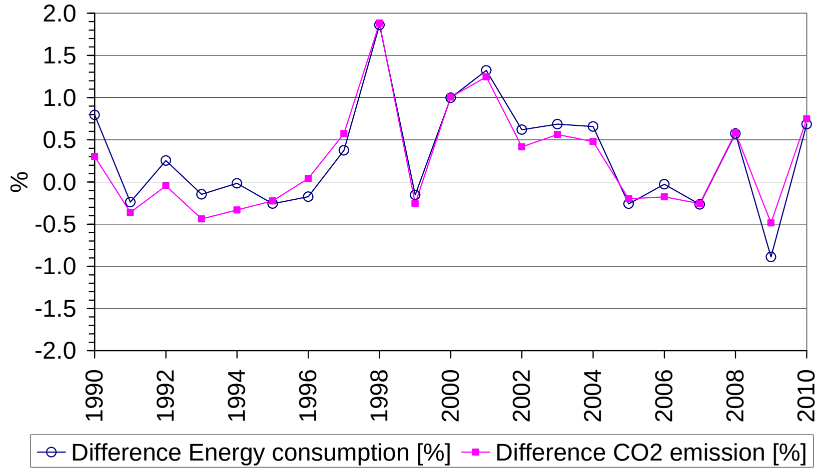

Figure 3.4.1 Comparison of the reference approach and the national approach.

The large differences in certain years, e.g. 1998 are due to high statistical differences in the Danish energy statistics in these years. This is illustrated in Figure 3.4.2.

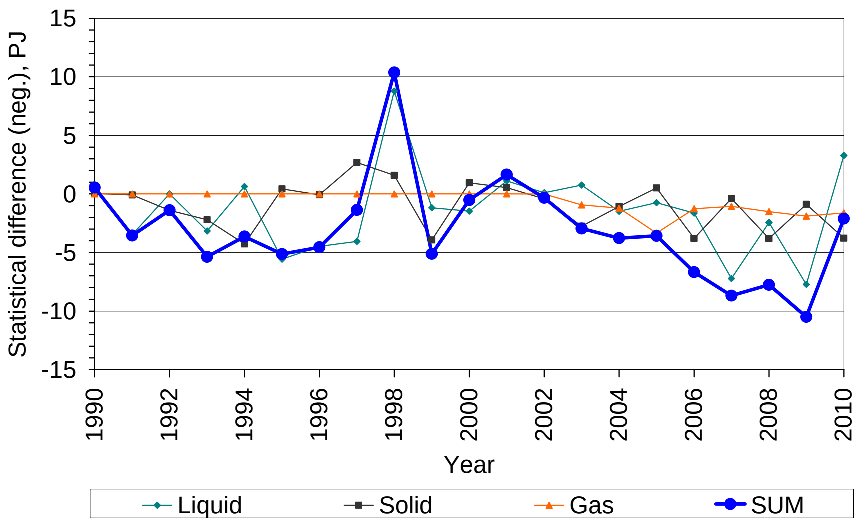

Figure 3.4.2 Statistical difference in the Danish energy statistics (DEA, 2011b).

3.5 Fugitive emissions (CRF sector 1B)

Fugitive emissions from fuels include emissions from production, storage, refining and transport of oil and natural gas. Emissions from solid fuels are not occurring in Denmark. Most fugitive emission sources are of minor importance related to the total Danish emissions. Fugitive and national total emissions are given in Table 3.5.1 with the fugitive emissions share of national total emission.

Table 3.5.1 National and fugitive emissions of CO_2, CH_4 N_2O and GHG in 2010, and the fugitive emissions share of national total emissions.

Compound	National emission		Fugitive emission		Fugitive/national emission
CO_2	47 872	Gg	357	Gg	0.7 %
CH_4	26	Gg	5.1	Gg	19.9 %
N_2O	1.2	Gg	0.003	Gg	0.2 %
GHG	58 623	Gg CO_2-eqv.	465	Gg CO_2-eqv.	0.8 %

The key source analysis shows that CO_2 from offshore flaring is a Tier 1 Level key source in 1990 and 2010 and a Tier 1 trend key source in 1990-2010. Further CH_4 from Refinery processes is a Tier 2 Trend key source in 1990-2010. (Table 3.5.2).

Table 3.5.2 Key categories in the fugitive emission sector

CRF table	Pollutant	Emission dource	Key category identification	
			Tier 1	Tier 2
1.B.2	CO_2	Flaring in refinery	-	-
1.B.2	CO_2	Flaring off-shore	Level 1990 and 2010 Trend 1990-2010	-
1.B.2	CO_2	Land based activities	-	-
1.B.2	CO_2	Off-shore activities	-	-
1.B.2	CO_2	Transmission of natural gas	-	-
1.B.2	CO_2	Distribution of natural gas	-	-
1.B.2	CO_2	Venting in gas storage	-	-
1.B.2	CH_4	Flaring in refinery	-	-
1.B.2	CH_4	Flaring off-shore	-	-
1.B.2	CH_4	Refinery processes	-	Trend 1990-2010
1.B.2	CH_4	Land based activities	-	-
1.B.2	CH_4	Off-shore activities	-	-
1.B.2	CH_4	Transmission of natural gas	-	-
1.B.2	CH_4	Distribution of natural gas	-	-
1.B.2	CH_4	Venting in gas storage	-	-
1.B.2	N_2O	Flaring in refinery	-	-
1.B.2	N_2O	Flaring off-shore	-	-

Calculations of fugitive emissions are mainly using Tier 3 methodology. Only calculation of emissions from distribution of oil products is using Tier 3 methodology. In accordance with the IPCC Good Practice Guidance (2000) emissions calculations for fugitive key sources are using higher methodological tiers than Tier 1. The applied methodologies and the level of detail for the applied emission factors in are listed in (Table 3.5.3).

Table 3.5.3 Applied methodology for fugitive emission sources

CRF	Source	Emissions reported	Method	Emission factor
1B2a ii	Oil – Production , Offshore activities	CO_2 CH_4 NMVOC	Tier 3 Tier 3 Tier 3	D D D
1B2a ii	Oil – Production , Onshore activities	CO_2 CH_4 NMVOC	Tier 3 Tier 3 Tier 3	D CS CS
1B2a iv	Oil - Refining /Storage	CH_4 NMVOC SO_2	Tier 3 Tier 3 Tier 3	PS PS PS
1B2a v	Oil - Distribution of oil products	NMVOC	Tier 1	CS
1B2b	Natural gas	CO_2 CH_4 NMVOC	Tier 3 Tier 3 Tier 3	CS CS CS
1B2c	Venting /flaring	CO_2 CH_4 N2O NO_x CO NMVOC SO_2	Tier 3 Tier 3 Tier 3 Tier 3 Tier 3 Tier 3 Tier 3	PS * D D PS, D ** D D CS

D: default, CS: country specific, PS: plant specific

* Plant specific emission factors are available from the EU ETS from 2006 and forward. For the years 1990-2005 country specific emission factors were applied.

** Plant specific emission factors are available for one refinery. For offshore flaring and flaring in the remaining refinery default emission factors are applied

3.5.1 Source category description

According to the IPCC sector definitions the category *fugitive emissions* is a sub-category under the main-category Energy (Sector 1). The category *fugitive emissions* (Sector 1B) is segmented into sub-categories covering emissions from solid fuels (coal mining and handling (1B1a), solid fuel transformation (1B1b) and other (1B1c)) and from oil and natural gas (oil (1B2a), natural gas (1B2b), venting and flaring (1B2c) and other (1B2d)). The sub-categories relevant for the Danish emission inventory are shortly described below according to Danish conditions:

- 1B1a: Fugitive emission from solid fuels: Coal mining is not occurring in Denmark. Therefore only emissions of particulate matter from storage and handling of coal are considered.
- 1B2a: Fugitive emissions from oil include emissions from exploration, production, transport, storage and refining of crude oil.
- 1B2b: Fugitive emissions from natural gas include emissions from transmission and distribution of natural gas. Emissions from gas storage are included in the transmission.
- 1B2c: Venting and flaring include activities onshore and offshore. Flaring occur both offshore and onshore in gas treatment and storage plants and in refineries. Venting occurs in gas storage plants. Venting of gas is assumed to be negligible in extraction and in refineries as controlled venting enters the gas flare system.

Activity data, emission factors and emissions are stored in the Danish emission database on SNAP sector categories (Selected Nomenclature for Air Pollution). In Table 3.5.4 the corresponding SNAP codes and IPCC sectors relevant to fugitive emissions are shown. Further, the table holds the SNAP names for the SNAP codes and the overall activity (e.g. oil and natural gas).

Table 3.5.4 List of the IPCC sectors and corresponding SNAP codes for the categories included in the Danish emission inventory model.

IPCC sectors	SNAP code	SNAP name	Activity
	04	Production processes	
1 B 2 a iv	040101	Petroleum products processing	Oil
1 B 2 a iv	040103	Other	Oil
	05	Extraction and distribution of fossil fuels and geothermal energy	
1 B 1 a	050103 *	Storage of solid fuel	Coal mining and handling
1 B 2 a ii	050201	Land-based activities	Oil
1 B 2 a ii	050202 **	Offshore activities	Oil
1 B 2 a v	050503	Service stations (including refuelling of cars)	Oil
1 B 2 b iii	050601	Pipelines	Natural gas
1 B 2 b iv	050602	Distribution networks	Natural gas
	09	Waste treatment and disposal	
1 B 2 c 2 i	090203	Flaring in oil refinery	Flaring
1 B 2 c 2 ii	050699	Venting in gas storage	Venting
1 B 2 c 2 ii	090206	Flaring in oil and gas extraction	Flaring

*Only relevant for emissions of particulate matter from storage and handling of coal.

**In the Danish inventory emissions from extraction of gas are united under “Extraction, 1st treatment and loading of liquid fossil fuels/offshore activities” (IPCC 1B2a / SNAP 050202).

Table 3.5.5 summarizes the Danish fugitive emissions in 2009. The methodologies, activity data and emission factors used for calculation are described in the following chapters.

Table 3.5.5 Summary of the Danish fugitive emissions 2010. P refers to point source and A to area source.

IPCC code	SNAP code	Source	Pollutant	Emission	Unit
1B2a i	050201	A	NMVOC	*2 566*	Mg
1B2a i	050201	A	CH_4	*842*	Mg
1B2a i	050201	A	CO_2	*<0.1*	Gg
1B2a i	050202	A	NMVOC	*2 224*	Mg
1B2a i	050202	A	CH_4	*1 781*	Mg
1B2a i	050202	A	CO_2	*5*	Gg
1B2a iv	040101	P	SO_2	*0 **	Mg
1B2a iv	040101	P	NMVOC	*3 867*	Mg
1B2a iv	040101	P	CH_4	*2 219*	Mg
1B2a iv	040103	P	SO_2	*981*	Mg
1B2a v	050503	A	NMVOC	*1 090*	Mg
1B2b iii	050601	A	NMVOC	*6*	Mg
1B2b iii	050601	A	CH_4	26	Mg
1B2b iii	050601	A	CO_2	< 0.1	Gg
1B2b iv	050603	A	NMVOC	*34*	Mg
1B2b iv	050603	A	CH_4	*142*	Mg
1B2b iv	050603	A	CO_2	*< 0.1*	Gg
1B2c	050699	P	NMVOC	*18*	Mg
1B2c	050699	P	CH_4	*57*	Mg
1B2c	050699	P	CO_2	*< 0.1*	Gg
1B2c	090203	P	SO2	*288*	Mg
1B2c	090203	P	NO_x	*19*	Mg
1B2c	090203	P	NMVOC	*27*	Mg
1B2c	090203	P	CH_4	*6*	Mg
1B2c	090203	P	CO	*62*	Mg
1B2c	090203	P	CO_2	*19*	Gg
1B2c	090203	P	N_2O	*0.2*	Mg
1B2c	090206	A	SO_2	*2*	Mg
1B2c	090206	A	NO_x	*146*	Mg
1B2c	090206	A	NMVOC	*13*	Mg
1B2c	090206	A	CH_4	*25*	Mg
1B2c	090206	A	CO	*126*	Mg
1B2c	090206	A	CO_2	*331*	Gg
1B2c	090206	A	N_2O	*3*	Mg
1B2c	090206	P	SO_2	*<0.1*	Mg
1B2c	090206	P	NOx	*9*	Mg
1B2c	090206	P	NMVOC	*0.5*	Mg
1B2c	090206	P	CH_4	*1*	Mg
1B2c	090206	P	CO	*1*	Mg
1B2c	090206	P	CO_2	*2*	Gg
1B2c	090206	P	N_2O	*<0.1*	Mg

* From 2001 SO_2 emissions from oil refining are included in stationary combustion.

3.5.2 Methodological issues

The following chapters give descriptions on the methods of calculation used in the Danish emission inventory. Further, the activity data and emission factors that form the basis for the calculations are described according to data source and values.

Use of EU ETS data

Reporting to the European Union Emission Trading Scheme (EU ETS) are available in the annual EU ETS reports for refineries, offshore oil and gas extraction facilities and the natural gas treatment plant, concerning fugitive emissions. EU ETS data are only included in the national emission inventory if higher tier methodologies are applied. The EU ETS data used are fully in line with the requirements in the IPCC good practice guidance and are considered the best data source on CO_2 emission factors due to the legal obligation for the relevant companies to make the accounting following the specified EU decisions. The EU ETS data are thereby a source of consistent data with low uncertainties. For further information on EU ETS please refer to chapter 1.4.10. Unfortunately, corresponding data do not exist before the commencement of EU ETS in 2006 and therefore it is not possible to set up time series based on EU ETS.

Refineries:

Activity data is measured with flow meters and amounts are reported with high accuracy and the oxidation factor is set to 1. CO_2 emission factors are calculated according to the relevant Tier given in the EU Commission Decision of 18 July 2007 (EU Commission, 2007). For combustion of fuel gas Tier 2b methodology based on yearly density and calorific values is applied, while the activity specific Tier 3 methodology is applied for diesel. CO_2 emissions factors for flaring are calculated using Tier 3 methodology based on the measured carbon contents of flare gas.

Offshore installations:

Activity data are measured with flow meters and amounts are reported with high accuracy (± 1.5 % for combustion and ± 7.5 – ± 17.5 % for flare). The oxidation factor is set to 1. CO_2 emission factors are calculated according to the relevant Tier given in the EU Commission Decision of 18 July 2007 (EU Commission, 2007). For combustion of fuel gas Tier 3 methodology, which is activity specific, is applied, while the country specific Tier 2a methodology is applied for diesel. CO_2 emissions factors for flaring are found using Tier 3 methodology based on the measured carbon contents of flare gas.

Fugitive emissions from oil (1B2a)

The emissions from oil derive from offshore activities, service stations and refineries. Emissions from offshore activities include emissions from extraction, onshore oil tanks and onshore and offshore loading of ships. In the case of service stations emissions from reloading of tankers and refuelling of vehicles are included. The emissions from refineries derive from petroleum products processing (oil refining). Emissions from flaring in refineries are included in the chapters concerning flaring.

Offshore activities

Fugitive emissions from oil include emissions from extraction, onshore oil tanks and onshore and offshore loading of ships.

The total emission can be expressed as:

$$E_{total} = E_{extraction} + E_{ship} + E_{oil\ tanks} \qquad \text{(Eq. 3.5.1)}$$

Fugitive emissions from extraction

According to the EMEP/EEA Guidebook (EMEP/EEA, 2009) the total fugitive emissions of volatile organic compounds (VOC) from extraction of oil and gas can be estimated by means of equation 3.5.2.

$$E_{extraction,VOC} = 40.2 \cdot N_P + 1.1 \cdot 10^{-2} P_{gas} + 8.5 \cdot 10^{-6} \cdot P_{oil} \qquad \text{(Eq. 3.5.2)}$$

where $E_{extraction,VOC}$ is the emission of VOC in Mg pr year, N_P is the number of platforms, P_{gas} is the production of gas, 10^6 Nm^3 and P_{oil} is the production of oil, 10^6 tonnes.

It is assumed that the VOC contains 75 % methane (CH_4) and 25 % NMVOC and in consequence the total emission of CH_4 and NMVOC for extraction of oil and gas can be calculated as:

$$E_{extraction,CH_4} = 0.75 \cdot E_{extraction,VOC} \qquad \text{(Eq. 3.5.3)}$$

$$E_{extraction,NMVOC} = 0.25 \cdot E_{extraction,VOC} \qquad \text{(Eq. 3.5.4)}$$

Loading of ships

Fugitive emissions of CH_4 and NMVOC from loading of ships include the transfer of oil from storage tanks or directly from the well into ships. The activity also includes losses during transport. When oil is loaded hydrocarbon vapour will be displaced by oil and new vapour will be formed, both leading to emissions. The emissions from ships are calculated by equation 3.5.5.

$$E_{ships} = EF_{ships,onshore} \cdot L_{oil,onshore} + EF_{ships,offshore} \cdot L_{oil,ofshore} \qquad \text{(Eq. 3.5.5)}$$

where EF_{ships} is the emission factor for loading of ships offshore and onshore and L_{oil} is the amount of oil loaded.

Oil tanks

The CH_4 and NMVOC emissions from storage of oil are given in the environmental reports from DONG Oil Pipe A/S for 2010 (DONG Oil Pipe A/S, 2011). An implied emission factor is calculated for use in the reporting template on the basis of the amount of oil transported in pipelines according to equation 3.5.6.

$$IEF_{tanks} = \frac{E_{tanks}}{T_{oil}} \qquad \text{(Eq. 3.5.6)}$$

where IEF_{tanks} is the implied emission factor for storage of raw oil in tanks, E_{tanks} is the emission and T_{oil} is the amount of oil transported in pipelines.

Service stations

NMVOC emissions from service stations are estimated as outlined in equation 3.5.7.

$$E_{service\ stations} = \left(EF_{reloading} \cdot T_{fuel}\right) + \left(EF_{refuelling} \cdot T_{fuel}\right) \qquad \text{(Eq.3.5.7)}$$

where $EF_{reloading}$ is the emission factor for reloading of tankers to underground storage tanks at the service stations, $EF_{refuelling}$ is the emission factor for refuelling of vehicles and T_{fuel} is the amount of gasoline used for road transport.

Oil refining

When oil is processed in the refineries, part of the volatile organic compounds (VOC) is emitted to the atmosphere. The VOC emissions from the petroleum refinery process include non-combustion emissions from handling and storage of feedstock (raw oil), from the petroleum product processing and from handling and storage of products. Emissions from flaring in refineries are included under "Flaring". Emissions related to process furnaces in refineries are included in stationary combustion with the relevant emission factors. When only the total VOC emission is given by the refinery the emission of CH_4 and NMVOC is estimated due to the assumption that 10 % of VOC is CH_4 and the remaining 90 % is NMVOC (Hjerrild, 1997).

Both the non-combustion processes including product processing and sulphur recovery plants emit SO_2. The SO_2 emissions are calculated by the refineries and implemented in the emission inventory without further calculation.

Fugitive emissions from gas (1B2b)

Transmission and distribution of gas

The fugitive emission from transmission, storage and distribution is based on information from the gas companies. The transmission and distribution companies give data on the transported amount and length and material of the pipeline systems. The fugitive losses from pipelines are given for the transmission company. The natural gas and town gas distribution companies don't include fugitive losses in their annual reports, but only the total gas loss including measure uncertainty, erroneous debited customers and displacements between production periods and settlement period. The share of the total gas loss owing to fugitive losses is estimated due to further information from one of four Danish distribution companies and used for the remaining companies too. From the fugitive losses of natural gas from transmission and distribution pipelines the emissions of CH_4 and NMVOC are calculated based on the gas quality measured by Energinet.dk.

Flaring

Emissions from flaring are estimated from the amount of gas flared offshore, in gas treatment/storage plants and in refineries and from the corresponding emission factors. From 2006 data on offshore flaring (flared amounts, calorific values and CO_2 emission factors) are given in the reports under the EU ETS and thereby flaring can be split to the individual production units. Before 2006 only the total flared amount is available.

3.5.3 Activity data

Extraction of oil and gas and loading of ships

Activity data used in the calculations of the emissions from oil and gas production and loading of ships are shown in Table 3.5.6. Data are based on information from the Danish Energy Agency (2011a) and from the environmental reports from DONG Oil Pipe A/S (DONG Oil Pipe A/S, 2011).

Table 3.5.6 Activity data for 2010.

Activity	Symbols	Amounts	Data source
Number of platforms	N_p	54	Danish Energy Agency, 2011a
Produced gas, 10^6 Nm^3	P_{gas}	8 056	Danish Energy Agency, 2011a
Produced oil, 10^3 m^3	$P_{oil,vol}$	14 223	Danish Energy Agency, 2011a
Produced oil, 10^3 tonnes	P_{oil}	12 232	Danish Energy Agency, 2011a
Oil loaded, 10^3 m^3	$L_{oil\ offshore}$	1 928	Danish Energy Agency, 2011a
Oil loaded, 10^3 tonnes	$L_{oil\ offshore}$	1 658	Danish Energy Agency, 2011a
Oil loaded, 10^3 m^3	$L_{oil\ on\text{-}shore}$	9 200	DONG Oil Pipe A/S, 2011
Oil loaded, 10^3 tonnes	$L_{oil\ on\text{-}shore}$	7 912	DONG Oil Pipe A/S, 2011

Denisty of crude oil = 0.86 tonnes pr m^3

As seen in Figure 3.5.1 the production of oil and gas in the North Sea has generally increased in the years 1990-2004. Since 2004 the production has decreased. The number of platforms is yet still increasing (Figure 3.5.2). Five major platforms were completed in 1997-1999, which is the main reason for the great increase in the oil production in the years 1998-2000.

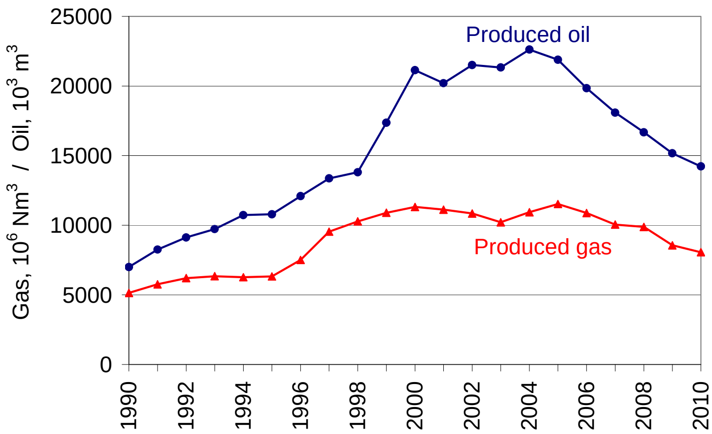

Figure 3.5.1 Production of oil and gas in the Danish part of the North Sea.

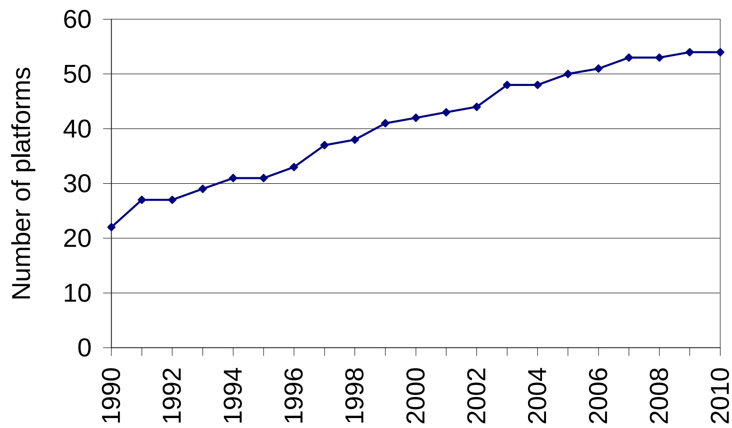

Figure 3.5.2 The number of platforms in the Danish part of the North Sea.

The amounts of oil loaded offshore on ships roughly follow the trend of the oil and gas production (Figure 3.5.3). In case of onshore loading of ships the trend is more smoothed.

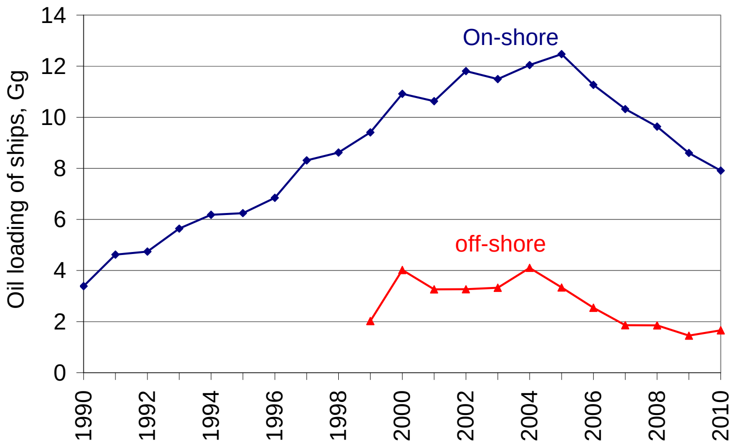

Figure 3.5.3 Onshore and offshore loading of ships.

Oil refining

Data on the amount of crude oil processed in the two Danish refineries are given by the refineries in their annual environmental report (A/S Dansk Shell, 2011; Statoil A/S, 2011). Data are shown in Table 3.5.7. In the last years the amount of crude oil being processed has been slightly decreasing to 7 414 Gg in 2010.

Table 3.5.7 Oil refineries. Processed crude oil in the two Danish refineries.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Crude oil, Gg	7 263	9 802	8 406	8 033	8 179	7 963	7 933	7 978	7 414

Service stations

The Danish Energy statistics contains data on the sale of gasoline that are the basis for estimating emissions of NMVOC from service stations. The gasoline sales show an increase from 1990-1998 and a slightly decreasing trend from 1999-2010 as shown in Figure 3.5.4. In 2010 the gasoline sale was 1 550 Gg.

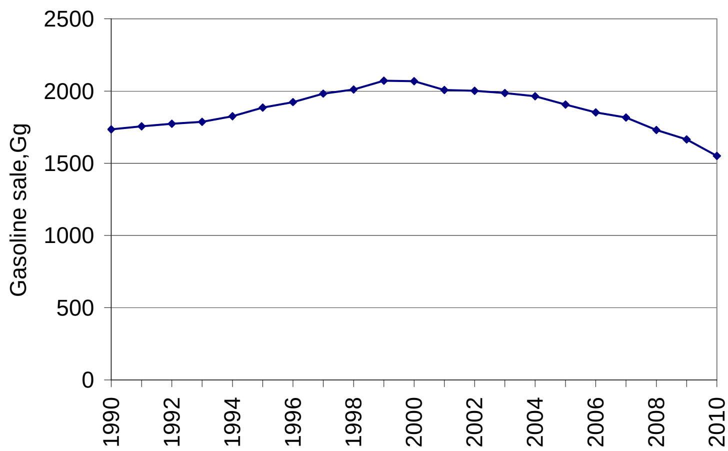

Figure 3.5.4 Gasoline sales in Denmark 1990-2010.

Transmission, storage and distribution of gas

The activity data used in the calculation of the emissions from natural gas are shown in Table 3.5.8. Transmission rates for 1990-1997 refer to the Danish energy statistics and to the annual environmental report of DONG Energy for 1998. The distribution rates for 1990-1998 are estimated according to the transmission rates. Transmissions and distribution rates for 1999-2006 refers to Dong Energy, Danish Gas Technology Centre and the Danish gas distribution companies. From 2007 and onwards the transmission rate stems from the annual environmental report by Energinet.dk (2011b). The distribution rates from 2007 and onwards are provided by the distribution companies, either in their annual reports or through personal communication. The distribution of town gas is based on the available data from the Danish town gas distribution companies of which several are closed down today.

Table 3.5.8 Activity data on transmission and distribution of gas. Town gas is included in distribution.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Transmission, Mm^3 *	2 739	4 689	7 079	7 600	7 600	6 400	7 565	6 500	7 462
Distribution, Mm^3 **	1 905	3 089	3 511	3 297	3 460	3 160	3 135	2 890	2 493

* In 1990-1997 transmission rates refer to Danish energy statistics, in 1998 the transmission rate refers to the annual environmental report of DONG Energy, in 1999-2006 emissions refer to DONG/Danish Gas Technology Centre (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007). Since 2007 transmission data refer to the annual environmental report by Energinet.dk.

**) In 1990-98 distribution rates are estimated from the Danish energy statistics. Distribution rates are assumed to equal total Danish consumption rate minus the consumption rates of sectors that receive the gas at high pressure. The following consumers are assumed to receive high pressure gas: town gas production companies, production platforms and power plants. In 1999-2006 distribution rates refer to DONG Energy / Danish Gas Technology Centre / Danish gas distribution companies (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007). Since 2007 the distribution rates are given by the companies. The distribution of town gas is based on the available data from the Danish town gas distribution companies of which more are closed down today.

In 2010 the gas transmission was 7 462 Mm_n^3 and the distribution rate is 2 493 Mm_n^3, hereof 22 Mm_n^3 town gas (Figure 3.5.5). The variations of the transmission rates mainly owe to variations in production amounts and the gas amounts used for injection at the exploration sites.

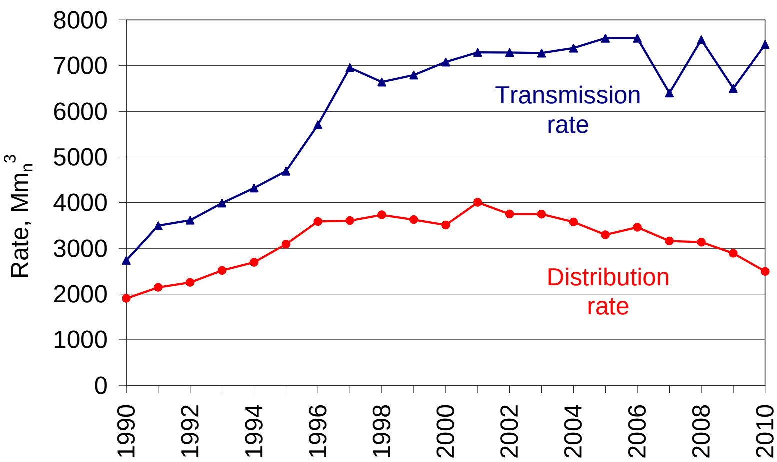

Figure 3.5.5 Rates for transmission and distribution of gas. Distribution cower both natural gas and town gas.

Data on the transmission pipelines excluding offshore pipelines and on the distribution network are given by Energinet.dk (2011b), DGC and the distribution companies concerning length and material. In 2010 the length of the transmission pipelines was approximately 860 km. Because the distribution system in Denmark is relatively new most of the distribution network is made of PE. In 2010 the length of the distribution network was approximately 23 402 km. The major part is made of plastic (MDPE) (approximately 90 %) and the remaining part is made of steel. For this reason the fugitive emission is negligible under normal circumstances as the MDPE distribution system is tight with no fugitive losses. However, the MDPE pipelines are vulnerable and therefore most of the fugitive emissions from the pipes are caused by losses due to excavation damages and construction and maintenance activities performed by the gas companies. These losses are either measured or estimated by calculation in each case by the gas companies. About 5 % of the distribution network is used for town gas distribution. This part of the network is older and the fugitive losses are greater. The fugitive losses from the town gas network are associated with more uncertainty as the losses are estimated as a percentage (15 %) of the meter differential. This assumption is based on expert judgement from one of the town gas companies (Jensen, 2008). It must be noted that more town gas distribution companies are now closed (one in 2004 and another in 2006), and therefore the data availability is very scarce.

In Denmark there are two natural gas storage facilities. Both are obligated to make an environmental report on an annual basis. Data on gas input and withdrawal are included and were 685 Mm^3 and 715 Mm^3 in 2010, respectively.

Venting and flaring

Activity data for venting in gas storage facilities are given in the environmental reports (DONG Energy, 2010; DONG Energy, 2011; Energinet.dk, 2011a).

Offshore flaring amounts are given in the publication "Denmark's oil and gas production" (Danish Energy Agency, 2011a) while flaring in treatment/storage plants are given in Energy's environmental reports (Dong Energy, 2010; Dong Energy, 2011). Flaring rates for the two Danish refineries are given in their environmental reports and additional data. From 2006 flaring amounts are given in the EU ETS reporting.

The flaring rates are shown in Figure 3.5.6, Figure 3.5.7 and Figure 3.5.8. Activity data for flaring in refineries are not available for the years 1990-1993. The flaring amount for 1994 has been adopted for the previous years. Use of a mean value for the following five or ten years as applied for e.g. flaring in storage and treatment plants are not appropriate in this case, as one of three refineries was closed down in 1996.

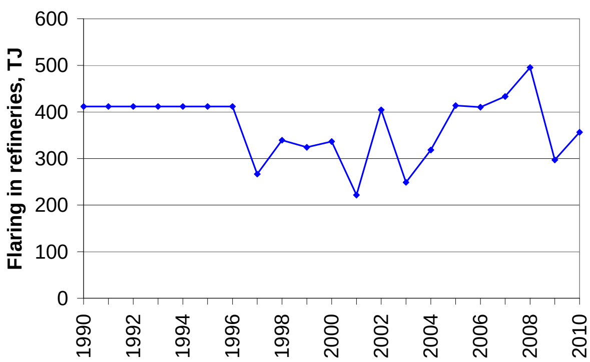

Figure 3.5.6 Amount flared in refineries (annual environmental reports from A/S Dansk Shell and Statoil A/).

Flaring rates in gas treatment and gas storage plants are not available until 1995. The mean value for the following ten years (1995 to 2004) has been adopted as basis for the emission calculation for the years 1990-1994. The amount of flared gas is high in 2007 because of larger maintenance work at the gas treatment plant. In 2008 there has been one situation with flaring of a larger amount of gas.

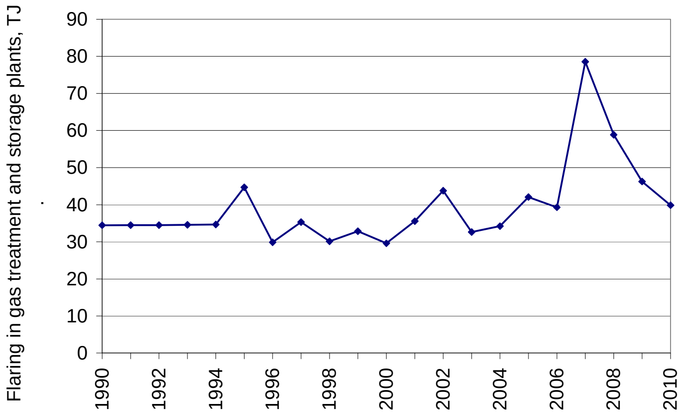

Figure 3.5.7 Amount flared in gas treatment and storage plants (annual environmental reports from DONG Energy).

The offshore flaring amounts have been decreasing over the last five years in accordance with the decrease in production as seen in Figure 3.5.8. Further, there is focus on reduction of the amount being flared for environmental reasons. The peak in 1999 owe to opening of three new fields.

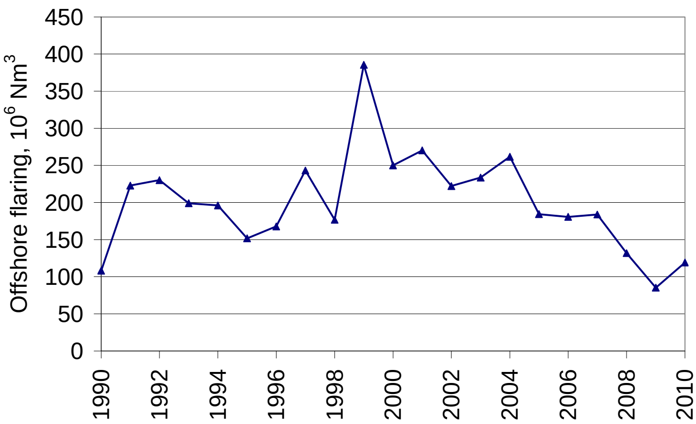

Figure 3.5.8 Amounts of gas flared offshore at exploration facilities (annual report from the Danish Energy Agency).

3.5.4 Emission factors

Extraction of oil and gas and loading of ships

Emissions of CH4 and NMVOC from extraction of oil and gas are calculated from standard formula as listed in equation 3.5.3 and 3.5.4. Emissions of CO_2 from extraction of oil and gas and from transport of oil in pipelines listed in Table 3.5.9 are based on the emission factor from IPCC Good Practice Guidance (IPCC 2000).

Table 3.5.9 CO_2 emission factors for extraction and storage/transport of oil.

	CO_2, g pr Mg cruide oil	Reference
Extraction	377	IPCC, 2000
Pipeline oil	0.509	IPCC, 2000

In the EMEP/EEA Guidebook standard emission factors for loading of ships for different countries are given. In the Danish emission inventory the Norwegian emission factors are used for estimation of fugitive emissions from loading of ships onshore and offshore (EMEP/EEA, 2009). The emission factors are listed in Table 3.5.10.

Table 3.5.10 Emission factors for loading of ships onshore and offshore.

	NMVOC, fraction of loaded	CH_4, fraction of loaded	Reference
Ships offshore	0.001	0.00005	EMEP/EEA, 2009
Ships on-shore	0.0002	0.00001	EMEP/EEA, 2009

Oil refining

The refineries deliver information on consumption of fuel gas and fuel oil. The calorific values are given by the refineries in the reporting to the EU ETS from 2006. Before 2006 the calorific values given by the refineries were used when available. When not available standard calorific values given in the basic data tables from the Danish Energy Agency combined with the conversion factor between fuel gas and fuel oil given by the refinery were used for calculation. The emissions are reported by the refineries for SO_2, NO_x and VOC. Only one of the two refineries has made a split between NMVOC and CH_4. For the other refinery it is assumed that 10 % of the VOC emission is CH_4 and the remaining 90 % is NMVOC (Hjerrild, 1997).

Service stations

NMVOC from service stations is calculated by use of different emission factors for the time series as shown in Table 3.5.11. In 1994 the emission factors for NMVOC from service stations were investigated by Fenhann & Kilde (1994) for the years 1990, 1991 and 1992, individually. The emission factors reported for reloading and refuelling for 1990 were used for the years 1985-1990, while the emission factors for 1991 was used for that year only. For the years 1992-1995 only emission factor for refuelling reported by Fenhann and Kilde (1994) was used in the Danish emission inventory. For reloading of tankers the British emission factor - as given in the UK Emission Factor Database (AEA Energy & Environment, 2010) - was adopted for the years 1992-2000. From 2008 the emission factors from the EMEP/EEA Guidebook (2009) are used for reloading and refuelling. For the years 2001-2007 and 1996-2007 the emission factors for reloading and refuelling, respectively, are estimated by using interpolation.

Table 3.5.11 Emission factors used for estimating NMVOC from service stations.

Year	Reloading of tankers, kg NMVOC pr tonnes gasoline	Refuelling of vehicles, kg NMVOC pr tonnes gasoline	Sum of reloading and refuelling, kg NMVOC pr tonnes gasoline	Source (reloading/refuelling)
1985-1990	1.28	1.52	2.80	Fenhann & Kilde,1994 / Fenhann & Kilde,1994
1991	0.64	1.52	2.16	Fenhann & Kilde,1994 / Fenhann & Kilde,1994
1992-1995	0.08	1.52	1.60	UK emf. database / Fenhann & Kilde,1994
1996	0.08	1.45	1.53	UK emf. database / interpolation 1995-2008
1997	0.08	1.39	1.47	UK emf. database / interpolation 1995-2008
1998	0.08	1.32	1.40	UK emf. database / interpolation 1995-2008
1999	0.08	1.25	1.33	UK emf. database / interpolation 1995-2008
2000	0.08	1.19	1.27	UK emf. database / interpolation 1995-2008
2001	0.077	1.12	1.20	Interpolation 2000-2008 / 1995-2008
2002	0.073	1.05	1.13	Interpolation 2000-2008 / 1995-2008
2003	0.070	0.99	1.05	Interpolation 2000-2008 / 1995-2008
2004	0.067	0.92	0.98	Interpolation 2000-2008 / 1995-2008
2005	0.063	0.85	0.91	Interpolation 2000-2008 / 1995-2008
2006	0.060	0.78	0.84	Interpolation 2000-2008 / 1995-2008
2007	0.056	0.72	0.77	Interpolation 2000-2008 / 1995-2008
2008 and onwards	0.053	0.65	0.70	EMEP/EEA 2009 / EMEP/EEA 2009

Transmission, storage and distribution of gas

The fugitive emissions of CH_4 and NMVOC from transmission, storage and distribution of natural gas are based on data on gas losses from the companies and on the average yearly natural gas composition given by Energinet.dk. Emissions of CO_2 from transmission and distribution of natural gas are calculated from country specific emission factors based on annual natural gas composition published by Energinet.dk (2010c). For distribution of town gas the emission factor is reduced due to the admixture of 50 % atmospheric air to the natural gas.

Venting and flaring

Venting

CH_4 and NMVOC emissions from venting are given in the environmental reports for the gas storage facilities. CO_2 emissions from venting are calculated from country specific emission factors based on annual natural gas composition published by Energinet.dk (2010c).

Flaring in refineries

The composition of fuel gas is given for 2008 by one of the two refineries. As the composition for fuel gas is marked different than the composition of natural gas, which has been used in earlier year's calculations, the new composition data are adopted in the calculations. The same fuel gas composition is used in calculations for the other Danish refinery. The new emission factors for CH_4 and NMVOC have been included in the inventory for all years in the time series as the 2008 fuel gas composition is assumed to be more accurate for the emission calculation than the yearly composition for natural gas being distributed in Denmark used in previous emission inventories. The CO_2 emission factor is based on the refineries reporting to the EU ETS for the years 2006 and onwards. Before 2006 corresponding data are not available and the CO_2 emission factors are calculated from the yearly natural gas composition given by Energinet.dk. For NO_x and CO the emission factors from the EMEP/EEA Guidebook (2009) are used. The emission factor applied for N_2O is based on the EMEP/Corinair Guidebook (2007) for flaring in oil and gas extraction as no value are given for flaring in refineries. The emission factors are listed in table 3.5.12.

Table 3.5.12 Emission factors for flaring in refineries.

Pollutant	Emission factor	Unit
NO_x *	32.2	g pr GJ
NMVOC	76.4	g pr GJ
CH_4	18.1	g pr GJ
CO	177	g pr GJ
CO_2 **	54.46 / 54.50	kg pr GJ
N_2O	0.47	g pr GJ

*The emission of NO_x is given for one refinery why the emission factor is used for one refinery only.

** The CO_2 emission is based on the refineries reports for ETS and is source specific.

Flaring offshore

The emission factors for offshore flaring are shown in Table 3.5.13. Since 2006 the CO_2 emission factor is calculated according to the reporting for EU ETS. Corresponding data are not available for earlier years and therefore the CO_2 emission factor is assumed to follow the same time series as for natural gas combusted in stationary combustion plants.

The NO_x emission factor is based on the conclusion in a Danish study of NO_x emissions from offshore flaring carried out by the Danish Environmental Protection Agency (2008). The recommended NO_x emission factor (31 008 g per GJ or 0.0015 tonnes NO_x per tonnes gas) corresponds well with the emission factors used to estimate NO_x emission in other countries with oil production in the North Sea (Netherlands: approximately 0.0014 tonnes NO_x per tonnes gas and United Kingdom: approximately 0.0013 tonnes NO_x per tonnes gas).

Emission factors for CH_4 and N_2O are based on the EMEP/Corinair Guidebook (2007) and emission factors for NMVOC and CO are based on the EMEP/EEA Guidebook (2009). For trace metals, dioxin and PAHs the emission factors given in the guidebook (EMEP/EEA, 2009) for stationary combustion Tier 1 are adopted for flaring in refineries.

Emissions from flaring in gas treatment and storage plants are calculated from the same emission factors which are used for offshore flaring. Only difference is the CO_2 emission factor for the years from 2006. The emission factor used for the plants are based on the same data source, the reporting for EU ETS, but the values are different than for offshore flaring. The gas that are flared in the treatment and storage plants are natural gas with the same composition as natural gas distributed in Denmark. Therefore, the emission factors in the EU ETS reports are the same as the one calculated on basis of the gas composition given by Energinet.dk (56.74 g per GJ in 2010).

Table 3.5.13 Emission factors for offshore flaring.

Pollutant	Emission factor	Unit
SO_2	0.014	g pr Nm^3
NO_x	1.227	g pr Nm^3
NMVOC	0.106	g pr Nm^3
CH_4	0.211	g pr Nm^3
CO	1.055	g pr Nm^3
CO_2	2.779	kg pr Nm^3
N_2O	0.021	g pr Nm^3

3.5.5 Emissions

Extraction of oil and gas and loading of ships

From the activity data in Table 3.5.6, equation 3.5.3 and equation 3.5.4 the fugitive emissions of CH_4 and NMVOC from extraction are calculated. Corresponding emissions from loading of ships can be estimated by Table 3.5.6 and equation 3.5.5. The emissions are listed in Table 3.5.14 along with the emissions from oil pipelines and storage tanks given in the environmental reports from DONG Oil Pipe A/S (2011). CO_2 emissions from oil pipeline and storage tanks and from extraction are calculated from standard emission factors (IPCC 2000).

Table 3.5.14 CO_2, CH_4 and NMVOC emissions for 2010.

	CO_2, Gg	CH_4, Mg	NMVOC, Mg
Onshore loading of ships	NA	79	1 582
Oil pipeline and storage tanks	< 0.1	763	984
Fugitive emissions from extraction	4.6	1 698	566
Offshore loading of ships	NA	83	1 658
Total	4.6	2 623	4 790

The fugitive emissions in Table 3.5.14 are aggregated in two sources; emissions related to onshore and offshore activities, respectively. Emissions in selected years of the time series for offshore and onshore activities related to extraction of oil and natural gas are shown in Table 3.5.15 and Table 3.5.16.

The major increase for NMVOC emission from offshore activities from 1995 to 2000 owe to introduction of offshore loading in 1999. A similar increase is not seen for CH_4 as emissions from extraction is the dominating source. Emissions from onshore activities are largely related to the extracted amounts of oil and gas (Figure 3.5.1).

Tabel 3.5.15 CO_2, CH_4 and NMVOC from offshore activities related to extraction of oil and natural gas (offshore loading of ships and extraction).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2, Gg	2.4	3.5	6.8	7.0	6.4	5.8	5.4	4.9	4.6
CH_4, Mg	708	990	1 566	1 775	1 759	1 839	1 837	1 775	1 781
NMVOC, Mg	236	330	4 476	3 873	3 087	2 442	2 437	2 018	2 224

Tabel 3.5.16 CO_2, CH_4 and NMVOC from onshore activities related to extraction of oil and natural gas (onshore loading of ships and oil tanks).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2, Gg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
CH_4, Mg	817	1 271	1 809	2 225	2 013	1 883	1 744	1386	842
NMVOC, Mg	2 404	3 913	6 183	6 994	6 403	5 981	5 551	3 818	2 566

Oil refining

In Table 3.5.17 the activity data and emissions of VOC from the Danish refineries are listed for selected years in the time series. Further, the emissions of SO_2 from oil refining and sulphur recovery in refineries are shown. The emission of SO_2 has shown a pronounced decrease since 1990 because of technical improvements at the refineries. Note that SO_2 from refining and recovery prior to 1994 was aggregated and reported as an area source in the IPCC category 1B2a vi. Note also that SO_2 from oil refining from 2001 are included in stationary combustion.

The large fluctuation in the SO_2 emission from sulphur recovery owes to outage and shut downs of the sulphur recovery units. The SO_2 emission from sulphur recovery has shown a gradual decrease from 1995 to 2000.

Table 3.5.17 Oil Refineries. Emissions of NMVOC and SO_2 from oil refining and SO_2 from sulphur recovery.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Crude oil, 1000 Mg	7263	9802	8406	8033	8179	9238	8976	9293	8954
VOC, Mg	3704	4200	5033	4158	5938	5984	5776	6097	6086
SO_2, oil refining, Mg	3335	585	178	0	0	0	0	0	0
SO_2, sulphur recovery, Mg		2437	803	347	755	746	931	420	981

1) Prior to 1994 SO_2 emissions from oil refining and sulphur recovery are reported as area sources in category 1B2a vi.

2) From 2001 SO_2 emissions from oil refining are included in stationary combustion.

Service stations

Emissions from service stations are calculated using the emission factors in Table 3.5.11 and the sold amounts of gasoline given by the Danish energy statistics (Danish Energy Agency, 2010b). The NMVOC emissions are listed in Table 3.5.18.

Table 3.5.18 Emissions of NMVOC from service stations for selected years of the time series.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
NMVOC, Mg	4 856	3 016	2 616	1 742	1 563	1 405	1 216	1 171	1 090

Transmission, storage and distribution of gas

The gas transmission company gives emissions of CH_4. The CH_4 emissions for transmission are estimated on the basis of registered loss in the transmission grid and the emission from the natural gas consumption in the pressure regulating stations (Oertenblad, 2007). The distribution companies give data on fugitive losses, and the CH_4 emissions are estimated due to the gas quality given by Energinet.dk.

The emissions of NMVOC are calculated on the basis of the CH_4 emission according to the gas quality measured by Energinet.dk (equation 3.5.8).

$$E_{NMVOC} = E_{CH_4} \times \left(w_{NMVOC} / w_{CH_4} \right) \quad \text{(Eq.3.5.8)}$$

where w_{NMVOC} is the weight-% NMVOC and w_{CH_4} is the weight-% CH_4 according to the gas quality of the current year.

Emissions of CH_4 and NMVOC from transmission of natural gas (including storage) and distribution of natural gas and town gas are shown in table 3.5.19 and table 3.5.20, respectively. Emission of CO_2 from transmission and distribution are very limited amounts and therefore not included in the tables.

For the years before 2000 emissions from transmission and venting in gas storage plants have not been estimated separately and both sources are included in the transmission category. As the pipelines in Denmark are relatively new, most emissions are due to construction and maintenance. The decrease in emission from transmission in 2007 is caused by the completion of a greater construction work and rerouting of a major pipeline. There have been no significant construction or renovation work in 2007 and therefore a low emission. The increase in 2008 owe to a minor increase in these work activities.

Increased emission from distribution in single years owes to venting of the distribution network related to inspection and maintenance, e.g. 2004 with an emission of 291 Mg CH_4.

Table 3.5.19 CH_4 emission from transmission and distribution.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Transmission Mg*	170	536	170	141	152	7	16	9	26
Distribution Mg**	255	299	227	238	260	269	156	135	142

*In 1991-95 CH_4 emissions are based on the annual environmental report from DONG for the year 1995.
In 1996-99 the CH_4 emission refers to the annual environmental reports from DONG for the years 1996-99.
In 2000-2006 the CH_4 emission refers to DONG/Danish Gas Technology Centre (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007).
From 2007 the CH_4 emission refers to the annual environmental reports from Energinet.dk.
**Danish Gas Technology Centre/DONG/Danish gas distribution companies (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007.
1) Data from Naturgas Fyn not included until 2007 as data have not been available.
2) Assumed same emission as in 2002.
3) Distribution data are extrapolated from 2006 according to change in transmission data.

Table 3.5.20 NMVOC emission from transmission and distribution. NMVOC emissions are estimated from the CH_4 emission according to the gas quality given by Energinet.dk.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Transmission, Mg*	36	121	52	36	37	2	4	2	6
Distribution, Mg**	57	69	66	61	63	66	38	32	34

*NMVOC emissions are estimated from the CH_4 emission according to the gas quality given by Energinet.dk.
**Danish Gas Technology Centre/DONG/Danish gas distribution companies (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007.
1) Data from Naturgas Fyn not included until 2007 as data have not been available.
2) Assumed same emission as in 2002.
3) Distribution data are extrapolated from 2006 according to change in transmission data.

Venting and Flaring

Venting is limited to the gas storage plants and thus the emissions are of minor importance (Table 3.5.5).

As shown in Figure 3.5.9 there was a marked increase in the amount of offshore flaring in 1997 and especially in 1999. The increase in 1997 was due to the new Dan field and the completion of the Harald field. The increase in 1999 was due to the opening of the three new fields Halfdan, Siri and Syd Arne.

The time series for the emission of CO_2 from offshore flaring fluctuates due to the fluctuations in the fuel rate and to a minor degree due to the CO_2 emission factor. The latter is based on gas quality measurements. From 2006 the calorific values for flare gas are given at installation level in the EU ETS. This information is incorporated in the inventory for the years from 2006 and onwards. This has lead to an increase of the CO_2 emission factor. The average of the emission factors for 2006-2008 is adopted for 1990-2005. Fuel rate and CO_2 emission are shown in Figure 3.5.8.

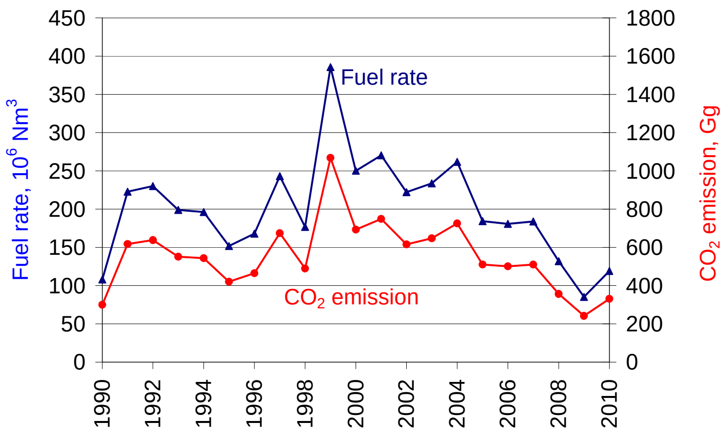

Figure 3.5.9 Fuel rate and CO_2 emission from offshore flaring of gas 1990-2010.

The emissions of other pollutants than CO_2 from offshore flaring are estimated from the same emission factors for all years and the variations reflect only the variations in the flared amounts. Emissions of selected pollutants are shown in Table 3.5.21.

Table 3.5.21 Emissions from flaring offshore and in gas treatment/storage plants.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
SO_2, Mg	2	2	4	3	3	3	2	1	2
NO_x, Mg	133	188	310	231	226	233	168	111	155
NMVOC, Mg	11	20	30	23	22	26	20	23	13
CO, Mg	114	161	265	195	192	169	141	91	127
CO_2, Gg	300	423	695	513	503	514	360	244	333

Aside from the offshore sector flaring also takes place in refineries and gas treatment/storage plants. Flaring in refineries is a significant fugitive emission source for SO_2. In 1990-1993 emissions from petroleum product processing were included in emissions from flaring in refineries (1B2c). From 1994 the data delivery format was changed, which made it possible to split the emissions into contributions from flaring and processing, respectively. Emissions from processing are from 1994 included in 1B2a iv.

The decreasing emissions of SO_2 from 1995 to 1998 are due to technical improvements of the sulphur recovery system at one of the two Danish refineries (Table 3.5.22). The increase in SO_2 from flaring in refineries in 2005 and 2007 was due to planned shutdowns due to inspection and maintenance at one of the two refineries. Further, in 2007-2009 the same refinery has had problems with the ATS system leading to an increased SO_2 emission from flaring.

Table 3.5.22 Emissions from flaring in refineries.

	1990*	1995	2000	2005	2006	2007	2008	2009	2010
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
SO_2 *, Mg	943	203	51	296	257	526	380	453	288
NO_x, Mg	41	13	11	26	22	24	26	17	19
NMVOC, Mg	34	31	26	32	31	33	38	23	27
CO, Mg	5	73	60	73	73	77	88	53	63
CO_2, Gg	23	23	19	23	23	24	27	16	19

*In 1990-1993 emissions from petroleum product processing were included in flaring in refineries due to the data delivery form. From 1994 emissions from petroleum product processing were given in 1B2a iv.

3.5.6 Uncertainties and time series consistency

Two set of uncertainty estimates are made for the Danish emission inventory for greenhouse gases based on Tier 1 and Tier 2 methodology, respectively. The uncertainty models follow the methodology in IPCC Good Practise Guidance (IPCC, 2000). Tier 1 is based on the simplified uncertainty analysis and Tier 2 is based on Monte Carlo simulations.

Uncertainty estimates are made for total emissions in the base year (only Tier 2), in the latest inventory year and for the emission trend for the corresponding time series. Uncertainty estimates are made for the GHGs separately and summarized.

Input data

The Tier 1 uncertainty model is based on emission data, uncertainty levels for activity data and uncertainty levels for emission factors for base year and latest inventory year. The Tier 2 model is based on activity data and emission factors for the same years and the same uncertainty levels as in Tier 1.

Emission data, activity data and emission factors are described in Chapter 3.5.3, 3.5.4 and 3.5.5.

The uncertainty levels used in the uncertainty models are based on different sources, e.g. IPCC Good Practice Guidance, EMEP/EEA Guidebook and reports under the EU ETS. Further, a number of the uncertainty levels are given as NERI assumptions. NERI assumptions are based on source and/or plant specific uncertainty levels for part of the SNAP category and assumptions for the remaining sources and/or plants in the category.

Input data are aggregated on SNAP level. Estimates are made for the greenhouse gases CO_2, CH_4 and N_2O both separately and summarized (GHG). Uncertainty levels for activity data and emission factors are listed in Table 3.5.23. Uncertainty levels are given in percentage related.

Table 3.5.23 Uncertainty levels for activity rates and emission factors.

Pollutant	Source	Activity data uncertainty level, %	Emission factor uncertainty level, %
CO_2	Land based activities	2N	40S
CO_2	Offshore activities	2N	30I
CO_2	Gas transmission	15G	2Q
CO_2	Gas distribution	25G, N	10Q, N
CO_2	Venting in gas storage plants	25G, N	2Q
CO_2	Flaring in refineries	11E	2E
CO_2	Flaring offshore	7.5E	2E
CH_4	Petroleum product processing	1E, N	125N
CH_4	Land based activities	2N	40S
CH_4	Offshore activities	2N	30I
CH_4	Gas transmission	15G	2Q
CH_4	Gas distribution	25G, N	10Q, N
CH_4	Venting in gas storage plants	15G, N	2Q
CH_4	Flaring in refineries	11E	15H, N
CH_4	Flaring offshore	7.5E	125G
N_2O	Flaring in refineries	11E	1 000I
N_2O	Flaring offshore	7.5E	1 000I

N: NERI assumption.

I: IPCC Good Practice Guidance (default value).

S: Statistisk Sentralbyrå, Statistics Norway, 2008.

E: EU Emission Trading Scheme (EU ETS).

G: EMEP/EEA Guidebook, 2009.

H: Holst, 2009 and Statoil A/S, 2010

Q: Annual gas quality, Energinet.dk

The CO_2 emission factors for flaring offshore and in refineries and the CO_2 and CH_4 emission factors for natural gas transmission, distribution and venting, are the most accurate as they are calculated on basis of gas composition measurements. Emissions factors for flare gas are available in the EU-ETS reporting while emissions factors for natural gas are published by Energinet.dk.

The CO_2 emission factor for offshore activities is based on standard emission factors from IPCC (2000). Source specific uncertainty levels are not included in IPCC (2000), but it is written that the uncertainty levels must be assumed to be in the range of ±25 % to ±50 % for most gases. For onshore activities, the emission factor uncertainty corresponds to the uncertainty for onshore loading by Statistics Norway (2008), and the same uncertainty level is assumed for the CH_4 emission factor for onshore activities.

Data from the Danish operators (one year only) indicate that the VOC emissions in the Danish inventory have an uncertainty around 30 %, which has been used as uncertainty level for CH_4 in the uncertainty model. The EMEP/CORINAIR Guidebook (2007) suggests an error of 65 % for the standard equation used to estimate fugitive emissions of VOC from extraction, noting that the error could be much higher when the equation is used for other fields than the ones in USA, which it has been based on. Further the EMEP/EEA Guidebook (2009) says that the uncertainty level of 65 % seems to be in reasonable agreement with estimates for Norway and UK – countries expected to have more similar conditions to Danish than USA. The EMEP/EEA uncertainty level is in the same order of magnitude as the Danish uncertainty level, which support the assumption that the Danish estimate are applicable for all years in the time series.

The uncertainty level for the emission factor for fugitive CH_4 emissions from refineries is dominated by a large uncertainty for one refinery. Further, measurements of fugitive emissions from the refineries are only available for one and two years, respectively, and these measurements indicate larger emissions than earlier estimates. As more measurements become available the uncertainty level is expected to decrease significantly.

According to IPCC (2000) the emission factor for N_2O is the least reliable. An uncertainty level of 1 000 % is adopted in the Danish uncertainty model.

The Tier 2 uncertainty model is based on Monte Carlo simulations and the input uncertainty levels are given for the 95 % confidence interval assuming a log-normal distribution. The input uncertainty levels are the same as those used in the Tier 1 uncertainty model (Table 3.5.20). For more information on the Tier 2 methodology, please see Chapter 1.7.

Results

The results of the Tier 1 uncertainty model for 2010 are shown in Table 3.5.24. In 2010 N_2O has the largest uncertainty for the total emission followed by CH_4 and CO_2. Due to the emission trend CH_4 has the largest uncertainty followed by N_2O and CO_2. The estimated uncertainty for the total GHG emission is 14 % and the GHG emission trend is 26 % ± 18 %-point.

Table 3.5.24 Uncertainty estimates for total emissions and emission trends from the Tier 1 uncertainty model.

	Emission, Gg CO_2-eqv	Uncertainty, % Lower and upper ()	Trend, %	Uncertainty, % Lower and upper ()
CO_2	352	8	9	11
CH_4	107	56	146	130
N_2O	1	941	0.1	130
GHG	460	14	26	18

Table 3.5.25 show the results from the Tier 2 uncertainty model for 1990 and 2010. The overall emission uncertainty in 2010 is -10/+21 %. The Tier 2 trend estimate is 26 % -21/+30 %-point.

Table 3.5.25 Uncertainty estimates for total emissions in 1990 and 2010 and for the emission trends from the Tier 2 uncertainty model.

	1990			2010			1990-2010		
	Median emission Gg CO_2-eqv	Uncertainty, %		Median emission Gg CO_2-eqv	Uncertainty, %		Median trend, %	Uncertainty, %	
		Lower (-)	Upper (+)		Lower (-)	Upper (+)		Lower (-)	Upper (+)
CO_2	325	15	17	355	7	7	65	143	123
CH_4	45	19	28	109	34	90	19	11	29
N_2O	1	93	951	1	93	1 208	-2	102	122
GHG	372	13	16	467	10	21	26	21	30

Tier 1 and Tier 2 emissions and uncertainties are shown together in Figure 3.5.10. The figures show that the emissions and median emissions from Tier 2 are very similar. Further, the uncertainty estimates are in the same range for Tier 1 and Tier 2. The N_2O uncertainty is leaved out of Figure 3.5.10 b as the N_2O uncertainties are much higher than for CO_2 and CH_4. It must be noted that the uncertainty models, especially the Tier 1 model, are not suitable for very large uncertainty levels and therefore the uncertainty estimates for N_2O may only be seen as an indicator for a large uncertainties while the values are less accurate. The Tier 2 model has been developed to be more suitable for very large uncertainties, as it is possible to apply truncation for uncertainties. This has been included in the uncertainty calculation for fugitive emissions in case of N_2O, as the uncertainty level for the emission factors is 1 000 %. A truncation of 2 000 % has been applied to ensure that the emission factor interval is within an order of magnitude as given in IPCC Good Practice Guidance.

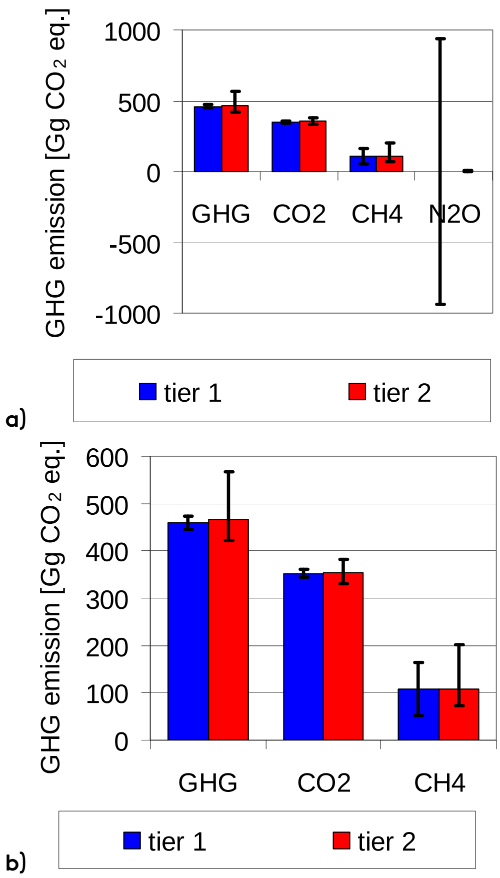

Figure 3.5.10 Emissions and uncertainty estimates from the Tier 1 and Tier 2 models; a) GHG, CH_4, CO_2 and N_2O, b) as figure a, but without N_2O

3.5.7 Source specific QA/QC and verification

The elaboration of a formal QA/QC plan started in 2004 and the first version was published in 2005 (Sørensen et al., 2005). The plan describes the concepts of quality work and definitions of sufficient quality, critical control points and a list of Points of Measuring, PM (Figure 3.5.10). Please refer to the general Chapter 1.6 for further information.

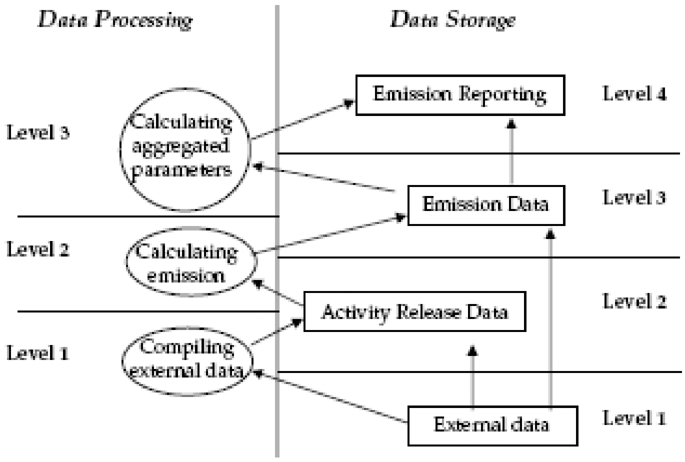

Figure 3.5.10 The general data structure for the Danish emission inventory (Sørensen et al., 2005).

Data storage level 1

Data storage level 1 refers to the data collected by NERI before any processing or preparing. Table 3.5.26 lists the external data deliveries used for the inventory of fugitive emissions. Further the table holds information on the contacts at the data delivery companies.

Table 3.5.26 List of external data sources.

Category	Data description	Activity data, emission factors or emissions	Reference	Contact(s)	Data agreement/ Comment
Offshore activities	Gas and oil production. Dataset for production of oil, gas and number of platforms. Amounts of offshore loading of ships	Activity data	The Danish Energy Agency	Jan H. Andersen	No formal data agreement.
Offshore flaring	Flaring offshore in oil and gas extraction	Activity data	The Danish Energy Agency	Peter Dal	Data agreement
Service stations	Data on gasoline sales from the Danish energy statistics.	Activity data	The Danish Energy Agency	Peter Dal	Data agreement
Gas transmission	Natural gas from the transmission company, sales and losses (meter differences)	Activity data	Energinet.dk	Christian Friberg B. Nielsen	Not necessary due to obligation by law
Onshore activities	Amounts of oil transport in pipeline and onshore loading to ships. Emissions from storage of raw oil in the terminal.	Activity data and emission data	DONG Olierør A/S	Stine B. Bergmann	No formal data agreement.
Gas distribution	Natural gas from the distribution company, sales and losses (meter differences)	Activity data	Naturgas Fyn, DONG Energy, HNG and MN	Gert Nielsen, Ida Pernille Schou	No formal data agreement.
Air emissions from refinery	Fuel consumption and emission data.	Activity data and emission data	Statoil A/S, A/S Danish Shell	Anette Holst, Lis Rønnow Rasmussen	No formal data agreement.
Storage and treatment of gas	Environmental reports from plants defined as large point sources (Lille Torup, Stenlille, Nybro)	Activity data	Various plants		Not necessary due to obligation by law
CO_2 emission factors for different sources	Reports according to the CO_2 emission trading scheme (ETS)	Activity data	Various plants		Not necessary due to obligation by law
Emission factors	Emission factors origin from a large number of sources	Emission factors	See chapter regarding emission factors		

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values.

The uncertainty for every dataset included in the inventory of fugitive emissions are evaluated and included in the Tier 1 and Tier 2 uncertainty calculations with short descriptions of the reasoning that underlie the specific values.

The general levels of uncertainty are relatively low. The largest uncertainties are expected for emissions from refineries and distribution of town gas, the latter being of minor importance to the total fugitive emissions.

For further comments regarding uncertainties, see Chapter 3.5.6.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the emission factors/calculation parameters with data from international guidelines, and evaluation of major discrepancies.

Systematic inter-country comparison has only been made on Data Storage Level 4. Refer to DS 4.3.2.

Data Storage level 1	3.Completeness	DS.1.3.1	Ensuring that the best possible national data for all sources are included, by setting down the reasoning behind the selection of datasets.

External data sources are the Danish Energy Agency, EU ETS reports and annual environmental reports from plants which are obligated to publish environmental reports. Further, annual reports from the gas distribution companies and the raw oil terminal are used. Some environmental reports and annual reports are supplemented with data and information from the given companies.

Only one national data set is found for all fugitive sources, are all data set is expected to be complete and include all activities/emissions form the source.

Energy statistics
The Danish Energy Agency reports fuel consumption statistics on the SNAP level based on a correspondence table developed in co-operation with NERI. Both traded and non-traded fuels are included in the Danish energy statistics. Data on offshore extraction, offshore flaring and gasoline sales are used for estimation of fugitive emissions.

Environmental reports
A large number of plants are obligated by law to publish an environmental report annually with information on fuel consumption and emissions, among other things. NERI compares data with those from previous years, discrepancies are checked and large fluctuations are verified.

Annual reports
The gas distribution companies and the raw oil terminal are not obligated to publish environmental reports. Instead the self-regulation reports, annual reports and/or additional data and information are used. All information is compared with previous years.

Reports for the European Union Greenhouse Gas Emission Trading System (EU ETS)
CO_2 emission factors for flaring offshore and in refineries are taken from the EU ETS reports since 2006 when the EU ETS reports became available. EU ETS reports are available for the individual Danish oil/gas production fields and for the refineries.

Emission factors from a wide range of sources
For specific references, see Chapter 3.5.4 regarding emission factors.

Data Storage level 1	4.Consistency	DS.1.4.1	The original external data has to be archived with proper reference.

All external data are stored in the inventory file system and are accessible for all inventory staff members. Data processing is carried out in seperate spreadsheets or databases to ensure that the external data are always available in the original form. Refer to Section 1.3.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery

Formal agreements are made with the Danish Energy Agency. Annual environmental reports are available due to legal requirements in this regard. The remaining data are published or delivered by the companies on voluntary basis. See Table. 3.5.26

Data Storage level 1	7.Transparency	DS.1.7.1	Listing of all archived datasets and external contacts.

See DS 1.3.1 and Table 3.5.26

Data Processing Level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source not part of DS.1.1.1 as input to Data Storage level 2 in relation to type and scale of variability.

Refer to Section 1.7 in the Danish NIR and the QA/QC Section 3.5.7.

Data Processing level 1	2.Comparability	DP.1.2.1	The methodologies have to follow the international guidelines suggested by UNFCCC and IPCC.

The methodologies in the inventory follow the principles in international guidelines by UNFCCC and IPCC.

Data Processing level 1	3.Completeness	DP.1.3.1	Identification of data gaps with regard to data sources that could improve quantitative knowledge.

Data gaps are found for distribution of town gas, as more companies are closed before the source was included in the Danish inventory. Emissions, which account for only a very limited part of the total fugitive emissions, are calculated on a very scarce data foundation.

More detailed data on emissions from exploration of oil and gas would be preferred, even though emissions calculated by use of the standard IPCC formula is in good agreement with an inventory made by the operators for one emission year. Unfortunately the inventory by the operators is not available for other years.

Regarding the VOC emissions from refineries, more detailed data material would be preferred.

Data Processing level 1	4.Consistency	DP.1.4.1	Documentation and reasoning of methodological changes during the time series and the qualitative assessment of the impact on time series consistency.

Since 2006 the EU-ETS data have been available for a number of sources. In all cases the new data replace use of data assumed to be less accurate. Therefore the CO_2 emission factors have been updated for all years, and no methodological change occur in the time series.

A change in the calculating procedure would entail elaboration of an updated description in Chapter 3.5.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time series

Time series for activity data on SNAP level as well as emission factors is used to identify possible errors in the calculation procedure.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

Emissions from offshore activities are compared to an inventory made by the operators and the emissions are found in good agreement.

For the remaining sources only one data set is available for calculation, and no verification using other measures are possible.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle, the equations used and the assumptions made must be described.

Descriptions are included in the NIR in Chapter 3.5.

Data Processing level 1	7.Transparency	DP.1.7.2	Clear reference to dataset at Data Storage level 1

Notes on data sources are included in the calculation files for all input data.

Data Processing level 1	7.Transparency	DP.1.7.3	A manual log to collect information about recalculations.

A log holding information on recalculations are included in the national inventory system. Further, a log is prepared annually holding information on status of the inventory work and recalculations for each source in the fugitive sector.

Data storage level 2

Data Storage level 2	5.Correctness	DS.2.5.1	Check if a correct data import to level 2 has been made

To ensure a correct connection between data on level 2 to data on level 1, different controls are in place, e.g. control of sums and random tests.

Data storage level 4

Data Storage level 4	4.Consistency	DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.

Time series for IEFs are checked to identify large fluctuations, which are afterwads investigated and explained. The level of the IEFs are compared to other relevant EFs, e.g. in standard EFs in guidebooks and guidelines.

The IEFs for transmission and distribution of natural gas are low compared to other countries as the Danish distribution network is relatively new and made of plastics, leading to negliable fugitive losses under normal circumstances. Only fugitive losses are due to excavations and maintenance and construction work.

Other QC procedures

A list of QA/QC tasks are performed directly in relation to the fugitive emission part of the Danish emission inventories. The following procedures are carried out to ensure the data quality:

- Checking of time series in the IPCC and SNAP source categories. Considerable changes are controlled and explained.
- Comparison with the inventory of the previous year. Any major changes are verified.
- Total emission, when aggregated to reporting tables, is compared with totals based on SNAP source categories (control of data transfer).
- A manual log table in the emission databases is applied to collect information about recalculations.
- The emission from the large point sources (refineries, gas treatment and storage plants) are compared with the emission reported the previous year.
- Some automated checks have been prepared for the emission databases:
  - Check of units for fuel rate, emission factor and plant-specific emissions.
  - Check of emission factors for large point sources. Emission factors for pollutants that are not plant-specific should be the same as those defined for area sources.
  - Additional checks on database consistency.
- Emission factor references are incorporated in the emission database, itself.
- Data sources are incorporated in the fugitive emission models.
- Most emission factor sources are incorporated in the fugitive emission models.
- Annual environmental reports and other hard copy data sources are kept for subsequent control of plant-specific emission data.

The QC work will continue in future years.

National external review

In 2009 a sector report for fugitive emissions from fuels was published (Plejdrup et al. 2009). The report was reviewed by Anette Holst from the Statoil A/S refinery.

3.5.8 Recalculations

In the emission inventory for 2010 there have been some recalculations as listed below.

Refineries

Emissions of CH_4 and NMVOC has been changed for the years 1994-2000 and 2002-2009 according to VOC measurements in carried out in 2001, as no further information on fugitive emissions from the refineries are or will become available for other historical years. This is the result of an extended communication with one refinery leading to a recommendation to use measured emissions, and not an estimated emissions calculated by weighting the measured emissions by the annual processed crude oil amount as done in previous inventories. The fugitive emissions are more related to other conditions than the processed amounts. The split of VOC emissions provided by the refineries have been revised in order to apply more similar approach for the two refineries. For Both refineries annual emissions of NMVOC and CH_4 are not available, and emissions are following based on the provided VOC emissions and assumptions for the part of VOC being NMVOC and CH_4, respectively. Assumptions are based on information form the refineries and on literature study of international proportions/conditions. In the previous inventory CH_4 is estimated as 10 % of VOC based on information from one refinery.

The CH_4 recalculation has increased the total fugitive emission by 1 % in 2009. The largest recalculation is in 2007 (3 %).

Updated SO_2 emissions for the years 2005-2009 provided by a refinery are included in the inventory. The recalculation has increased the total fugitive SO_2 emissions by 6 % in 2009.

Gas distribution

Emission factors for CH_4 and NMVOC for town gas distribution has been corrected for an error. Distribution of town gas is a minor source and the recalculation is insignificant for all years (< 0.001 % of the total fugitive CH_4 emission in 2009).

Offshore flaring

Activity data has been corrected for 2008 for two offshore installations. The calorific value has been corrected for the whole time series according to the average calorific value in the EU ETS reports for 2008-2010 which affects the emission factor for CO_2 and NMVOC. Further the emission factor for NMVOC has been corrected by including a conversion from m_s3 to m_n3. For 2007 the emission factor is changed to the average CO_2 emission factor from EU ETS for 2008-2010 as the 2007 EU ETS reports are not as detailed for 2007 as for the following years. The activity data has been updated according to the latest figures from the Danish Energy Agency.

The recalculation has increased the fugitive CO_2 emission by 1 % in 2009 and 8 % in 1990.

Flaring in refineries

The CO_2 emission factor has been updated for the years 1990-2006 for flaring in refineries. The emission factor applied is estimated as the average emission factor from the EU ETS reports for the years 2006-2010 and 2007-2010 for the two refineries.

The recalculation has decreased the fugitive CO_2 emission by 0.2 % in 2009 and 0.4 % in 1990.

New sources

CO_2 emissions have been included in the inventory for offshore extraction, pipeline transport and storage of oil, transmission of natural gas, and distribution of natural gas and town gas. This has increased to total fugitive CO_2 emission in 2009 by 1.4 % and in 1990 by 0.6 %.

3.5.9 Source specific planned improvements

The following future improvements are suggested.

- **Emissions from storage of fuels in tank facilities:** The current edition of the Danish emission inventory holds emissions from storage and refining of crude oil and from service stations. To make the inventory complete emissions from storage of fuels outside the refineries in tank facilities will be included in the future if data are available. Work is ongoing to locate large tank facilities in Denmark and collect the available data. In cases where no emission estimates or measurements are available a set of emission factors have to be set up.

- **Emissions from offshore extraction of oil and gas:** The fugitive emissions from extraction of oil and gas are based on a standard formula. If better estimates become available those will be implemented.

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4 Industrial processes (CRF sector 2)

4.1 Overview of the sector

4.1.1 Emission overview

The aim of this chapter is to present industrial emissions of greenhouse gases, not related to generation of energy. An overview of the sources identified is presented in Table 4.1 with an indication of the contribution to the industrial part of the emission of greenhouse gases in 2010. The emissions are extracted from the CRF tables.

Table 4.1 Overview of industrial greenhouse gas sources (2010).

Process	IPCC Code	Substance	Emission ktonne CO_2 eq.	%
Refrigeration	2F	HFCs+PFCs	699	41.5
Cement	2A		672	39.9
Foam blowing	2F	HFCs	87.3	5.18
Lime	2A		45.6	2.71
Limestone and dolomite use	2A		45.6	2.70
Other (lubricants)	2G		33.2	1.97
Other (laboratories, double glaze windows)	2F	SF_6	23.7	1.41
Aerosols / Metered dose inhalers	2F	HFCs	16.7	0.99
Other (yellow bricks)	2A		15.8	0.94
Electrical equipment	2F	SF_6	14.2	0.84
Other (fibre optics)	2F	HFCs+PFCs	10.5	0.62
Other (container glass, glass wool)	2A		9.33	0.55
Other (expanded clay products)	2A		6.00	0.36
Catalysts / fertilisers	2B		2.12	0.13
Road paving	2A		1.73	0.10
Food and Drink	2D		1.56	0.092
Asphalt roofing	2A		0.016	0.001
Metal production	2C		NO	-
Nitric acid	2B	N_2O	NO	-
Total			1 685	100

The subsectors *Mineral products* (2A) constitutes 47 %, *Chemical industry* (2B) constitutes below 1 %, *Metal production* (2C) constitutes 0 %, *Consumption of halocarbons and SF_6* (2F) constitutes 51 %, *Other, Food and Drink* (2D) constitutes below 1 %, and *Other, Lubricants* (2G) constitutes 2.0 % of the industrial emission of greenhouse gases. The total emission of greenhouse gases (excl. LULUCF) in Denmark is estimated to 61.2 Mt CO_2 equivalents, of which industrial processes contribute with 1.69 Mt CO_2 equivalents (2.8 %). The emission of greenhouse gases from industrial processes from 1990-2010 are presented in Figure 4.1.

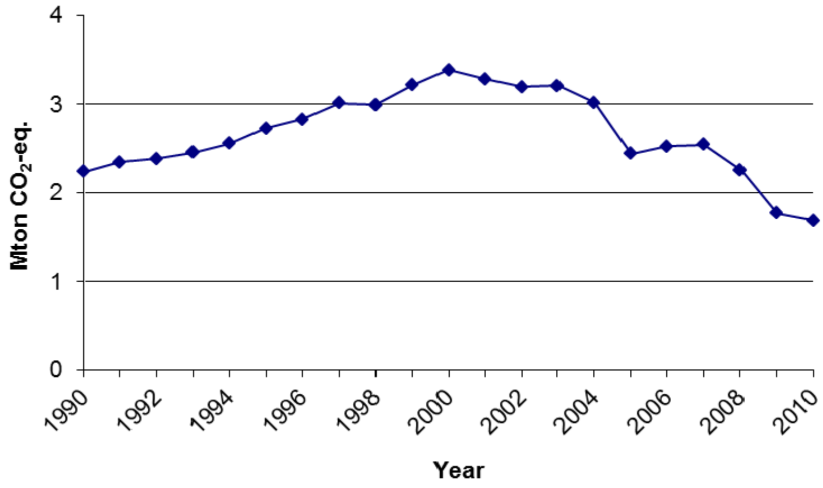

Figure 4.1 Emission of greenhouse gases from industrial processes (CRF Sector 2) from 1990-2010.

The key categories in the industrial sector – refrigeration and cement - constitute 1.14 and 1.10 % of the total emission of greenhouse gases. The trends in greenhouse gases from the industrial sector/subsectors are presented in Table 4.2 and they will be discussed subsector by subsector below. The emissions are extracted from the CRF tables.

Table 4.2 Emission of greenhouse gases from industrial processes in different subsectors from 1990-2010.

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (kt CO_2)									
A. Mineral Products	1 069	1 405	1 616	1 544	1 607	1 606	1 320	881	796
B. Chemical Industry	0.80	0.80	0.65	3.01	2.18	2.16	2.40	2.13	2.12
C. Metal Production	28.4	38.6	40.7	15.6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Food and Drink	4.45	3.91	3.90	4.46	2.17	1.72	2.67	1.92	1.56
G. Other	49.7	48.8	39.7	37.6	37.5	37.9	34.0	31.2	33.2
Total	1 152	1 497	1 701	1 604	1 649	1 647	1 360	916	833
CH_4	-	-	-	-	-	-	-	-	-
N_2O (kt N_2O)									
B. Chemical Industry	3.36	2.92	3.24	NO	NO	NO	NO	NO	NO
HFCs (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	NE	218	607	802	823	850	853	799	800
PFCs (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	NE	0.50	17.9	13.9	15.7	15.4	12.8	14.2	13.3
SF_6 (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	44.5	107	58.8	21.3	35.6	29.9	31.2	36.3	37.9

4.1.2 Methodology overview

Table 4.3 gives a brief overview over methodologies applied for industrial processes. Further description of the applied methodologies can be found in the following chapters.

Table 4.3 Methodology overview.

			Tier	EF	Key category
Industrial Proc.	2A1 Cement production	CO_2	T3	PS	Yes
Industrial Proc.	2A2 Lime production	CO_2	T2	T1	No
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	T2	T1,PS	No
Industrial Proc.	2A5 Asphalt roofing	CO_2	T1	CS	No
Industrial Proc.	2A6 Road paving with asphalt	CO_2	T1	CS	No
Industrial Proc.	2A7 Glass and Glass wool	CO_2	T3	T1	No
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	T2	PS	No
Industrial Proc.	2C1 Iron and steel production	CO_2	T1	T1	No
Industrial Proc.	2D2 Food and Drink	CO_2	T2	T2,PS	No
Industrial Proc.	2G Lubricants	CO_2	T1	T1	No
Industrial Proc.	2B2 Nitric acid production	N_2O	T1	PS	Yes
Industrial Proc.	2F Consumption of HFC	HFC	T1,T2	CS	Yes
Industrial Proc.	2F Consumption of PFC	PFC	T1,T2	CS	No
Industrial Proc.	2F Consumption of SF6	SF_6	T1,T2	CS	No

4.1.3 Key categories

Key Category Analysis (KCA) for the years 1990 and 2010 as well as for the trend has been carried out. Table 4.4 present the result. A detailed KCA is presented in Chapter 1.5 and Annex 1.

Cement production is identified as key source (level) according to Tier 1 for 1990 and 2010. Nitric acid production is identified as key source in 1990 and the trend is also a key source according to Tier 1 and 2. Consumption of HFC is identified as key source in 2010 and the trend is also a key source according to Tier 1 and 2.

Table 4.4 Key Category Analysis for Industrial processes.

			Tier 1			Tier 2		
			1990	2010	1990-2010	1990	2010	1990-2010
Industrial Proc.	2A1 Cement production	CO_2	Level	Level				
Industrial Proc.	2A2 Lime production	CO_2						
Industrial Proc.	2A3 Limestone and dolomite use	CO_2						
Industrial Proc.	2A5 Asphalt roofing	CO_2						
Industrial Proc.	2A6 Road paving with asphalt	CO_2						
Industrial Proc.	2A7 Glass and Glass wool	CO_2						
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2						
Industrial Proc.	2C1 Iron and steel production	CO_2						
Industrial Proc.	2D2 Food and Drink	CO_2						
Industrial Proc.	2G Lubricants	CO_2						
Industrial Proc.	2B2 Nitric acid production	N_2O	Level		Trend	Level		Trend
Industrial Proc.	2F Consumption of HFC	HFC		Level	Trend		Level	Trend
Industrial Proc.	2F Consumption of PFC	PFC						
Industrial Proc.	2F Consumption of SF6	SF_6						

4.2 Mineral products (2A)

4.2.1 Source category description

The subsector *Mineral products* (2A) cover the following processes:

- Production of cement.
- Production of lime (and quicklime).

- Production of bricks, tiles and expanded clay products.
- Limestone and dolomite use.
- Roof covering with asphalt materials.
- Road paving with asphalt.
- Production of container glass/glass wool.

Production of cement is identified as a key category; see *Annex 1: Key Category Analyses*.

The time series for the emission of CO_2 from *Mineral products* (2A) are presented in Table 4.5. The emissions are extracted from the CRF tables and the values are rounded.

Table 4.5 Time series for emission of CO_2 (kt) from Mineral products (2A).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
1. Production of Cement	882	1 204	1 385	1 363	1 395	1 407	1 155	764	672
2. Production of Lime	116	87.7	76.7	63.5	69.2	66.9	65.6	43.2	45.6
3. Limestone and dolomite use	13.7	53.7	89.7	56.2	71.7	49.6	38.7	37.9	45.6
5. Asphalt roofing	0.019	0.020	0.032	0.024	0.024	0.025	0.025	0.016	0.016
6. Road paving	1.76	1.77	1.72	1.84	1.84	2.00	1.92	1.64	1.73
7. Other									
Glass and Glass wool	17.4	14.1	15.9	12.6	13.5	15.0	15.1	10.8	9.33
Yellow Bricks	23.0	28.8	32.6	32.2	34.8	38.0	28.4	16.5	15.8
Expanded Clay	14.9	15.3	14.2	14.0	20.9	26.9	16.1	6.48	6.00
Total	1 069	1 405	1 616	1 544	1 607	1 606	1 320	881	796

The increase in CO_2 emission is most significant for the production of cement until 2007; however, in the latest years the emission has been decreasing. The overall development in the CO_2 emission from 1990 to 2010 shows a decreasing trend from 882 to 672 kt CO_2, i.e. by 24 %. The maximum emission occurred in 2004 and constituted 1 459 kt CO_2; see Figure 4.2.

The increase can be explained by the increase in the annual cement production. The emission factor has only changed slightly as the distribution between types of cement especially grey/white cement has been almost constant from 1990-1997. The decrease during the latest years may be explained by the decrease in the construction activity.

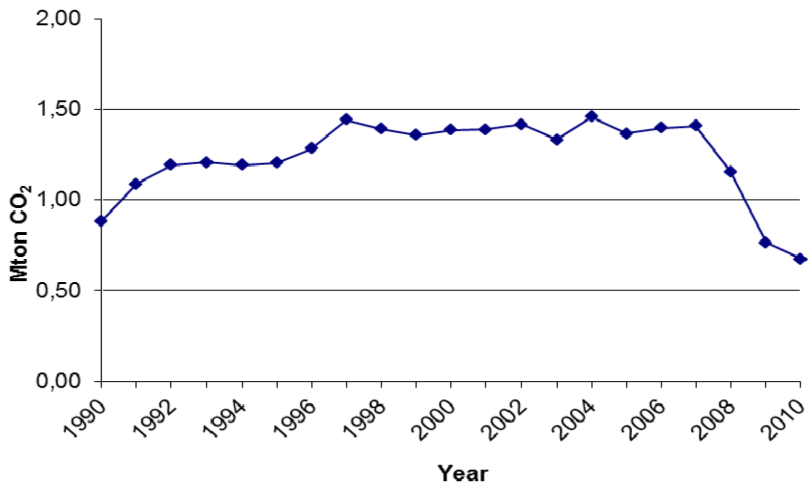

Figure 4.2 Emission of CO_2 from cement production.

4.2.2 Methodological issues

General

The CO_2 emission from the production of cement has been estimated by the company (Aalborg Portland, 2011a; 2011b; 2011c). The emission factor has been estimated from the loss of ignition determined for the different kinds of clinkers produced, combined with the volumes of grey and white cements produced. Determination of loss of ignition takes into account all the potential raw materials leading to release of CO_2 and omits the Ca-sources leading to generation of CaO in cement clinker without CO_2 release. The applied methodology is in accordance with EU guidelines on calculation of CO_2 emissions (Aalborg Portland, 2008).

However, from the year 2005 the CO_2 emission determined by Aalborg Portland for EU-ETS is used in the inventory (Aalborg Portland, 2010a). The reporting to EU-ETS also provides detailed information of alternative fuels used in the production of clinker; see Table 4.6.

Table 4.6 Alternative fuels used in production of cement clinker (Aalborg Portland 2011a).

Fuel type	Biomass fraction, %
Cemmiljø fuel	30-56
Paper residues	79
Dry wastewater sludge	100
Meat and bone meal	100
Tyre residues	15
Textile residues from tyres	100
Wood waste	100
Garden waste	100
Glycerine	100

Activity data and emission factors for cement production are presented in Table 4.7.

Table 4.7 Activity data, emission factors, and CO_2 emission for cement production.

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Tonnes TCE	1 619 976	2 273 775	2 612 721	2 706 371	2 842 282	2 946 294	2 551 346	1 663 126	1 454 043
Tonnes clinker	NI	NI	2 452 394	2 520 788	2 632 112	2 706 048	2 269 687	1 493 230	1 313 654
Tonnes clinker + white cement[1]	1 406 212	2 353 123	-	-	-	-	-		
EF tonnes CO_2 pr tonnes TCE[2]	0.545	0.529	-	-	-	-	-		
EF tonnes CO_2 pr tonnes TCE[3]	-	-	0.530	-	-	-	-		
EF tonnes CO_2 pr tonnes TCE[4]	-	-	-	0.504	0.491	0.478	-		
EF tonnes CO_2 pr tonnes clinker[5]	*0.628*	*0.512*	0.565	0.541	0.530	0.520	0.509	0.512	0.512
Tonnes CO_2	882 402	1 203 777	1 384 742	1 363 000	1 395 466	1 408 329	1 154 749	764 407	672 224

1. 1990-1997: Amount of clinker produced has not been measured as for 1998-2008. Therefore, the amount of GLK-, FHK-, SKL-/RKL-clinker and white cement is used as estimate of total clinker production.
2. 1990-1997: EF based on information provided by Aalborg Portland.
3. 1998-2004: EF based on information provided by Aalborg Portland (Aalborg Portland, 2008c).
4. 2005-2009: EF based on emissions reported to EU-ETS (Aalborg Portland, 2010a).
5. 1998-2009: EF based on clinker production statistics provided by Aalborg Portland (Aalborg Portland, 2011).

NI No information.

The EF depends on the ratio: white/grey cement and the ratio between three types of clinker for grey cement: GKL-clinker/FHK-clinker/SKL-RKL-clinker. The ratio white/grey cement is known from 1990-1997 with maximum in 1990 and thereafter decreasing. The ratio: GKL-clinker/FHK-clinker/SKL-RKL-clinker is known from 1990-1997. The individual EF for the different clinker types are respectively: 0.477, 0.459, and 0.610 tonne CO_2 per ton. The production of SKL/RKL-clinker peaks in 1991 and decreases hereafter. FKH-clinker is introduced in 1992 and increase to 35 % in 1997.

When estimating the activity for 1990-1997 the amount of white cement is summed with the amount of clinker for grey cement as an estimate for total clinker production. Information on the total production of clinker from 1998-2010 has been provided by the company recently (Aalborg Portland 2008, 2011c).

The company has at the same time stated that data until 1997 can not be improved as they are not available anymore.

The CO_2 emission from the production of burnt lime (quicklime) as well as hydrated lime (slaked lime) has been estimated from the annual production figures, registered by Statistics Denmark – see Table 4.8 and emission factors.

Table 4.8 Statistics for production of lime and slaked lime (tonnes) (Statistics Denmark, 2011).

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Lime	127 978	100 789	92 002	71 239	78 652	75 504	74 981	46 202	50 397
Slaked lime	27 686	15 804	8 159	13 839	13 731	14 028	12 326	12 842	11 173

The emission factors applied are 0.785 kg CO_2 per kg CaO as recommended by IPCC (IPCC, 1997, vol. 3, p. 2.8) and 0.541 kg CO_2 per kg hydrated lime (calculated from company information on composition of hydrated lime (Faxe Kalk, 2003)). One Danish company – Faxe Kalk – is covered by the EU-ETS, however, the company do only account for approximately 75 % of the Danish production of lime and hydrated lime (average from 1999-2008). A number of small companies accounts for the remaining of the Danish production.

The CO_2 emission from the production of bricks and tiles has been estimated from information on annual production registered by Statistics Denmark, corrected for amount of yellow bricks and tiles. This amount is unknown and, therefore, is assumed to be 50 %; see Table 4.9.

Table 4.9 Statistics for production of yellow bricks and expanded clay products (tonnes) (Statistics Denmark, 2010).

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Bricks (1000 pieces.)	291 348	362 711	414 791	407 940	465 504	348 928	322 137	226 363	212 051
Yellow bricks[1]	291 348	362 711	414 791	407 940	465 504	348 928	322 137	226 363	212 051
Expanded clay products	331 760	340 881	316 174	310 901	411 869	504 925	303 948	140 915	157 378

1. Assumptions: Brick weight: 2 kg/brick, 50 % yellow bricks.

The content of $CaCO_3$ and a number of other factors determine the colour of bricks and tiles and, in the present estimate, the average content of $CaCO_3$ in clay has been assumed to be 18 % (the $CaCO_3$ content in clay for bricks varies from e.g. 0.5 % in clay for red bricks and 19.8 % in clay for yellow bricks (Tegl Info, 2004). The emission factor for lime (0.44 kg CO_2 per kg $CaCO_3$) has been used to calculate the emission factor for yellow bricks: 0.079 tonne CO_2 per tonne yellow bricks. For verification of this approach, see Figure 4.3.

For 2006-2010 emission factors have been derived from CO_2 emissions reported by the brickworks to EU-ETS (confidential reports from approximately 20 brickworks) and production statistics (Statistics Denmark, 2011). The emission factors are calculated to 0.0728-0.1089 tonne CO_2 per tonne yellow bricks.

The CO_2 emission from the production of container glass/glass wool has been estimated from production statistics published in environmental reports from the producers (Rexam Glass Holmegaard, 2007; Ardagh Glass Holmegaard, 2011; Saint-Gobain Isover, 2011) and emission factors based on release of CO_2 from specific raw materials (stoichiometric determination).

The CO_2 emission from consumption of limestone for flue gas cleaning has been estimated from statistics on generation of gypsum (wet flue gas cleaning processes) and the stoichiometric relations between gypsum and release of CO_2:

$$SO_2\ (g) + ½O_2\ (g) + CaCO_3\ (s) + 2H_2O \rightarrow CaSO_4{,}2H_2O\ (s) + CO_2\ (g)$$

and the emission factor is: 0.2325 tonnes CO_2 per tonne gypsum.

Statistics on the generation of gypsum from power plants are compiled by Energinet.dk (2008). However, for 2006 - 2009 information on consumption of $CaCO_3$ at the relevant power plants has been compiled (from environmental reports) and used in the calculation of CO_2 emission from flue gas cleaning.

Information on the generation of gypsum at waste incineration plants does not explicitly appear in the Danish waste statistics (Miljøstyrelsen, 2012). However, the total amount of waste products generated can be found in the statistics. The amount of gypsum is calculated by using information on flue gas cleaning systems at Danish waste incineration plants (Illerup et al., 1999; Nielsen & Illerup, 2002) and waste generation from the different flue gas cleaning systems (Hjelmar & Hansen, 2002).

The CO_2 emission from the production of expanded clay products has been estimated from production statistics compiled by Statistics Denmark and an emission factor of 0.045 tonne CO_2 per tonne product. For 2006-2009 emission factors have been derived from CO_2 emissions reported to EU-ETS (Damolin, 2011; Maxit, 2011) and production statistics (Statistics Denmark, 2011). The emission factors are calculated to 0.0507 and 0.0529 tonne CO_2 per tonne product.

The indirect emission of CO_2 from asphalt roofing and road paving has been estimated from production statistics compiled by Statistics Denmark and default emission factors presented by IPCC (1997) and EMEP/CORINAIR (2004). The default emission factors, together with the calculated emission factor for CO_2, are presented in Table 4.10.

Table 4.10 Default emission factors for application of asphalt products.

		Road paving with asphalt	Use of cutback asphalt	Asphalt roofing
CH_4	g pr tonnes	5	0	0
CO	g pr tonnes	75	0	10
NMVOC	g pr tonnes	15	64 935	80
Carbon content fraction of NMVOC	%	0.667	0.667	0.8
Indirect CO_2	Kg pr tonnes	0.168	159	0.250

EU-ETS (EU Emission Trading Scheme)

Guidelines for calculating company specific CO_2 emissions are developed by the EU (EU, 2007). The guidelines present standard methods for minor companies and methods for developing individual plans for major companies. The standard methods include default emission factors similar to the default emission factors presented by IPCC (e.g. for limestone), whereas, the major companies has to use individual methods to determine the actual composition of raw materials (e.g. purity of limestone or Ca per Mg ratio in dolomite) or the actual CO_2 emission from the specific process.

4.2.3 Uncertainties and time series consistency

The time series are presented in Table 4.5. The methodology applied for the years 1990-2010 is considered to be consistent. The emission factor has only changed slightly as the distribution between types of cement, especially grey/white cement, has been almost constant from 1990-1997. Furthermore, the activity data originates from the same company for all years.

For the production of lime and bricks, as well as container glass and glass wool, the same methodology has also been applied for all years. The emission factors are based either on stoichiometric relations or on a standard assumption of $CaCO_3$-content of clay used for bricks. The source for the activity data is, for all years, Statistics Denmark.

The source specific uncertainties for mineral products are presented in Chapter 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.2.4 Verification

The estimation of CO_2 release from the production of bricks based on an assumption of 50 % yellow bricks has been verified by comparing the estimate with actual information on emission of CO_2 from calcination of lime compiled by the Danish Energy Agency (DEA) (DEA, 2004). The information from the companies (tile-/brickworks; based on measurements of $CaCO_3$ content of raw material) has been compiled by DEA in order to allocate a CO_2 quota to Danish companies with the purpose of future reductions. The result of the comparison is presented in Figure 4.3.

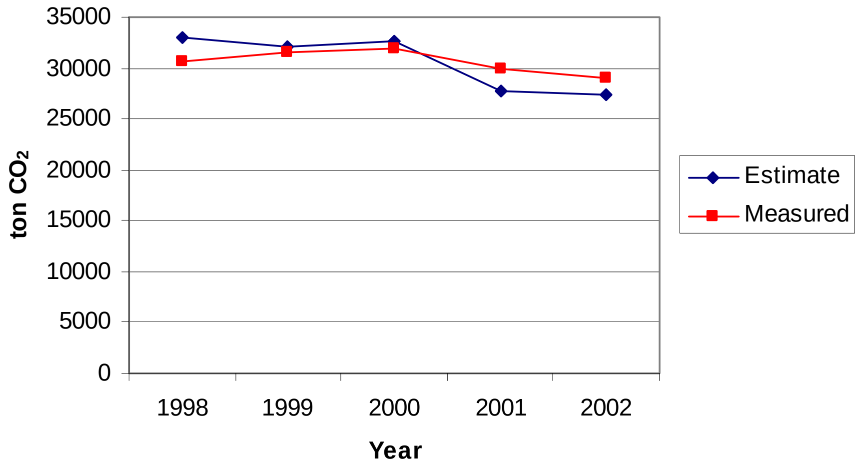

Figure 4.3 Estimated and "measured" CO_2 emission from tile-/brickworks; "measured" means information provided to the Danish Energy Agency by the individual companies (DEA, 2004).

Figure 4.3 shows a reasonable correlation between the estimated and measured CO_2 emission.

The ERT has recommended Denmark to develop a national EF based on the IEF for the years 2006-2010 i.e. emissions based on company reports to EU-ETS. Figure 4.4 presents three scenarios for yellow bricks and expanded clay products:

1. Applied methodology from 1990-2005. The EF is based on the assumption that clay for yellow bricks contains 18% $CaCO_3$.

2. CO_2 emission based on company reporting to EU ETS for the years 2006-2010.

3. Methodology recommended by UNFCCC ERT. The national EF is based on an average of IEF from the years 2006-2010.

Expanded clay products are also a mix of different products with different $CaCO_3$ addition or content. The actual mix is unknown.

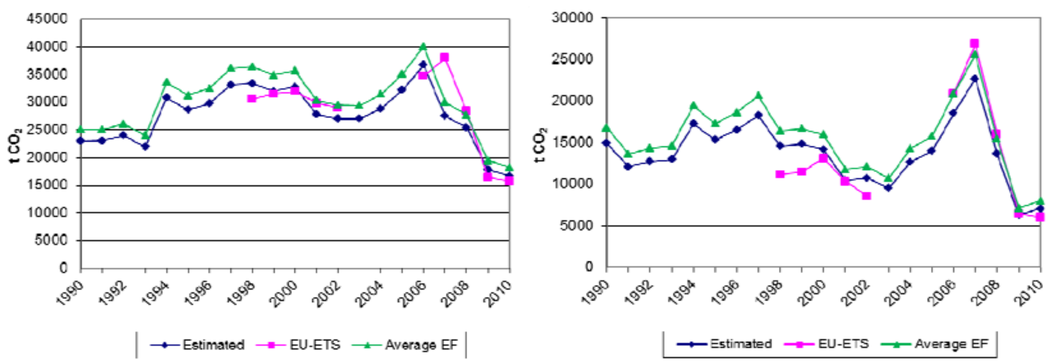

Figure 4.4 CO_2 emission from production of yellow bricks and expanded clay products. The scenarios present the applied methodology (Estimated), available EU-ETS data, and emissions based on a national EF (Average EF) as recommended by the UNFCCC ERT.

The recommended methodologies have weaknesses as the (average) EFs are based on actual reported emissions from brickworks and an assumed amount of yellow bricks as well as actual reported emissions from producers of expanded clay products and an assumed product mix. The reliability of the EFs therefore depends on non verifiable assumptions.

Changes in the methodologies do not change/improve the base year estimates and the best and most precise estimate for the resent years is considered to be the estimates made by the companies for EU-ETS.

4.2.5 Recalculations

No source specific recalculations have been performed regarding emissions from mineral products.

4.2.6 Source specific planned improvements

Company specific information on consumption of $CaCO_3$ for flue gas cleaning at waste incineration plants will be included if possible. Import/export statistics for cement clinker will be investigated.

4.3 Chemical industry (2B)

4.3.1 Source category description

The subsector *Chemical industry* (2B) covers the following processes:

- Production of nitric acid/fertiliser.
- Production of catalysts/fertilisers.

Production of nitric acid is identified as a key category due to the trend. However this is due to the closing of the lone plant producing nitric acid in Denmark in 2004.

The time series for emission of CO_2 and N_2O from *Chemical industry* (2B) are presented in Table 4.11.

Table 4.11 Time series for emission of greenhouse gasses from Chemical industry (2B).

2B	1990	1995	2000	2005	2006	2007	2008	2009	2010
2. Nitric acid production (kt N_2O)	3.36	2.92	3.24	NO	NO	NO	NO	NO	NO
2. Nitric acid production (kt CO_2 eq.)	1 043	904	1 004	NO	NO	NO	NO	NO	NO
5. Other (kt CO_2)	0.80	0.80	0.65	3.01	2.18	2.16	2.40	2.13	2.12
Total (kt CO_2 eq.)	1 044	905	1 004	3.01	2.18	2.16	2.40	2.13	2.12

The emissions are extracted from the CRF tables and the values are rounded.

The emission of N_2O from nitric acid production is the most considerable source of GHG from the chemical industry. The trend for N_2O from 1990 to 2003 shows a decrease from 3.36 to 2.89 kt, i.e. -14 %, and a 40 % decrease from 2003 to 2004. However, the activity and the corresponding emission show considerable fluctuations in the period considered and the decrease from 2003 to 2004 can be explained by the closing of the plant in the middle of 2004.

From 1990 to 2010, the emission of CO_2 from the production of catalysts/fertilisers has increased from 0.80 to 2.12 kt with maximum in 2004-5, due to an increase in the activity as well as changes in raw material consumption.

4.3.2 Methodological issues

The N_2O emission from the production of nitric acid/fertiliser is based on measurement data for 2002. For the previous years, the N_2O emission has been estimated from annual production statistics from the company and an emission factor of 7.5 kg N_2O per tonne nitric acid, based on the 2002 measurements (Kemira Growhow, 2004). The production of nitric acid ceased in the middle of 2004.

The CO_2 emission from the production of catalysts/fertilisers is based on information in an environmental report from the company (Haldor Topsøe, 2011), combined with personal communication. In the environmental report, the company has estimated the amount of CO_2 from the process and the amount from energy conversion. Based on information from the company, the emission of CO_2 has been calculated from the composition of raw materials used in the production (for the years 1990 and 1996-2004). The raw materials are e.g.: $CaCO_3$, $CoCO_3$, $CsCO_3$, Cu_2CO_3, K_2CO_3, $MnCO_3$, and $ZnCO_3$; however, the actual composition is confidential. For 2005 to 2010 the EF is assumed to be the same as in 2004 based on the same activity (produced amount). For the years 1991-1995, the production, as well as the CO_2 emission, has been assumed to remain the same as in 1990.

4.3.3 Uncertainties and time series consistency

The time series are presented in Table 4.9. The applied methodology regarding N_2O is considered to be consistent. The activity data is based on information from the specific company. The emission factor applied has been constant for the whole time series and is based on measurements in 2002. The production equipment has not been changed during the period.

The estimated CO_2 emissions from production of catalysts/fertilisers are considered to be consistent as they are based on stoichiometric relations combined with company assumptions for the years 1991-1995.

The source specific uncertainties for the chemical industry are presented in Section 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.3.4 Recalculations

No source specific recalculations have been performed regarding emissions from the chemical industry.

4.3.5 Source specific planned improvements

No improvements are planned for this sector.

4.4 Metal production (2C)

4.4.1 Source category description

The subsector *Metal production* (2C) covers the following process:

- Steelwork

The time series for emission of CO_2 from *Metal production* (2C) is presented in Table 4.12. The emissions are extracted from the CRF tables and the values presented are rounded.

Table 4.12 Time series for emission of CO_2 (ktonne) from Metal production (2C).

2C	1990	1995	2000	2005	2006	2007	2008	2009	2010
1. Iron and steel production	28.4	38.6	40.7	15.6	NO	NO	NO	NO	NO

From 1990 to 2001, the CO_2 emission from the electro-steelwork increased from 28 to 47 ktonnes, i.e. by 68 %. The increase in CO_2 emission is similar to the increase in the activity as the consumption of metallurgical coke per amount of steel sheets and bars produced has almost been constant during the period. The electro-steelwork reopened and closed down again in 2005.

4.4.2 Methodological issues

The CO_2 emission from the consumption of metallurgical coke at steelworks has been estimated from the annual production of steel sheets and steel bars combined with the consumption of metallurgical coke per produced amount (Stålvalseværket, 2002). The carbon source is assumed to be coke and all the carbon is assumed to be converted to CO_2 as the carbon content in the products is assumed to be the same as in the iron scrap. The emission factor (consumption of metallurgical coke per tonnes of product) has been almost constant from 1994 to 2001; steel sheets: 0.012-0.018 tonne metallurgical coke per tonne and steel bars: 0.011-0.017 tonne metallurgical coke per tonne. The emission factor (3.6 tonnes CO_2 per tonne metallurgical coke) is based on values in the IPCC-guidelines (IPCC (1997), vol. 3, p. 2.26). The CO_2 emission has been calculated from amounts of final products but related to amount of steel scrap handled at the electro steelwork. Emissions of CO_2 for 1990-1991 and for 1993 have been determined with extrapolation and interpolation, respectively.

4.4.3 Uncertainties and time series consistency

The time series (see Table 4.12) is considered to be consistent as the same methodology has been applied for the whole period. The activity, i.e. amount of steel sheets and bars produced as well as consumption of metallurgical coke, has been published in environmental reports. In 2002, production stopped. For 2005 the production has been assumed to be one third the production in 2001 as the steelwork was operating between 4 and 6 months in 2005.

The source specific uncertainties for the metal production are presented in Section 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.4.4 Recalculations

No source specific recalculations have been performed regarding emissions from the metal production.

4.4.5 Source specific planned improvements

No improvements are planned in this sector.

4.5 Other production (2D)

4.5.1 Source category description

The subsector *Other production*, Food and Drink (2D2) cover the following process:

- Bread
- Beer
- Spirits
- Sugar production
- Meat (fish etc. frying/curing)
- Margarine and solid cooking fats
- Coffee roasting

Sugar production is the only process contributing to emission of CO_2 whereas all processes contribute to emission of NMVOC. The time series for emission of CO_2 from *Other production, Food and Drink* (2D) is presented in Table 4.13.

Table 4.13 Time series for emission of CO_2 (kt) from Other production, Food and Drink (2D).

2D	1990	1995	2000	2005	2006	2007	2008	2009	2010
2. Food and Drink	4.45	3.91	3.90	4.46	2.17	1.72	2.67	1.92	1.56

The emissions are extracted from The CRF tables and the values are rounded.

4.5.2 Methodological issues

The CO_2 emission from the refining of sugar is estimated from production statistics for sugar and a number of assumptions: consumption of 0.02 tonne $CaCO_3$ per tonne sugar and precipitation of 90 % CaO resulting in an emission factor at 0.0088 tonne CO_2 per tonne sugar. The assumptions are based on environmental reports covering the year 2002. However, from the year 2006-2010 the CO_2 emission compiled by the company for EU-ETS is used in the inventory (Danisco, 2011).

The time series for sugar production is presented in Table 4.14.

Table 4.14 Production of sugar (tonne).

2D	1990	1995	2000	2005	2006	2007	2008	2009	2010
Sugar	505 709	444 143	487 107	488 934	450 666	329 811	400 261	428 446	420 000[1]

1. The production in 2010 has been estimated.

4.5.3 Uncertainties and time series consistency

The time series is presented in Table 4.13. The same methodology has been applied for 1990-2005. From 2006-2010 data from EU-ETS has been available and therefore included in the inventory.

4.5.4 Recalculations

No source specific recalculations have been performed for the sector *Food and Drink*.

4.5.5 Source specific planned improvements

Implementation of an EF based on information in the company reporting to EU-ETS will be investigated.

4.6 Production of Halocarbons and SF_6 (2E)

There is no production of Halocarbons or SF_6 in Denmark.

4.7 Metal production (2C) and consumption of Halocarbons and SF_6 (2F)

4.7.1 Overview of the sector

The sub-sector *Consumption of halocarbons and SF_6* (2F) includes the following source categories and the following F-gases of relevance for Danish emissions:

- 2C4: SF_6 used in Magnesium Foundries: SF_6
- 2F1: Refrigeration: HFC-32, -125, -134a, -152a, -143a, PFC (C_3F_8)
- 2F2: Foam blowing: HFC-134a, -152a
- 2F4: Aerosols/Metered dose inhalers: HFC-134a
- 2F8: Production of electrical equipment: SF_6
- 2F9: Other processes (laboratories, double glaze windows, fibre optics): SF_6, HFC-23, CF_4, C_3F_8, C_4F_8

The description of consumption and emission of F-gases given below is based on an inventory published as (Poulsen & Werge, 2012). For further details refer to this report.

General trends

A quantitative overview is given below for each of these source categories and each F-gas, showing their emissions in tonnes through the times-series. The data is extracted from the CRF tables that form part of this submission and the data presented is rounded values. It must be noticed that the inventories for the years 1990-1994 might not cover emissions of these gases in full. The choice of base-year for these gases is 1995 for Denmark.

Figure 4.5 present the emission trends within the different subsectors.

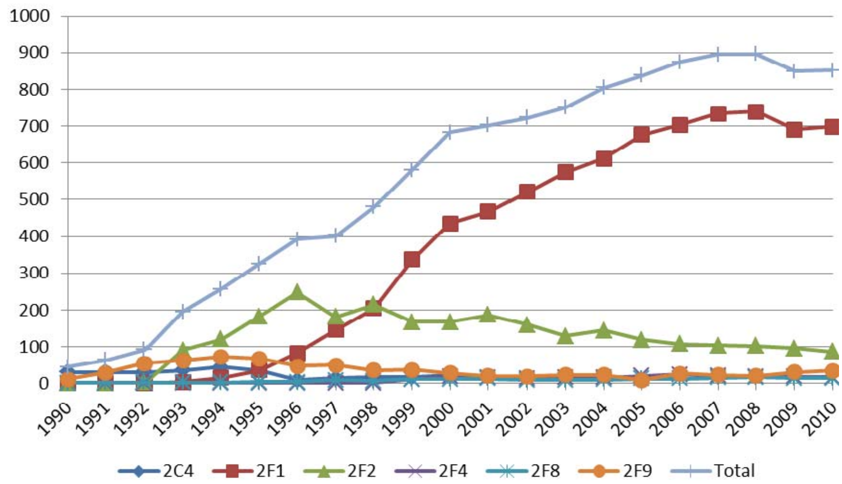

Figure 4.5 Time series for the sub-sectors (ktonne CO_2 equivalents).

The sub-sectors will be described below in the following sections:

- Refrigeration (2F1)
- Foam blowing (2F2)
- Aerosols/metered dose inhalers (2F4)
- Other processes (2C4, 2F8, 2F9)

The emission of SF_6 has been decreasing in recent years due to the fact that activities under Magnesium Foundry no longer exist and due to a decrease in the use of electric equipment. Also, a decrease in "other" occurs, which for SF_6 is used in window plate production use, laboratories and in the production of running shoes.

The emission of HFCs increased rapidly in the 1990s and, thereafter, increased more modestly due to a modest increase in the use of HFCs as a refrigerant and a decrease in foam blowing. The F-gases have been regulated in two ways since 1 March 2001. For some types of use there is a ban on use of the gases in new installations and for other types of use, taxation is in place. These regulations seem to have influenced emissions so that they now only increase modestly.

The phase out of F-gasses has in particular been effective within the foam blowing sector and refrigeration installations. According to foam blowing, there was a stepwise phase-out of HFC-134a used for foam blowing in hard and soft foam production, during the period 2001-2004. In 2006, all foam productions in DK have substituted HFC. Especially the phase-out of HFCs in soft foam is significant for the GWP emission in this period.

With respect to HFC refrigeration, it is not possible to determine a stabile decreasing trend yet. Since the introduction of taxes on HFC's in 2001, the consumption decreased in 2002-2003, but then the consumption of HFCs for refrigeration purposes increased again. Especially HFC-404a and HFC-134a increased. This increase is explained with another regulatory initiatives in Danish legislation, where new refrigeration systems containing HCFC-22 (ODP) was banned from 2001. It coursed a boom in HFC refrigeration systems during 2002-2004, because the HFC technology was cheap and well proven. Thus, the consumption of HFC for refrigeration has changed after 1 January 2007, where new larger HFC installations with stocks exceeding 10 kg are banned. Alternative refrigeration technologies based on CO_2, propane/butane and ammonia is now introduced and available for customers.

Table 4.15 and Figure 4.6 quantify an overview of the emissions of the gases in CO_2 equivalents. The reference is the trend table as included in the CRF table for year 2010.

Table 4.15 Time series for emission of HFCs, PFCs and SF_6 (kt CO_2 equivalents.).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFCs	-	218	607	802	823	850	853	799	800
PFCs	-	0.50	17.9	13.9	15.7	15.4	12.8	14.2	13.3
SF_6	44.5	107	58.8	21.3	35.6	29.9	31.2	36.3	37.9
Total	44.5	326	683	838	875	895	897	849	851

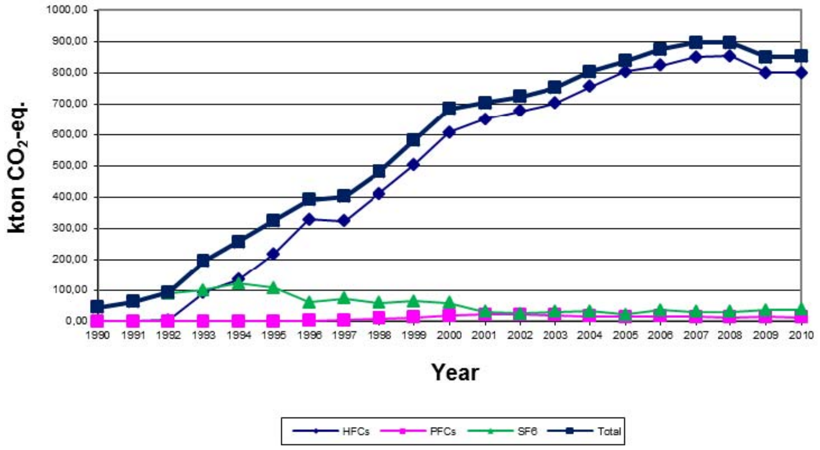

Figure 4.6 Time series for emission of HFCs, PFCs and SF_6 (kt CO_2 equivalents.).

The decrease in the SF_6 emission has brought its emissions in CO_2 equivalents down to the level of PFC. Overall, and for all uses, the most dominant group by far is HFCs. In this grouping, HFCs constitute a key category, both with regard to the key category level and trend analysis.

General methodology

The data for emissions of HFCs, PFCs, and SF_6 has been obtained in continuation on work on inventories for previous years. The determination includes the quantification and determination of any import and export of HFCs, PFCs, and SF_6 contained in products and substances in stock form. This is in accordance with the IPCC guidelines (IPCC (1997), vol. 3, p. 2.43ff), as well as the relevant decision trees from the IPCC Good Practice Guidance (IPCC, 2000) p. 3.53ff).

For the Danish inventories of F-gases, a Tier 2 bottom-up approach is basically used. As for verification using import/export data, a Tier 2 top-down approach is applied. In an annex to the F-gas inventory report 2010 (Poulsen & Werge, 2012)), there is a specification of the approach applied for each subsource category.

The following sources of information have been used:

- Importers, agency enterprises, wholesalers and suppliers.
- Consuming enterprises, and trade and industry associations.
- Recycling enterprises and chemical waste recycling plants.
- Statistics Denmark.
- Danish Refrigeration Installers' Environmental Scheme (KMO).

- Previous evaluations of HFCs, PFCs and SF_6.

Suppliers and/or producers provide consumption data of F-gases. Emission factors are primarily defaults from the GPG, which are assessed to be applicable in a national context. In case of commercial refrigerants and Mobile Air Condition (MAC), information from Danish suppliers has been used. The actual amount of F-gas used for refilling is used as an estimate on the actual emission.

Import/export data for sub-source categories where import/export is relevant (MAC, fridge/freezers for household) are quantified on estimates from import/export statistics of products + default values of the amount of gas in the product. The estimates are transparent and described in the annex to the report referred to above.

The Tier 2 bottom-up analysis used for determination of emissions from HFCs, PFCs, and SF_6 covers the following activities:

- Screening of the market for products in which F-gases are used.
- Determination of averages for the content of F-gases per product unit.
- Determination of emissions during the lifetime of products and disposal.
- Identification of technological development trends that have significance for the emission of F-gases.
- Calculation of import and export on the basis of defined key figures, and information from Statistics Denmark on foreign trade and industry information.

The determination of emissions of F-gases is based on a calculation of the actual emission. The actual emission is the emission in the evaluation year, accounting for the time lapse between consumption and emission. The actual emission includes Danish emissions from production, from products during their lifetimes and from waste products.

Consumption and emissions of F-gases are, whenever possible, determined for individual substances, even though the consumption of certain HFCs has been very limited. This has been carried out to ensure transparency of evaluation in the determination of GWP values. However, the continued use of a category for *Other HFCs* has been necessary since not all importers and suppliers have specified records of sales for individual substances.

The potential emissions have been calculated as follows:

Potential emission = import + production - export - destruction/treatment.

Table 4.16 Content (w/w%)[1] of "pure" HFC in HFC-mixtures, used as trade names.

HFC mixtures	HFC-32 %	HFC-125 %	HFC-134a %	HFC-143a %	HFC-152a %	HFC-227ea %
HFC-365						8
HFC-401a					13	
HFC-402a		60				
HFC-404a		44	4	52		
HFC-407a	23	25	52			
HFC-410a	50	50				
HFC-507a		50		50		

1. The mixtures do also contain substances that do not have GHG potential and therefore, the substances do not sum up to 100 %.

The substances have been accounted for in the survey according to their trade names, which are mixtures of HFCs used in the CRF, etc. In the transfer to the "pure" substances used in the CRF reporting schemes, the following ratios have been used; see Table 4.16.

The national inventories for F-gases are provided and documented in a yearly report (Poulsen & Werge, 2012). Furthermore, detailed data and calculations are available and archived in an electronic version. The report contains summaries of methods used and information on sources as well as further details on methodologies.

4.7.2 2F1 Refrigeration

Source category description

2F1 Refrigeration consists of the following processes:

- Household fridges/freezers
- Commercial refrigeration
- Transport refrigeration
- Mobile air conditioning
- Stationary air conditioning.

Table 4.17 present the emissions of F-gases from consumption of HFCs and PFC in refrigeration and air conditioning systems.

Table 4.17 Emission of F-gases from consumption of HFCs and PFC in refrigeration and air condition systems (2F1 Refrigeration) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFC-32	NE	0,11	5,75	13,7	14,5	15,4	16,8	17,6	17,5
HFC-125	NE	2,58	43,1	67,7	70,6	73,6	75,3	74,7	72,8
HFC-134a	NE	14,3	112	181	188	198	198	167	184
HFC-152a	NE	NO	0,58	0,26	0,21	0,17	0,14	0,11	0,093
HFC-143a	NE	2,43	39,6	60,3	63,0	65,6	66,0	64,6	62,5
PFC (C_3F_8)	NE	0,072	2,29	1,99	1,76	1,51	1,29	1,13	1,00

Methodological issues

The data collection is described in the Section 4.7.1 Overview of the sector, General methodology.

The activity data expressed as total amount of HFCs and PFC filled into new products and present in operating systems is presented in Table 4.18 and Table 4.19, respectively.

Table 4.18 Consumption of HFCs and PFC in refrigeration and air condition systems (2F1 Refrigeration) (t/year).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Domestic refrigeration									
HFC-125	NE	0.88	3.96	1.61	1.90	1.32	0.86	0.53	0.64
HFC-134a	NE	6.16	2.62	65.7	63.2	33.6	37.7	17.6	6.82
HFC-143a	NE	1.04	4.68	1.90	2.25	1.56	1.02	0.62	0.76
HFC-152a	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NE	NO	NO	NO	NO	NO	NO	NO	NO
Commercial Refrigeration[1]									
C_3F_8	NE	1.50	6.30	0.45	NO	0.090	0.06	NA	NA
HFC-125	NE	66.3	118	91.9	99.9	91.8	79.5	65.8	67.9
HFC-134a	NE	4.68	203	151	214	106	127	136	106
HFC-143a	NE	60.8	108	81.4	89.1	71.3	55.4	55.4	54.5
HFC-152a	NE	NA	1.30	NO	NO	NO	NO	NO	NO
HFC-32	NE	7.00	22.3	21.4	22.7	29.6	30.9	17.4	20.2
Transport Refrigeration									
HFC-125	NE	1.92	7.92	3.28	2.90	0.37	3.24	2.57	2.69
HFC-134a	NE	0.12	0.72	0.79	0.67	0.44	0.79	0.75	0.74
HFC-143a	NE	1.56	9.36	3.87	3.42	0.43	3.83	3.04	3.18
Mobile Air-Conditioning									
HFC-125	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NE	NO	24,0	33,3	34,4	35,2	35,7	43,8	67,3
HFC-143a	NE	NO	NO	NO	NO	NO	NO	NO	NO

1. Including stationary A/C.

Table 4.19 HFCs and PFC present in operating refrigeration and air condition systems (2F1 Refrigeration) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Domestic refrigeration									
HFC-125	NE	0.86	25.9	35.1	36.6	37.5	38.0	38.1	37.5
HFC-134a	NE	165	625	824	846	854	855	839	811
HFC-143a	NE	1.02	30.6	41.5	43.3	44.3	44.9	45.0	44.4
HFC-152a	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NE	NO	NO	NO	NO	NO	NO	NO	NO
Commercial Refrigeration									
C_3F_8	NE	1.92	25.9	17.6	15.0	12.9	11.3	10.0	8.97
HFC-125	NE	77.7	414	659	691	712	707	688	626
HFC-134a	NE	79.5	690	1 076	1 179	1 157	1 109	1 088	1 074
HFC-143a	NE	71.5	366	580	610	619	604	582	517
HFC-152a	NE	NA	5.75	2.12	1.69	1.38	1.13	0.93	0.77
HFC-32	NE	6.90	70.7	141	150	164	173	172	167
Transport Refrigeration									
HFC-125	NE	2.15	26.4	15.7	15.8	13.4	14.2	14.3	14.4
HFC-134a	NE	0.14	9.87	7.06	6.49	5.80	5.57	5.33	5.13
HFC-143a	NE	1.84	28.2	17.5	17.8	15.2	16.2	16.4	16.6
Mobile Air-Conditioning									
HFC-125	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NE	NO	149	213	224	229	231	229	231
HFC-143a	NE	NO	NO	NO	NO	NO	NO	NO	NO

The applied EF is presented in Table 4.20. The EFs for commercial refrigerators, mobile A/C, and transport refrigeration has been assessed and compared with national conditions (Poulsen, 2002; citation from Poulsen & Werge, 2012).

Table 4.20 Applied EF for refrigeration and air condition systems (2F1 Refrigeration).

	Consumption, %	Stock, %	Lifetime
Household fridges and freezers	2	1 annual	15 years
Commercial refrigerators	1.5	10 annual	
Mobile air conditioning systems	0.5	33 annual	
Stationary air conditioning systems	1.5	10 annual	
Transport refrigeration	0.5	17 annual	6-8 years

Detailed information on the amount of HFCs used for refilling of mobile A/C has been available for 2009 and 2010, and therefore, a new approach has been implemented in the calculation of emissions. HFCs for mobile A/C are only used for refilling, and therefore the amount used for mobile A/C is assumed to be the same as the amount emitted during use (Poulsen & Werge, 2012):

Consumption of HFC for MAC = refilled stock = emission

Uncertainties and time series consistency

See Section 4.7.7 Uncertainties and time series consistency.

Recalculations

No source specific recalculations have been performed regarding emissions from consumption of HFCs and PFC for refrigeration and air conditioning.

Source specific planned improvements

No improvements are planned for this sector.

4.7.3 2F2 Foam blowing

Source category description

2F2 Foam blowing consists of the following processes:

- Hard foam, refrigerators
- System foam, shoes etc.
- Soft foam

Table 4.21 present the emissions of F-gases from consumption of HFCs in foam blowing.

Table 4.21 Emission of HFCs from consumption in foam blowing (2F2) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFC-32	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NE	136	127	91.2	81.8	78.9	78.6	73.2	66.7
HFC-152a	NE	43.4	16.2	1.49	2.56	2.82	3.39	3.61	4.29

Methodological issues

The data collection is described in the Section 4.7.1 Overview of the sector, General methodology.

Table 4.22 and Table 4.23 present the consumption of F-gases in foam blowing and the amount accumulated in stock, respectively.

Table 4.22 Consumption of HFC in foam blowing (2F2) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Hard foam									
HFC-134a	NE	193	220	52.8	104	94.6	76.1	0.06	0.17
HFC-152a	NE	4.00	1.00	5.50	11.3	13.0	15.0	12.0	15.0
Soft foam									
HFC-125	NE	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NE	105	43.9	11.9	2.75	NO	NO	NO	NO
HFC-152a	NE	43.0	15.4	NA	0.32	NO	NO	NO	NO
HFC-32	NE	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.23 HFC present as stock in hard foam (2F2) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Hard foam									
HFC-134a	NE	416	1 415	1 258	1 176	1 090	1 005	885	762
HFC-152a	NE	3.60	15.3	24.8	33.9	41.9	53.6	62.0	72.7

The applied EF is presented in Table 4.24.

Table 4.24 Applied EF for foam blowing (2F2).

	Consumption; %	Stock, %	Lifetime
Foam in household fridges and freezers	10	4.5 annual	15 years
Soft foam (open cell)	100[1]		
Joint filler	100[1]		
Foaming of polyether (shoe soles)	15	4.5	3 years
System foam	0[2]	-[3]	

1. 100% emission during the first year after production.
2. No emission during production of system foam.
3. System foam is only produced for export.

System foam is produced in a closed environment and is only produced for export. Therefore, the consumption of HFCs do not contribute to the Danish stock.

Uncertainties and time series consistency

See Section 4.7.7 Uncertainties and time series consistency.

Recalculations

A few corrections have been made in the CRF for consumption of HFC-134a to hard foam – IEF and stock, however, no methodological changes have been implemented.

Source specific planned improvements

No improvements are planned for this sector.

4.7.4 2F4 Aerosols/Metered dose inhalers

Source category description

2F4 Aerosols/Metered dose inhalers consist of HFCs used for:

- Propellant in aerosols
- Medical dose inhalers

Table 4.25 present the emissions of F-gases from consumption of HFCs in aerosols and medical dose inhalers.

Table 4.25 Emissions of HCF from consumption of HFC in aerosols/medical dose inhalers (2F4) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFC-134a	NO	NO	14.5	16.1	18.8	16.0	14.3	13.6	12.9

Methodological issues

The data collection is described in the section 4.7.1 Overview of the sector, General methodology.

Table 4.26 present the emissions of F-gases from consumption of HFCs in aerosols and medical dose inhalers.

Table 4.26 Consumption of HFC-134a in aerosols/medical dose inhalers (2F4) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Metered dose inhalers	NE	NO	1.61	5.63	6.43	7.62	7.23	7.07	7.07
Aerosols	NE	NO	11.5	15.0	9.80	7.00	7.10	6.00	5.23

The applied EF is presented in Table 4.27.

Table 4.27 Applied EF for aerosols/medical dose inhalers.

	Consumption/ filling	Stock	Lifetime
Aerosols	0 %	50 % first year 50 % second year	2 years
Medical dose inhalers	0 %	50 % first year 50 % second year	2 years

Uncertainties and time series consistency

See Section 4.7.7 Uncertainties and time series consistency.

Recalculations

No source specific recalculations have been performed regarding emissions from use of HFC-134a in aerosols and medical dose inhalers.

Source specific planned improvements

No improvements are planned for this sector.

4.7.5 Other processes (2C4, 2F8 and 2F9)

Source category description

Other processes (2C4, 2F8 and 2F9) consist of the following processes:

- Consumption of SF_6 in magnesium foundries; see Table 4.28
- Consumption of SF_6 in electrical equipment; see Table 4.29
- Consumption of SF_6 in running shoes; see Table 4.30
- Consumption of SF_6 in laboratories; see Table 4.30
- Consumption of SF_6 in double glazed windows; see Table 4.30
- Consumption of HFC and PFC in fibre optics; see Table 4.30
- Consumption of PCF as detergent; see Table 4.30

Table 4.28-4.30 presents the emissions of F-gases from consumption of HFCs, PFC and SF_6 in other processes.

Table 4.28 Emissions from SF_6 used in magnesium foundries (2C4) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
SF_6 used in magnesium foundries	1.30	1.50	0.89	NO	NO	NO	NO	NO	NO

Table 4.29 Emissions from consumption of SF_6 in electrical equipment (2F8) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
SF_6	0.060	0.16	0.47	0.52	0.54	0.63	0.68	0.61	0.59

Table 4.30 Emissions from consumption of SF_6, HFCs, and PFCs in other processes (2F9) (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
SF_6	0.50	2.83	1.10	0.37	0.95	0.62	0.63	0.91	0.99
HFC-23	NO	NO	NO	NO	0.08	0.24	0.12	0.24	0.36
CF_4	NO	NO	NO	NO	0.25	0.14	0.11	0.36	0.36
C_3F_8	NE,NO	NA,NO	0.27	NO	NO	NO	NO	NO	NO
C_4F_8	NO	NO	NO	NO	0.20	0.45	0.35	0.45	0.45

Methodological issues

The data collection is described in the Section 4.7.1 Overview of the sector, General methodology.

Table 4.31 HFCs, PFC and SF_6 consumed in other processes (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Electrical equipment									
SF_6	NE	1.40	4.00	3.58	3.65	5.11	5.59	3.75	3.18
Detergent									
C_3F_8	NE	NO	0.54	NO	NO	NO	NO	NO	NO
Double glaze windows									
SF_6	NE	13.5	4.13	NO	NO	NO	NO	NO	NO
Fibre optics									
$c\text{-}C_4F_8$	NE	NO	NO	NO	0.20	0.45	0.35	0.45	0.45
CF_4	NE	NO	NO	NO	0.25	0.14	0.11	0.36	0.36
HFC-23	NE	NO	NO	NO	0.080	0.24	0.12	0.24	0.36
Laboratories									
SF_6	NE	0.40	NO	NO	0.58	0.26	0.27	0.55	0.64
Shoes									
SF_6	NE	0.11	0.11	NO	NO	NO	NO	NO	NO
Various									
SF_6	NE	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.32 SF_6 accumulated as stock in other processes (t).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Electrical equipment									
SF_6	NE	26.2	57.3	67.9	71.0	75.5	80.4	83.5	85.5
Double glaze windows									
SF_6	NE	25.0	38.4	36.6	36.2	35.8	35.5	35.1	34.8

The applied EF is presented in Table 4.33. Special attention has been given to use of SF_6 as insolation in high-voltage plants (Poulsen, 2001; ELTRA, 2004; citation from Poulsen & Werge, 2012).

Table 4.33 Applied EF other processes.

	Consumption	Stock	Lifetime
Liquid cleaners	50 % first year 50 % second year		
Fibre optics production	100 % in the year of production		
Insolation gas in double glaze windows	15 %	1% annual	20 years
Insolation gas in high voltage switches	5 %	0.5 % annual 5 % in reuse/ drawing off	?
Shock-absorbing in Nike Air training footwear	-[1]	-[2]	5 years

1. No emission from production in Denmark.
2. Yearly emission has been estimated to 0.11 tonne (Poulsen & Werge, 2012).

Uncertainties and time series consistency

See Section 4.7.7 Uncertainties and time series consistency.

Recalculations

A calculation error has been identified in calculation of stock in double glaze windows for the year 1998. Correction of the error results in changes in the stock in the following and therefore changes in the emission from stock in all years from 1998-2010. However, no methodological changes have been implemented.

No source specific recalculations have been performed regarding emissions from use of HFCs, PFCs, and SF_6 in other processes.

Source specific planned improvements

No improvements are planned for this sector.

4.7.6 QA/QC and verification

Comparison of emissions estimates using different approaches

This comparison of Tier 1 potential emissions has been used for a check on the Tier 2 actual emission estimates. This check was carried out in 1995-1997 and, for all three years, it shows a difference of approx. factor 3 higher emission by using potential emission estimates.

This comparison of bottom-up estimates has not yet been compared with the top-down Tier 2 approach. This comparison will be developed.

National activity data check

The spread sheets containing activity data have incorporated several data-control mechanisms, which ensure that data estimates do not contain calculation failures. A very comprehensive QC procedure on the data in the model for the whole time series has been carried out for the 2011(2012) submission in connection with the process which provided, (1) data for the CRF background tables 2(II).F. for the years (1993)-2009 and (2) data for potential emissions in CRF tables 2(I). This procedure consisted of a check of the input data for the model for each substance. As regards the HFCs, this checking was carried out in relation to their trade names. Conversion was made to the HFC substances used in the CRF tables, etc. A QC was that emission of the substances could be calculated and checked comparing results from the substances as trade names and as the "no-mixture" substances used in the CRF.

Emission factors check

Country-specific emission factors are explained and documented for MAC and commercial refrigerants and SF_6 in electric equipment. Separate studies have been carried out and reported; see the previous chapters for references. For other sub-source categories, the country-specific emission factors are assessed to be the same as the IPCC default emission factors.

Emission check

As the F-gas inventory is developed and made available in full in spread sheets, where HFCs data relate to trade names, special procedures are performed to check the full possible correctness of the transformation to the CRF-format through Access databases.

4.7.7 Uncertainties and time series consistency

The time series for actual emissions of Halocarbons and SF_6 are presented in Section 4.7.1. The time series are consistent as regards the methodology. The potential emission estimates are only included in the CRF.

Tier 1 and Tier 2 uncertainty estimates has been calculated by use of default uncertainties.

In general, uncertainty in inventories will arise through at least three different processes:

1. Uncertainties from definitions (e.g. incomplete, unclear, or faulty definition of an emission or uptake);
2. Uncertainties from natural variability of the process that produces an emission or uptake;
3. Uncertainties resulting from the assessment of the process or quantity depending on the method used: (i) uncertainties from measuring; (ii) uncertainties from sampling; (iii) uncertainties from reference data that may be incompletely described, and (iv) uncertainties from expert judgement.

Uncertainties due to poor definitions are not expected to be an issue in the F-gas inventory. The definitions of chemicals, the factors, sub-source categories in industries etc. are well defined.

Uncertainties from natural variability are likely to occur over the short-term while estimating emissions in individual years. But over a longer time period, 10-15 years, these variabilities level out in the total emission. This is due to that input data (consumption of F-gases) is known and is valid data, and has no natural variability due to the chemicals stabile nature.

Uncertainties that arise due to imperfect measurement and assessment are probably an issue for the:

- Emission from MAC (HFC-134a).
- Emission from commercial refrigerants (HFC-134a).

Due to the limited knowledge for these sources, the expert assessment of consumption of F-gases can lead to inexact values of the specific consumption of F-gases.

The uncertainty varies from substance to substance. Uncertainty is greatest for HFC-134a due to its widespread application in products that are imported and exported. The greatest uncertainty in application is expected to arise from consumption of HFC-404a and HFC-134a in commercial refrigerators and mobile refrigerators. The uncertainty involved in year-to-year data is influenced by the uncertainty associated with the rates at which the substances are released. This results in significant differences in the emission determinations in the short-term (approx. five years); differences that balance in the long-term.

The source specific uncertainties for consumption of halocarbons and SF_6 are presented in Chapter 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.8 Other (2G)

4.8.1 Source category description

The subsector *Other* (2G) covers the following process:

- Oxidation of lubricants during use.

The time series for emission of CO_2 from *Other* (2G) is presented in Table 4.34.

Table 4.34 Time series for emission of CO_2 (kt) from Other (2G).

2G	1990	1995	2000	2005	2006	2007	2008	2009	2010
Oxidation of lubricants during use	49.7	48.8	39.7	37.6	37.5	37.9	34.0	31.2	33.2

The emissions are extracted from the CRF tables and the values are rounded.

The emission of CO_2 from oxidation of lubricants during use is decreasing from 49.7 kt in 1990 to 33.2 kt in 2010.

4.8.2 Methodological issues

The emission of CO_2 from oxidation of lubricants during use is calculated according to the following formula:

$$E_{CO2} = LC \bullet CC_{\text{lub}\,ricant} \bullet ODU_{\text{lub}\,ricant} \bullet 44/12$$

where:

E_{CO2} = emission of CO_2

LC = consumption of lubricants

CC = carbon content of lubricant

ODU = amount of lubricant oxidised during use

In the calculation the following default values have been applied: CC = 20.1 kg C per kg lubricant and ODU = 0.2. The activity data applied is presented in Table 4.35.

Table 4.35 Consumption of lubricant oil (TJ) (Danish Energy Agency).

2G	1990	1995	2000	2005	2006	2007	2008	2009	2010
Oxidation of lubricants during use	3 372	3 314	2 693	2 550	2 544	2 574	2 307	2 116	2 251

4.8.3 Uncertainties and time series consistency

The time series is presented in Table 4.34. The applied methodology has been the same during all the years and is therefore considered to be consistent. The activity data is based on information from Danish Energy Agency. The same emission factor has been used for all the years from 1990 to 2010.

4.8.4 Recalculations

No source specific recalculations have been performed regarding emissions from the consumption of lubricants.

4.8.5 Source specific planned improvements

No improvements are planned for this sector.

4.9 Uncertainty

4.9.1 Tier 1 uncertainty

The source specific uncertainties for industrial processes are presented in Table 4.36. The uncertainties are based on IPCC guidelines combined with assessment of the individual processes.

The producer has delivered the activity data for production of cement as well as calculated the emission factor based on quality measurements. The uncertainties on activity data and emission factors are assumed to be 1 % and 2 %, respectively.

The activity data for production of lime and bricks are based on information compiled by Statistics Denmark. Due to the many producers and the variety of products, the uncertainty is assumed to be 5 %. The emission factor is partly based on stoichiometric relations and partly on an assumption of the number of yellow bricks. The last assumption has been verified (see Table 4.36). The combined uncertainty is assumed to be 5 %.

The producers of glass and glass wool have registered the consumption of -raw materials containing carbonate. The uncertainty is assumed to be 5 %. The emission factors are based on stoichiometric relations and, therefore, uncertainty is assumed to be 2 %.

The producers have registered the production of nitric acid during many years and, therefore, the uncertainty is assumed to be 2 %. The measurement of N_2O is problematic and is only carried out for one year. Therefore, uncertainty is assumed to be 25 %.

The uncertainty for the activity data as well as for the emission factor is assumed to be 5 % for production of catalysts/fertilisers and iron and steel production.

The emission of F-gases is dominated by emissions from refrigeration equipment and therefore, the uncertainties assumed for this sector will be used for all the F-gases. The IPCC propose an uncertainty at 30-40 % for regional estimates. However, Danish statistics have been developed over many years and, therefore the uncertainty on activity data is assumed to be 10 %. The uncertainty on the emission factor is, on the other hand, assumed to be 50 %. The base year for F-gases for Denmark is 1995.

Table 4.36 Uncertainties on activity data and emission factors as well as overall trend uncertainties for the different greenhouse gases.

	Activity data uncertainty	Emission factor uncertainty				
		CO_2	N_2O	HFCs[3]	PFCs[3]	SF_6[3]
Greenhouse gases	%	%	%	%	%	%
2A1. Production of Cement	1	2				
2A2. Production of Lime and Bricks	5	5				
2A3. Limestone and dolomite use	5	5				
2A5. Asphalt roofing	5	25				
2A6. Road paving with asphalt	5	25				
2A7. Other[1]	5	2				
2B2. Nitric acid production	2		25			
2B5. Other[2]	5	5				
2C1. Iron and Steel production	5	5				
2D. Food and Drink	5	5				
2F. Consumption of HFC	10			50		
2F. Consumption of PFC	10				50	
2F. Consumption of SF_6	10					50
2G. Other: Lubricants	2	5				
Overall uncertainty in 2010		1.869	25.08[4]	50.99	50.99	50.99
Trend uncertainty		0.917	1.439[4]	51.98	373.6	4.991

1) Production of yellow bricks, expanded clay products, container glass and glass wool.
2) Production of catalysts/fertilisers.
3) The base year for F-gases is for Denmark 1995.
4) 2004. The production closed down in the middle of 2004.

4.9.2 Tier 2 uncertainty

The tier 2 uncertainty for CO_2 emission from industrial processes and consumption of F-gases is presented in Table 4.37 and Table 4.38. The uncertainty estimates are based on the same individual uncertainties as applied for the tier 1 uncertainty estimate.

Table 4.37 Tier 2 uncertainty for industrial processes.

		1990			2010			1990-2010		
		Median Emission	Uncertainty (%) Lower (-)	Upper (+)	Median Emission	Uncertainty (%) Lower (-)	Upper (+)	Median Emission	Uncertainty (%) Lower (-)	Upper (+)
CO_2	ktonnes	1152	2	2	831	2	2	315	2	1

Table 4.38 Tier 2 uncertainty for consumption of F-gases.

		1995			2010			1995-2010		
		Median Emission	Uncertainty (%) Lower (-)	Upper (+)	Median Emission	Uncertainty (%) Lower (-)	Upper (+)	Median Emission	Uncertainty (%) Lower (-)	Upper (+)
CO_2 eq.	ktonnes	292	22	33	864	28	41	-510	-55	-30

4.10 Quality assurance/quality control (QA/QC)

4.10.1 Internal QA/QC

The approach used for quality assurance/quality control (QA/QC) is presented in Chapter 1.6. The present chapter presents QA/QC considerations for industrial processes based on a series of Points of Measuring (PMs); see Chapter 1.6.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values.

The uncertainty assessment has been performed on Tier 1 and Tier 2 level by using default and country specific uncertainty factors. The applied uncertainty factors are presented in Table 4.36.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

See DS.1.1.1. As Tier 1 and default uncertainty factors are applied, the individual datasets have not been assessed.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Comparability of the data has not been performed at "Data Storage level 1". However, investigation of comparability at CRF level is in progress.

The applied data sets are presented in Table 4.39.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included setting down the reasoning behind the selection of datasets.

Table 4.39 Applied data sets.

File or folder name	Description	AD or E	Reference	Contact(s)	Comment
Ardagh Glass Holmegaard gr2010.pdf		E	www.ardaghglass.com		
Nordic Sugar Nakskov gr2009-2010.pdf		AD	www.nordicsugar.com		AD used for estimation of production at three different locations 1990-1995.
Nordic Sugar Nykøbing gr2009-2010.pdf		AD	www.nordicsugar.com		AD used for estimation of production at three different locations 1990-1995.
Faxe_Kalk-brandt_kalk.pdf	Chemical composition of product.		www.faxekalk.dk		
Faxe_Kalk-hydratkalk_191103.pdf	Chemical composition of product.		www.faxekalk.dk		
Haldor Topsoe gr2010.pdf		AD, E	www.topsoe.dk		
Haldor Topsoe 1990.xls		E	Haldor Topsøe	Allan Willumsen	
Haldor Topsoe – emissioner 1996 – 2004.xls		E	Haldor Topsøe	Allan Willumsen	
Kemira GR2003.pdf		AD, E	www.kemira-growhow.com		
Rockwool gr2010.pdf		AD	www.rockwool.dk		
Saint Gobain gr2010.pdf		AD,E	Saint-Gobain Isover www.isover.dk	Anette Åkesson	
Stålvalseværket (2002) – paper version.		AD, E	Stålvalseværket		
Aalborg Portland miljoredegorelse_2010.pdf		AD, E	www.aalborg-portland.dk		
Aalborg Portland energy 2000-2004 answer.xls		AD	Aalborg Portland	Henrik Møller Thomsen, Torben Ahlmann-Laursen	
_animal residues.xls		AD	Danmarks Statistik; www.statistikbanken.dk		
_bread.xls		AD	Danmarks Statistik; www.statistikbanken.dk		
_beverage.xls		AD	Danmarks Statistik; www.statistikbanken.dk		

The data sources - in general - can be grouped as follows:

- Company specific environmental reports.
- Personal communication with individual companies.
- Company specific information compiled by Danish Energy Agency in relation to the EU-ETS.
- Industrial organisations.
- Statistics Denmark.
- Secondary literature.
- IPCC guidelines.

The environmental reports contribute with company-specific emission factors, technical information and, in some cases, activity data. The environmental reports are primarily used for large companies and, for some companies, are supplemented with information from personal contacts, especially for completion of the time series for the years before the legal requirement to prepare environmental reports (i.e. prior to 1996).

Statistics Denmark is used as source for activity data as they are able to provide consistent data for the period 1990-2009. In the cases where the statistics do not contain transparent data, statistics from industrial organisations are used to generate to required activity data.

For many of the processes, the default emission factors are based on chemical equations and are, therefore, the best choice. In some cases, the default EF has been modified in order to reflect local conditions.

Secondary literature may be used in the interpretation or in disaggregation of the public statistics.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

See DS.1.4.1. Consistency is secured by application of the same data source over the period in question, e.g. activity data from Statistics Denmark, or by using personal contacts in the individual companies to obtain activity data for the period when environmental reports were not mandatory. For some activities, statistics compiled by industrial organisations were applied.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the condition of delivery.

An agreement regarding inclusion of information - compiled by Danish Energy Agency for EU-ETS - in the Danish GHG-inventory has been signed. The implementation of this information has been introduced for production of cement, bricks, expanded clay products, and sugar refining.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset.

The datasets applied are presented in Table 4.39. For the reasoning behind their selection, see DS.1.3.1.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external dataset have to be available for any single value in any dataset.

The data applied, including references for citation, are presented in Table 4.39.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset.

The applied data including external contacts are presented in Table 4.39.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability (distribution as: normal, log normal or other type of variability).

The uncertainty assessment has been performed on Tier 1 level, assuming a normal distribution of activity data as well as emission data, by application of default uncertainty factors. Therefore, no considerations regarding distribution or type of variability have been performed.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals).

See DP.1.1.2.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines.

The applied methodologies are in line with the international guidelines issued by the IPCC combined with national adjustments. The degree of fulfilment of the required methodology has been documented in an internal note (Kyoto note).

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values.

The emission factors applied are mostly based on chemical equations and are, therefore, in accordance with the default EFs. E.g. for production of nitric acid, where the emission factor is dependent on process conditions, a comparison has been made to the default EF listed in the guideline. E.g. for the deviation of the emission factor for calcination in the cement process, an explanation has been developed in cooperation with the company.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

See DP.1.1.3

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is which is lacking.

This issue will be investigated further.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

Accessibility to critical company-specific information will be established as a consequence of the formal agreement with the Danish Energy Agency concerning data compiled in relation to the EU-ETS.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

Recalculations are described in the NIR. A manual log is included in the tool used for data processing at Data Processing level 2. This log also includes changes on Data Processing level 1.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

The sector report for industry (in prep.) presents an independent example of the calculations to ensure the correctness of every data manipulation.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time series.

The calculations are verified by checking the time series.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures.

A methodology to verify calculation of results using other measures will be developed.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one-to-one correctness between external data sources and the databases at Data Storage level 2.

A methodology to check the correctness between external data sources and the databases at storage level 2 will be developed.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.

The calculation principles and equations are based on the methodology presented by the IPCC. A detailed description can be found in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.

The theoretical reasoning for choice or development of methods is described in detail in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods.

The assumptions used in the different methods are described in the sector report for industry (in prep.) and also included in the present report. An explicit list of assumptions will be developed in the coming sector report.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to data set at Data Storage level 1.

Explicit references from the data processing to each dataset can be found in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations.

A manual log is included in the tool used for data processing at data level 2. This log also includes changes on Data Processing level 2. A detailed log will be developed in the sector report for industry (in prep.).

Data Processing level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1.

The sector report for industry (in prep.) presents the connection between the datasets on Data Storage level 1 and Data Processing level 2. Individual calculations are used to check the output of the data processing tool used at Data Processing level 2.

Data Processing level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

See DS.2.5.2.

4.10.2 External QA/QC

External QA/QC is described for one source: cement production.

Cement production

Aalborg Portland has an environmental management system that meets the requirements in DS/ISO 14001, EMAS etc. (Aalborg Portland, 2011b). The environmental management system is part of an integrated process management system. The system is certified according to the standards by the accredited body: Danish Standards. Information on raw material consumption as well as internal recycling is compiled in an environmental database. Some pollutants (NO_x, SO_2, CO and TSP) are measured continuously. Emission of CO_2 is calculated based on (fuel and) raw material consumption and raw material flow according to an approved CO_2 emission plan (EU-ETS). The CO_2 emission plan has to fulfil the requirements in the guidelines developed by EU (EU, 2007).

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5 Solvents and Other Product Use (CRF sector 3)

5.1 Introduction

This section presents the Danish methodology used for calculating pollutant emissions from use of solvents and other products in industries and households that are related to the source categories Paint application (CRF sector 3A), Degreasing and dry cleaning (CRF sector 3B), Chemical products, manufacture and processing (CRF sector 3C) and Other (CRF sector 3D). Covered pollutants are; NMVOC, CO_2 and N_2O.

Solvents are chemical compounds that are used on a global scale in industries and as constituents in final products to dissolve e.g. paint, cosmetics, adhesives, ink, rubber, plastic, pesticides, aerosols or are used for cleaning purposes, i.e. degreasing. NMVOCs are main components in solvents - and solvent use in industries and households is typically a dominant source of anthropogenic NMVOC emissions (UNFCCC, 2008; Pärt, 2005; Karjalainen, 2005). In industries where solvents are produced or used, NMVOC emissions to air and as liquid can be recaptured and either used or destroyed. Solvent containing products are used indoor and outdoor and the majority of solvent sooner or later evaporate. A small fraction of the solvent ends up in waste or as emissions to water and may finally also contribute to air pollution by evaporation from these compartments. Emission inventories for solvents are based on model estimates, as direct and continuous emissions are rarely measured.

In this section the methodology for the Danish emission inventory for Solvent and Other Product Use is presented and the results for the period 1990 – 2010 are summarised. The method is mainly based on the detailed approach described in EMEP/CORINAIR (2004) and emissions are calculated for industrial sectors, households for the stated CRF sectors, as well as for individual pollutants.

5.2 Methodology

Until 2002 the Danish solvent emission inventory was based on questionnaires, which were sent to selected industries and sectors requiring information on solvent use. In 2003 it was decided to implement a method that is more complete, accurate and transparent with respect to including the total amount of used solvent, attributing emissions to industrial sectors and households and establishing a reliable model that is readily updated on an annual basis.

Emission modelling of solvents can basically be done in two ways: 1) By estimating the amount of (pure) solvents consumed, or 2) By estimating the amount of solvent containing products consumed, taking account of their solvent content (EMEP/CORINAIR, 2004).

In 1) all relevant solvents must be estimated, or at least those together representing more than 90 % of the total pollutant emission, and in 2) all relevant source categories must be inventoried or at least those together contributing more than 90 % of the total pollutant emission. A simple approach is to use a per capita emission for each category, whereas a detailed approach is to get all relevant consumption data (EMEP/CORINAIR, 2004).

The detailed method 1) is used in the Danish emission inventory for solvent use, thus representing a chemicals approach, where each pollutant is estimated separately. The sum of emissions of all estimated pollutants used as solvents equals the pollutant emission from solvent use.

Method 2) is used for determining emissions from fireworks, tobacco and charcoal for barbeques included in 3D Other Use.

5.2.1 Pollutant list

NMVOC is the most abundant chemical group in relation to Solvent and Other Product Use. Additionally there is also some use and/or emissions of NO_2 and CO_2.

The definitions of solvents and VOC that are used in the Danish inventory (Nielsen et al., 2010) are as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Organic solvent shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative". VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular condition of use".

This implies that some NMVOCs, e.g. ethylenglycol, that have vapour pressures just around 0.01 kPa at 20 °C, may only be defined as VOCs at use conditions with higher temperature. However, use conditions under elevated temperature are typically found in industrial uses. Here the capture of solvent fumes is often efficient, thus resulting in small emissions (communication with industries).

The Danish list of NMVOCs comprises approx. 30 pollutants or pollutant groups representing more than 95 % of the total emission from solvent use, cf. Table 5.4. CO_2 conversion factors, where all carbon in a carbon-containing pollutants molecule, is converted to CO_2, are also listed in Table 5.4.

5.2.2 Activity data

For each pollutant or product a mass balance is formulated:

$$\text{Consumption} = (\text{production} + \text{import}) - (\text{export} + \text{destruction/disposal} + \text{hold-up}) \qquad \text{(Eq. 1)}$$

Data concerning production, import and export amounts of solvents and solvent containing products are collected from StatBank DK (2011), which contains detailed statistical information. Manufacturing and trading industries are committed to reporting production and trade figures to the Danish

Customs & Tax Authorities in accordance with the Combined Nomenclature. Import and export figures are available on a monthly basis from 1990 to present and contain trade information from approx. 200 countries worldwide. Production figures are reported quarterly as "industrial commodity statistics by commodity group and unit" from 1990 to present.

Destruction and disposal of solvents lower the pollutant emissions. In principle this amount must be estimated for each pollutant in all industrial activities and for all uses of pollutant containing products. At present the solvent inventory only considers destruction and disposal for a limited number of pollutants. For some pollutants it is inherent in the emission factor, and for others the reduction is specifically calculated from information obtained from the industry or literature.

Hold-up is the difference in the amount in stock in the beginning and at the end of the year of the inventory. No information on solvents in stock has been obtained from industries. Furthermore, the inventory spans over several years so there will be an offset in the use and production, import and export balance over time.

In some industries the solvents are consumed in the process, e.g. in the graphics and plastic industry, whereas in the production of paints and lacquers the solvents are still present in the final product. These products can either be exported or used in the country. In order not to double count consumption amounts of pollutants it is important to keep track of total solvent use, solvents not used in products and use of solvent containing products. Furthermore some pollutants may be represented as individual pollutants and also in chemical groups, e.g. "o-xylene", "mixture of xylenes" and "xylene". Some pollutants are better inventoried as a group rather than individual pollutants, due to missing information on use or emission for the individual pollutants. The Danish inventory considers single pollutants, with a few exceptions.

Activity data for pollutants are thus primarily calculated from Equation 1 with input from StatBank DK (2011). When StatBank (2011) holds no information on production, import and export or when more reliable information is available from industries, scientific reports or expert judgements the data can be adjusted or even replaced.

5.2.3 Emission factors

For each pollutant the emission is calculated by multiplying the consumption with the fraction emitted (emission factor), according to:

Emission = consumption * emission factor

The present Danish method uses emission factors that represent specific industrial activities, such as processing of polystyrene, dry cleaning etc. or that represent use categories, such as paints and detergents. Some pollutants have been assigned emission factors according to their water solubility. Higher hydrophobicity yields higher emission factors, since a lower amount ends in waste water, e.g. ethanol (hydrophilic) and turpentine (hydrophobic).

Emission factors for solvents are categorised in four groups in ascending order: (1) Lowest emission factors in the chemical industry, e.g. lacquer and paint manufacturing, due to emission reducing abatement techniques and destruction of solvent containing waste, (2) Other industrial uses, e.g. graphic industry, have higher emission factors, (3) Non-industrial use, e.g. auto repair and construction, have even higher emission factors, (4) Diffuse use of solvent containing products, e.g. painting, where practically all the pollutant present in the products will be released during or after use.

For a given pollutant the consumed amount can thus be attributed with two or more emission factors; one emission factor representing the emissions occurring at a production or processing plant and one emission factor representing the emissions during use of a solvent containing product. If the chemical is used in more processes and/or is present in several products more emission factors are assigned to the respective chemical amounts.

Emission factors can be defined from surveys of specific industrial activities or as aggregated factors from industrial branches or sectors. Furthermore, emission factors may be characteristic for the use pattern of certain products. The emission factors used in the Danish inventory also rely on the work done in the joint Nordic project (Fauser et al., 2009).

5.2.4 Source allocation

The Danish Working Environment Authority (WEA) is administrating the registrations of chemicals and products to the Danish product register. All manufacturers and importers of products for occupational and commercial use are obliged to register. The following products are comprised in the registration agreement:

- Chemicals and materials that are classified as dangerous according to the regulations set up by the Danish Environmental Protection Agency (EPA).
- Chemicals and materials that are listed with a limit value on the WEA "limit value list".
- Materials, containing 1 % or more of a chemical, which is listed on the WEA "limit value list".
- Materials, containing 1 % or more of a chemical, which are classified as hazardous to humans or the environment according to the EPA rules on classification.

There are the following important exceptions for products, which does not need to be registered:

- Products exclusively for private use.
- Pharmaceuticals ready for use.
- Cosmetic products.

The Danish product register does therefore not comprise a complete account of used pollutants. Source allocations of exceptions from the duty of declaration are done based on information from trade organisations, industries, scientific reports and information from the internet.

Outputs from the inventory are

- a list where the most predominant pollutants are ranked according to emissions to air,
- specification of emissions from industrial sectors and from households,

- contribution from each pollutant to emissions from industrial sectors and households,
- yearly trend in emissions, expressed as total pollutant and single pollutant, and specified in industrial sectors and households.

5.3 Emissions, activity data and emission factors

5.3.1 NMVOC and CO_2 equivalent emissions

Table 5.1 and Figure 5.1 show the emissions of NMVOC and CO_2 from 1990 to 2010, where the used amounts of single pollutants have been assigned to specific products and CRF sectors. A general increase is seen for all sectors from 1990 to 1996 followed by a decrease from 1997 to 2006 and stagnation in the period 2007 to 2010. Table 5.2 shows the used amounts of pollutants for the same period. Table 5.1 is derived from Table 5.2 by applying emission factors relevant to individual pollutants and production or use activities. Table 5.3 showing the used amount of products (activity data) is derived from Table 5.2, by assessing the amount of pollutants that is comprised within products belonging to each of the four source categories. The CO_2 conversion factor for each pollutant is shown in Table 5.4.

In Table 5.4 the emission for 2010 is split into individual pollutants. The most abundantly used solvents are ethanol, turpentine, or white spirit defined as a mixture of stoddard solvent and solvent naphtha and propylalcohol. Ethanol is used as solvent in the chemical industry and as windscreen washing agent. Turpentine is used as thinner for paints, lacquers and adhesives. Propylalcohol is used in cleaning agents in the manufacture of electrical equipment, flux agents for soldering, as solvent and thinner and as windscreen washing agent. Household emissions are dominated by propane and butane, which are used as propellant in spray cans, primarily in cosmetics. For some pollutants the emission factors are precise but for others they are rough estimates. The division of emission factors into four categories implies that high emission factors are applicable for use of solvent containing products and lower emission factors are applicable for use in industrial use.

The full time series for NMVOC emissions (Table 5.1), used amounts of NMVOC (Table 5.2) and used amount of products (Table 5.3) are presented in Annex 3D; Table 3D-2a, b, c, Table 3D-3 and Table 3D-4 respectively.

Table 5.1 Emission of NMVOC and CO_2-eqv. in Gg pr year.

Total emissions Gg pr year	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Paint application (3A)	6.02	6.89	7.44	6.08	6.08	5.95	5.40	4.89	4.07	3.39	3.66	3.32	3.11
Degreasing and dry cleaning (3B)	7.05E-05	7.67E-05	2.93E-05	1.25E-05	2.98E-05	2.89E-05	2.4E-05	1.83E-05	1.46E-05	2.17E-05	1.5E-05	1.31E-05	1.24E-05
Chemical products, manufacturing and processing (3C)	7.96	9.11	6.74	6.10	6.39	4.76	5.90	6.12	5.94	6.07	5.84	4.90	4.96
Other (3D)	23.7	28.8	26.6	23.8	23.4	21.4	20.6	20.0	20.3	17.7	18.0	19.2	18.7
Total NMVOC	37.6	44.8	40.7	36.0	35.8	32.1	31.9	31.1	30.3	27.1	27.5	27.4	26.8
Total CO_2-eqv.	92.42	107.24	99.06	87.10	87.35	79.20	77.21	74.65	70.83	63.42	64.81	64.60	62.19

Table 5.2 Used amounts of NMVOC in Gg pr year.

Used amounts of chemical Gg pr year	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Paint application (3A)	13.9	15.3	17.3	14.2	14.3	13.4	12.8	12.1	10.2	8.76	9.10	8.04	7.46
Degreasing and dry cleaning (3B)	0.705	0.767	0.293	0.125	0.298	0.289	0.240	0.183	0.146	0.217	0.150	0.131	0.124
Chemical products, manufacturing and processing (3C)	81.4	101	114	110	108	103	127	148	150	163	155	137	128
Other (3D)	37.9	47.8	44.4	39.8	42.3	35.5	35.1	39.7	35.1	31.8	32.9	35.0	33.0
Total NMVOC	134	165	175	165	165	152	175	200	196	204	197	180	169

Table 5.3 Used amounts of products (activity data) in Gg pr year.

Used amounts of products Gg pr year	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Paint application (3A)	92.6	102	115	94.7	95.4	89.5	85.2	80.9	67.7	58.4	60.6	53.6	49.8
Degreasing and dry cleaning (3B)	1.41	1.53	0.586	0.251	0.597	0.578	0.481	0.366	0.292	0.433	0.299	0.263	0.247
Chemical products, manufacturing and processing (3C)	407	505	568	552	541	514	635	742	751	817	773	683	641
Other (3D)	210	260	250	224	242	214	211	227	210	185	189	203	187
Total products	711	869	934	871	879	818	931	1050	1029	1061	1022	940	878

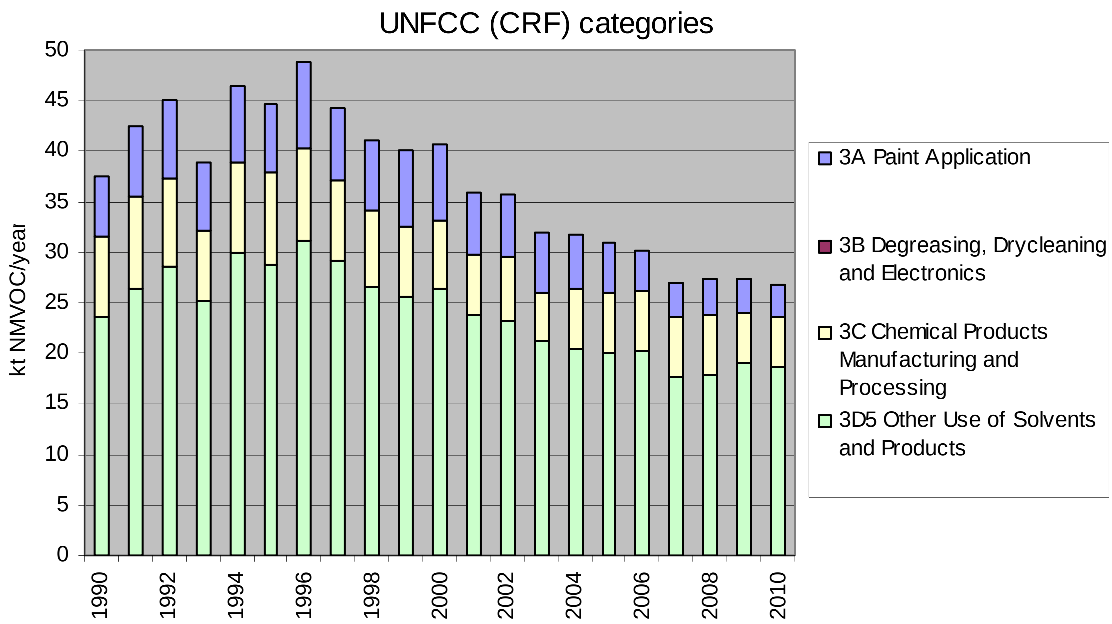

Figure 5.1 Emissions of NMVOC in kt NMVOC per year. The methodological approach for finding emissions in the period 1990 – 2010 is described in the text. Figures can be seen in Table 5.1.

Table 5.4 NMVOCs with highest emissions 2010, and CO_2 conversion factors assuming that all carbon molecules in the NMVOC molecule are converted to carbon in CO_2.

Pollutant	CAS no	Emissions 2010 (tonnes)	CO_2-conversion factor (g CO_2 pr g NMVOC)
ethanol	64-17-5	7,948	1.91
turpentine (white spirit: stoddard solvent and solvent naphtha)	64742-88-7 8052-41-3	5,788	2.79
propylalcohol	67-63-0	2,932	2.20
cyanates	79-10-7	2,123	1.83
pentane	109-66-0	1,556	3.06
methanol	67-56-1	1,057	1.38
propylenglycol	57-55-6	946	1.74
acetone	67-64-1	839	2.28
propane	74-98-6	654	2.86
butane	106-97-8	654	2.93
butanone	78-93-3	481	2.45
xylene	1330-20-7 95-47-6 108-38-3 106-42-3	472	3.32
phenol	108-95-2	201	2.81
cyclohexanones	108-94-1	164	2.69
toluene	108-88-3	158	3.35
glycolethers	110-80-5 107-98-2 108-65-6 34590-94-8 112-34-5 and others	158	1.95
ethylenglycol	107-21-1	124	1.42
formaldehyde	50-00-0	124	1.47
butanoles	78-92-2 2517-43-3 and others	105	2.24
acyclic aldehydes	78-84-2 111-30-8 and others	82.4	2.31
ethylacetate	141-78-6	50.1	2.00
styrene	100-42-5	43.4	3.39
1-butanol	71-36-3	26.2	2.38
naphthalene	91-20-3	14.7	3.44
butylacetate	123-86-4	14.0	2.28
tetrachloroethylene	127-18-4	2.03	0.531
acrylic acid	79-10-7	0.159	1.83
Total 2010		26,716	

5.3.2 N_2O, CO_2 and CO_2 equivalent emissions

3D1 Other: Use of N_2O for Anaesthesia, 3D4 Other: Other Use of N_2O & 3D5 Other: Other

Five companies sell N_2O in Denmark and only one company produces N_2O. N_2O is primarily used in anaesthesia by dentists, veterinarians and in hospitals and in minor use as propellant in spray cans, use in laboratories, racing cars and in the production of electronics. Due to confidentiality no data on produced amount are available and thus the emissions related to N_2O

production are unknown. An emission factor of 1 is assumed for all uses, which equals the sold amount to the emitted amount. Sold amounts are obtained from the respective companies and the produced amount is estimated from communication with the company.

Total sold and estimated produced N_2O for sale in Denmark, which equals the emissions, is shown in Table 5.5.

Table 5.5 N_2O emissions. EF = 1, i.e. sale equals emissions, and CO_2-eqv. in Gg pr year.

Total emissions Gg pr year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
3D1 & 3D4	0.00206	0.00776	0.00859	0.0133	0.0191	0.0342	0.0356	0.0407	0.0330	0.0458	0.0343
Total CO_2-eqv.	0.639	2.41	2.66	4.12	5.93	10.6	11.0	12.6	10.2	14.2	10.7

Table 5.6 and 5.7 presents the emissions, activity data and emission factors for N_2O and CO_2 from the use of fireworks, tobacco and charcoal for barbeques (BBQ) other product uses, which are included in 3D Other Use. Full time series for emissions and activity data can be found in Annex 3D-5 and 3D-6. Activity data are gathered from Statbank (2011).

Table 5.6 Emission of CO_2 and N_2O from the product use of fireworks, tobacco and char-

		1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 emission from										
Fireworks	Mg	55.3	130	210	159	182	193	189	233	234
N_2O emission from										
Fireworks	Mg	2.47	5.80	9.39	7.13	8.15	8.66	8.45	10.4	10.5
Tobacco	Mg	0.74	0.66	0.65	0.62	0.63	0.60	0.59	0.58	0.56
BBQ	Mg	0.22	0.24	0.40	0.45	0.62	0.36	0.31	0.41	0.25
Total	Mg	3.43	6.70	10.4	8.19	9.39	9.62	9.35	11.4	11.3
Total	Gg CO_2-eqv.	1.12	2.21	3.45	2.70	3.09	3.18	3.09	3.77	3.74

Table 5.7 Activity data for the product use of fireworks, tobacco and charcoal for barbe-

Year		1990	1995	2000	2005	2006	2007	2008	2009	2010
Fireworks	Gg	1.3	3.0	4.9	3.7	4.2	4.5	4.4	5.4	5.4
Tobacco	Gg	11.5	10.3	10.1	9.6	9.7	9.3	9.2	9.0	8.8
BBQ	Gg	7.2	7.9	13.4	14.9	20.6	12.2	10.4	13.7	8.4

Emission factors for use of fireworks, tobacco and charcoal for barbeques (BBQ) are found from literature studies and are shown in Table 5.8.

Table 5.8 Emission factors for other product use, per Mg.

Compound	Unit	Fireworks	Tobacco	BBQ
CO_2	Mg	0.043 (a)	NO	NO
N_2O	kg	1.935 (a)	0.064 (b)	0.030 (c)

(a) Netherlands National Water Board (2008), (b) Wood, (c) IPCC Guidelines (1996),

5.4 Uncertainties and time series consistency

5.4.1 NMVOC and CO_2 equivalents

Tier 1 and 2 uncertainties are expressed as ± 95%-confidence interval limits in percentage relative to the calculated mean emissions for 1990 and 2010, respectively.

Table 5.9 Tier 1 uncertainties for NMVOC and CO_2 equivalents

Pollutant	Total emission uncertainty, %	Trend 1990-2010, %
NMVOC	23	11
CO_2-eqv.	22	9.7

Table 5.10 Tier 2 uncertainties for NMVOC and CO_2 equivalents

Pollutant	1990			2010			Trend 1990-2010		
	Median Emission (Gg)	Lower (%)	Upper (%)	Median Emission (Gg)	Lower (%)	Upper (%)	Median difference (Gg)	Lower (%)	Upper (%)
NMVOC	37.6	-13	+16	26.7	-14	+17	10.9	-3.2	+3.7
CO_2-eqv.	92.6	-13	+16	62.2	-14	+17	30.3	-4.0	+4.6

Important uncertainty issues related to the mass-balance approach are

(i) Identification of pollutants that qualify as NMVOCs. Although a tentative list of 650 pollutants from NAEI (2000) has been used, it is possible that relevant pollutants are not included, e.g. pollutants that are not listed with their name in Statistics Denmark (StatBank DK, 2011) but as a product.

(ii) Collection of data for quantifying production, import and export of single pollutants and products where the pollutants are comprised. For some pollutants no data are available in StatBank DK (2011). This can be due to confidentiality or that the amount of pollutants must be derived from products wherein they are comprised. For other pollutants the amount is the sum of the single pollutants *and* product(s) where they are included. The data available in StatBank DK (2011) is obtained from Danish Customs & Tax Authorities and they have not been verified in this assessment.

(iii) Distribution of pollutants on products, activities, sectors and households. The present approach is based on amounts of single pollutants. To differentiate the amounts into industrial sectors it is necessary to identify and quantify the associated products and activities and assign these to the industrial sectors and households. No direct link is available between the amounts of pollutants and products or activities. From the Nordic SPIN database it is possible to make a relative quantification of products and activities used in industry, and combined with estimates and expert judgement these products and activities are differentiated into sectors. The contribution from households is also based on estimates. If the household contribution is set too low, the emission from industrial sectors will be too high and vice versa. This is due to the fact that the total amount of pollutant is constant. A change in distribution of pollutants between industrial sectors and households will, however, affect the total emissions, as different emission factors are applied in industry and households, respectively.

A number of activities are assigned as "other", i.e. activities that cannot be related to the comprised source categories. This assignment is based on expert judgement but it is possible that the assigned amount of pollutants may more correctly be included in other sectors. More detailed information from the industrial sectors is continuously being implemented.

(iv) Rough estimates and assumed emission factors are used for some pollutants. For some pollutants more reliable information has been obtained from the literature and from communication with industrial sectors. In some cases it is more appropriate to define emission factors for sector specific activities rather than for the individual pollutants. A quantitative measure of the uncertainty has not been assessed. Single values have been used for emission factors and activity distribution ratios etc.

5.4.2 CO_2, N_2O and CO_2 equivalents

Tier 1 and 2 uncertainties for CO_2, N_2O and their respective CO_2 equivalents are shown in Table 5.11 and 5.12, respectively.

Table 5.11 Tier 1 uncertainties for CO_2, N_2O and CO_2 equivalents.

Pollutant	Total emission uncertainty, %	Trend 1990-2010, %	Uncertainty trend %-age points
CO_2	100.3	323.7	47.9
N_2O	93.2	229.7	78.8
GHG (CO_2-eqv.)	87.5	234.3	72.5

Table 5.12 Tier 2 uncertainties for CO_2, N_2O and CO_2 equivalents.

Pollutant	1990			2010			Trend 1990-2010		
	Median Emission (Gg)	Lower (%)	Upper (%)	Median Emission (Gg)	Lower (%)	Upper (%)	Median difference (Gg)	Lower (%)	Upper (%)
CO_2	55.8	-61	+150	236	-61	+150	-181	-490	+200
N_2O	3.47	-44	+110	22.0	-29	+73	-18.5	-350	+140
GHG (CO_2-eqv.)	1137	-43	+105	3770	-53	+130	-2640	-340	+130

The main issues leading to uncertainties are:

Collection of data for quantifying production, import and export of products. Some data, like private import (cross-border shopping) of tobacco, are not available in StatBank DK (2011).

5.5 Quality assurance/quality control (QA/QC) and verification

Table 5.13 External and internal data for NMVOC emission inventory.

File or folder name	Description	AD or Emf.	Reference	Contact(s)	Data agreement/Comment
"Emissioner NMVOC" folder	Production, import and export data from Statistics Denmark	Activity data	Statistics Denmark	Patrik Fauser	
NMVOC emissions.xls	Calculations, emission factors, SPIN data. For industrial branches (NACE)	Activity data and emission factors	Statistics Denmark, SPIN, reports, personal communication	Patrik Fauser	
Use Category National.xls	Calculations, emission factors, SPIN data (UCN and NACE) and use amounts from Statbank.	Activity data and emission factors	Statistics Denmark, SPIN, reports, personal communication	Patrik Fauser	
Emission factors solvent use.xls	Emission factors for chemicals in CRF and SNAP sub-categories. CO_2 conversion factors.	Emission factors and CO_2 conversion factors	Scientific reports, personal communication and expert judgement	Patrik Fauser	

The QA/QC procedure is outlined in Section 1.6. In general, Critical Control Points (CCP) has been defined as elements or actions, which need to be addressed in order to fulfil the quality objectives. The CCPs have to be based on clear measurable factors, expressed through a number of Points for Measuring (PM).

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every data set including the reasoning for the specific values

The sources of data described in the methodology section and in DS.1.2.1 and DS.1.3.1 are used in this inventory. It is the accuracy of these data that define the uncertainty of the inventory calculations. Any data value obtained from StatBank DK (2011) and SPIN are given as a single point estimate and no probability range or uncertainty is associated with this value. Information from reports is sometimes given in ranges. Uncertainties are therefore assessed from expert judgement and guidebook estimates.

Data Storage level 1	2. Comparability	DS.1.2.1	Comparability of the emission factors/calculation parameters with data from international guidelines, and evaluation of major discrepancies.

1) Production and import/export data from StatBank DK (2011) for single chemicals can be directly compared with data from Eurostat (2011) for other countries. This has been done for a few chosen chemicals and countries. Furthermore, chosen Danish data from Eurostat (2011) have been validated with data from StatBank DK (2011) in order to check the consistency in data transfer from national to international databases.

2) Use categories for chemicals in products are found from the Nordic SPIN database. Data for all Nordic countries are available and reported uniformly. For chosen chemicals a comparison of chemical amounts and use has been made between countries.

3) A joint Nordic project funded by the Nordic Council of Ministers has been used on methodological issues and for emission factors.

Data Storage level 1	3.Completeness	DS.1.3.1	Ensuring that the best possible national data for all sources are included, by setting down the reasoning behind the selection of datasets.

A number of external data sources form the basis for calculating emissions of single chemicals. The general methodology in the emission inventory is described above.

1) StatBank DK (2011) is used as the main database for collecting data on production, import and export of single chemicals, chemical groups and for some products. In order to obtain a uniform and unique set of data it is important that the data for e.g. production of single chemicals is in the same reporting format and from the same source. The amount of data is very comprehensive and is linked with the data present in Eurostat. The database covers all sectors and is regarded as complete on a national level.

2) Nordic SPIN database provides data on the use of chemicals in Norway, Sweden, Denmark and Finland. It is financed by the Nordic Council of Ministers, Chemical group, and the data is supplied by the product registries of the contributing countries. The Danish product register (PROBAS) is a joint register for the WEA and the EPA and comprises a large number of chemicals and products. The information is obtained from registration according to the EPA rules and from scientific studies and surveys and other relevant sources. The product register is the most comprehensive collection of chemical data in products for Denmark and with the availability of data from the other Nordic countries it enables an inter-country comparison. For each chemical the data is reported in a uniform way, which enhances comparability, transparency and consistency.

3) Reports from and personal contacts with industrial branches. It is fundamental to have information from the industrial branches that have direct contact with the activities, i.e. chemicals and products of interest. The information can be in the form of personal communication, but also reported surveys are of great importance. In contrast to the more generic approach of collecting information from large databases, the expert information from industrial branches may give valuable information on specific chemicals and/or products and industrial activities. By considering both sources a verification as well as optimum reliability and accuracy is obtained.

4) The present inventory procedure builds partly on information from the previous Danish solvent emission inventory, which is based on questionnaires to industrial branches. Furthermore a joint Nordic collaboration on solvent inventories has given important information on methods and data.

Data Storage level 1	4.Consistency	DS.1.4.1	The original external data has to be archived with proper reference.

Data are predominantly extracted from the internet (StatBank 2011 and SPIN). These are saved as original copies in their original form. Specific information from industries and experts are saved as e-mails and reports.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery

As stated in DS.1.4.1 most data are obtained from the internet. No explicit agreements have been made with external institutions.

Data Storage level 1	7.Transparency	DS.1.7.1	Listing of all archived datasets and external contacts.

Datasets are archived as stated in Table 5.6. External contacts are stored in e-mail and documents.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source not part of DS.1.1.1 as input to Data Storage level 2 in relation to type and scale of variability.

No data are used in addition to those included in DS.1.1.1

Data Processing level 1	2.Comparability	DP.1.2.1	The methodologies have to follow the international guidelines suggested by UN-FCCC and IPCC.

The methodological approach is based on the detailed methodology as outlined in the Emission Inventory Guidebook. See also DS.1.3.1.

Data Processing level 1	3.Completeness	DP.1.3.1	Identification of data gaps with regard to data sources that could improve quantitative knowledge.

In "Uncertainties and time series consistency" important uncertainty issues related to missing quantitative knowledge is stated. To summarise; (i) identification and inclusion of all relevant chemicals (and products) Identification of chemicals that qualify as NMVOCs. The definition in the solvent directive (Directive 1999/13/EC) is used. Here VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular condition of use". A tentative list of 650 chemicals from the "National Atmospheric Emission Inventory" (NAI 2000) has been used, it is possible that relevant chemicals are not included. (ii) Collection of data for quantifying production, import and export of single chemicals. For some chemicals no data are available in StatBank DK (2008). This can be due to confidentiality or that the amount of chemicals must be derived from products wherein they are comprised. (iii) Distribution of chemicals on products, activities, sectors and households. No direct link is available between the amounts of chemicals and products or activities. From the Nordic SPIN database it is possible to make a relative quantification of products and activities used in industry, and combined with estimates and expert judgement these products and activities are differentiated into sectors. More detailed information from the industrial sectors may still be required. (iv) Emission factors for single chemicals, products and industrial and household activities. For many industrial and household activities involving solvent containing products no estimates on emission factors are available. Large variations occur between industry and product groups. And given the large number of chemicals more specific knowledge regarding industrial processes and consumption is needed.

Data Processing level 1	4.Consistency	DP.1.4.1	Documentation and reasoning of methodological changes during the time series and the qualitative assessment of the impact on time series consistency.

Any changes in calculation procedures are noted for each year's inventory.

Data Processing level 1	5.Correctness	DP.1.5.1	Verification of calculation results using time series

No detailed guidelines or calculations are accessible for time series. These are therefore not used for verification.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using other measures

Calculations performed by IIASA using RAINS codes, which are based on a different methodological approach gives total emission values that are similar to the emissions found in the present approach.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle, the equations used and the assumptions made must be described.

See methodological approach.

Data Processing level 1	7.Transparency	DP.1.7.2	Clear reference to dataset at Data Storage level 1

See methodological approach.

Data Processing level 1	7.Transparency	DP.1.7.3	A manual log to collect information about recalculations.

This is stated in documents listed in Table 5.6.

Data Storage level 2	5.Correctness	DS.2.5.1	Check if a correct data import to level 2 has been made

The transfer of emission data from level 1, storage and processing, to data storage level 2 is manually checked.

Data Storage level 4	4.Consistency	DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.

See DP.1.5.1 and DP.1.5.2.

5.6 Recalculations

Improvements and additions are continuously being implemented due to the comprehensiveness and complexity of the use and application of solvents in industries and households. The main improvements in the 2011 reporting include the following:

- Inclusion of NMVOC use and calculations of NMVOC emissions for the time period 1990 to 1994
- Inclusion of Tobacco smoking and Combustion of Charcoal for Barbeques in Other Product Use

5.7 Planned improvements

- PAH, PCB, dioxin and mercury use and emissions may be implemented for a variety of uses
- Pollutants that are listed as products in Statistics Denmark, e.g. cosmetics, may be assessed

5.8 References

Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, Brüssel, 1999.

Directive 2001/81/EC Of The European Parliament And Of The Council of 23 October 2001 - on national emission ceilings for certain atmospheric pollutants. Official Journal of the European Communities.

Directive 2004/42/EC of the European Parliament and Council on the Limitation of Emissions of Volatile Organic Compounds due to the Use of Organic Solvents in Certain Paints and Varnishes and Vehicle Refinishing Products and Amending Directive 1999/13/EC 30.04.2004, L 143/87.

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6 Agriculture (CRF sector 4)

The emission of greenhouse gases from agricultural activities includes:

- CH_4 emission from enteric fermentation and manure management.
- N_2O emission from manure management and agricultural soils.
- NMVOC emission from agricultural soils.
- Emission of CH_4, N_2O, NMVOC, CO and NO_x from burning of straw on field.

Emissions from rice production and burning of savannas do not occur in Denmark and consequently these categories have been reported as Not Occurring.

6.1 Overview of sector

In CO_2 equivalents, the agricultural sector contributes with 16 % of the overall greenhouse gas emission (GHG) in 2010. Next to the energy sector, the agricultural sector is the largest source of GHG emission in Denmark. The majority of agricultural greenhouse gas emissions are covered by N_2O and CH_4, which contributes in 2010 with 91 % and 75 % respectively of the total Danish emissions of N_2O and CH_4.

From 1990 to 2010, the emissions decreased from 12.5 million tonnes CO_2 eqv. to 9.5 million tonnes CO_2 eqv., which corresponds to a 24 % reduction (Table 6.1). N_2O is the largest contributor to the overall agricultural greenhouse gas emission, in 2010 accounting for 56 % in CO_2 equivalents. The decrease in the agricultural emission is caused by a decrease in N_2O emission, while the CH_4 emission is nearly unaltered.

Table 6.1 Emission of GHG in the agricultural sector in Denmark 1990 – 2010

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CH_4, Gg CO_2-eqv.	4 242	4 239	4 048	4 043	4 021	4 100	4 106	4 095	4 146
N_2O, Gg CO_2-eqv.	8 220	7 276	6 346	5 740	5 574	5 730	5 778	5 445	5 373
Total, Gg CO_2-eqv.	12 462	11 515	10 394	9 783	9 595	9 830	9 884	9 540	9 520

The major part of the emission is related to livestock production, which in Denmark is dominated by the production of cattle and pigs.

Figure 6.1 shows the distribution of the greenhouse gas emission across the main agricultural sources. The total N_2O emission from 1990-2010 has decreased by 35 %. The decrease in national emissions can largely be attributed to the decrease in N_2O emissions from agricultural soils. This reduction is due to a proactive national environmental policy over the last twenty years to prevent loss of nitrogen from agricultural soil to the aquatic environment. These measures includes among other things a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals pr hectare (ha) and maximum nitrogen application rates for agricultural crops. A combination of these increasing environmental requirements and the efforts to obtain economic advantage, the farmers has been forced to improve the utilisation of nitrogen in manure. An improvement of feed efficiency has been one of the most important drivers to reach the objectives. This has lead to a halving of nitrogen use in synthetic fertiliser and a decrease of emission per produced kg meat, which all has reduced the overall GHG emission.

The CH_4 emissions from 1990 to 2010 shown in Figure 6.1 indicate a decrease in emission from enteric fermentation, which is mainly due to a decrease in the number of cattle. A contrasting development has taken place in emission from manure management. Structural changes in the sector have led to a move towards the use of slurry-based housing systems, which have a higher emission factor than systems with solid manure. By coincidence, the decrease and the increase almost balance each other out and the total CH_4 emission from 1990 to 2010 has decreased by 5 %.

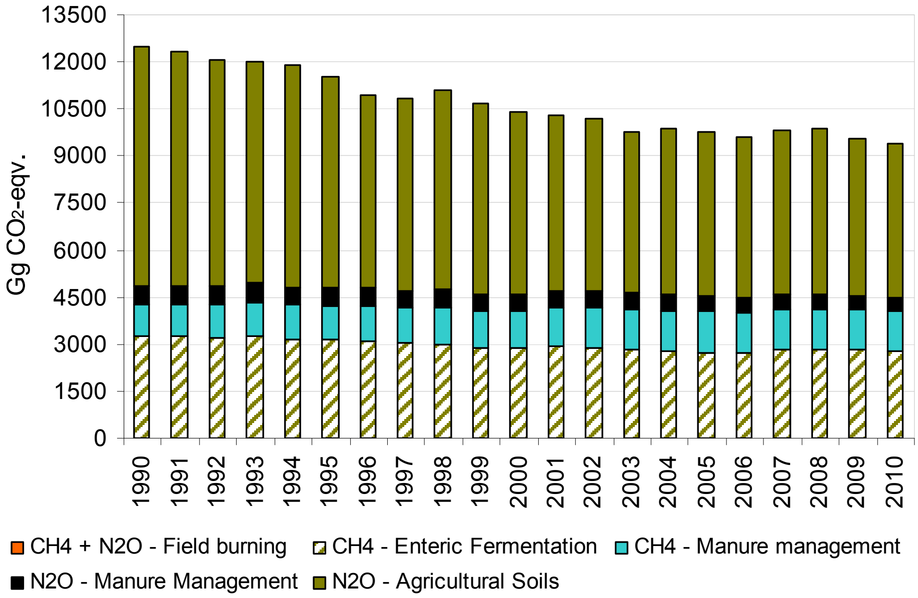

Figure 6.1 Danish greenhouse gas emissions 1990 – 2010.

6.1.1 Key category identification

In the key category analysis the agriculture emissions are divided into 14 subcategories, refer Annex 1. In Table 6.2 is listed KCA covering Tier 1 and Tier 2. Tier 1 only gives key source identification based on the quantitative emission, while the Tier 2 analyse also include information on uncertainties estimates (refer to Chapter 1.5). In 1990 is 9 of the 14 agricultural sources registered as key categories and 11 sources are key categories if uncertainties are taken into account (Tier 2). In 2010, 5 of the sources are listed as key categories according to level and trend for Tier 1 and 6 sources in Tier 2.

The three most important agriculture key categories are CH_4 from enteric fermentation and N_2O emission from agricultural soils – nitrogen leaching and run-off and synthetic fertilisers.

Table 6.2 Key category identification Tie1 and Tier 2 from the agricultural sector 1990 and 2010.

CRF table	Compounds	Emission source	Key category identification	
2010			Tier 1	Tier 2
4.A	CH_4	Enteric fermentation	Level/trend	Level
4.B(a)	CH_4	Manure management	Level/trend	Level/trend
4.F	CH_4	Field burning of agri. residues	-	-
4.B(a)	N_2O	Manure management	Level	Level
4.D1.1	N_2O	Synthetic fertilisers	Level/trend	Level/trend
4.D1.2	N_2O	Animal manure applied to soils	Level/trend	Level/trend
4.D1.3	N_2O	N-fixing crops	-	Level
4.D1.4	N_2O	Crop residue	Level	Level
4.D1.5	N_2O	Cultivation of histosols	-	Level
4.D1.6	N_2O	Sewage sludge and industrial waste	-	-
4.D2	N_2O	Pasture, range and paddock	-	Level/trend
4.D3.1	N_2O	Atmospheric deposition	Level	Level/trend
4.D3.2	N_2O	Nitrogen leaching and run-off	Level/trend	Level/trend
4.F	N_2O	Field burning of agri. residues	-	-
1990				
4.A	CH_4	Enteric fermentation	Level	Level
4.B(a)	CH_4	Manure management	Level	Level
4.F	CH_4	Field burning of agri. residues	-	-
4.B(b)	N_2O	Manure management	Level	Level
4.D1.1	N_2O	Synthetic fertilisers	Level	Level
4.D1.2	N_2O	Animal manure applied to soils	Level	Level
4.D1.3	N_2O	N-fixing crops	-	Level
4.D1.4	N_2O	Crop residue	Level	Level
4.D1.5	N_2O	Cultivation of histosols	-	Level
4.D1.6	N_2O	Sewage sludge and industrial waste	-	-
4.D2	N_2O	Pasture, range and paddock	Level	Level
4.D3.1	N_2O	Atmospheric deposition	Level	Level
4.D3.2	N_2O	Nitrogen leaching and run-off	Level	Level
4.F	N_2O	Field burning of agri. residues	-	-

6.2 Data references

The calculations of the emissions are based on methods described in the IPCC Reference Manual (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).

Activity data and emission factors are collected and discussed in cooperation with specialists and researchers in various institutes, such as the DCA - Danish Centre for Food and Agriculture – Aarhus University, Statistics Denmark, the Danish Agricultural Advisory Service, the Danish Plant Directorate and the Danish Environmental Protection Agency. In this way, both data and methods will be evaluated continually, according to the latest knowledge and information. DCE - Danish Center for Environment and Energy, Aarhus University has established data agreements with the institutes and organisations to assure that the necessary data is available to prepare the emission inventory on time.

Table 6.3 List of institutes involved in the emission inventory for the agricultural sector.

References	Link	Abbreviation	Data/information
Danish Center for Environment and Energy, Aarhus University	http://www.dmu.dk/Luft/Emissioner	DCE	- data collecting - emission calculations - responsible for QA/QC - reporting
Statistics Denmark – Agricultural Statistics	www.dst.dk	DSt	- livestock production - milk yield - slaughtering data - export of live animal - poultry - land use - crop production - crop yield
Danish Centre for Food and Agriculture, Aarhus University		DCA	- N-excretion - feeding situation - animal growth - N-fixed crops - crop residue - N-leaching/runoff - NH_3 emissions factor
The Danish Agricultural Advisory Service	www.lr.dk	DAAS	- housing type (until 2004) - grazing situation - manure application time and methods - estimation of extent of field burning of agricultural residue
Danish Environmental Protection Agency	www.mst.dk	EPA	- sewage sludge used as fertiliser - industrial waste used as fertiliser
The Danish Plant Directorate	www.pdir.dk	PD	- synthetic fertiliser (consumption and type) - housing type (from 2005) - sewage sludge used as fertiliser (from 2005 based on the register for fertilization) - number of animals from CHR
The Danish Energy Agency	www.ens.dk	DEA	- manure used in biogas plants

The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called IDA (Integrated Database model for Agricultural emissions). The model complex is designed in a relational database system (MS Access). Input data are stored in tables in one database called IDA_Backend and the calculations are carried out as queries in another linked database called IDA. This model complex, as shown in Figure 6.2, is implemented in great detail and is used to cover emissions of NH_3, particulate matter and greenhouse gases. Thus, there is a direct coherence between the NH_3 emission and the emission of N_2O.

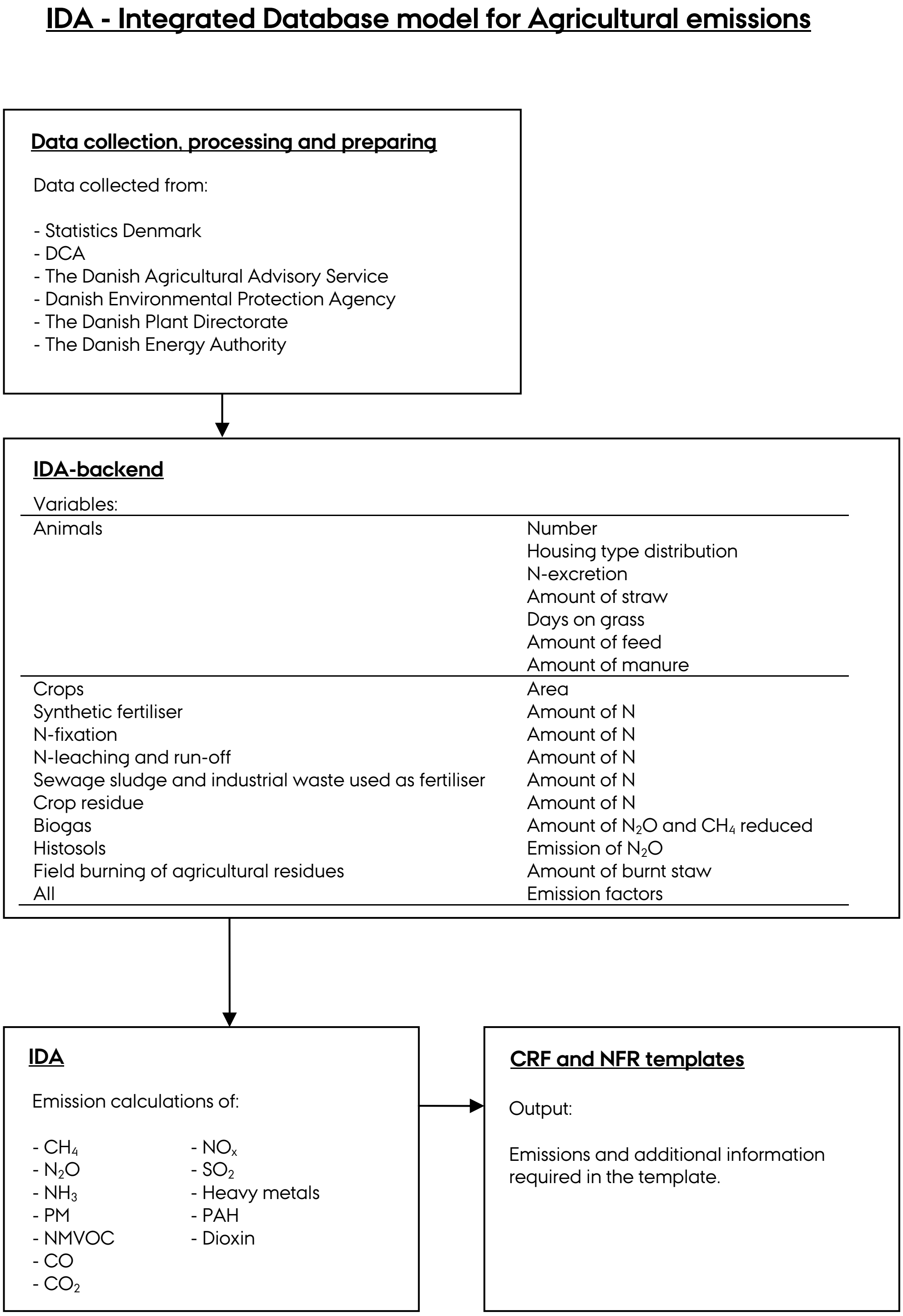

Figure 6.2 IDA - Integrated Database model for Agricultural emissions

Most emissions relate to livestock production, which basically is based on information on the number of animals, the distribution of animals according to housing type and, finally, information on feed consumption and excretion.

IDA operates with 38 different livestock categories, according to livestock category, weight class and age. These categories are subdivided into housing type and manure type, which results in around 170 different combinations of livestock subcategories and housing types (see Annex 3E-1). For each of these combinations, information on e.g. feed intake, digestibility, excretion and methane conversion factors is attached. The emission is calculated from each of these subcategories and then aggregated in accordance with the IPCC livestock categories given in the CRF.

Table 6.4 Livestock categories and subcategories.

CRF 4B	Aggregated livestock categories as given in IPCC	Includes	No. of subcategories in IDA, animal type/housing system
4B 1a	Dairy Cattle[1]	Dairy Cattle	23
4B 1b	Non-dairy Cattle[1]	Calves (<½ yr), heifers, bulls, suckling cattle	75
4B 3	Sheep	Including lambs	1
4B 4	Goats	Including kids (meet, dairy and mohair)	3
4B 6	Horses	<300 kg, 300 - 500 kg, 500 - 700 kg, >700 kg	4
4B 8	Swine	Sows, Weaners, fattening pigs	26
4B 9	Poultry	Hens, pullet, broilers, turkey, geese, ducks	24
4B 13	Other	Fur farming, deer, ostrich, pheasant	10

1) For all subcategories, large breed and jersey cattle are distinguished from each other.

It is important to point out that changes over the years, both to the national emission and the implied emission factor, are not only a result of changes in the numbers of animals, but also depend on changes in the allocation of subcategories, changes in feed consumption and changes in housing type.

6.2.1 Number of animals

Livestock production is primarily based on the agricultural census from Statistics Denmark (DSt). The emission from bulls, fattening pigs and poultry is based on slaughter data. Approximate numbers of horses, goats and sheep on small farms are added to the number in DSt because Statistics Denmark does not include farms less than 5 ha. Statistics Denmark is the source for the database kept by FAO (Food and Agriculture Organization of the United Nations). This explains why the number of sheep, goats and horses in FAO and the Danish emission inventory disagree. The largest difference is found for horses. In the agricultural census, for 2010 the number of horses is estimated to be 60 000. Including horses on small farms and riding schools, however, the number of horses rises to approximately 165 000 (Clausen, 2010). Data on the number of sheep and goats is based on the Central House-animal farm Register (CHR) which is the central register of farms and animal of the Ministry of Food, Agriculture and Fisheries.

Information of number of deer, ostriches and pheasants are not included in Statistics Denmark and the number of deer and ostriches are based on information delivered from CHR. The number of pheasants is based on expert judgement from DCE and the pheasant breeding association.

In Annex 3E-2 is provided number of animal allocated on all livestock subcategories for all years 1990-2010.

6.2.2 Housing type

From 2005, all farmers have to report to the Danish Plant Directorate information concerning the use of housing type. Annex 3E-1 shows the housing type for each livestock category 1990 – 2010.

Before 2005 there exist no official statistics concerning the distribution of animals according to housing type. The distribution is, therefore, based on an expert judgement from the Danish Agricultural Advisory Service (DAAS) and DCA. Approximately 90-95 % of Danish farmers are members of DAAS, which regularly collects statistical data from the farmers on different issues, as well as making recommendations with regard to farm buildings. Hence, DAAS have a very good feeling of which housing types are currently in use.

6.2.3 Feed consumption and excretion

The DCA provide Danish standards related to feed consumption, excreted volumes, nutrient content of nitrogen, phosphor and potassium, dry matter in manure, contribution of different manure type. These standards are all a part of the "Danish Normative System", which is used for fertilizer planning and control by the Danish farmers and authorities (Poulsen et al., 2010). The complexity and dynamics of the system has increased during the years to secure the development of accurate values. Furthermore the normative system includes emission factors for NH_3 which is based on a combination of measurements and model calculations. Emission factors for NH_3 from the housing unit and storage are given in Annex 3E-3 and 4.

The Danish normative standards are based on practical farming and thus reflect the actual Danish agricultural production conditions. DCA receive data from the Danish Agricultural Advisory Service (DAAS), which is the central office for all Danish agricultural advisory services. DAAS carries out a considerable amount of research itself, as well as collecting efficacy reports from the Danish farmers for dairy production, meat production, pig production, etc., to optimise productivity in Danish agriculture. Feeding plans are used to provide values to the Danish Normative System and for dairy cows the values are based on approximately 800 feeding plans. In total the normative standards covers feed plans from 15-18 % of the Danish dairy production, 25-30 % of the pig production, 80-90 % of the poultry production and approximately 100 % of the fur production are collected. A very high fraction of the pig production is represented, which is caused by the intensive focus on the possibilities to optimize the feed intake to increase the feed efficiency. The values covering the cattle production can be considered as reliable, even though there are not represented more than halved of the production. These values include mainly feeding plans from the farmers with a production efficiency corresponding to a middle level. The farmers with high productivity level are often not user of Danish Agricultural Advisory Service, which also is the case for farmers with a low productivity level.

Previously, the normative standards were updated and published every third or fourth year (Laursen, 1987; Laursen, 1994; Poulsen and Kristensen, 1997). From 2001 these standards are updated annually and available to download at the homepage of DCA:
http://www.agrsci.au.dk/ny_navigation/institutter/institut_for_husdyrbiologi_og_sundhed/husdyrernaering_og_miljoe/normtal (27.12.2011).

One of the reports concerning the normative data is published in English in Poulsen and Kristensen (1998) and is available at the homepage of DCA:
http://web.agrsci.dk/djfpublikation/djfpdf/djfhd7.pdf (27.12.2011).

6.3 CH_4 emission from enteric fermentation (CRF sector 4A)

6.3.1 Description

The major part of the agricultural CH_4 emission originates from digestive processes. In 2010, this source accounts for 30 % of the total GHG emission from agriculture. The emission is primarily related to ruminants and, in Denmark, particularly to cattle, which, in 2010, contributed with 85 % of the emission from enteric fermentation. The emission from pig production is the second largest source and covers 10 % of the national emission from enteric fermentation, followed by horses (3 %) and sheep, goats and deer (2 %).

6.3.2 Methodological issues

The methodology for estimating emissions from enteric fermentation is based on the Revised 1996 IPCC Guidelines (IPCC, 1997) and the IPCC Good Practice Guidance (IPCC, 2000). The methodology for poultry, ostrich and pheasants are based on Tier 1, while the remaining animal categories are based on the Tier 2/Country Specific (CS) approach. CH_4 emission from enteric fermentation from fur farming is considered to be not applicable based on country-specific information (Hansen, 2010). Feed consumption for all animal categories is based on the Danish normative figures. Default values for the methane conversion rate (Y_m) given by the IPCC are used for all livestock categories, except for dairy cattle and heifers, where a national Y_m is used for all years.

Tier 1

Emission factors used for poultry, ostrich and pheasants are based on the emission factors given by Wang & Huang (2005) (see Table 6.5). EF for broilers with a life cycle of 30-56 days is scaled in proportion to 42 days for broilers given by Wang & Huang (2005). Organic broilers with a life cycle of 81 days are scaled in proportion to the Taiwan country chicken with 91 days of life cycle and pullet with a life cycle of 112-119 days is scaled in proportion to the 140 days given for pullets by Wang & Huang (2005). EF for ducks, geese, turkeys, ostrich chickens and pheasant chickens is scaled by weight in proportion to a broiler with 40 days of life cycle. For laying hens EF for laying hens given by Wang & Huang (2005) is used and for ostrich hens and pheasant hens EF is scaled by weight in proportion to a laying hen.

Table 6.5 EF for poultry in mg CH_4 per head per lifecycle.

	CH_4 emission factor
Broilers, 42 days	15.87
Taiwan country chicken, 91 days	84.82
Pullets, 140 days	3 561
Laying hens, 365 days	10 610

Source: Wang & Huang, 2005.

Tier 2

The Tier 2/CS equation for EF of enteric fermentation is the sum of the feeding situation in winter and summer. The EF is based on actual feeding plans, which is provided from data for feed units (FU) for each livestock category – see below. Feeding with sugar beets is taken into account because sugar beet feeding gives a higher methane production rate compared to grass and maize due to the high content of easily convertible sugar. However, it is only dairy cattle and heifers which have sugar beets in the feed. The parts of the equation concerning sugar beet will be left out for the remaining animal categories.

$$EF = EF_{winter} + EF_{summer}$$

$$EF_{winter} = FU \cdot ((\frac{GE_{FU\,winter}}{55.65}) \cdot Y_{m\,excl\,sugar\,beet} \cdot$$
$$(1 - \frac{\text{grazing days}}{365} - \frac{\text{days with sugar beet}}{365}) +$$
$$(\frac{GE_{FU\,winter}}{55.65}) \cdot Y_{m\,incl\,sugar\,beet} \cdot \frac{\text{days with sugar beet}}{365})$$

$$EF_{summer} = FU \cdot (\frac{GE_{FU\,summer}}{55.65}) \cdot Y_{m\,grazing} \cdot \frac{\text{grazing days}}{365}$$

Where:

FU = feeding units
$GE_{FU,winter}$ = gross energy pr feeding unit, MJ pr FU
$GE_{FU,\,summer}$ = gross energy pr feeding unit, MJ pr FU
Y_m = methane conversion factor, percent of gross energy in feed converted to methane (IPCC, 1997)

Thus, to calculate the total gross energy intake, the gross energy per feed unit – defined as GE_{FU} – needs to be estimated. A feed unit in Denmark is defined as the feed value in 1.00 kg barley with a dry matter content of 85 % (Statistics Denmark, yearbook 2010). For other cereals e.g. wheat and rye one feed unit is 0.97 kg and 1.05 kg, respectively.

Gross energy intake

The calculation of $GE_{FU,\,winter}$ and $GE_{FU,\,summer}$ is based on the composition of feed intake and the energy content in proteins, fats and carbohydrates based on actual efficacy feeding controls or actual feeding plans at farm level, collected by DAAS or DCA. The data is given in Danish feed units or kg feedstuff and these values are converted to mega joule (MJ).The calculation is shown in the equation below:

The principle for estimation of $GE_{FU,\,winter}$ and $GE_{FU,\,summer}$ is the same, why the following equation only is defines as GE_{FU}.

$$GE_{FU} = \frac{\text{MJ/day}}{\text{FU/day}}$$

$$\text{FU/day} = \frac{\text{kg dm}}{\text{day}} \cdot \frac{\text{FU}}{\text{kg dm}}$$

$$\text{MJ/day} = \frac{\text{kg dm}}{\text{day}} \cdot \frac{\text{MJ}}{\text{kg dm}}$$

$$\text{MJ/kg dm} = \%_{\text{Crude protein}} \cdot E_{\text{Crude protein}} + \%_{\text{Raw fat}} \cdot E_{\text{Raw fat}} + \%_{\text{Carbonhydrates}} \cdot E_{\text{Carbonhydrates}}$$

$$\%_{\text{Carbonhydrates}} = 100 - (\%_{\text{Crude protein}} + \%_{\text{Raw fat}} + \%_{\text{Raw ashes}})$$

In Annex 3E-5 and 6 are for listed all parameters for winter feeding plans covering the amount of proteins, fats and carbohydrates in the feed, FU per kg, kg dry matter per day and MJ per day. Annex 3E-7 and 8 provides additional information about feed intake given in FU and grazing days for each livestock category.

Estimation of $GE_{FU,\ summer}$ covers the time where grassing animal

For dairy cows, the energy intake comes out at 18.3 MJ pr. FU in a standard winter feed regardless of whether the animal grazes or not, which is based on information from DCA. For bull calves (< ½ year), as well as bulls older than ½ year, the same energy content value is used, as for dairy cows.

For horses, heifers, suckling cattle, sheep and goats an average winter feed plan is provided based on information from DCA and DAAS on which the calculation of the gross energy content is based. Gross energy for deer is based on feed plans for goats, as their feeding conditions resemble those of deer the most.

Table 6.6 Gross energy per feeding unit, MJ per FU

	GFU_{winter}	GFU_{summer}
Dairy cattle	18.3	18.3
Calves and bulls	18.3	18.8
Heifers	25.8	18.8
Suckling cattle	34.0	18.8
Sows	17.5	17.5
Weaners	16.5	16.5
Fattening pigs	17.3	17.3
Horses, sheep, goats and deer	30.0	18.8

In Annex 3E-9a, the annual average feed intake given in GE as MJ/day is shown, from 1990 to 2010, for each CRF livestock category and Annex 3E-9b shows the GE for each subcategory for non-dairy cattle and swine.

The Tier2/CS for enteric fermentation differs mainly from the IPCC Tier 2 in the calculation of GE. A comparison between these two methods is shown in Chapter 6.3.4.

Methane conversion rate (Y_m)

Investigations from DCA have shown a change in fodder practice from use of sugar beet to maize (whole cereal). Sugar beet feeding gives a higher methane production rate compared to grass and maize due to the high content of easily convertible sugar. The development in fodder practice reflects the change in the average Y_m for dairy cattle and heifer from 6.39 in 1990 to 5.94 in 2010.

The estimation of the national values of Y_m is based on model "Karoline" developed by DCA based on average feeding plans for 20 % of all dairy cows in Denmark obtained from the Danish Agricultural Advisory Service DAAS (Olesen et al.; 2005). DCA have estimated the CH_4 emission for a winter feeding plan for two years, 1991 (Y_m=6.7) and 2002 (Y_m=6.0). Y_m for the years between 1991 and 2002 are estimated by interpolation and for 1990 and 2003 to 2010 by extrapolation where the actual sugar beet area is taken into account. Data for actual sugar beet area are shown in Table 6.7. Sugar beets are only included in the winter feeding plan and the Y_m is therefore also adjusted for days on winter and summer feeding plan. It is assumed that winter feeding plan covers 200 days. The value of the estimated Y_m for 1991 and 2002 are, when adjusted for winter/summer, 6.35 and 5.96, respectively (see Table 6.8).

Table 6.7 Area grown with sugar beets and maize for feeding 1990-2010, ha.

Area	1990	1995	2000	2005	2006	2007	2008	2009	2010
Sugar beet for feeding	102 347	52 927	17 577	4 974	4 035	3 819	5 206	5 257	4 118
Maize for feeding	18 735	36 583	61 493	131 027	135 245	144 869	159 030	168 917	172 168

Table 6.8 Average CH_4 conversion rate (Y_m) – national factor used for dairy cattle and heifers > ½ year 1990 – 2010, %.

Dairy cattle + Heifers > ½ year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Y_m - average	6.39	6.16	6.00	5.94	5.93	5.93	5.94	5.94	5.94

Implied emission factor

Table 6.9 shows the implied emission factors for all IPCC livestock categories. The implied emission factor (IEF) vary across the years for dairy cattle, non-dairy cattle, swine, goats and poultry due to changes for feed consumption, distribution of animals in subcategories and number of grazing days. For goats new subcategories are introduced in 2005 and therefore the IEF differs from the other years. For sheep, horses, deer, ostrich and pheasants the IEF is constant. The emission from fur farming is considered to be not applicable (Hansen, 2010).

Table 6.9 Implied emission factor – Enteric Fermentation 1990 – 2010, kg CH_4 pr head pr yr.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
1. Cattle									
a. Dairy	116.62	119.45	117.16	128.12	129.24	130.46	130.67	133.76	134.35
b. Non-Dairy	34.77	34.96	35.01	36.98	38.89	40.10	40.82	40.12	39.82
3. Sheep	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17
4. Goats	13.15	13.15	13.15	12.87	12.86	12.83	13.04	13.06	13.06
6. Horses	21.81	21.81	21.81	21.81	21.81	21.81	21.81	21.81	21.81
8. Swine	1.09	1.08	1.11	1.07	1.09	1.09	1.12	1.10	1.05
9. Poultry	0.004	0.003	0.003	0.004	0.003	0.003	0.004	0.003	0.003
10. Other									
Fur farming	NA	NA	NA	NA	NA	NA	NA	NA	NA
Deer	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30
Ostrich	NO	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Pheasant	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003

NO = Not occurring

NA = Not applicable

The increase in the IEF for dairy cattle from 1990-2010 is the result of rising milk yields and thus increasing feed consumption. On average, the milk yield has increased from 6 000 litre pr cow in 1990 to approximately 8 500 litre pr cow in 2010 (Statistics Denmark). A comparison with IPCC Tier 2 calculation in Chapter 6.3.4 shows that the IEF used in the Danish inventory are lower. However, the national IEF is considered reasonable because this can be explained by the improvement in feed efficiency which has taken place in Danish agriculture from 2000.

The category "Non-Dairy Cattle" includes calves, heifers, bulls and suckling cattle and the implied emission factor is a weighted average of these different subcategories. The development 1990 - 2004 in IEF shows a slight increase and 2009 – 2010 a slight decrease, which is due to changes in the distribution of animals in subcategories. From 2005 to 2008 the IEF increases due to a higher feed consumption for heifers.

The Danish IEF for non-dairy cattle is lower than the Tier 1 default value given in the IPCC Reference Manual (IPCC, 1997). This is due to a combination of lower Y_m value for heifers and lower weight/lower feed intake (Table 6.10). In Chapter 6.3.4 the national IEF is compared with IPCC Tier 2 calculation and the result shows a good correlation which indicates the Danish estimate is correct.

Table 6.10 Subcategories for Non-Dairy Cattle 2010 – enteric fermentation.

Non Dairy Cattle – subcategories		Number of animals (DSt)	Energy intake, MJ pr day	Methane conversion rate (Y_m), %	IEF, kg CH_4 pr head pr yr
Calves, bull (0-6 month)	200 kg	132 171	61.66	4.00	16.18
Calves, heifer (0-6 month)	150 kg	155 897	102.33	6.00	39.73
Bulls (6 month to slaughter)	large breed: 440 kg sl. weight jersey: 330 kg sl. weight	140 855	116.32	4.00	29.30
Heifers (6 month to calving)	325 kg	472 838	130.3	5.94	50.94
Suckling cattle	Up to 800 kg	101 087	163.55	6.00	63.91
Average - Non-Dairy Cattle					39.82
IPCC – default value			128.0		48.00

The annual variations for swine primarily reflect the changes in the distribution of animals in subcategories (sows, weaners and fattening pigs). The feed intake for sows and weaners has overall increased while the feed intake for fattening pigs has decreased as a result of improved fodder efficiency (Annex 3E-7 and 9b).

In Table 6.11 the IEF for swine subcategories is shown. The Danish IEF for swine is lower than the IPCC default value. The energy intake for fattening pigs is nearly the same as the default value, while the energy intake for weaners is significant lower. The relatively high feed intake for sows does not influence the average value significant because of the low number of sows. The lower Danish IEF can probably be explained as the distribution of animals in subcategories – due to a high share of weaners.

Table 6.11 Subcategories for Swine 2010 – enteric fermentation.

Swine – subcategories	Number of animals (DSt)	Energy intake, MJ pr day	Methane conversion rate (Y_m), %	IEF, kg CH_4 pr head pr yr
Sows (incl. piglets until 7.4 kg)	1 116 756	72.84	0.60	2.83
Weaners (7.4 – 32 kg)	6 166 446	14.07	0.60	0.39
Fattening pigs (32 – 107 kg)	5 889 858	40.27	0.60	1.41
Average - Swine				1.05
IPCC – default value		38	0.60	1.5

It is important to point out that the IEF for sheep and goats includes emission from lambs and kids due to the Danish normative data. This explains why the Danish IEFs are nearly twice as high as the IPCC default value. A comparison with IPCC Tier 2 which includes lamb indicates that the Danish estimates can be comparable with the IPCC default and therefore seems to be reasonable (see Chapter 6.3.4).

Activity data

In Table 6.12, the development in the number of animals from the agricultural statistics (Statistics Denmark), DAAS and CHR from 1990 to 2010 is presented (for subcategories see Annex 3E-2). The agricultural census does not include farms less than 5 ha. In the Danish emission inventory, the decision has been made to add number of sheep, goats and horses on small farms and deer, pheasants and ostriches based on information from DAAS and CHR (see Chapter 6.2.1).

Since 1990, the number of swine and poultry has increased, in contrast to the number of cattle, which has decreased. The number of cattle has decreased because the milk yield has increased while the total production of milk has been a fixed by the EU milk quota. Buffalos, camels & llamas and mules & asses are not occurring in Denmark.

Table 6.12 Number of animals from 1990 to 2010, 1000 head.

CRF Table 4.A, 4.B (a) and 4.B (b)	1990	1995	2000	2005	2006	2007	2008	2009	2010
IPCC livestock categories:									
Dairy Cattle	753	702	636	564	550	545	558	563	568
Non-Dairy Cattle	1 486	1 388	1 232	1 006	984	1 021	1 006	977	1 003
Sheep*	92	81	112	126	128	124	117	116	111
Goats*	7	7	8	11	12	13	14	16	16
Horses*	135	143	150	175	180	185	190	178	165
Swine	9 497	11 084	11 922	13 534	13 361	13 723	12 738	12 369	13 173
Poultry	16 249	19 619	21 830	17 632	17 425	16 741	15 406	19 676	18 731
Other;									
Fur farming	2 264	1 850	2 199	2 552	2 708	2 837	2 810	2 721	2658
Pheasant**	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063
Deer**	10	10	10	10	10	10	10	9	10
Ostrich**	NO	3	9	4	4	1	0.5	0.4	0.4

* Including animals on small farms (less than 5 ha), which are not covered by the Statistics Denmark.
** Not included in DSt.
NO = Not occurring.

6.3.3 Time series consistency

The CH_4 emission from enteric fermentation is given in Table 6.13. From 1990 to 2010, the emission has decreased by 15 %, which is primarily related to a decrease in the number of cattle. The number of pigs has increased from 9.5 million in 1990 to 13.2 million in 2010, but this increase is only of minor importance in relation to the total CH_4 emission from enteric fermentation.

Table 6.13 Emission of CH_4 from Enteric Fermentation 1990 – 2010, Gg CH_4.

CRF 4.A	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy Cattle	87.83	83.91	74.46	72.29	71.12	71.16	72.91	75.32	76.34
Non-Dairy Cattle	51.66	48.52	43.14	37.20	38.28	40.94	41.08	39.21	39.93
Sheep	1.58	1.39	1.92	2.17	2.19	2.13	2.02	1.98	1.91
Goats	0.10	0.09	0.11	0.15	0.16	0.16	0.18	0.20	0.21
Horses	2.94	3.11	3.27	3.82	3.93	4.03	4.14	3.87	3.60
Swine	10.33	12.02	13.17	14.53	14.62	14.99	14.27	13.66	13.87
Poultry	0.06	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06
Other;									
Fur farming	NA	NA	NA	NA	NA	NA	NA	NA	NA
Deer	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Ostrich	NO	#	#	#	#	#	#	#	#
Pheasant	#	#	#	#	#	#	#	#	#
Total, Gg CH_4	154.62	149.22	136.25	130.33	130.47	133.57	134.78	134.42	131.00
Total, Gg CO_2 eqv.	3 247	3 134	2 861	2 737	2 740	2 805	2 830	2 823	2 751

NO = Not occurring.
NA = Not applicable.
# - emission ≤ 0.0003.

6.3.4 Tier 2/Country Specific compared to IPCC Tier 2 method

As recommended by ERT a comparison between IPCC Tier 2 and Denmark's Tier2/Country Specific (CS) calculation method for enteric fermentation is made. In the IPCC Guidelines default values are given for dairy cattle, non-dairy cattle and sheep, therefore a comparison is made for these three groups. The comparison is based on 2008 data.

Calculations of IEFs are made by IPCC Tier 2, with both default and national values for Y_m, and Denmark's Tier 2/CS method. A comparison between IEFs (Table 6.14) shows that the Danish method gives a value for dairy cattle that is up to 7 % lower than the IPCC Tier 2 method. For non-dairy cattle the result is up to 5 % higher. To compare the IEF for sheep the calculation includes lamb. The Danish method gives a 7 % lower value than the IPCC with default values for Y_m, but a 9 % higher value than IPCC with national values for Y_m.

Table 6.14 IEFs for enteric fermentation calculated by different methods, 2008.

kg CH_4 pr animal pr year	Tier 2 (IPCC Y_m)	Tier 2 (DK Y_m)	Tier 2/CS
Dairy Cattle	140.3	137.9	130.7
Non-Dairy Cattle	38.8	38.3	40.8
Sheep (incl. lambs)	18.4	15.8	17.2

The three different Tier 2 calculations for Non-dairy cattle all show an IEF between 38.3-40.4 kg per head per year, which indicates that the Tier 2/CS used in the Danish inventory is reasonable. However, these values are lower compared to the Tier 1 default value at 48 kg per head per year given in the Reference Manual (IPCC, 1997) (Table 4.-4) which probably can be explained by a combination of lower Y_m for heifers and lower animal weight/lower feed intake.

The calculations of IEF for sheep indicate that the value used in the Danish inventory are reasonable. A Tier 2 calculation, where the productions of lamb are included, based on IPCC Y_m shows an IEF at the same level.

The lower value for IEF for dairy cattle is mainly due to a lower value for gross energy (GE) (Table 6.15). The Danish values for feed consumption are based on the Danish normative figures and the normative data are based on actual efficacy feeding controls or actual feeding plans at farm level, more info on GE calculations in Chapter 6.3.2.

Table 6.15 Gross energy for dairy cattle calculated by different methods, 2008.

MJ pr animal pr day	Tier 2 (IPCC Y_m and DK Y_m)	Tier 2/CS
Dairy cattle	356.4	335.3

According to Statistics Denmark dairy cattle produce 22.5 kg milk in average per animal per day in 2008. Table 6.16 shows the needed energy intake to achieve this milk production calculated by two different methods. By using the Tier 2 calculation given in the Reference Manual (IPCC, 1997) 15.8 MJ is needed to produce 22.5 kg milk per animal per day. National data for feed intake which reflect the actual Danish agricultural conditions shows a lower need of energy intake corresponding to 14.9 MJ. This is a result of improved feeding efficiency.

Table 6.16 MJ pr kg milk produced 2008.

	Kg milk pr animal pr day	MJ pr kg milk Tier 2	MJ pr kg milk Tier 2/CS
Dairy cattle	22.5	15.8	14.9

In Figure 6.3 is shown the Danish trend of MJ per kg milk for dairy cattle. It is seen that the energy intake per kg milk have overall decreased from 1996 to 2008. Around 1999 the Danish level of MJ per kg milk was at the same level as given in the IPCC Tier 2 method. Since then, feeding efficiency has continued to rise due to the structural development, i.e. bigger farms and more intensive production. This explains the lower IEF for dairy cattle based on the Danish methodology.

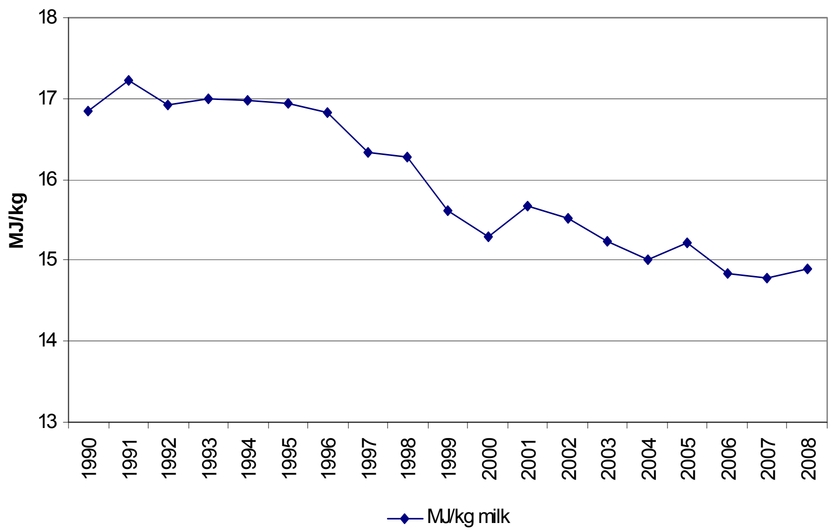

Figure 6.3 The Danish trend for MJ pr kg milk produced for dairy cattle, 1990-2008.

6.4 CH_4 and N_2O emission from manure management (CRF sector 4B)

6.4.1 Description

This source contributes with 18 % of the total greenhouse gas emission from the agricultural sector in 2010. The major part of the emission originates from the production of cattle (37 %) followed by swine production (40 %). The remaining part is mainly from poultry and fur farming (13 %).

6.4.2 Methodological issues

CH_4 emission

The IPCC Tier 2/CS methodology is used for the estimation of the CH_4 emission from manure management. The calculation is based on manure excretion instead of feed intake as described in IPCC Reference manual (IPCC, 1997). Default values for maximum methane producing capacity, B_0 and methane conversion factor, MCF given by the IPCC are used. The calculation of volatile solids (VS) is based on national data.

Table 6.17 CH_4 – Manure management – use of national parameters and IPCC default values.

CH_4 – Manure management	National parameters	IPCC default value
Volatile solids, VS	Based on amount of manure (Annex 3E-10a and 10b)	
Maximum methane producing capacity, B_0		IPCC 1997
Methane conversion factor, MCF		IPCC 1997

The amount of manure is calculated for each combination of livestock subcategory and housing type and then aggregated to the IPCC livestock categories. In the calculation grazing days and use of straw in the housing are taken into account. Equation for CH_4 calculation:

$$CH_{4\,Manure} = CH_4 \text{ housing} + CH_4 \text{ grazing}$$

$$CH_4 \text{ housing} = VS_{\text{housing}} \cdot MCF \cdot 0.67 \cdot B_0$$

$$CH_4 \text{ grazing} = VS_{\text{grazing}} \cdot MCF \cdot 0.67 \cdot B_0$$

Estimation of VS

VS is calculated from data concerning amount of manure, dry matter content, share of VS in dry matter, amount of bedding and grazing days. Except from grazing days, all these parameters are based on Danish Normative data.

The determination of VS is country-specific, given that it is based on the amount of manure excreted.

$$VS_{\text{housing}} = \frac{m}{365} \cdot DM_M \cdot VS_{DM} \cdot (365 - g_1) + s \cdot DM_S \cdot (1 - \frac{\%\,\text{ash}}{100}) \cdot (365 - g_2)$$

$$VS_{\text{grass}} = \frac{m}{365} \cdot DM_M \cdot VS_{DM} \cdot g_1$$

where:	VS	= volatile solids, kg animal^{-1} yr^{-1}
	m	= amount of manure excreted, kg animal^{-1} yr^{-1}
	DM	= dry matter of M manure or S straw, pct
	VS_{DM}	= volatile solids of dry matter, pct
	g_1	= feeding days on grass, days yr^{-1}
	g_2	= actual days on grass, days yr^{-1}
	s	= amount of straw, kg animal^{-1} yr^{-1}
	% ash	= ash content in straw

The ash content in straw is set to 4.5 % (DAAS, 2005). The VS of dry matter is 78 % for cattle, horses, sheep, goats and deer. For pigs, poultry and fur animals the VS of dry matter is 75 % (Møller, 2003). The number of days on grass is shown in Annex 3E-8. The amount of manure excreted and straw used depends on housing type and is given in the normative figures table (Poulsen, 2011).

The VS daily excretion in average for all main livestock categories and cattle subcategories is shown in Annex 3E-10a and 10b.

MCF used for slurry

Default values provided in the IPCC guidelines for the methane production B_0 and MCF are used. For liquid systems, the MCF of 10 % in the Reference Manual (IPCC, 1997) is used.

The Revised 1996 IPCC guidelines (IPCC, 1997) provide a default MCF of 10 % for liquid/slurry, which is based on research of Hashimoto & Steed (1993) and Woodbury & Hashimoto (1993). This MCF value was changed to 39 % in the IPCC Good Practice Guidance (IPCC, 2000), without any scientific argumentation, documentation or specific references. It has to be remarked that the 2006 IPCC Guidelines (IPCC, 2006) return to a MCF value of 10 % for Danish conditions referenced to "Judgement of IPCC Expert Group in combination with Mangino et al. (2001) and Sommer et al. (2000)" (IPCC, 2006).

The methane emission from liquid systems is very sensitive to temperature effects. Basically most of the manure is stored in Denmark under cold conditions (<5-10 degrees Celsius). The CH_4 formation practically stops at 4 °C and therefore there are no plausible arguments that 39 % of total CH_4 capacity should be released under Danish conditions. Danish studies confirm this assumption (Husted, 1994 and Sommer et al., 2000). Furthermore, investigations based on measurements in Canada, where conditions are similar to Denmark, support this value (Massé et al., 2003). Support of the value of 10 % is also found from a Swedish review (Dustan, 2002), taking into account both the cold climate and the fact that the slurry containers in Scandinavia usually have a surface cover.

Considering the agricultural conditions in Denmark and the present scientific knowledge as described above a MCF of 10 % for liquid/slurry is more appropriate under the Danish conditions. The Danish decision of using a MCF of 10 % is as demonstrated above backed by several scientific papers as well as both the Revised 1996 IPCC Guidelines (IPCC, 1997) and the 2006 IPCC Guidelines (IPCC, 2006). Therefore Denmark intends to continue using a MCF value of 10 % until further scientific knowledge is published contradicting the above mentioned references.

It has to be remarked that countries with comparable climate use a MCF for liquid/slurry at the same level as default recommended in the Revised IPCC

1996 Guidelines (IPCC, 1997). Sweden, Finland and Germany use the same value as Denmark, i.e. a MCF of 10 %, Belgium uses 19 % and Norway and the Netherlands use a MCF below 10 %.

A lower CH_4 emission from biogas treated slurry

Study indicates a lower CH_4 emission from slurry treated in biogas plants (Sommer et al., 2001). No description on how to include biogas treated slurry in the inventories is provided in the IPCC guidelines. Therefore, the Danish inventory uses data based on a Danish study (Sommer et al., 2001).

Unfortunately, it have not been possible to get new activity data on amount of biogas treated slurry in 2010, therefore an extrapolation of the 2009 amount is provided. In 2010 is the calculated amount of slurry treated in biogas plant 2.4 million tonnes of slurry (DEA, 2010). It is assumed that of the total amount of biogas treated slurry, cattle slurry makes up 45 % and pig slurry 55 % (Tafdrup, 2010). The amount of biogas treated slurry is equivalent to approximately 8 % of all animal manure.

The lower CH_4 emission as a consequence of biogas treated slurry is calculated as the difference between non-treated slurry and treated slurry.

$$CH_{4,\text{lower}} = CH_{4,\text{non-treated slurry}} - CH_{4,\text{treated slurry}}$$

The calculation is based on the amount of volatile solids (VS) calculated as the VS percentage of dry matter (DM) which is 80 % for both cattle and pig slurry. The dry matter content is based on the Danish normative figures (Poulsen et al., 2001 and Poulsen, 2011).

The CH_4 emission from treated and non-treated slurry is calculated as:

$$CH_{4,\text{non-treated slurry}} = VS \cdot B_o \cdot MCF \cdot 0.67$$

$$CH_{4,\text{treated slurry}} = VS \cdot B_o \cdot MCF \cdot 0.67 \cdot E_{\text{lower}}$$

Where; $CH_{4,\text{non-treated slurry}}$ and $CH_{4,\text{treated slurry}}$ are the emission of non-biogas treated slurry and biogas treated slurry, respectively. VS express the total amount of volatile solid in non-biogas treated slurry and biogas treated slurry, B_0 is the maximum methane forming capacity, MCF is the methane conversion factor and the factor 0.67 express the conversion from m^3 to kg. E_{lower} is the lower emission of biogas treated slurry compared to untreated slurry.

Based on results from Sommer et al. (2001) it is assumed that the emission from treated cattle slurry is reduced by 23% compared with untreated slurry. This leads to an E_{lower} for cattle of 0.77. Likewise, results from treated pig slurry show a 40 % lower emission than for untreated slurry, which leads to an E_{lower} at 0.60 (Sommer et al., 2001). Refer to Annex 3E-11.

All key model parameters for estimating the lower CH_4 emission in 2010 as a result of biogas plants are listed in Table 6.18. Data for 1990 to 2010 are shown in Annex 3E-12a.

Table 6.18 Key model parameters used to calculate the lower CH_4 emission due to biogas treated slurry.

2010	Slurry biogas treated	DM[a]	VS of DM[b]	VS in treated slurry	MCF[c]	B_0[c]	E_{lower}[d]	CH_4 emission in untreated slurry	CH_4 emission in biogas treated slurry	Lower the total CH_4 emission with
	1000 Gg	Pct	Pct.	10^6 kg VS	pct	m^3 CH_4 pr kg VS		Gg CH_4	Gg CH_4	Gg CH_4
Cattle slurry	1.08	10.3	80	88.62	10	0.24	0.77	1.43	1.09	0.33
Pig slurry	1.31	6.1	80	64.15	10	0.45	0.60	1.93	1.16	0.78
Lower emission										1.11

[a] Poulsen et al., 2001 and Poulsen, 2011.

[b] Møller, 2003.

[c] IPCC default.

[d] Sommer et al., 2001.

Due to biogas treated slurry, the total emission of CH_4 in 2010 is lowered by 1.11 Gg CH_4 (Table 6.18), which correspond to a 2 % reduction of the total CH_4 emission from manure management in 2010. Calculations for the lower CH_4 emission for all years 1990 – 2010 are listed in Table 6.19.

The lower emission is subtracted in the emission related to manure management from dairy cattle and fattening pigs, which are the main sources of the production of slurry.

Table 6.19 Lower CH_4 emissions as a result of biogas treated slurry 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Amount of treated slurry, Mt									
- cattle	0.09	0.29	0.52	0.87	0.96	0.97	0.99	1.08	1.08
- swine	0.10	0.35	0.64	1.06	1.18	1.18	1.20	1.31	1.31
VS total in treated slurry									
- cattle	0.01	0.02	0.04	0.07	0.08	0.08	0.08	0.09	0.09
- swine	0.01	0.02	0.03	0.05	0.06	0.06	0.06	0.06	0.06
Total reduced emission, Gg CH_4	0.09	0.30	0.54	0.90	0.99	1.00	1.02	1.11	1.11

CH_4 implied emission factors

Table 6.20 shows the development in the implied emission factors from 1990 to 2010. Variations between the years for dairy cattle, non-dairy cattle, poultry, swine and fur farming reflect changes in feed intake, distribution of animals in subcategories, grazing situation and changes in housing type system.

The IEFs for sheep and deer is unaltered because of very few changes in feed intake and grazing days. A more detailed division in subcategories for goats and horses is implemented from 2007 and 2003, respectively, and explains the small changes in IEFs.

Table 6.20 Implied emission factors – Manure Management 1990 – 2010, kg CH_4 pr head pr yr.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
1a. Dairy Cattle	21.06	22.87	27.55	34.25	33.94	32.20	32.18	33.09	33.23
1b. Non-Dairy Cattle	5.96	7.13	7.88	9.23	9.60	9.60	9.71	9.66	9.49
3. Sheep	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
4. Goats	2.44	2.44	2.44	2.45	2.44	2.43	2.45	2.45	2.45
6. Horses	2.96	2.96	2.96	2.95	2.95	2.95	2.95	2.95	2.95
8. Swine	2.12	2.19	2.22	2.22	2.17	2.20	2.27	2.29	2.20
9. Poultry	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03
10. Other									
Fur farming	0.57	0.59	0.65	0.79	0.84	0.89	0.92	0.97	0.99
Deer	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Ostrich	NO	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
Pheasant	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

IEF for dairy cattle has increased as a result of increasing milk yield, but also because of changes in housing types. Annex 3E-1 shows the changes in housing types from 1990 to 2010. Old-style tethering systems with solid manure have been replaced by loose-housing with slurry-based systems. The MCF for liquid manure is ten times higher than that for solid manure. For non-dairy cattle the same development in IEF is seen, but here it is mainly because an increasing proportion of bull-calves are raised in housings with deep litter, where the MCF is also high.

For pigs and fur farming, there has been a similar development as for dairy cattle with a move from solid manure to slurry-based systems.

The IEF for sheep and goats includes lambs and kids and the housing systems for these categories are defined as deep litter with a MCF of 10 %. This explains why the Danish IEF is considerably higher than the IPCC default value, which if given for sheep and goats housed in solid storage systems.

The implied emission factors based on Tier 2/CS compared to the IPCC default values shows some differences and can be explained by looking at the values for the most important parameters such as volatile solids (VS), feed consumption and the share of animals placed on slurry based system.

As shown in Table 6.21 the national IEF for dairy cattle is particularly higher, which is mainly due to the fact that more cattle are housed on slurry based system than given in the IPCC assumptions. Furthermore VS used for Danish dairy cattle are higher due to higher milk yield.

For non dairy cattle the national VS value is nearly the same as the default, but a high proportion of the animals are housed in deep litter or liquid/slurry systems, 40 % and 30 % in 2010 respectively, which both have a MCF at 10 %.

Table 6.21 Cattle – important parameters for calculation of the average implied emission factor for manure management 2010.

	IPCC			DK - 2010		
	VS kg dm pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr	VS kg dm pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr
Dairy	5.1	40	14	6.2	87	33
Non-dairy (average)	2.7	50	6	2.8	30	9
Calves, bull				1.5	0	0
Calves, heifer				1.8	0	0
Bulls > ½ yr				4.0	36	17
Heifer > ½ yr				2.8	49	9
Suckling cattle				4.2	9	12

The category of swine operates with three subcategories. The IEF is lower compared with the IPCC default value due to a lower VS value. In the Reference Manual (IPCC, 1997) is used an average feed intake of 38 MJ pr head pr day which is significantly higher than the average feed intake for Danish weaners and fattening pigs.

Table 6.22 Swine – important parameters for calculation of the average implied emission factor for manure management 2010.

	IPCC				DK – 2010			
	VS kg dm pr hd pr day	Feed intake MJ pr hd pr day	Pit > 1 month %	IEF Kg CH_4 pr hd pr yr	VS kg dm pr hd pr day	Feed intake MJ pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr
Swine	0.5	38	73	3.0	0.2		97	2.2
Sows (incl. piglets until 7 kg)					0.4	73		6.7
Weaners (7-32 kg)					0.1	2		0.2
Fattening pigs (32-107 kg)					0.3	10		0.8

Table 6.23 Emission of CH_4 from Manure Management 1990 – 2010, Gg CH_4.

CRF 4.A	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy Cattle	15.86	16.07	17.51	19.33	18.68	17.56	17.96	18.63	18.88
Non-Dairy Cattle	8.86	9.90	9.71	9.28	9.45	9.80	9.77	9.44	9.52
Sheep	0.26	0.23	0.31	0.36	0.36	0.35	0.33	0.33	0.31
Goats	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04
Horses	0.40	0.42	0.44	0.52	0.53	0.55	0.56	0.52	0.49
Swine	20.13	24.26	26.41	30.01	29.04	30.25	28.90	28.34	28.92
Poultry	0.47	0.54	0.52	0.53	0.48	0.49	0.49	0.51	0.53
Other;									
Fur farming	1.29	1.09	1.44	2.01	2.27	2.53	2.57	2.64	2.64
Deer	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00
Ostrich	NO	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00
Pheasant	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00
Total, Gg CH_4	47.29	52.53	56.39	62.07	60.85	61.57	60.63	60.45	61.33
Total, Gg CO_2 eqv.	993	1 103	1 184	1 303	1 278	1 293	1 273	1 270	1 288

No = Not occurring.

N_2O emission

The N_2O emission from manure management is based on the amount of nitrogen in the manure in housings. The emission from manure deposited on grass is included in "Pasture, Range and Paddock Manure" (Chapter 6.5.2). The IPCC default emission factors are applied, see Table 6.24.

Table 6.24 Emission factors for N_2O from manure management.

	Emission factor	
	Unit	IPCC – default values
Handling of manure:		
Solid manure, poultry	kg N_2O-N pr kg N	0.005
Solid manure, other	kg N_2O-N pr kg N	0.02
Slurry and urine	kg N_2O-N pr kg N	0.001
Deep litter	kg N_2O-N pr kg N	0.02
Deep litter, farmyard manure < 1 month[1]	kg N_2O-N pr kg N	0.005

[1] Farmyard manure, which is faeces and urine mixed with large amounts of bedding (usually straw) on the floors of cattle or pig housing.

The total amount of nitrogen in manure has decreased by 11 % from 1990 to 2010 (Table 6.25), despite the increasing production of pigs and poultry. This reduction is due to improvements in fodder efficiency, especially for fattening pigs. A decrease in total amount of nitrogen means also a decrease for the N_2O emission. Another reason for the decreased N_2O emission is the lower emission factor for liquid manure than for solid manure. The move from the previous more traditional tethering systems with solid manure to slurry based systems lead to a reduction in the emission of N_2O.

It is important to point out that the N-excretion rates shown in Table 6.25 are values weighted for the subcategories (Table 6.3). N-excretion reflects nitrogen excreted per animal per year. The variations in N-excretion in the time series reflect changes in feed intake, fodder efficiency and distribution of animals in subcategories.

Table 6.25 Nitrogen excretion, annual average 1990 – 2010, kg N pr head pr yr.

CRF Table 4.B(b)	1990	1995	2000	2005	2006	2007	2008	2009	2010
Livestock category									
Dairy cattle	129.49	125.23	125.31	133.30	134.66	137.58	137.98	138.12	138.63
Non-dairy	35.59	36.26	36.39	40.88	43.33	44.79	45.53	44.81	43.15
Sheep	21.18	21.90	16.95	16.95	16.95	16.95	16.95	16.95	16.95
Goats	21.18	21.90	16.95	15.83	15.74	15.64	16.32	16.37	16.40
Swine	11.84	9.70	9.61	9.19	8.52	8.54	8.63	8.33	7.65
Poultry	0.63	0.62	0.55	0.73	0.65	0.67	0.74	0.55	0.60
Horses	44.15	39.56	39.56	39.56	39.56	39.56	39.56	39.56	39.56
Fur farming	4.90	4.65	4.62	5.38	5.18	5.18	5.29	5.51	5.81
Deer	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Ostrich	0	15.61	15.60	15.60	15.60	15.60	15.60	15.60	15.60
Pheasant	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
N-excretion, total, Gg N pr yr	293	274	270	277	266	274	269	260	258
N-excretion, housing, Gg N pr yr	258	239	235	251	241	250	246	237	237

Table 6.26 shows the N_2O emission from manure management distributed on the main livestock categories. The total emission is decreased from 1990 to 2010 and this trend is particularly determined by the emission from cattle and pigs. The overall fall can be explained by change in housing types towards more animals on slurry based system – e.g. for dairy cattle 70 % in 1990 which is increased to 87 % in 2010. The same development is seen for swine where the part of slurry based system has increased from 89 % in 1990 to 97 % in 2010. Furthermore, the N-excretion form slaughter pigs and piglets have decreased significantly.

Table 6.26 Emission of N_2O from manure management 1990-2010, Gg N_2O

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy Cattle	0.57	0.50	0.42	0.31	0.32	0.32	0.31	0.29	0.30
Non-Dairy Cattle	0.38	0.38	0.37	0.39	0.40	0.43	0.43	0.41	0.41
Sheep	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Goats	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
Swine	0.54	0.46	0.46	0.46	0.39	0.37	0.31	0.26	0.26
Poultry	0.26	0.33	0.35	0.36	0.32	0.32	0.32	0.31	0.32
Horses	0.09	0.09	0.09	0.11	0.11	0.12	0.12	0.11	0.10
Fur farming	0.08	0.06	0.06	0.05	0.04	0.03	0.03	0.03	0.02
Deer	IE	IE	IE	IE	IE	IE	IE	IE	IE
Ostrich	NO	0.0013	0.0035	0.0014	0.0014	0.0002	0.0002	0.0001	0.0001
Pheasant	IE	IE	IE	IE	IE	IE	IE	IE	IE
Total excl. biogas	1.94	1.84	1.76	1.70	1.60	1.60	1.53	1.43	1.42

IE = Included elsewhere. Deer and pheasants are at pasture 365 days a year and the emissions are reported under 4.D.2 Pasture, Range and Paddock.

A lower N_2O emission from biogas treated slurry

Studies indicate a lower N_2O emission from biogas treated slurry compared to untreated slurry (Sommer et al., 2001 and Sommer et al., 2004). The lower emission is a result of displacement in allocation between the fraction of degradable and non-degradable VS. Biogas treated slurry increase the fraction of non-degradable VS, which promote the oxygen content in soil. These conditions will reduce the potential for N_2O emission, because N_2O emission takes place in environments without oxygen or with very low concentrations of oxygen (Sommer et al., 2001).

In practice this effect of a lower N_2O emission will take place in the manure applied on soil. However, it is chosen, in the inventory, to account for the lower N_2O emission by subtracting it from the manure management emission. The biogas treatment is done before the slurry is applied to soil.

No methodology is provided in the IPCC Reference Manual or GPG on how to account for this reduction. The estimation is based on a Danish study (Sommer et al., 2001). The reduced N_2O emission is calculated as:

$$N_2O\text{-}N_{lower} = N_2O\text{-}N_{non\text{-}treated\ slurry} - N_2O\text{-}N_{treated\ slurry}$$

The N_2O emission from treated and non-treated slurry is calculated as:

$$N_2O\text{-}N_{non\text{-}treated} = N_{slurry\ non\text{-}treated} \cdot N_{content} \cdot EF_{N_2O}$$

$$N_2O\text{-}N_{treated} = N_{slurry\ treated} \cdot N_{content} \cdot E_{N_20} \cdot EF_{lower}$$

Where; $N_2O_{non\text{-}treated}$ slurry and $N_2O_{treated}$ slurry are the emission of non-biogas treated slurry and biogas treated slurry, respectively. N_{slurry} is the total amounts of N in slurry, EF_{N2O} express the N_2O emission factor based on IPCC default (1.25 %). E_{lower} is the lower emission of biogas treated slurry compared to untreated slurry.

Based on result in Sommer et al. (2001) it is assumed that the emission from treated cattle slurry is 36 % lower compared to untreated slurry, which lead to an E_{lower} at 0.64. Result from Sommer et al. (2001) concerning the pig slurry shows a 41 % lower N_20 emission from treated slurry, which provide a E_{lower} at 0.59. Refer to Annex 3E-11.

All key model parameters for estimating the lower N_2O emission in 2010 as a result of biogas plants are listed in Table 6.27.

Table 6.27 Key model parameters used to calculate the lower N_20 emission due to biogas treated slurry.

2010	Slurry biogas treated	Total N in treated slurry, %[a]	E_{lower}[b]	N_2O emission in untreated slurry	N_2O emission in biogas treated slurry	Lower the total N_2O emission with
	1000 Gg	Pct.		Gg N_2O	Gg N_2O	Gg N_2O
Cattle slurry	1.08	0.538	0.64	0.072	0.046	0.026
Pig slurry	1.31	0.541	0.59	0.089	0.053	0.036
Lower emission						0.063

[a] Poulsen et al., 2001

[b] Sommer et al., 2001.

Data for 1990 to 2010 are shown in Annex 3E-12b.

Due to the biogas treatment, the emission of N_2O in 2010 is reduced by 0.06 Gg N_2O (Table 6.28) which corresponds to a 4 % reduction of the N_2O emission from manure management in 2010.

Table 6.28 Lower N_2O emissions from manure management as a result of biogas-treated slurry 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Amount of treated slurry, Mt									
- cattle	0.09	0.29	0.52	0.87	0.96	0.97	0.99	1.08	1.08
- swine	0.10	0.35	0.64	1.06	1.18	1.18	1.20	1.31	1.31
Total reduced emission, Gg N_2O	0.01	0.02	0.03	0.05	0.06	0.06	0.06	0.06	0.06
Total N_2O emission incl. biogas, Gg N_2O	1.93	1.83	1.73	1.65	1.54	1.55	1.47	1.36	1.36

6.4.3 Time series consistency

In Table 6.29, the national emission from manure management from 1990 to 2010 is shown. The N_2O emission has decreased by 30 %. The national emission from manure management has, nevertheless, increased by 7 % in CO_2 equivalents due to the increase in the CH_4 emission.

Table 6.29 Emissions of N_2O and CH_4 from Manure Management 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
N_2O emission									
Liquid manure, Gg N_2O	0.30	0.27	0.25	0.26	0.25	0.26	0.26	0.24	0.24
Solid manure, Gg N_2O	1.01	0.81	0.64	0.50	0.45	0.43	0.36	0.30	0.28
Other manure, Gg N_2O	0.62	0.75	0.84	0.89	0.84	0.86	0.86	0.82	0.83
Total, Gg N_2O	1.93	1.83	1.73	1.65	1.54	1.55	1.47	1.36	1.36
Total, Gg CO_2 eqv.	600	566	537	512	478	479	457	423	421
CH_4 emission									
Total, Gg CH_4	47.29	52.53	56.39	62.07	60.85	61.57	60.63	60.45	61.33
Total, Gg CO_2 eqv.	993	1 103	1 184	1 303	1 278	1 293	1 273	1 270	1 288
Total Manure Management, Gg CO_2 eqv.	1 593	1 669	1 722	1 816	1 756	1 772	1 730	1 693	1 709

Incl. the reduction from biogas treated slurry.

6.5 N_2O emission from agricultural soils (CRF sector 4D)

6.5.1 Description

The N_2O emissions from agricultural soils, contribute, in 2010 with 52 % of the emission from the agricultural sector. Figure 6.4 shows the distribution and the development from 1990 to 2010 according to different sources. The emission has overall decreased 35 %. The increase from 2007 to 2008 was due to a rise in the use of fertiliser, which can mainly be explained by stockpiling due to expectations of rising prices, in 2009 the emission have decreased again.

The main part of the emission originates as direct emission. The largest sources here are manure and fertiliser applied on agricultural soils. Another large source is the indirect N_2O emission, of which the emission from nitrogen leaching is an essential part.

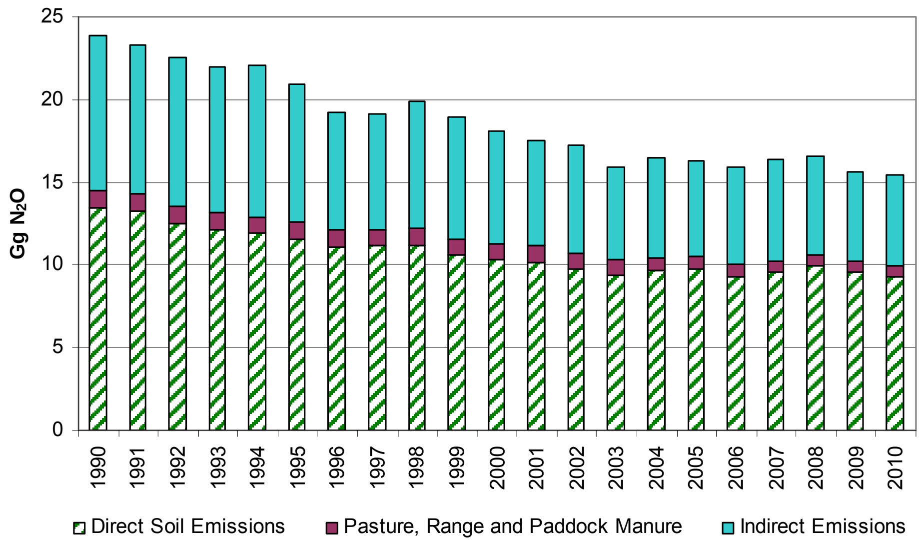

Figure 6.4 N_2O emissions from agricultural soils 1990 - 2010.

6.5.2 Methodological issues

To calculate the N_2O emission IPCC Tier 1b is used in combination with a country specific method (CS). Tier 1 b is use in calculation of emission from N-fixing crops, crop residue and atmospheric deposition.

Emissions of N_2O are closely related to the nitrogen balance and all data concerning the evaporation of NH_3 and data for manure condition is applied from the national NH_3 emission inventory. This is described in great detail in Mikkelsen et al. (2011) and Denmark's annual inventory report to the UNECE-Convention on Long-Range Transboundary Air Pollution (Nielsen et al., 2011) and are available on the internet. Specific for calculation of emission from nitrogen leaching and runoff a national model is used.

In connection to calculation of N_2O from agricultural soils the N_2O emission factors for all sources are based on the default values given by the IPCC (2000). A NH_3 and N_2O emission factor overview is presented in Table 6.30. The estimated emissions from the different sub-sources are described in the text, which follows.

Table 6.30 Emission factors – NH_3 and N_2O from agricultural soils 1990 – 2010.

	NH_3 emission factor (national data) Kg NH_3-N pr kg N	N_2O emission factor (IPCC default value) kg N_2O -N pr kg N
1. Direct Soil Emissions		
Synthetic Fertiliser Applied to Soils	0.02	0.0125
Animal Wastes Applied to Soils	0.21*	0.0125
N-fixing Crops		0.0125
Crop Residue		0.0125
Cultivation of Histosols		8**
2. Animal Production	0.07	0.02
3. Indirect Soil Emissions		
Atmospheric Deposition		0.01
Nitrogen Leaching and Run-off		0.025***
4. Other		
Industrial Waste Used as Fertiliser		0.0125
Sewage Sludge Used as Fertiliser	0.02	0.0125

*Varies from year to year, has decreased from 0.28 in 1990.

**Unit: kg N_2O-N pr ha.

***Groundwater = 0.015, rivers = 0.0075 and estuaries = 0.0025.

Direct emissions

Synthetic fertiliser

The amount of nitrogen (N) applied to soil via use of synthetic fertiliser is estimated from sales estimates from the Danish Plant Directorate, the source for the FAO database. Table 6.31 shows the consumption of each fertiliser type. Furthermore, the NH_3 emission factor for each fertiliser is given, based on the values given in EMEP/EEA (2009). The Danish value for the FracGASF is estimated at 0.02 and is considerably lower than the recommended default value in IPCC, i.e. 0.10. The NH_3 emission depends on fertiliser type and the major part of the Danish emission is related to the use of calcium ammonium nitrate and NPK fertiliser, where the emission factor is 0.01 kg NH_3-N pr kg N. The low Danish FracGASF is also due to the small consumption of urea (<1%), which has a high emission factor.

Table 6.31 Synthetic fertiliser consumption 2010 and the NH_3 emission factors.

Synthetic fertiliser year 2010	NH_3 Emission factor[1] kg NH_3-N pr kg N	Consumption[2] t N
Fertiliser type		
Calcium and boron calcium nitrate	0.01	0.5
Ammonium sulphate	0.01	6.1
Calcium ammonium nitrate and other nitrate types	0.01	94.1
Ammonium nitrate	0.01	8.4
Liquid ammonia	0.02	5.8
Urea	0.13	0.5
Other nitrogen fertiliser	0.06	18.9
Magnesium fertiliser	0.01	0.0
NPK-fertiliser	0.01	48.1
Diammonphosphate	0.01	0.9
Other NP fertiliser types	0.01	4.5
NK fertiliser	0.01	2.2
Total consumption of N in synthetic fertiliser		190.0
National emission of NH_3-N, M kg	2.89	
Average NH_3-N emission (FracGASF)	0.02	

[1]) EMEP/EEA (2009).

[2]) The Danish Plant Directorate (2011).

The use of synthetic fertiliser includes fertiliser used in parks, golf courses and private gardens. 1 % of the synthetic fertiliser can be related to these uses outside the agricultural area.

As a result of increasing requirements for improved use of nitrogen in livestock manure and reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertiliser has more than halved from 1990 to 2010 (Table 6.32). From 2007 to 2008 the consumption increased which is due to stockpiling based on an expectation of rising prices and therefore the consumption is decreased again in 2009.

Table 6.32 Nitrogen applied as fertiliser to agricultural soils 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
N content in synthetic fertiliser, Gg N	400	316	251	206	192	195	220	200	190
NH_3-N emission, Gg NH_3-N	5	5	3	3	3	3	3	3	3
N in fertiliser applied on soil, Gg N	395	311	248	204	189	192	217	197	187
N_2O emission, Gg N_2O	7.76	6.12	4.88	4.00	3.71	3.77	4.27	3.87	3.68

Manure applied to soil

The amount of nitrogen applied to soil is estimated as the N-excretion in housings minus the NH_3 emission, which occur in housings, under storage and in relation to the application of manure. These values are based on national estimations and are calculated in the NH_3 emission inventory (Table 6.33). Emission factors for NH_3 from the housing unit and storage are given in Annex 3E-3 and 4. The total N-excretion in housings from 1990 to 2010 has decreased by 8 %. Despite this reduction in N-excretion, the amount of nitrogen applied to soil remains almost unaltered, due to the reduction in the NH_3 emission.

Table 6.33 Nitrogen applied as manure to agricultural soils 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
N-excretion, housing, Gg N	258	239	235	251	241	250	246	237	237
N ab Storage, Gg N	214	200	197	212	206	217	213	206	206
NH_3-N emission from application, Gg NH_3-N	31	26	23	17	17	18	17	17	17
N in manure applied on soil, Gg N	183	175	174	195	189	199	196	190	190
N_2O emission, Gg N_2O	3.59	3.43	3.42	3.83	3.71	3.91	3.84	3.73	3.72

The FracGASM express the fraction of total N-excretion (N ab animal) that is volatilised as NH_3 emission in housings, storage and application. The FracGASM has decreased from 0.25 in 1990 to 0.19 in 2010 (Table 6.34). This is the result of an active strategy to improve the utilisation of the nitrogen in manure.

Table 6.34 FracGASM 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total N-excretion, Gg N	295	273	271	285	276	284	276	265	263
NH_3-N emission from manure, Gg NH_3-N	44	42	42	42	41	44	43	43	43
FracGASM	0.25	0.23	0.22	0.20	0.20	0.20	0.19	0.19	0.19

N-fixing crops

To estimate the emission from N-fixing crops, IPCC Tier 1b is applied. The emission calculated is based on nitrogen content, the fraction of dry matter and the content of protein for each harvest crop type. Data for crop yield is based on data from Statistics Denmark. For nitrogen content in the plants, the data is taken from Danish feedstuff tables (Danish Agricultural Advisory Centre). The estimates for the amount of nitrogen fixed in crops are made by the DCA (Kristensen, 2003, Høgh-Jensen et al., 1998, Kyllingsbæk, 2000).

$$N_2O\text{ - }N_{N\text{ - }fix} = \sum (Ts_{i,\,yield} \cdot N_{i,\,pct} \cdot (1 + N_{i,\,pct\ in\ root\ and\ stubble}) \cdot A_{pct\ fix}) \cdot EF_{N2O}$$

Where:

N_2O-N	= nitrous oxide emission
$Ts_{i,\,yield}$	= dry matter yield, kg per ha for crop type *i*
$N_{i,\,pct}$	= nitrogen percentage in dry matter
$N_{i,\,pct\ root\ +\ stubble}$	= nitrogen percentage in root and stubble
$A_{pct\ fix}$	= percentage of nitrogen which is fixed
EF_{N2O}	= emission factor, IPCC standard value of 1.25 pct

The Danish inventory includes emissions from clover-grass, despite the fact that this source is not mentioned in the IPCC GPG. Area with grass and clover covered approximately 19 % of the total agricultural area in 2009 and, for this reason, represents an important contributor to the national emission from N-fixing crops.

In Table 6.35 and Annex 3E-13 and 14 the background data for estimating the N-fixing is listed. The emission from N-fixing crops decreases from 1990-2009, largely due to a reduction in agricultural area (Annex 3E-15).

Table 6.35 Emissions from N-fixing crops 2010.

	Crop yield, tonnes	N-fixing, kg N per tonnes crop yield	N-fixing total, kg N fix	N_2O emission, Gg N_2O
Legumes to maturity	33.8[b]	37.3	1 260	0.025
Lucerne	315.2	7.7	2 415	0.047
Crops for silage	1 092.7	6.1	1 327	0.026
Legumes/marrow-stem kale	NO	6.1	NO	NO
Grass and clover in rotation	14 150.4	8.2	30 595	0.601
Grass not in rotation	3 180.4	8.2	1 302	0.026
Fields with catch crop	515.0	8.2	1 114	0.022
Peas for conservation[a]	7.0	37.3	261	0.005
Seeds of leguminous grass crops			819	0.016
- Red clover	616[c]	200[d]		
- White clover	3 779[c]	180[d]		
- Black medic	88[c]	180[d]		
Total N-fixed			39 093	
Total N_2O emission				0.768

[a] Dry matter content for straw is 0.87 and the N-fraction is 0.010.

[b] Yield of seed, yield of straw is 60 % of yield of seed.

[c] Area, ha.

[d] kg N per ha.

Crop residue

To estimate the emission from crop residue, IPCC Tier 1b is applied. N_2O emissions from crop residues are calculated as the total aboveground quantity of crop residue returned to soil. For cereals, the aboveground residues are calculated as the amount of straw plus stubble and husks. The total amount of straw is given in the annual census and reduced by the amount used for feeding, bedding and bio fuel in power plants. Straw for feed and bedding is subtracted because this quantity of removed nitrogen returns to the soil via manure.

$$N_2O - N_{crop\ residue,j} = \sum_{1}^{N} ha_{i,\ j} \cdot (N_{i,\ stubble} + N_{i,\ husks} + N_{i,\ tops} + N_{i,\ leafs}) \cdot EF_{N_2O}$$

Where:

i	= crop type
j	= year
ha	= on which the crop is grown
N_i	= nitrogen derived from husks, stubble, plant tops and leaf debris, kg ha^{-1}
EF_{N2O}	= emission factor, IPCC standard value of 1.25 %

National values for nitrogen content are used provided by the DCA (Djurhuus and Hansen 2003). It is calculated based on relatively few observations, but is at present the best available data. Data for yield and area cultivated are collected from Statistics Denmark. Background data is given in Annex 3E-16 and 17.

The national emission from crop residues has decreased 13 % from 1990 to 2010 (Table 6.36). This decrease is a result of a fall in cultivated area of beets for feeding, which has been replaced by cultivation of green maize. Another reason is a fall in the agricultural area and a greater part of the straw is harvest – 52 % in 1990 and 60 % in 2010.

Table 6.36 Emissions from crop residue 1990 – 2010.

Crop residue	1990	1995	2000	2005	2006	2007	2008	2009	2010
Stubble	18.9	18.2	18.2	17.6	17.8	17.4	17.9	17.5	17.9
Husks	11.4	11.6	12.0	12.3	12.4	12.1	11.9	12.4	12.4
Top of beets and potatoes	7.1	3.8	5.3	4.9	4.4	4.5	4.4	4.3	4.3
Leafs	6.8	10.3	9.0	9.4	9.4	9.3	7.9	7.0	7.4
Straw	15.1	10.4	10.8	10.2	10.0	9.3	8.1	10.0	9.7
Crop residue, total, Gg N	59.3	54.2	55.3	54.4	54.1	52.6	50.1	51.2	51.7
N_2O emission, Gg	1.17	1.06	1.09	1.07	1.06	1.03	0.98	1.01	1.02
$Frac_R$	0.86	0.85	0.85	0.85	0.85	0.85	0.86	0.87	0.86
$Frac_{NCRO}$	0.018	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
$Frac_{NCRBF}$	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Frac vaules

The fractions $Frac_{NCRO}$, $Frac_{NCRBF}$ and $Frac_R$ are calculated for all years by using the definitions given in the IPCC Reference Manual pp 4.92 – 4.94.

The $Frac_{NCRO}$ and $Frac_{NCBRF}$ are calculated as the N-content in harvest crops divided with the total amount of dry matter in harvest crops. $Frac_{NCBRF}$ covers all crops which is N-fixing crops and $Frac_{NCRO}$ all the non N-fixing crops. In Table 6.37 the national calculated fraction values are compared to default values given in the Reference Manual (IPCC, 1997). The national values differ slightly during the years and are a bit higher than the IPCC default values. For N-fixing crops the explanation could be that Denmark includes fields with clover grass, which has a high N-content. The higher national $Frac_{NCRO}$ could be a consequence of the relatively large part of straw that is harvested and used for feeding, bedding and fuel. As provided by Statistics Denmark nearly 60 % of the straw in 2010 is harvested.

The fractions $Frac_R$ are given in kg N pr kg crop-N as given in the Reference Manual (IPCC, 1997). The fraction is calculated as N-content in the hole above ground crop biomass that is removed from the field as a crop product divided with total N-content in all parts of plants above ground.

The national $Frac_R$ is much higher than the IPCC default. The national value express, that 84 % to 87 % of the total N in crops is removed from the field. The remaining is the N-content in straw and tops from beets and potatoes, which are left on the field. From 1990 to 2010 the $Frac_R$ is increased as a consequence of a fall in cultivated area of feeding beets.

Table 6.37 Frac values.

Fractions	Text in CRF Table 4.Ds2 – additional information	Unit	IPCC default values	National Values 1990-2010
$Frac_{NCRO}$	Fraction of residue dry biomass that is N (all other crops than N-fixing crop)	Kg N pr kg dm	0.015	0.017-0.018
$Frac_{NCRBF}$	Fraction of total above-ground biomass of N-fixing crop that is N	Kg N pr kg dm	0.03	0.04
$Frac_R$	Fraction of N in the hole above ground crop biomass that is removed from the field as a crop product	kg N pr kg crop-N	0.45	0.84-0.87

Cultivation of histosols

N_2O emissions from histosols are based on the area with organic soils multiplied by the default emission factor given by the IPCC. New data for the area of histosols indicate that the area is smaller than previously assumed. The area of histosols is shown in Table 6.38. The emission factor used is the IPCC default and constant for all years 1990-2010, 8 kg per ha.

Table 6.38 Area of histosols in ha, 1990-2010.

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Area, ha	57 982	53 941	49 900	45 858	45 050	44 242	43 434	42 625	41 817

Other Direct Emissions

The category, "Other", includes emission from sewage sludge and sludge from industries applied to agricultural soils as fertiliser. Information about industrial waste, sewage sludge applied on agricultural soil and the content of nitrogen is obtained from a series of reports published by the Danish Environmental Protection Agency. From 2005 the amount from sewage sludge and N content is based on the information registered in the fertilizer accounts controlled by The Danish Plant Directorate. The recent official figures regarding the amount of sludge from the industrial waste are data covering year 2002 (Petersen & Kielland, 2003). Data covering year 2008 and 2009 are received from Econet AS (Petersen, Claus. Pers comm., 2011) and will be included in an EPA report under preparation. Based on these data the amount in 2003-2007 is interpolated.

It is assumed that 1.9 % of N-input applied to soil volatises as NH_3, which is based on information from the Danish Environmental Protection Agency (Bielecki, 2002).

Table 6.39 Emission from sludge applied on agricultural soils 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Nitrogen in sewage sludge, t N	3 115	4 635	3 625	2 173	2 158	2 167	2 394	2 979	2 850
Nitrogen in industrial waste, t N	1 529	4 500	5 147	5 509	5 068	4 626	4 185	3 993	4 000
NH_3-N emission, t NH_3-N	58	87	68	41	40	41	45	56	53
N applied as fertiliser to the soil, t N	4 586	9 048	8 705	7 641	7 185	6 753	6 534	6 916	6 797
N_2O emission, Gg N_2O	0.09	0.18	0.17	0.15	0.14	0.13	0.13	0.14	0.13

Pasture, Range and Paddock Manure

The amount of nitrogen deposited on grass is based on estimations from the NH_3 inventory. Grazing days is based on expert judgement from the Danish Agricultural Advisory Centre. N-excretion on grass has decreased due to a reduction in the number of dairy cattle. An NH_3 emission factor of 7 % is used for all animal categories based on studies from the Netherlands and the United Kingdom (Jarvis et al., 1989a, Jarvis et al., 1989b and Bussink, 1994).

Table 6.40 Nitrogen excreted on grass 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
N-excretion, grass, Gg N	34	36	34	26	25	23	23	22	22
NH_3-N emission, Gg NH_3-N	2	2	2	2	2	2	2	2	2
N deposited on grass, Gg N	32	33	32	24	23	22	22	21	20
N_2O emission, Gg	1.00	1.04	1.00	0.76	0.72	0.68	0.69	0.66	0.64
FracGRAZ	0.12	0.13	0.13	0.09	0.09	0.09	0.09	0.09	0.08

$Frac_{GRAZ}$ is estimated as the volatile fraction from grazing animals compared with the total excreted nitrogen (N ab animal) (Table 6.40). The decrease in $Frac_{GRAZ}$ is due to a decrease in the production of grazing animals e.g. cattle.

Indirect emissions

Atmospheric deposition

To estimate the emission from atmospheric deposition, IPCC Tier 1b is applied. Atmospheric deposition includes all NH_3 emission sources included in the Danish NH_3 emission inventory (Nielsen et al., 2011). This includes the emission from livestock manure, use of synthetic fertiliser, crops, NH_3-treated straw used as feed, field burning of crop residue and sewage sludge plus sludge from industrial production applied to agricultural soils.

The emission from atmospheric deposition has decreased from 1990 – 2010 as a result of the reduction in the total NH_3 emission, from 93 433 tonnes of NH_3-N in 1990 to 59 097 in 2010.

Table 6.41 NH_3 emission 2010.

NH_3 emission	2010
	t NH_3-N
Manure, housing	49 940
Manure, grassing	1 525
Synthetic fertiliser	2 857
Crops	4 453
NH_3 treated straw	195
Burning of agricultural residue	73
Sewage sludge and sludge from the industrial production	53
Emission total	59 096
N_2O emission, Gg	0.93

Nitrogen leaching and Run-off

Nitrogen, which is transported through the soil, can be transformed to N_2O. The IPCC recommends an N_2O emission factor of 0.025 used, of which 0.015 is for leaching to groundwater, 0.0075 for transport to watercourses (in IPCC definition called rivers) and 0.0025 for transport out to sea (in IPCC definition called estuaries). The N_2O emission from nitrogen leaching is a sum of the emission for all three parts calculated as:

$$N_2O_{leaching} = (N_{leach-ground} \cdot EF_{ground} + N_{leach-rivers} \cdot EF_{rivers} + N_{leach-estuatires} \cdot EF_{estuatires}) \cdot \frac{44}{28}$$

In connection with the Action Plans for the Aquatic Environment, nitrogen leaching to groundwater, rivers and estuaries has been estimated, see Table 6.42. The calculation of N to the groundwater is based on two different models– SKEP/Daisy and N-LES (Børgesen & Grant, 2003) carried out by DCA and DCE, Aarhus University (see overview of model in Annex 3E Figure 1). SKEP/DAISY is a dynamical crop growth model taking into account the growth factors, whereas N-LES is an empirical leaching model based on more than 1500 leaching studies performed in Denmark during the last 15 years. The models produce rather similar results for nitrogen leaching on a national basis (Waagepetersen et al., 2008). The SKEP/Daisy model has estimated the total N leached from 2003-2007 to be 172-159 thousand tonnes N, where as N-LES model has estimated the total N leached to be 163-154 thousand tonnes in the same period. An average of the results from the two models is used in the emission inventory.

Data concerning the N-leaching to rivers and estuaries is based on data from NOVANA (National Monitoring program of the Water Environment and Nature) received from the department of Bioscience, Aarhus University (Windorf et al., 2011). NOVANA is a monitoring program which includes monitoring of the ecologic, physic and chemical condition of water areas and transport of water and a range of substances, including N, to lakes and the sea (Wiberg-Larsen et al., 2010). These studies include measurements from 223 monitoring stations in all parts of Denmark and have been going on from the early 1990's.

Table 6.42 N leaching to groundwater, rivers and estuaries in Gg, 1990-2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Groundwater	267	235	179	160	156	157	163	154	150
Rivers	103	106	95	67	79	99	80	60	69
Estuaries	101	92	81	56	66	82	65	49	55

Figure 6.5 shows leaching from groundwater estimated in relation to the nitrogen applied to agricultural soils as livestock manure, synthetic fertiliser and sludge. The average proportion of nitrogen leaching from groundwater has decreased from around 39 % in the middle of the nineties to around 33 % in 2010. The decline is due to an improvement in the utilisation of nitrogen in manure. The reduction in nitrogen applied is particularly due to the fall in the use of synthetic fertiliser, which has been reduced by 50 % from 1990 to 2010.

The proportion of N input to soils lost through leaching and runoff ($Frac_{LEACH}$) used in the Danish emission inventory is higher than the default value of the IPCC (30 %). The high values are partly due to the humid Danish climate, with the precipitation surplus during winter causing a downward movement of dissolved nitrogen. $Frac_{LEACH}$ has decreased from 1990 and onwards. At the beginning of 1990s, manure was often applied in autumn. Now the main part of manure application takes place in the spring and early summer, where there are nearly no downward movements of soil water. The decrease in $Frac_{LEACH}$ over time is due to increasing environmental requirements and banning manure application after harvest. The data based on model estimates from DCA and DCE reflects the Danish conditions and is considered the best estimate.

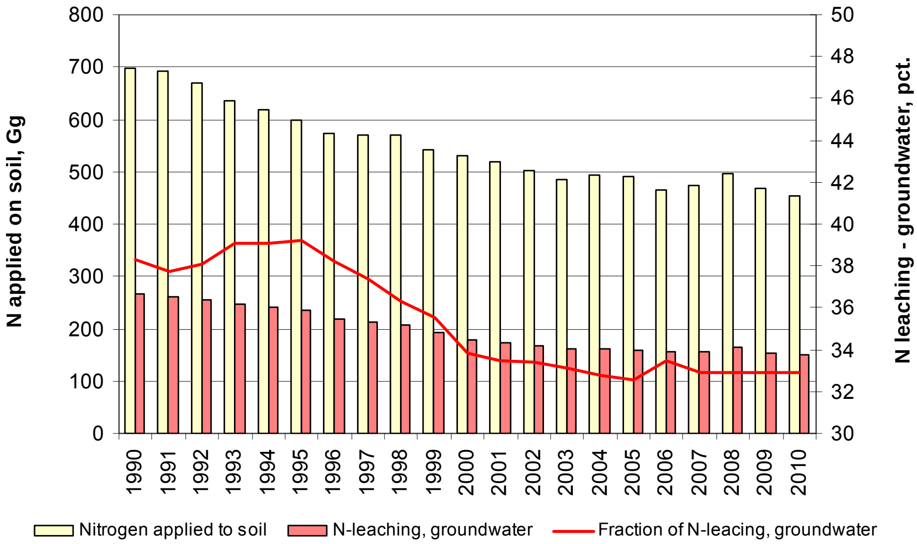

Figure 6.5 Nitrogen applied to agricultural soils and N-leaching, groundwater 1990-2010.

6.5.3 Activity data

Table 6.43 provides an overview on activity data from 1990 to 2010 used in relation to the estimation of N_2O emission from agricultural soils. The amount of nitrogen applied to agricultural soil has decreased from 1 078 Gg N to 704 Gg N, corresponding to a 35 % reduction, which results in a lower N_2O emission.

Table 6.43 Activity data - agricultural soils 1990 – 2010, Gg N.

CRF – Table 4.D	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total amount of nitrogen applied on soil	1 078	935	808	744	715	726	751	720	704
1. Direct Emissions									
Synthetic Fertilizers	395	311	248	204	189	192	217	197	187
Animal Manure Applied to Soils	183	175	174	195	189	199	196	190	190
N-fixing Crops	44	37	38	34	35	35	35	41	39
Crop Residue	59	54	55	54	54	53	50	51	52
Industrial Waste	2	5	5	6	5	5	4	4	4
Sewage Sludge	3	5	4	2	2	2	2	3	3
2. Pasture, Range and Paddock Manure	32	33	32	24	23	22	22	21	20
3. Indirect Emissions									
Atmospheric Deposition	93	80	72	65	63	63	62	59	59
Nitrogen Leaching and Runoff	267	235	179	160	156	157	163	154	150

6.5.4 Time series consistency

The N_2O emissions from agricultural soils have been reduced by 35 % from 1990 to 2010. This is largely due to a decrease in the use of synthetic fertiliser and a decrease in N-leaching as a result of national environmental policy, where action plans have focused on decreasing the nitrogen losses and on improving the nitrogen utilisation in manure.

Table 6.44 Emissions of N_2O from Agricultural Soils 1990 – 2010, Gg N_2O.

CRF – Table 4.D	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total N_2O emission	24.58	21.64	18.73	16.86	16.43	16.93	17.16	16.19	15.97
1. Direct Emissions	13.93	11.89	10.68	10.11	9.70	9.93	10.31	9.94	9.71
Synthetic Fertilisers	7.76	6.12	4.88	4.00	3.71	3.77	4.27	3.87	3.68
Animal Manure Applied to Soils	3.59	3.43	3.42	3.83	3.71	3.91	3.84	3.73	3.72
N-fixing Crops	0.87	0.73	0.75	0.67	0.68	0.68	0.69	0.80	0.77
Crop Residue	1.17	1.06	1.09	1.07	1.06	1.03	0.98	1.01	1.02
Cultivation of Histosols	0.73	0.68	0.63	0.58	0.57	0.56	0.55	0.54	0.53
Industrial Waste	0.03	0.09	0.10	0.11	0.10	0.09	0.08	0.08	0.08
Sewage Sludge	0.06	0.09	0.07	0.04	0.04	0.04	0.05	0.06	0.05
2. Pasture, Range and Paddock	1.00	1.04	1.00	0.76	0.72	0.68	0.69	0.66	0.64
3. Indirect Emissions	9.38	8.41	6.79	5.80	5.84	6.16	6.02	5.46	5.49
Atmospheric Deposition	1.47	1.26	1.13	1.02	0.98	0.99	0.97	0.93	0.93
Nitrogen leaching and Runoff	7.91	7.15	5.66	4.77	4.85	5.18	5.05	4.53	4.57

6.6 Field burning of agricultural residues (CRF sector 4F)

Field burning of agricultural residues has in Denmark been prohibited since 1990 and may only take place in connection with production of grass seeds on fields with repeated production and in cases of wet or broken bales of straw. The amount of burnt straw from the grass seed production is estimated as 15 % of the total amount produced. The amount of burnt bales of or wet straw is estimated as 0.1 % of total amount of straw. Both estimates are based on an expert judgement by the Danish Agricultural Advisory Service. The total amounts are based on data from Statistics Denmark.

From field burning is seen emissions of a series of different compounds and related to GHG emissions of the following compounds are estimated CH_4, N_2O, NO_x, CO, CO_2, SO_2 and NMVOC. For emission of NMVOC see Chapter 6.7. The emission of NO_x and CO is given CRF Table 4s2. Emission of CO_2 (biogenic) and SO_2 is estimated, but not reported because this is not possible in CRF tables in present format. Equation for calculating emission of various compounds:

$$Emi = BB \cdot \frac{EF}{1\,000\,000} \cdot FO$$

$$BB = CP \cdot FB \cdot FR_{dm}$$

Emi = emission of compounds, Gg
BB = total burned biomass, Gg dm
CP = crop production, t
FB = fraction burned in fields
FR_{dm} = dry matter fraction of residue
EF = emission factor, g pr kg dm
FO = fraction oxidized

Table 6.45 Factors for estimating emissions of CH_4 and N_2O, 2010.

2010		Crop production	Fraction burned in fields	Dry matter (dm) fraction of residue	Total Biomass burned	EF	Fraction oxidized	Emission
		t			Gg dm	g pr kg dm		Gg
CH_4	Mixed cereals	5 469 000	0.001	0.85	4 649	2.7	0.90	0.011
CH_4	Straw from seeds of grass	285 030	0.15	0.85	36 341	2.7	0.90	0.088
N_2O	Mixed cereals	5 469 000	0.001	0.85	4 649	0.07	0.90	0.0003
N_2O	Straw from seeds of grass	285 030	0.15	0.85	36 341	0.07	0.90	0.002
Total CO_2-eqv								2.89

The emission of CH_4, N_2O, NO_x, CO, CO_2 and SO_2 from field burning contributes with less than 1 % of the national emission.

The fraction value $Frac_{BURN}$ is calculated by using the definitions as given in IPCC Reference Manual pp 4.92 – 4.94. $Frac_{BURN}$ is calculated as the amount of N in burned straw divided with the total amount of N in crop residue and the fractions are given in kg N pr kg crop-N. For all years the value of $Frac_{BURN}$ is around 0.01 kg N pr kg crop-N, which is low compared to IPCC default value. This is due to the prohibition of field burning in Denmark.

6.7 NMVOC emission

Around 3 % of the total NMVOC emission originates from the agricultural sector, which, in the Danish emission inventory, includes emission from agricultural soils, such as arable land crops and grassland, and field burning of agricultural residue. Activity data is obtained from Statistics Denmark. The emission factor for agricultural soils is for land with arable crops 393 g NMVOC pr ha and for grassland, 2120 g NMVOC pr ha (Fenhann & Kilde, 1994), (Priemé & Christensen, 1991). IPCC default value for the emission factors for field burning of agricultural residue is used. The emission from agricultural soils contributes with 89 % and field burning with 11 % of the agricultural NMVOC emission in 2010.

Table 6.46 Areas and NMVOC emission from agricultural soils 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Arable crops, 1000 ha	2322	2064	2043	2086	2083	2050	2107	2103	2096
Grassland, 1000 ha	466	446	413	446	460	459	490	497	521
NMVOC emission, Gg	1.90	1.76	1.68	1.77	1.79	1.78	1.87	1.88	1.93

Table 6.47 NMVOC emission from field burning of agricultural residue 1990 – 2010.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
NMVOC emission, Gg	0.20	0.24	0.30	0.33	0.34	0.29	0.27	0.32	0.23

6.8 Uncertainties

Uncertainties are calculated using both a Tier 1 and a Tier 2 approach; see Chapter 1.7 for a description of the Tier 2 methodology. The same uncertainty values for activity data and emission factors are used for both Tier 1 and Tier 2.

6.8.1 Uncertainty values

Uncertainties regarding animal production, such as number of animals, feeding consumption, normative figures etc. are very small. Number of animals is estimated by Statistics Denmark and all cattle, sheep and goats have their own ID-number (ear tags) and, hence, uncertainty with regard to their numbers is almost non-existing. Statistics Denmark has estimated the uncertainty in the number of pigs to be less than 1 %.

The Danish Normative System for animal excretions is based on data from the Danish Agricultural Advisory Service (DAAS), which is the central office for all Danish agricultural advisory services. DAAS engages in a great deal of research as well as the collection of efficacy reports from Danish farmers for dairy production, meat production, swine production, etc. to optimise productivity in Danish agriculture. In total, feeding plans from 15-18 % of Danish dairy production, 25-30 % of pig production, 80-90 % of poultry production and approximately 100 % of fur production are collected annually. These basic feeding plans are used to develop the standard values of the “Danish Normative System”.

The normative figures (Poulsen et al., 2001) are comprised of arithmetic means. Based on feeding plans, the standard deviation in N-excretion rates between farms can be estimated to ±20 % for all animal types (Hanne D. Poulsen, DCA). However, due to the large number of farms included in the norm figures the arithmetic mean, it can be assumed as a very good estimate with a low uncertainty.

Data for hectares under cultivation is estimated by Statistics Denmark and the uncertainties are based on their estimates. For the most common crops the uncertainties are below 5 %.

In the 2011 submission the uncertainty estimates for both activity data and emission factors were re-evaluated and some adjustments were made. For CH_4 emission form animals (CRF category 4.A and 4.B) the uncertainties for activity data is lowered due to the combined effect of low uncertainty in actual animal numbers, relatively low uncertainty for feed consumption and excretion rates, this gives a relatively low uncertainty in the activity data as a whole – between 2% and 22%. The uncertainties for the emission factors for CH_4 emission form animals are adjusted based on IPCC 1997 and 2000.

For the N_2O emission uncertainties for the activity data is based on the uncertainties for NH_3 emission due to the high correlation between the NH_3 and N_2O emission. Uncertainties related to the N_2O emission factor is based on Good Practice Guidance. See Table 6.48 for uncertainty values for the agricultural sector.

Table 6.48 Uncertainties values for activity data and emission factors for CH_4 and N_2O.

CRF category		Emission factor	Uncertainties value for activity data, %	Uncertainties value for emission factor, %
4.A Enteric Fermentation		CH_4	2	20
4.B Manure Management		CH_4	5	20
		N_2O	22	50
4.D Agricultural Soils				
4.D1 Direct soil emissions				
	Synthetic Fertilisers	N_2O	25	100
	Animal Manure Applied to Soils	N_2O	30	100
	N-fixing Crops	N_2O	20	100
	Crop Residue	N_2O	20	100
	Cultivation of Histosols	N_2O	20	100
	Sewage sludge used as fertiliser	N_2O	20	100
	Industrial waste used as fertiliser	N_2O	20	100
4.D2 Animal Production		N_2O	25	100
4.D3 Indirect soil emissions				
	Atmospheric Deposition	N_2O	19	100
	N-Leaching and Runoff	N_2O	20	100
4.F Field Burning of Agricultural Residue				
		CH_4	25	50
		N_2O	25	50

6.8.2 Result of the uncertainty calculation

Table 6.49 shows the result of the Tier 1 and Tier 2 uncertainty calculation for 2010. A calculation of 1990 gives nearly the same uncertainty values for all emission sources. The overall uncertainty calculation for the agricultural sector based on Tier 1 is estimated to ±25 %. Tier 2 calculation shows an uncertainty interval from -19 % to +33.

For most of the emission sources the uncertainty level based on Tier 2 are nearly at the same level as for Tier 1, see Figure 6.6. The two calculations can be considered as consistent. The lowest uncertainties are seen for CH_4 emission from enteric fermentation and manure management and the highest for emission form grazing animals and this pattern is reflected in both calculations.

The biggest difference between the Tier 1 and Tier 2 uncertainty calculations is seen for N_2O from manure management.

Table 6.49 Comparison between Tier 1 and Tier 2 uncertainty calculation, 2010.

Uncertainty		Tier 1		Tier 2		
		Emission, Gg CO_2-eqv	Uncertainty, %	Median emission, Gg CO_2-eqv	Uncertainty, %	
			Lower and upper (±)		Lower (-)	Upper (+)
4 Agriculture total	CH_4 and N_2O	9 520	25	10 047	19	33
4.A Enteric Fermentation	CH_4	2 856	20	2 865	12	13
4.B Manure Management	CH_4 and N_2O					
	CH_4	1 288	21	1 293	11	13
	N_2O	421	55	456	20	27
4.D Agricultural soil:	N_2O					
4.D1 Direct soil emissions	N_2O	3 051	57	3 282	41	77
4.D2 Pasture, Range and Paddock Manure	N_2O	197	103	198	62	161
4.D3 Indirect soil emissions	N_2O	1 703	86	1 744	54	130
4.F Field Burning of Agricultural Residues	CH_4 and N_2O					
	CH_4	2	56	2	42	70
	N_2O	1	56	1	42	70

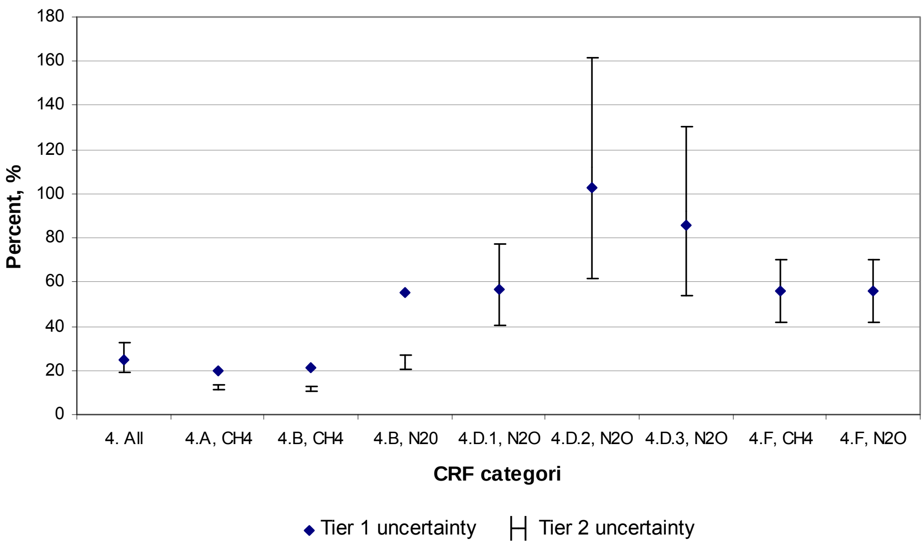

Figure 6.6 Tier 1 and Tier 2 uncertainties for the agricultural sector, 2010.

6.9 Quality assurance and quality control (QA/QC)

A first step of development and implementation of a general QA/QC plan for all sectors started in 2004 which is described in a publicised manual (Sørensen et al., 2005). The manual describes the concepts of quality work and how to handle quality management by using Critical Control Points and a list of Point of Measurements. For more detailed information of the structure in the general QA/QC plan refers to Chapter 1.6 for QA/QC.

A complete list Points of Measures (PM) are given in Table 1.2. PM related to the agricultural inventory is listed below in Chapter 6.9.2 and are primarily connected to data storage and data processing level 1. For PM not mentioned below please refer to Chapter 1.6.

The QA/QC work specific for the agricultural sector is still improved. The overall framework regarding a QA/QC plan for agriculture are constructed in form of six stages (see section 6.9.1) and each stage focus on quality assurance and quality check in different part of the inventory process. This year a more detailed set up for stage I, II and III are developed – refer to Annex 3E-18.

The QA/QC procedure is divided in six stages as listed below:

Table 6.50 Stages of QA/QC procedure.

Stage I	**Check of input data**
	- check of data input in IDA are consistent with data from external data suppliers
Stage II	**Check of IDA data – overall**
	- check of recalculations for total emissions compared with the latest submission (2011)
	- check of total emissions for the total CO_2-eqv. and for each compound
Stage III	**Check of IDA data – specific**
	- check of annual changes of activity data, emission factors, IEF and other important variables as GE, Nex, housing system distribution, grazing days
Stage IV	**Check by comparing calculation with estimates from other institutions**
	- the total Nex for all livestock production estimated by DCA
	- the Register for fertilization controlled by the Danish Plant Directorate
Stage V	**Check of data registered in CRF**
	- compare data in CRF with data from IDA
Stage VI	**Check of the inventory in general (external review)**
	- check that data is used correctly
	- check the methodology and the calculations

Stage I: Check of input data

At stage I it is checked that all input data in IDA is consistent with data from the external data suppliers. Data from the Statistics Denmark has to be checked for the livestock production, slaughter data for poultry and pigs, check of land use and crop yield. Data input from the DCA has to be checked for feed intake, N-excretion, manure production, dry matter content, grasing days. Data from the Danish Plant Directive: distribution of housing systems and the use of nitrogen in synthetic fertiliser.

Stage II: Check of IDA data - overall

At stage II a check of the overall calculations in IDA is made, where the first step is to compare the inventory with the last reported emission inventory - submission 2011. In the case where an error cover all time series, it can be difficult to identify this error by checking the changes in inter annual values. Therefore, a check of recalculations is needed.

Next step in stage II is a check of total emissions of CH_4, N_2O, NMVOC and the other compounds which are related to the field burning of agricultural residues. For each compound a check of trends of times series 1990-2010 and inter annual changes is provided. Significant jumps or dips from one year to another could indicate an error - otherwise it has to be explained.

Stage III: Check of IDA data - specific

At stage III a check of specific variables in IDA is provided for both inter annual changes and trends for the entire time series. Variables includes activity data, emission factors, IEF and other important key variables such as feed intake, GE, Nex and housing systems distribution.

Stage IV: Check by comparing calculation with estimates from other institutions

The purpose of stage IV is to verify the calculations in IDA, as far as external data estimations are available. For other purposes DCA for some years calculate the over all N excretion from the total livestock production in DK, which could be compared with the survey given in the emission inventory. Another possibility to check some of the IDA estimations is the information in the fertilizer accounts controlled by The Danish Plant Directorate. Farmers with more than 10 animal units have to be registered and have to keep accounts of the N content in manure, received manure or other organic fertilizer. These comparisons will properly show some differences, which not necessarily indicate an error, but the most important cause of the difference has to be identified.

Stage V: Check of data registered in CRF

Stage V primarily focuses on the last reported year 2010 and the base year (1990), where all activity data, emissions and IEFs are checked. Furthermore, CRF sum emissions are checked with sum emissions in IDA. If an error is detected a more detailed check is done to find the reason for the error.

Stage VI: Check of the inventory in general

A detailed description of the methodology used to calculate the Danish agricultural emissions is published as a sectoral report for agriculture (Mikkelsen et al., 2011). General checks of the inventory include considerations of which data input is used, how they are used in the calculations and whether more accurate data are available. The review of the sectoral report addresses these issues and is a most valuable part of the QA of the agricultural sector.

Status for the QA/QC plan

The framework for working out a specific QA/QC plan for the agricultural sector is complete. Stage I-III is done as part of the process of inventory preparation, which has reduced the number of errors in the CRF and in this way meet the ERT recommendations. A more detailed list showing the checked variables of stage I – III is provided in Annex 3E-18.

Concerning the stage IV we have provide some random check but need to provide a more systematic check. We are aware of some external calculations which can be compared with the estimations in IDA – e.g. total N-excretion in manure calculated of DCA. Furthermore, some comparisons with the Register of Fertilization administrated by the Danish Plant Directorate can be provided.

Stage VI is implemented. Two reports describing the methodology in calculation of agricultural emissions in details are published (Mikkelsen et al., 2006 and Mikkelsen et al., 2011). Both reports have been reviewed by experts not involved with the preparation of the emission inventory. The 2011 report was reviewed by: Nicholas J. Hutchings from the DCA, Aarhus University and Johnny M. Andersen from the Faculty of Life Sciences, University of Copenhagen. The reviewers have reviewed all sections of the report. In the next updated version is it planned to contact relevant reviewers to focus on specific subject areas.

6.9.1 QA/QC plan expressed in Critical Control Points and Point of Measurements

Data storage level 1

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

The following external data are in used in the agricultural sector, in more details see Table 6.2:

- Data from the annual agricultural census made by Statistics Denmark.
- DCA, Aarhus University.
- The Danish Plant Directorate.
- Danish Agricultural Advisory Service (DAAS).
- The Danish Energy Authority.
- Danish Environmental Protection Agency.

The emission factors come from various sources:

- IPCC guidelines.
- DCA, Aarhus University: NH_3 emission, CH_4 emission from enteric fermentation and manure management.

Statistics Denmark

The agricultural census made by Statistics Denmark is the main supply of basic agricultural data. In Denmark, all cattle, sheep and goats have to be registered individually and hence the uncertainty in the data is negligible. For all other animal types, farms having more than 10 animal units are registered.

DCA

The DCA is responsible for the delivery of N-excretion data for all animal and housing types. Data on feeding consumption on commercial farms are collected annually by DAAS from on-farm efficacy controls. For dairy cattle, data is collected from 15-20 % of all farms, for pigs, 25-30 % and for poultry and mink, 90-100 % of all farms. The farm data are used to calculate average N-excretion from different animal and housing types. Due to the large amount of farm data involved in the dataset, N-excretion is seen as a very good estimate for average N-excretion at the Danish livestock production.

Danish Plant Directorate

Total area with the various agricultural crops is provided to the Danish Plant Directorate via the agricultural subsidy system. For every parcel of land (via a vector-based field map with a resolution of >0.01 ha), the area planted with different crops is reported. If the total crop area within a parcel is larger than the parcel area, a manual control of the information is performed by the Plant Directorate. The area with different crops, therefore, represents a very precise estimate.

All farmers are obligated to do N-mineral accounting on a farm and field level with the N-excretion data from DCA. Data at farm level is reported annually to the Danish Plant Directorate. The N figures also include the quantities of synthetic fertilisers bought and sold. Suppliers of synthetic fertilisers are required to report all N sales to commercial farmers to the Plant Directorate. The total sold to farmers is very close to the amount imported by the suppliers, corrected for storage. The total amount of synthetic fertiliser in Denmark is, therefore, a very precise estimate for the synthetic fertiliser consumed. This is also valid for N-excretion in animal manure.

The Danish Plant Directorate, as the controlling authority, performs analysis of feed sold to farmers. On average, 1600 to 2000 samples are analysed every year. Uncertainty in the data is seen as negligible. The data are used when estimating average energy in feedstuffs for pigs, poultry, fur animals, etc.

From 2005 the Danish Plant Directorate provides data for distribution of housing type.

Danish Agricultural Advisory Service (DAAS)

DAAS is the central office for all Danish agricultural advisory services. DAAS carries out a considerable amount of research itself, as well as collecting efficacy reports from the Danish farmers for dairy production, meat production, pig production, etc., to optimise productivity in Danish agriculture. From DAAS data on housing type until 2004, grazing situation and information on application of manure is received.

The Danish Energy Agency

The amount of slurry treated in biogas plants is received from the Danish Energy Agency.

Danish Environmental Protection Agency

Information on the sludge from waste water treatment and the manufacturing industry and the amount applied on agricultural soil is obtained from the Danish Environmental Protection Agency.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

The most important emission source is related to the animal production. Uncertainty for the animal data is very low due to the very strict environmental laws in Denmark. Standard deviation regarding the numbers of cattle and pigs has been estimated to <0.7 %. For poultry the standard deviation is <2.1 %. For all years, 25-35 % of all holdings are included in the census. The standard deviation for N-excretion between farms is reported as 25 % for dairy cattle and pigs, but due to the large numbers involved in the estimation of the average N-excretion, the average is assumed to be a precise estimate for the Danish agricultural efficacy level.

Regarding uncertainties for the remaining emission sources see Chapter 6.8.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

Please, refer to Chapter 6.8 and Table 6.49.

Data Storage level 1	1. Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

The Danish N-excretion levels are generally lower than IPCC default values. This is due to the highly skilled, professional and trained farmers in Denmark, with access to a highly competent advisory system.

The feed consumption pr animal is in line with similar data from Sweden, although they are not quite comparable because Denmark is using feeding units (FE) which cannot easily be converted to energy content. Earlier, one feeding unit was defined as one kg of barley. Today, the calculations are more complicated and depend on animal type.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

External data received are stored in the original format in quality management database system.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and DCE about the conditions of delivery.

DCE has established formal data agreements with all institutes and organisations which deliver data, to assure that the necessary data is available to prepare the inventory on time.

Data Storage level 1	6.Robustness	DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external data set.

Please refer to Chapter 1.7.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset.

Please refer to DS 1.1.1.

Data Storage level 1	7.Transparency	DS.1.7.2	The archiving of data sets needs to be easy accessible for any person in the emission inventory.

Please refer to Chapter 1.7.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external data set have to be available for any single value in any dataset.

A great deal of documentation already exists in the literature list, and also given in the quality management database system:
I:/rosproj/luft_emi/inventory-/2008/4_Agriculture/level_1a_storage/

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset.

Statistics Denmark:

Mr. Ole Nielsen (oni@dst.dk)

Mr. Karsten K. Larsen (kkl@dst.dk)

DCA (Aarhus University):

Mrs. Hanne Damgaard Poulsen (hannedamgaard.poulsen@agrsci.dk)

Mr. Nick Hutchings (nick.hutchings@agrsci.dk)

Mr. Christen Duus Børgesen (Christen.Borgesen@agrsci.dk)

The Danish Agricultural Advisory Centre:

Mr. Ole Aaes (OEA@Landscentret.dk)

Mr. Eric F. Clausen (EFC@landscentret.dk)

Mr. Barthold Feidenshans'l (BAF@landscentret.dk)

Danish Plant Directorate:

Mr. Troels Knudsen (tkn@pdir.dk)

Mrs. Mette Thomsen (mth@pdir.dk)

The Danish Energy Agency:

Mr. Søren Tafdrup (st@ens.dk)

The Danish Environmental Protection Agency:

Mrs. Trine Leth Kølby (trile@mst.dk)

Data processing level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability).

The Tier 1 methodology is used to calculate the uncertainties for the agricultural sector. The uncertainties are based on a combination of IPCC guidelines and expert judgement (Olesen et al., 2001, Poulsen et al., 2001, Gyldenkærne, 2005) and a normal distribution is assumed. A Tier 2 calculation is provided, please refer to Chapter 6.8.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals).

Please refer to DP 1.1.1.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines.

Denmark has worked out a report with a more detailed description of the methodological inventory approach in Mikkelsen et al. (2006) and an updated version in Mikkelsen et al. (2011). The first report has been reviewed by the Statistics Sweden, who is responsible for the Swedish agricultural inventory and the updated report has been reviewed of qualified persons with comprehensive agricultural knowledge; Nicholas J. Hutchings from the DCA, Aarhus University and Johnny M. Andersen from the Faculty of Life Sciences, University of Copenhagen. None of the reviewers is involved in the preparation of the annual inventory.

Furthermore, data sources and calculation methodology developments are continuously discussed in cooperation with specialists and researchers in different institutes and research sections. As a consequence, both the data and methods are evaluated continually according to the latest knowledge and information.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

The methodological approach is consistent with the IPCC Reference Manual and the Good Practice Guidance.

Implied emission factors for CH_4 from enteric fermentations are, in general, lower than the IPCC default values, which is due to the professional way farms are managed in Denmark. There has been an increase in emission from the enteric fermentation of CH_4 due to increase in milk production. The IEF is in line with Canada, the Netherlands, Sweden and Finland, who all have agricultural conditions comparable to Denmark.

The IEF for CH_4 from manure management is, in general, higher compared with the default IPCC values for Western Europe because of the higher percentage handled as slurry. However, due to the high efficiency at farm level, energy intake is lower pr head and the subsequent CH_4 emission from slurry is, thereby, lower. Denmark uses an MCF factor of 10 % as provided in the 1996 guidelines and not the 39 % in the revision to the 1996 guidelines. For further explanation, see Chapter 6.4.2.

$Frac_{LEACH}$ is higher than the default IPCC values. $Frac_{LEACH}$ has decreased from 1990 and onwards. In the beginning of 1990s, manure was often applied in autumn. The high values are partly due to the humid Danish climate, with the precipitation surplus during winter causing a downward moment of dissolved nitrogen. The decrease in $Frac_{LEACH}$ over time is caused by sharpened environmental requirements, banning manure application after harvest. As a result, most manure application occurs during spring and summer, where there is a precipitation deficit. The generally accepted leaching values in Denmark are 0.3 for mineral nitrogen and 0.45 for organic-bound nitrogen. These values are based on a series of leaching studies.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The methodological approach is consistent with the IPCC Reference Manual and the Good Practice Guidance.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

Regarding the reduction potential for biogas treated slurry, more information and investigation would be preferred. There is ongoing work to increase the accuracy of this emission source.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important missing accessibility to critical data sources

All known major sources are included in the inventory. In Denmark, only very few data are restricted. Accessibility is not a key issue; it is more lack of data.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure

The calculation procedure is consistent for all years.

Data Processing level 1	4.Consistency	DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations

Please refer to Chapter 1.7.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

During the development of the model, thorough checks have been made by all persons involved in preparation of the agricultural section.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time series.

Time series for activity data, emission factors and national emission are performed to check consistency in the methodology, to avoid errors, to identify and explain considerable year to year variations.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures.

A comparison between IPCC Tier 2 method for enteric fermentation and Denmark's Tier 2/CS is made, see Chapter 6.3.4.

Data Processing level 1	5.Correctness	DP.1.5.4	Show one-to-one correctness between external data sources and the databases at Data Storage level 2

In the database key ids is used to identify the unique data. The data on DS level 1 is linked to the key id used in the database so a clear reference from DS level 1 to higher levels of both DP and DS is secured.

Data Processing level 1	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons that can replace each other in the technical issue of performing the calculations.

Please refer to Chapter 1.7.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.

All calculation principles are described in the NIR and the documentation report (Mikkelsen et al., 2011).

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.

All theoretical reasoning is described in the NIR and the documentation report (Mikkelsen et al., 2011).

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind methods.

All theoretical reasoning is described in the NIR and the documentation report (Mikkelsen et al., 2011).

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1.

In the database key ids is used to identify the unique data. The data on DS level 1 is linked to the key id used in the database so a clear reference from DS level 1 to higher levels of both DP and DS is secured.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations.

Changes compared with the last emissions report are described in the NIR and the national emission changes is given in a table under the section, "Recalculation". The text describes whether the change is caused by changes in the dataset or changes in the methodology used. Furthermore a log table is filled in when data are updated or adjusted continuously.

Data storage and processing level 2

For point of measurements not mentioned below please refer to Chapter 1.7.

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1.

A manual check-list is under development for correct connection between all data types at level 1 and 2.

Data Processing level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

A manual check-list is under development for correctness of data import to level 2.

6.10 Recalculation

Below follows an overview of improvements and recalculations implemented since the 2011 submission.

Improvements

Some recommendations given by ERT during the reviews and some of the planned improvements from previous years have been incorporated in the Danish inventory:

- As recommended by ERT more detailed information on N_2O emission from manure management is provided in Table 6.26, with emissions divided on animal categories.
- Also recommended by ERT information on area of N-fixing crops 1990-2010 are provided in Annex 3E-15.
- Notation keys regarding the FracFUEL are corrected from NE to NO in submission 2012. According to the Danish Energy Statistics livestock manure is not burned for fuel.
- Theinformation covering the quantity of NH_3 emission from N excreted from grassing animals is included in the table 6.41 as recommended by ERT.
- As recommended by ERT further detailed explanation describing the estimation of lower emission of CH_4 and N_2O as results of biogas treated slurry are provided. In NIR sections 6.4 more text are inserted and furthermore another Table in Annex 3E (Annex 3E-11) showing the basic data from Sommer et al. (2001) is provided.
- Further information describing the VS content in manure and the methodology converting of the Danish feed units (FU) to gross energy (GE) is provided in NIR submission 2012 to improve the transparency for use of national values as recommended by ERT.
- As recommended by the ERT the values concerning the milk yield now are on the QA/QC check list as a separate item.
- To achieve improvements on transparency of the QA/QC procedure a detailed list showing the checked variables at stage I-III is provided in Annex 3E-18.
- A review of the distribution of animals on housing types has been made. From 2005 information on housing type are received from the Danish Plant directorate. For previously years the distribution is based on an expert judgement from the Danish Agricultural Advisory Service. The distribution of housing types has been review in corporation with DAAS and large differences have been evened out. This adjustment has no significant effects on the total emissions.

Recalculations

Some changes in calculation of agricultural emissions 1990-2009 have taken place. The recalculation has contributed to an increase in the total agricultural emissions for the years 1990-2008 of 0.6 to 1 % and a decrease in 2009 of 0.7 % given in CO_2 equivalent (Table 6.51).

Table 6.51 Changes in GHG emission in the agricultural sector compared with the CRF reported last year.

	1990	1995	2000	2005	2006	2007	2008	2009
Previous inventory (Gg CO_2 eqv.)								
4.A Enteric Fermentation	3 249	3 119	2 852	2 711	2 712	2 779	2 796	2 859
4.B Manure Management	1 580	1 634	1 671	1 732	1 681	1 721	1 668	1 654
4.D Agricultural Soils	7 553	6 680	5 787	5 234	5 105	5 234	5 329	5 088
4.F Field Burning of Agricultural Residues	3	3	4	4	4	4	3	4
Recalculated (Gg CO_2 eqv.)								
4.A Enteric Fermentation	3 247	3 134	2 861	2 737	2 740	2 805	2 830	2 823
4.B Manure Management	1 593	1 669	1 722	1 816	1 756	1 772	1 730	1 693
4.D Agricultural Soils	7 620	6 709	5 807	5 226	5 095	5 249	5 309	5 020
4.F Field Burning of Agricultural Residues	3	3	4	4	4	4	3	4
Change in Gg CO_2 eqv.								
4.A Enteric Fermentation	-2	15	9	26	27	26	34	-36
4.B Manure Management	13	35	51	83	75	51	62	38
4.D Agricultural Soils	67	29	21	-8	-11	15	-20	-68
4.F Field Burning of Agricultural Residues	0	0	0	0	0	0	0	0
Change in pct.								
4.A Enteric Fermentation	-0.1	0.5	0.3	1.0	1.0	0.9	1.2	-1.3
4.B Manure Management	0.8	2.1	3.1	4.8	4.4	3.0	3.7	2.3
4.D Agricultural Soils	0.9	0.4	0.4	-0.2	-0.2	0.3	-0.4	-1.3
4.F Field Burning of Agricultural Residues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change in total, Gg CO_2 eqv.	78	79	81	101	92	92	76	-66
Change in total, pct.	0.6	0.7	0.8	1.0	1.0	0.9	0.8	-0.7

The most significant inventory changes are mentioned below:

An error in the calculation of emission of CH_4 from enteric fermentation from sows has been corrected as recommended by the ERT. This has increased the emission of CH_4 from enteric fermentation with up to 1 % in the years 1990-2009. The emission from enteric fermentation has in 2009 overall decreased, but this is due to a correction of the number of heifers. The correction for heifers has a higher decreasing effect than the increasing effect of the correction for sows.

CH_4 from manure management have in the recalculation increased 1-4 % in 1990-2009 compared to last year submission. The two main reasons for the recalculation is; updated data for dry matter content in manure for sows for all years 1990-2009 and a correction of an error in the calculation of CH_4 from manure management from dairy cattle in the years 1990-2006.

Recalculations made for the NH_3 emission has affected the emission of N_2O. EF for NH_3 from synthetic fertilisers has been review and this have an increasing effect on the N_2O emission. A recalculation of NH_3 emission for livestock has affected N_2O emission from manure management and manure applied on soil. N_2O emission from atmospheric deposition is affected of all recalculations of NH_3.

Some recalculations have been made due to updated data. Updated data for area of histosols 1990-2009, nitrogen leaching 1990-2009 and nitrogen in industrial waste 2002-2009 have been use in the calculations of emissions of N_2O.

Some changes in number of animals have been made. The calculation of number of bulls has been changed for all years, 1990-2009, to being based on slaughter data from DSt. For the number of weaners and fattening pigs an error in calculation has been corrected for the years 1990-2009. For heifers an error in the number of animals in 2009 have been corrected.

6.11 Planned improvements

The Danish emission inventory for the agricultural sector meets the requirements given in the IPCC Good Practice Guidance. In the years to come and based on the ERT recommendations, two specific improvements have to be mentioned.

First of all DK plans to make more efforts to improve the documentation of the expected reduced emissions of CH_4 and N_2O as a consequence of biogas treated slurry. The first step is an attempt to improve activity data. Present activity data regarding the amount of biogas treated slurry is received from the Danish Energy Agency. A contact is established to the Danish Biogas Plant Association, which is an organisation of biogas plant owners in Denmark. The organisation receives production data from the twenty of the biggest centralised biogas plants. However, data regarding the treated slurry can not be used directly but have to be adjusted against information on separated or other possible technical solutions, which can affect the amount of slurry or the content of CH_4 and N_2O.

Another issue which has to be investigated are improvements of the documentation regarding the emission reduction potential. This I planned to be done by a literature study. Other countries e.g. Germany also use biogas treated slurry and could have some available interesting data. Based of this knowledge it is hopefully possible to do some improvements in submission 2012.

Besides the biogas issue, further work to document the comprehensive QC procedures is planned. Further focus will in particular be addressed to compare the calculations from IDA with estimates from other institutions as far as available data makes it possible (refer to "Stage V" in the QA/QC plan – see Chapter 6.9.1).

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7 LULUCF (CRF sector 5)

7.1 Overview of the sector

This chapter covers only the territory of Denmark without the Faroe Islands and Greenland. Greenland is submitting a separate NIR and the corresponding CRF tables for the Greenlandic territory to UNFCCC. This can be found as Chapter 16 in this NIR.

Denmark (Capital: Copenhagen) is situated around 56°N and 13°E and covers 43,098 km^2. No permanent ice is occurring and only very small insignificant areas with rocks. The climate is according to IPCC GPG 2003 cold and wet. Denmark is an intensive agricultural country where most of the area is affected by agriculture. The average temperature in the standard 30 year, 1961-1990 was 7.7 °C with a minimum temperature in February of 0.3 °C and a maximum in July of 17.0 °C. Year 2010 had an average mean temperature of only 7.0 °C. Not since 1996 has a lower average temperature been recorded. The year 2009 was the eight warmest recorded year since 1873 and slightly cooler than 2008, which had an average temperature of 9.4 °C (www.dmi.dk) or 22 % above 1961-1990.

All land is classified into Forest, Cropland, Grassland, Wetlands, Settlements or Other Land.

7.1.1 Abbreviations

The following abbreviations are used in accordance with definitions in the IPCC guidelines:

A: Afforestation, areas with forest established after 1990 under article 3.3.
R: Reforestation, areas which have temporarily been unstocked for less than 10 years - included under article 3.4.
D: Deforestation, areas where forests are permanently removed to allow for other land use, included under article 3.3.
FF: Forest remaining Forest, areas remaining forest after 1990.
FL: Forest Land meeting the definition of forests.
CL: Cropland.
GL: Grassland.
SE: Settlements.
OL: Other land, unclassified land.
FM: Forest Management, areas managed under article 3.4.
CM: Cropland Management, areas managed under article 3.4.
GM: Grazing land Management, areas managed under article 3.4.

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of carbon dioxide. Removals are given as negative figures and emissions are reported as positive figures according to the guidelines. For 2010 emissions from LULUCF were estimated to be a net sink of approximately 1,118 Gg CO_2 equivalents or 1.8 % of the total reported Danish emission.

7.1.2 Methodology overview

Tier

The type of emission factor and the applied tier level for each emission source are shown in Table 7.1 below. The tier level has been determined based on the 1996 Guidebook (IPCC 1997).

Distinguishing between tier level 2 and 3 have been based on the emission factor. The tier levels definitions have been interpreted as follows:

- Tier 1: The emission factor is an IPCC default tier 1 value.
- Tier 2: The emission factors are country specific and based on either a few emission measurements or IPCC tier 2 emission factors.
- Tier 3: Based on models which include carbon stock changes methodologies.

Table 7.1 shows which of the source categories are key in any of the key source analysis[1] (including LULUCF, tier 1/tier 2, level/trend).

Table 7.1 Methodology and type of emission factor.

		Tier	EF	Key category
5.A.1 Broadleaves	CO_2	Tier 3, Tier 1	CS, D	Yes
5.A.1 Conifers	CO_2	Tier 3, Tier 1	CS, D	Yes
5.A.2 Broadleaves	CO_2	Tier 3, Tier 1	CS, D	No
5.A.2 Conifers	CO_2	Tier 3, Tier 1	CS, D	Yes
5(II) Forest Land.	N_2O	Tier 2	CS	No
5.B Cropland, Living biomass	CO_2	Tier 2	CS	No
5.B Cropland, Mineral soils	CO_2	Tier 3	CS, D	Yes
5.B Cropland, Organic soils	CO_2	Tier 2	CS, D	Yes
5(III) Disturbance, Land converted to cropland	N_2O	Tier 2	CS, D	No
5.C Grassland, Living biomass	CO_2	Tier 2	CS, D	Yes
5.C Grassland, Mineral soils	CO_2	Tier 2	CS, D	No
5.C Grassland, Organic soils	CO_2	Tier 2	CS, D	No
5.D Wetlands, Living biomass	CO_2	Tier 2	CS, D	No
5.D Wetlands, Dead organic matter	CO_2	Tier 2	CS, D	No
5.D Wetlands, Soils	CO_2	Tier 2	CS, D	Yes
5(II) Wetlands	N_2O	Tier 2	CS, D	No
5.E Settlements, Living biomass	CO_2	Tier 2	CS, D	No
5(IV) Cropland Limestone	CO_2	Tier 2	CS, D	Yes
5(V) Biomass Burning	CH_4	Tier 2, Tier 1	CS, D	No
5(V) Biomass Burning	N_2O	Tier 2, Tier 1	CS, D	No

7.1.3 Key categories

Key Category Analysis (KCA) tier 1 and 2 for year 1990, 2010 and trend for Denmark has been carried out in accordance with the IPCC Good Practice Guidance / IPCC Guidelines (2006). Table 7.2 shows which of the LULUCF categories are identified as key categories. The table is based on the analysis including LULUCF. Detailed key category analysis is shown in NIR Chapter 1.5 and Annex 1.

[1] Key category according to the KCA tier 1 or tier 2 for Denmark (excluding Greenland and Faroe Islands), including LULUCF, level 1990/ level 2010/ trend.

The CO_2 emissions from forests are key for all except for afforestation with conifers. For cropland both mineral and organic soils are key sources as well as lime stone.

Table 7.2 Key categories, LULUCF.

			Tier 1			Tier 2		
			1990	2010	1990-2010	1990	2010	1990-2010
LULUCF	5.A.1 Broadleaves	CO_2	Level	Level	Trend	Level	Level	Trend
LULUCF	5.A.1 Conifers	CO_2		Level	Trend		Level	Trend
LULUCF	5.A.2 Broadleaves	CO_2						Trend
LULUCF	5.A.2 Conifers	CO_2			Trend			Trend
LULUCF	5.B Cropland, Mineral soils	CO_2	Level	Level	Trend	Level	Level	
LULUCF	5.B Cropland, Organic soils	CO_2	Level	Level	Trend	Level	Level	Trend
LULUCF	5.C Grassland, Living biomass	CO_2	Level		Trend			Trend
LULUCF	5.C Grassland, Organic soils	CO_2				Level	Level	
LULUCF	5.D Wetlands, Soils	CO_2						Trend
LULUCF	5(IV) Cropland Limestone	CO_2	Level		Trend	Level		Trend

7.1.4 Methods

Approximately 2/3 of the total Danish land area is cultivated and 13.4 forested. Together with high number of cattle and pigs there is a high (environmental) pressure on the landscape. To reduce the impact an active policy has been adopted to protect the environment. The adopted policy aims at doubling the forested area within the next 80-100 years, restoration of former wetlands and establishment of protected national parks. In Denmark almost all natural habitats and all forests are protected. Therefore only limited conversions from forest or wetlands into cropland or grassland are occurring.

Estimation of carbon stock changes in the Danish forests is based on a combination of surveys and the National Forest Inventory (NFI). Changes in carbon stock in mineral cropland soils are estimated with a nationally developed Tier 3 model, whereas the emission calculation from organic soils is based on nationally developed emission factors.

A land use/land cover map was produced for the base year 1990 and for the year 2005 based on earth observation (EO) data (23 August 1990) and other data collected from 1992-2005. From 2005 and onwards knowledge on the development in Denmark combined with vector maps is used. Table 7.3 shows the overall development from 1990 to 2010. The preliminary result is an increase in the afforested area of 46,841 ha, but also that deforestation has taken place of approximately 6,922 ha in that period. Afforestation is mainly taking place on CL and OL not previous classified as forest. Areas, which are deforestated are mainly converted to GL and SE. Since 1990 more than 70,000 hectares have been changed into SE and other infrastructures. No FL, CL and GL are converted into OL by definition.

Table 7.3 Land Use Change from 1990 to 2010 based on EO and other GIS vector layers. The figures are given in hectares.

1990\2010	Forest	Cropland	Grassland	Wetlands	Settlements	Other	Sum
Forest	532,865	944	4,562	39	1,377	-	539,788
Cropland	27,846	2,774,523	48,983	7,246	64,581	-	2,923,179
Grassland	1,193	6,241	106,202	1,202	2,264	-	117,102
Wetlands	4	-	-	1,596	-	-	1,600
Settlements	-	642	335	-	384,471	-	385,447
Other	17,798	2,902	5,088	10,012	2,041	304,843	342,685
Sum	579,706	2,785,251	165,170	20,095	454,735	304,843	4,309,800
Percentage	13	65	4	0	11	7	100

A detailed QA/QC process of the developed Land Use matrix is still ongoing and will continue during 2012 to provide consistent maps for the period 1990 - 2012.

The emission data are reported in the CRF format under IPCC categories 5A (Forestry), 5B (Cropland), 5C (Grassland), 5D (Wetlands) and 5E (Settlements) and 5F (Other Land). Denmark is free from ice and rocks and Other Land therefore represents unmanaged areas including beaches and sand dunes. Fertilisation of Forests and Other Land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. All liming is reported under Cropland because only very limited amounts are used in forestry and on permanent grassland. Field burning of wooden biomass is prohibited in Denmark. Wildfires in forest are reported for the first time. This is normally around 0-10 hectares per year. Controlled burning of heathland is taking place of approximately 300 hectares to maintain the heath.

Savannas and rice cultivation do not occur in Denmark.

Table 7.4 gives an overview of the emission from the LULUCF sector in Denmark. Forests have been sinks in Denmark for the last decade but due to the age distribution of the forests - containing a majority of mature forests - a slight decrease of the carbon stock is observed, as the old forests are regenerated with young trees and a net source were observed. The changes occur before the 2008-2012 period and the results can also partly be attributed to the recalculations - as described later. Currently the NFI indicates that forests are a sink. Cropland is ranging from being a net source from up to 4,642 Gg in 1990 to be a net source of 3,185 Gg in 2010. High fluctuations in Cropland between years are related to the actual crop yield that year and the climatic conditions. Low yields combined with high temperatures reduce the total amount of carbon in agricultural soils whereas a year with a high yield and low temperatures increase the carbon stock in soil. From 1990 and onwards a general decrease in the emission from Cropland is estimated due to a higher incorporation of straw (ban of field burning), demands of growing of catch crops in the autumn, a change from low yielding spring barley to high yielding winter wheat, an increased carbon stock in hedgerows, a reduced consumption of lime and that organic agricultural soils are disappearing. The area with restored wetlands has increased and consequently the accumulation of organic matter has also increased here leading to a lower net source.

Table 7.4 Overall emission (Gg CO_2) from the LULUCF sector in Denmark, 1990-2010.

Greenhouse gas source and sink categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
5. Land Use, Land-Use Change and Forestry, CO_2	4.403,3	3.398,6	5.873,9	4.623,1	1.919,0	-2.380,5	2.775,2	-889,2	-2.183,5
A. Forest Land	-835,9	-916,1	1.914,8	1.068,6	-2.641,1	-6.635,3	-1.017,4	-3.602,5	-5.688,9
B. Cropland	4.642,2	4.001,5	3.419,1	3.200,1	4.209,6	3.924,4	3.482,2	2.389,6	3.185,3
C. Grassland	405,9	197,4	370,0	202,8	193,0	191,4	190,3	188,4	185,9
D. Wetlands	86,7	49,3	33,8	41,1	39,1	16,7	-6,5	5,0	-0,2
E. Settlements	104,4	66,5	136,4	110,4	118,4	122,3	126,5	130,4	134,4
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
5. Land Use, Land-Use Change and Forestry, N_2O	0,063	0,048	0,064	0,043	0,043	0,042	0,042	0,041	0,041
A. Forest Land	0,052	0,047	0,044	0,041	0,041	0,040	0,039	0,039	0,039
B. Cropland	0,010	0,000	0,020	0,002	0,002	0,002	0,002	0,002	0,002
C. Grassland	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
D. Wetlands	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
E. Settlements	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
5. Land Use, Land-Use Change and Forestry, CO_2 eqv. CO_2 and N_2O	4.423,3	3.413,5	5.893,9	4.636,5	1.932,4	-2.367,3	2.788,2	-876,4	-2.170,7

7.2 Forest remaining forest (5.A.1)

7.2.1 Forest census

From 1881 to 2000, a National Forest Census has been carried out roughly every 10 years based on questionnaires sent to forest owners (Larsen and Johannsen, 2002). Since the data was based on questionnaires and not field observations, the actual forest definition may have varied. The basic definition was that the tree covered area should be minimum 0.5 ha to be a forest. There were no specific guidelines as to crown cover or the height of the trees. Open woodlands and open areas within the forest were generally not included. All values for growing stock, biomass or carbon pools based on data from the National Forest Census were estimated from the reported data on forest area and its distribution to main species, age class and site productivity classes. The two last censuses were carried out in 1990 and 2000.

The 1990 National Forest Census was based on reported forest statistics from 22,300 respondents, resulting in information on area, main species, age class distribution and productive indicators. The estimated forest area was 445,000 ha or 10.3 % of the land. Of the total forest area 64 % was coniferous forest and 34 % was deciduous forest (the remainder was temporarily unstocked). The total volume was estimated at 55.2 million cubic metres of which 57 % was coniferous.

The number of respondents in the 2000 National Forest Census was 32,300, which is considerably higher than in the 1990 survey. The change in the number of respondents probably contributed to the observed increase in forest area and growing stock between the 1990 and 2000 census. The estimated forest area was 486,000 ha or 11.3 % of the land. Of the total forest area 60 % was coniferous forest and 36 % was deciduous forest (the remainder was temporarily unstocked). The total volume was estimated at 77.9 million cubic metres of which 63 % was coniferous.

7.2.2 National forest inventory

In 2002, a new sample-based National Forest Inventory (NFI) was initiated (Nord-Larsen et al., 2008). This type of forest inventory is very similar to inventories used in other countries, e.g. Sweden or Norway. The NFI has replaced the National Forest Census.

The NFI is a continuous sample-based inventory with partial replacement of sample plots based on a 2 x 2 km grid covering the Danish land surface. At each grid intersection, a cluster of four circular plots (primary sampling unit, PSU) for measuring forest factors (e.g. wood volume) are placed in a 200 x 200 m grid. Each circular plot (secondary sampling unit, SSU) has a radius of 15 meters. When plots are intersected by different land-use classes or different forest stands, the individual plot is divided into tertiary sampling units (TSU).

About one third of the plots is assigned as permanent and is re-measured in subsequent inventories every five years. Two thirds are temporary and are moved randomly within the particular 2x2 km grid cell in subsequent inventories. The sample of permanent and temporary field plots has been systematically divided into five non-overlapping, interpenetrating panels that are each measured in one year and constitute a systematic sample of the entire country. Hence all the plots are measured in a 5-year cycle.

Based on analysis of aerial photos, each sample plot (SSU) is allocated to one of three basic categories, reflecting the likelihood of forest or other wooded land (OWL) cover in the plot: (0) Unlikely to contain forest or other wooded land cover, (1) Likely to contain forest, and (2) Likely to contain other wooded land. All plots in the last two categories are inventoried in the field.

In the most recent five-year rotation of the NFI (2006-2010) the average number of clusters (PSU) and sample plots (SSU) were 2,197 yr^{-1} and 8,607 yr^{-1}, respectively. On average 1,795 yr^{-1} plots (SSU) were identified as having forest or other wooded land cover based on the aerial photos and were thus selected for inventory. However, measurements were not obtained for some plots. Missing plot observations were caused by a number of factors, including start up problems that resulted in insufficient time to complete the measurements and prohibited access to some plots on privately owned land. In 2005, the Forest Act was revised, so consequently forest owners are obliged to provide access. A total of average 387 sample plots were missing in the 2006-2010 inventories.

Table 7.5 Number of measured clusters and sample plots in the five year rotation 2006-2010. Forest covered sample plots not inventoried in the field are denoted "Missing".

Year	Clusters			Sample plots		
	Total	Forest	Missing	Total	Forest	Missing
2006	2,179	718	57	8,531	1,624	138
2007	2,201	772	109	8,644	1,804	246
2008	2,212	804	2	8,644	1,893	3
2009	2,195	782	0	8,604	1,797	0
2010	2,196	793	0	8,614	1,855	0
Total	10,983	3,869	168	43,037	8,973	387

Each plot is divided into three concentric circles with radius 3.5, 10 and 15 m. A single caliper measurement of diameter is made at breast height for all trees in the 3.5 m circle. Trees with diameter larger than 10 cm are measured in the 10 m circle and only trees larger than 40 cm are measured in the 15 m circle. On a random sample of 2-6 trees further measurements of total height, crown height, age and diameter at stump height are made and the presence of defoliation, discoloration, mast, mosses and lichens are recorded. The presence of regeneration on the plots is registered and the species, age and height of the regeneration are recorded. Stumps from trees harvested within a year from the measurement are measured for diameter.

Deadwood is measured on the sample plots. Standing deadwood with a diameter at breast height diameter larger than 4 cm is measured according to the same principles as live trees. Lying deadwood with a diameter of more than 10 cm is measured within the 15 m radius sample plot. Length of the lying deadwood is measured as the length of the tree that exceeds 10 cm in diameter and is within the sample plot. The diameter is measured at the middle of the lying deadwood measured for length. In addition to the size measurements of deadwood the degree of decay is recorded on an ordinal scale.

On each plot the presence and state of ditches and drainage conditions are recorded. Further, the presence of peatland is recorded and the depth of the peat is measured. Finally, the depth of the humus layer is measured on all plots.

7.2.3 Forest area mapping

Due to differences in methodologies major inconsistencies in forest areas and other forest variables are observed between the different forest inventories (i.e. the 1990 and 2000 Forest Census and the 2006 National Forest Inventory). With the objective to obtain time consistent and precise estimates of forest areas to report to UNFCC and under the Kyoto protocol, two projects have aimed at mapping the forest area in Denmark based on satellite images. Forest area and forest area change have been estimated for the years 1990 and 2005.

A land use/land cover map was produced for the base year 1990 and for the year 2005 based on EO data (23 August 1990) and other data collected from 1992-2005 and for 2005 using NFI in situ data. Forest maps are developed using Landsat imagery mainly Landsat 5 (TM) and 7 (ETM+) data to classify and estimate the area of forest cover types in Denmark. Portions of seven scenes covering the whole country were classified into forest and non-forest classes. The approach involved the integration of sampling, image processing, and estimation. A detailed QA/QC process started in 2011 and will conclude in 2012 - with the production of maps for 2012.

The product is specified by a Minimum Mapping Unit (MMU) of 0.5 ha, a geometric accuracy of < 15 m RMS and a thematic accuracy of 90 % +/- 5 % for the six major land use classes: Forest, Grass, Crop, Wetland, Urban, and Other.

7.2.4 Forest definition

The forest definition adopted in the NFI is identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10 %. The minimum width is 20 m." Temporarily non-wooded areas, fire breaks and other small open areas, that are an integrated part of the forest, are also included.

7.2.5 Estimation of forest carbon pools

In the following, procedures for estimating forest carbon pools are described. For the specific formulas used in the calculations, readers are referred to Annex 3F.

Estimation of forest area

Based on analysis of aerial photos, each sample plot (SSU) is allocated to one of three forest status categories (Z), reflecting the likelihood of forest or other wooded land (OWL) in the plot: (0) Unlikely to be covered by forest or other wooded land, (1) Likely to be covered by forest, and (2) Likely to be covered by other wooded land.

On individual sample plots (j) the forest cover percentage (X) is calculated as the proportion of the forest area (A) to the total plot area of the 15 m radius circle (A15). The average forest percentage ($\overline{X}$) on plots with forest status Z=1 (and 2) is calculated as the sum of the forest percentages times an indicator variable (R) that is 1 if Z equals 1 (or 2) and 0 otherwise, divided by the number of plots with forest status Z=1 (or 2).

The overall average forest percentage ($\overline{\overline{X}}$) is calculated as the sum of: (1) observed forest cover percentages of the individual sample plots, (2) the number of unobserved sample plots with forest status Z=1 times the average forest cover percentage of sample plots with forest status 1, and (3) the number of unobserved sample plots with forest status 2 times the average forest cover percentage of observed sample plots with forest status Z=2 divided by the number of observed and unobserved sample plots. In this context sample plots with forest status 0 are regarded as observed and assumed to have a forest cover percentage of 0. Finally, the overall forest area (A_{Forest}) is calculated as the overall average forest percentage times the total land area (A_{total}).

When estimating the forest area with a specific characteristic (*k*), such as forest established before or after 1990, the proportion of the plot area with the particular characteristic is found by summing the forested plot areas times an indicator variable (*R*) that is 1 if the plot has the *k*th characteristic and 0 otherwise. Subsequently the plot area with the *k*th characteristic is divided by the total forested plot area.

The total forest area with a particular characteristic (A_k) is found as the forest area percentage with the particular characteristic *k* times the total forest area.

Estimation of volume, biomass and carbon pools

For estimation of volume of individual trees, we use the volume functions developed for the most common Danish forest tree species (Madsen, 1985, Madsen 1987 and Madsen and Heusèrr 1993). The functions use individual tree diameter and height as well as quadratic mean diameter of the forest stand as independent variables.

Based on the trees measured for both height and diameter, diameter-height regressions are developed for each species and growth region. The functions use the observed mean height and mean diameter on each sample plot for creating localized regressions using the regression form suggested by Sloboda et al. (1993). For plots where no height measurements are available, generalized regressions are developed based on the Näslund-equation modified by Johannsen (1992).

The next step is to estimate the quadratic mean diameter of the trees on the sample plot. As the trees are measured in different concentric circles depending on their diameter, the basal area on each sample plot is estimated by scaling the basal area of each tree (standing or felled) according to the circular area in which the tree has been measured. A similar calculation has been made for the number of stems. Finally, mean squared diameter is calculated from the basal area and stem numbers.

Based on the diameter, estimated or measured height of individual trees and the squared mean diameter before thinning, the volume of individual trees is estimated using the species specific volume functions by Madsen (1987) and Madsen & Heusèrr (1993). The volume of trees less than 3 meters tall is estimated using an alternative function. The calculated volumes are total stem volume over bark for conifers and total above ground volume over bark for deciduous species.

Based on the estimated individual tree volumes, above ground biomass of the individual tree (stem biomass for conifers and total above ground biomass for broadleaves) is subsequently calculated as the total volume times the basic density. Species specific basic densities are based on Moltesen (1988), Skovsgaard et al. (2011) and Skovsgaard & Nord-Larsen (2012). Finally, total biomass (below and above ground) is estimated using expansion factors. For coniferous species an expansion factor model developed for Norway spruce (Skovsgaard et al. 2011) is applied whereas for deciduous species an expansion factor model developed for beech (Skovsgaard & Nord-Larsen, 2012) is used.

Total or regional volume, biomass and pools of carbon are estimated based on the estimates of individual tree volumes, biomass and carbon. First, volume, biomass or carbon per hectare is estimated for each of the concentric circles (c=3.5, 10 or 15 m radius) on each plot as the plot area depends on the diameter of the tree. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare for the three concentric circles is estimated. The overall mean volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional volume, biomass or carbon is estimated as the forest area times the overall mean volume.

The total volume, biomass or carbon pools with a given characteristic are estimated in a similar way as the total figures. First, volume, biomass or carbon per hectare with the given characteristic is estimated for each of the concentric circles (c=3.5, 10 or 15 m radius) on each plot. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare with the given characteristic for the three concentric circles is estimated. The overall mean volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional volume, biomass or carbon with the given characteristic is estimated as the forest area times the overall mean volume.

Dead wood volume, biomass and carbon content

The volume of standing dead trees is calculated similarly to the calculations for live trees. The volume of lying dead trees within the sample plot is calculated as the length of the dead wood times the cross sectional area at the middle of the dead wood. Biomass of the dead wood is calculated as the volume times the species specific basic density and a reduction factor according to the structural decay of the wood. Finally, carbon content for each standing or lying dead tree is calculated by multiplying the dead wood biomass by 0.5.

Total or regional volume, biomass and carbon pools of deadwood are estimated based on the estimates of volumes, biomass and carbon for individual dead trees or pieces of dead wood. First, deadwood volume, biomass or carbon per hectare is estimated for each of the concentric circles (c=3.5, 10 or 15 m radius). Estimates for lying dead wood are made using the 15 m circle. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare of deadwood for the three concentric circles is estimated. The overall mean deadwood volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional deadwood volume, biomass or carbon is estimated as the forest area times the overall mean volume.

Forest floor

On each NFI plot (SSU) the depth of the forest floor is measured. As peatlands are reported specifically, a maximum depth of 15 cm is used in the calculations. Forest floor carbon for individual species is estimated by multiplication of the forest floor depth with the plot area, a species specific density (Vesterdal & Raulund-Rasmussen, 1998) and the fraction of the individual species. The fractions are based on the proportion of basal area of the individual species and total forest floor carbon is estimated by summation of forest floor carbon of the different species.

Average forest floor carbon is estimated by summation of forest floor carbon on the individual plots and dividing the total by the total plot area. Total forest floor carbon is subsequently estimated by multiplication of the average forest floor carbon by the total forest area.

Forest floor carbon stocks were assessed in the Forest Soil Inventory described below. However, there was no good basis to estimate change over time for this C pool as historic data were very scarce (see below). Hence changes in this C pool were based on depth measurements performed on all NFI plots.

Forest mineral soil

The NFI monitoring was supplemented by an additional forest soil inventory in order to document that forest soils is not an overlooked source for CO_2 emissions. The monitoring of soil C-stocks concerns two of the five carbon pools identified by IPCC (2003), litter (forest floor) and mineral soil to a depth of minimum 30 cm.

There is relatively good information from various soil profile databases on mineral soil carbon stocks to 1 m depth for well-drained Danish forest soils (Vejre et al., 2003; Krogh et al., 2003). However, there has been no spatially systematic study performed on temporal change in forest soil carbon. This has limited the possibility to explore the development in forest soil carbon stocks over time. This need is most pronounced for the quickly changing litter carbon pool and previous C stock estimations (Vejre et al. 2003) did not include moist and wet forest soils.

According to decision 16/CMP "A Party may choose not to account for a given pool in a commitment period if transparent and verifiable information is provided that the pool is not a source." The forest soil inventory aims to document that forest soils are not a major source for emissions of CO2, i.e. that there is no detectable depletion in soil carbon. This may be called the "no source principle"(Somogyi & Horvath, 2007). According to IPCC (2003) the necessary documentation may come from various sources such as:

- Representative and verifiable sampling and analysis to show that the pool has not decreased
- Reasoning based on sound knowledge of likely system responses
- Surveys of peer-reviewed literature for the activity, ecosystem type, region and pool in question
- Combined methods.

Based on literature and reasoning based on sound knowledge there is little evidence to support that the soil C pool in forest remaining forest would currently be changing to an extent that would be detectable by sampling with decadal frequency. For well-drained soils there may be temporal changes in soil carbon stocks at fine spatial resolution (ha-level) due to clear-cutting and replanting, but for the entire forest area with the whole range of age classes, the assumption is that soil carbon stocks are unchanged over time. In fact, the conversion toward close-to-nature forestry with continuous crown cover and abandonment of clearcutting suggests a future increase in soil carbon stocks rather than depletion (Brunner et al., 2005; Yanai et al., 2000). Areas with wet forest soils have probably been sources for increased CO_2 emissions in a period after ditching and drainage activities took place from the late 19th century. These activities led to increased mineralization of peaty soils. However, during the last 20 years, drainage activities have diminished strongly and has almost ceased in state forests as a direct effect of the Strategy for the State forests to convert to more Close to Nature Forest Management, including restoration of more natural hydrology (see more on http://www.naturstyrelsen.dk/). Here, the natural hydrological conditions are actively restored by filling up ditches in some areas. It is expected that this change in management will lead to sequestration of carbon as these forest soils gradually get wetter and the rate of decomposition decreases more than rates of organic matter inputs from litterfall. Exact information on the extent of restored natural hydrology is not available, but is being assessed based on expert judgement and information from forest managers.

Since the reporting in 2009 for 1990-2007, quantitative information has gradually become available; a project (SINKS) initiated in 2007 has delivered data on soil C change based on repeated sampling of soil C pools in forests remaining forests, and more data on soil C pools are being made available. The preliminary data suggest that forest soil C pools are not sources for CO_2 and thus support that more accurate estimates of litter and soil C pool removals/emissions do not need to be included in the reporting.

New data

The only existing systematic sampling of Danish forest soils has been conducted within the so-called Kvadratnet ("square grid", http://www.landbrugsinfo.dk/Planteavl/Goedskning/Naeringsstoffer/Kvadratnet-for-nitratundersoegelser/Sider/Startside.aspx). It was established in the

1980's in order to optimize the applied amounts of fertilizer in agriculture by monitoring nitrate leaching to groundwater resources in the most common land uses. Soil samples from the years around 1990 exist in soil storages. Given the time constraints of the commitment period and reporting deadlines, changes in soil carbon stocks could only be assessed by repeated sampling of soils within this monitoring grid.

The "Kvadratnet" monitoring grid is 7x7 km and by 1990 it included 108 plots with forest cover (Østergaard & Mamsen, 1990). Soil sampling and analysis was conducted in 1986-90 in all 108 forest plots of Kvadratnettet, and a subset of 25 plots was resampled in 1994 (Breuning-Madsen & Olsson, 1995) as a part of the Pan-European forest monitoring programme, which uses these 25 plots for assessment of the forest condition. The 25 plots resampled in 1994 have been resampled again in 2007 as a part of the demonstration project BioSoil (http://forest.jrc.ec.europa.eu/contracts/biosoil), under the Pan-European forest monitoring programme Forest Focus and in 2008/2009 the other 83 plots were resampled, except for one plot for which the land owner did not grant access to re-sampling.

Mineral soil samples from 1990 are thus available from 108 forest plots. The sampling was complete for the period 2007-2010, while soil-archive samples from 1990 were missing for six plots. Soil samples from 1986-1987 were used for one of these plots while it was not possible to retrieve archived soil samples for the last five plots. The sampling of O-horizons was also complete for the 108 plots for the period 2007-2009, while O-horizon samples from 1990 were of a very poor quality and only available from 32 plots. Consequently, forest floor samples from 1994 were used to represent forest floors in 1990, while results based on soil samples 0-100 cm from 1994 were only used to check other data.

The plots were in all cases (with a few exceptions due to practical circumstances) designed as a 50 x 50 m square. In 2007-09 ten forest floor and mineral soil cores were collected along a transect determined as the diagonal from the south-west to north-east corner of the square. In the 1990 16 soil cores were taken randomly across the square plot, while forest floor samples were only collected occasionally in an unspecified manner.

The O-horizon samples from 2007-2009 were area-based samples (Vesterdal & Raulund-Rasmussen, 1998) removed from a 25 x 25 cm area, that were brought to the laboratory in separate bags.

The mineral soil samples from 2007-2009 were taken in the ten sampling points where O-horizons had been removed. A 2-3 cm thick soil corer was used. The mineral soil samples from around 1990 were taken in a similar manner for the 16 sampling points. Samples from 4-5 different horizons were pooled in the field. Only one joint sample pr. plot per depth were analysed for carbon content. Hence, information on within-plot variation in soil carbon contents is not available. The division into horizons differed slightly between the three sampling campaigns: 1986-1990, 2007 and 2008/2009. In 1986-1990 the division was 0-25, 25-50, 50-75 and 75-100 cm; in 2007 (the 25 BioSoil plots) it was 0-10, 10-20, 20-40, 40-80 and 80-100 cm; and in 2008/2009 0-10, 10-25m 25-50, 50-75 and 75-100 cm.

In the lab, all samples were dried at 40°C until constant weight. Before sieving through a 2 mm sieve, more clay-rich mineral soil samples were crushed in a mortar, while sandy soil samples were gently crushed or sieved directly. The stones (>2 mm) left after sieving were weighed (DW_{stone}), while the fine soil (<2 mm) was dried at 40°C for at least 48 h, and then weighed (DW_{soil}). A sub-sample of the fine soil, about 20 g, was removed after thorough mixing for finer grinding in an agate mortar.

The ten O-horizon samples from each plot were weighed separately, and then ground in Retsch grinder through a 2 mm net. From each of the ten samples, 10 % of the material was removed after thorough mixing to get a pooled sample for the plot. About 100 ml of the pooled sample was removed after thorough mixing and then ground more finely in a Tecator mill.

Mineral soil samples were analysed by dry combustion (Elementar Analyzer) for total organic carbon (TOC) and O-horizon samples for total carbon by a laboratory certified according to ISO 10694. Analyses were done by Agrolab/ Institut Koldingen, Sarstedt, Germany.

For each of the plots, the mineral soil carbon stocks in 2007-2009, $C_{m\text{-}2009}$ (tonne C ha^{-1}), was calculated as

$$C_{m-2009} = \sum_{i=1}^{4(or5)} d_{m-2009} \cdot 10000 \cdot (1 - RV_{stone-2009}) \cdot \rho_{soil} \cdot c_{soil-2009}$$

where d_m is the depth of a given horizon (m), and ρ_{soil} is the bulk density of soils (g cm^{-3}) assessed by use of published pedotransfer functions (Vejre et al., 2003). $c_{soil\text{-}2009}$ is the C concentration (mg g^{-1}). RV_{stone} is the relative volume of the stone (versus that of the fine soil):

$$RV_{stone-2009} = \frac{DW_{stone-2009} / \rho_{stone}}{DW_{stone-2009} / \rho_{stone} + DW_{soil-2009} / \rho_{soil}}$$

where ρ_{stone}=2.65 g cm^{-3}, $DW_{soil\text{-}2009}$ (g)is the dry weight of the fine soil (<2 mm) in the soil samples from 2007-2009 and $DW_{stone\text{-}2009}$ (g) is correspondingly the weight of stones in the soil sample (>2 mm).

For each of the plots, the forest floor carbon stocks in 2007-2009, $C_{ff\text{-}2009}$ (t C ha^{-1}), was calculated as

$$C_{ff-2009} = \sum_{i=1}^{10} DW_{ff-2009,i} \cdot 0.0016 \cdot c_{ff-2009}$$

where $DW_{ff\text{-}2009,i}$ (g dry weight) is the dry weight of sample number i, i=1-10 and $c_{ff\text{-}2009}$ is the C concentration of the pooled sample per plot (mg g^{-1})

The mineral soil dry weight in 1990 was calculated in the same manner as for 2007-2009, assuming that the relative stone volume was identical to that of 2007-2009. The forest floor depth was, however, not measured in 1990, nor was an area-based forest floor weight recorded. Forest floor depth (d_{ff}, m) measured for profiles on 25 plots in 1994, was used instead, while forest floor densities for the individual plots were obtained from the new measurements performed in 2007. For these 25 plots, forest floor C-stocks in 1990, $C_{ff\text{-}1990}$ (tonne C ha-1) were calculated as

$$C_{ff-1990} = d_{ff} \cdot 10000 \cdot \rho_{ff-2007} \cdot c_{ff-1990}$$

where $c_{ff\text{-}1990}$ (mg g^{-1}) is the carbon concentration of the forest floor samples from 1994 (measured in 2007), and $\rho_{ff\text{-}2007}$ (g m^{-3}) is the average bulk density of the forest floor for the individual plot as measured in 2007:

$$\rho_{ff-2009} = \frac{\sum_{i=1}^{10} DW_{ff,i}}{0.25 \cdot 0.25}$$

Considering the forest structure in Denmark with many small forests (about 70 % of the forest estates are of less than 5 ha) the "Kvadranet" is a very coarse grid. Even if the grid was fully sampled, it is therefore unlikely that the 108 plots represent the Danish forest area of approximately 500.000 ha. We thus evaluated based on power analyses that further sampling was necessary for future monitoring and chose to include a randomly selected subset of the permanent plots of the National Forest Inventory (NFI) for this purpose. A total of 277 plots were sampled.

It will not be possible, as with the "Kvadratnet", to resample soils of the NFI plots for changes in soil C within the short time frame before Kyoto Protocol reporting. From 2012 and onward the NFI plots can be resampled to better support the work to demonstrate that soil carbon stocks are not a source for CO_2 emissions. As the Danish reporting of the three forest carbon pools aboveground biomass, belowground biomass and dead wood is based on the NFI, this will also ensure the consistency of monitoring of all five forest carbon pools defined by IPCC (2003). In the first reporting efforts, however, information on C-stocks and site properties from the NFI will enable better upscaling of results from "Kvadratnet" to the Danish forest area.

Changes in forest soil carbon stocks in forests planted before 1990

The preliminary results from the "Kvadratnet" showed that there is a large variation in soil C pools among sites for both forest floors (only 32 plots) and mineral soils. The mean C pool of forest floors was about 22 and 28 tonnes C ha^{-1} in 1990 and 2007-09, respectively. The corresponding C pools for mineral soils were 156 in 1990 and 157 tonnes C ha^{-1} in 2007-09 (Table 7.6). A simple t-test of the mean changes in forest floor and mineral soils pools between 1990 and 2007-2009 (5.6 and 1.5 tonnes C ha^{-1} yr^{-1} respectively) indicate that changes were not significant (Table 7.7, Figure 7.1a-b).

Table 7.6 Basic statistics on soil C pools measured in the "Kvadratnet".

	Mean Pool	Standard deviation	Minimum	Maximum
	tonne C ha^{-1}			
Forest floor 1990	22.12	19.12	0.76	80.34
Forest floor 2007-2009	27.68	30.05	3.94	164.48
Mineral soil 1990	155.78	115.91	29.31	848.14
Mineral soil 2007-2009	157.26	100.34	18.66	853.08

Table 7.7 Basic statistics on the differences in C soil pools between 1990 and 2007-2009 and statistics from a simple t-test (H_0: change in soil C-stock = 0).

	Total number of sites	Number of sites in t-test	Mean change	Std	Minimum	Maximum	P-value
			(tonne C ha^{-1})				
Forest floor	108	31	5.56	24.78	-61.44	84.13	0.22
Mineral soil	108	104	1.48	47.56	-182.62	131.51	0.75

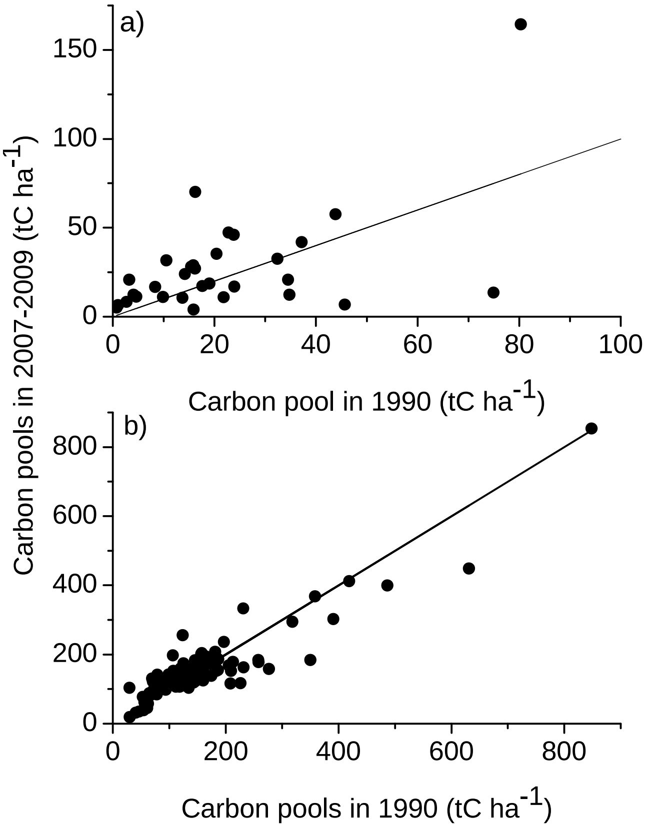


Figure 7.1 C pools in forest soils for forest before 1990. a) Forest floor C in 2007-2009 versus 1990, b) Mineral soil C in 2007-2009 versus 1990. Lines: y=x.

Some mineral soils had one or several horizons of organic origin and these soils had very high soil C-stocks to 1 m depth (>300 tonne C ha^{-1}), and these will probably be handled separately in further work with the data. Determination of true changes in organic soils requires that the total depth of the organic layer is known, while soils were only sampled until 1 m in SINKS.

Carbon pools 2006-2011

Carbon pools in live and dead biomass estimated for the most recent rotation of the NFI (2006-2011) is 38.4 million tonnes C. The live above ground biomass carbon makes up about 82 % of the total carbon in biomass and dead wood makes up only 1.7 % of the total. Carbon in biomass in forests established after 1990 make up 3.0 % of the total.

Table 7.8 Carbon in forest biomass for NFI rotations with reference years 2006-2011.

			2006	2007	2008	2009	2010	2011
Forests established before 1990	Area		533.435	533.321	533.207	533.093	532.979	532.865
	Live biomass	Above ground	28.883	29.172	30.317	30.383	30.645	31.684
		Below ground	5.663	5.708	5.942	5.973	6.023	6.237
	Dead wood		515	492	498	522	562	595
	Forest soil	Litter	5.146	5.321	5.817	5.897	6.388	6.663
		Mineral soil	90.055	90.035	90.016	89.997	89.978	89.958
Forests established after 1990	Area		34.394	36.577	39.998	43.420	46.841	50.262
	Live biomass	Above ground	621	791	744	799	881	907
		Below ground	140	174	161	171	185	187
	Dead wood		68	73	82	84	102	92
	Forest soil	Litter	310	355	353	384	430	421
		Mineral soil	6.282	6.681	7.306	7.931	8.556	9.180

The amount of carbon in biomass in forests established before 1990 has been slowly increasing since 2006. Based on preliminary results of an evaluation of the subsequent measurement cycles 2002-2006 and 2007-2011, the increase is at least partly caused by an increased average biomass per hectare. However, part of the increase is also due to an increase in forest area, which is caused by improved detection of forest caused by improvements of aerial photos used for this.

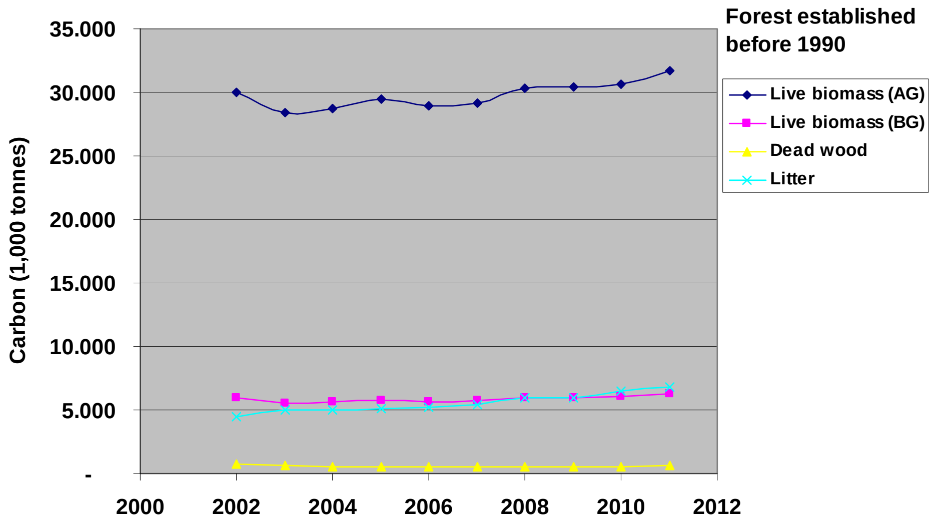


Figure 7.2 Forest carbon in forests established before 1990 estimated from NFI data from 2002-2011. Note that estimates for 2002-2005 are based on only 1-4 years of measurements. Only from 2006 the estimates are based on a full five-year rotation of the NFI.

The amount of carbon in biomass in forests established after 1990 has been increasing rapidly during the time of NFI measurements. The very low estimates of forest carbon at the beginning of the NFI measurements may in part be due to a large number of plots not measured in the field as a result of start up problems which may have biased the results. Also, in the early measurements aerial photographs were of a poorer quality and recent afforestations may have been difficult to detect.

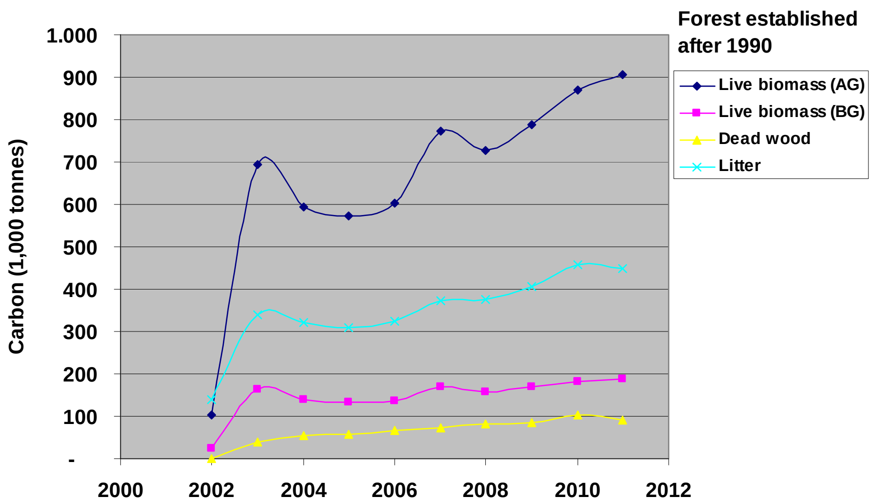


Figure 7.3 Forest carbon in forests established after 1990 estimated from NFI data from 2002-2011. Note that estimates for 2002-2005 are based on only 1-4 years of measurements. Only from 2006 the estimates are based on a full five-year rotation of the NFI.

7.2.6 Uncertainties and time series consistency

Danish national forest inventories have developed over the years from the earliest inventories more than a century ago. More recently the development has been quite rapid, thus influencing the estimation of forest carbon pools in relation to LULUCF.

In the 1990 forest census the number of questionnaires sent to respondents was 22,300. In the subsequent inventory the number of respondents increased to 32,300. Not unexpectedly this led to a substantial increase in estimated forest area, which is not possible to separate from the actual increase in forest area that occurred during that period of time. Also, it is not possible to single out the effect of the increased number of questionnaires on estimates of species distribution, carbon pools etc.

In 2002, the sample based forest inventory released the previous forest census for the first time enabling annual forest statistics. The NFI includes areas and forest owners that have not previously been included in the forest census. Firstly because not every forest owner was included in the previous surveys and secondly because not all forest areas according to the FAO definitions would be perceived as forest by the respondents. Consequently, the change from questionnaire based forest census to sample based forest inventory has lead to an increase in forest area estimates that is not possible to separate from the actual increase in forest area that occurred during that period of time.

Specifically, in relation to the reporting of carbon pools in forest, the change from questionnaire based forest census to sample based forest inventory has changed the calculation of forest volume, biomass and carbon. In the forest census, forest carbon is estimated from the reported forest area within different species, age and site classes and a number of forest growth models. In the forest inventory, forest volume (and subsequently carbon) is measured on the plots. The observed forest area and carbon is subsequently expanded to regions or the entire country using statistical models. This has lead to a substantial increase in forest volume, biomass and carbon estimates, mainly due to methodological differences.

In the estimation of carbon emissions from existing forests, the information collected in relation to different forest census and inventories is combined with the satellite based land use/land cover map for the base year 1990 and for the year 2005. Hereby, consistent estimates of emissions from existing forests are obtained utilising as much information from the data sources as possible and hereby providing best possible time series. For the period from 2006 and onwards - there is full consistency of the data.

The uncertainty of the estimates of the carbon pools have been analysed by the use of bootstrap analysis. For the total carbon pool of the living biomass standard error is estimated to be 0,6 tonne C pr. ha or equalling 0,9 percent. Applying the stock change method the emission/sink estimates of the different parts of the carbon pools depend on the certainty of each pool at two consecutive times.

The uncertainty of the estimates for subsets of the full forest area is related to the sampling intensity. With more subdivisions the uncertainty increases as the sampling size is reduced. Full bootstrap analyses of this have not yet been performed, but are scheduled for inclusion in the next reporting as remeasurement data for the forest area then will be available and contribute to the analysis of the uncertainty estimates.

Below is a first Tier 1 estimate of the uncertainty in the forest, Table 7.9. This will be evolved before the next submission.

Table 7.9 Tier 1 estimate of the uncertainty in the forest.

		1990	2008					
		Emission/sink, Gg CO_2 eqv.	Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5. LULUCF		4422,3	-2170,7				30,0	650,6
5.A Forests		-820,2	-5676,9				36,5	2069,8
Broadleaves, Forest remaining forest	CO_2	-707,9	-3752,2	15	50	52,2	52,2	1958,7
Conifers, Forest remaining forest	CO_2	-136,4	-1937,1	15	50	52,2	52,2	1011,2
Broadleaves, Land converted to forest	CO_2	2,6	177,8	15	50	52,2	52,2	92,8
Conifers, Land converted to forest	CO_2	5,8	-177,4	15	50	52,2	52,2	92,6
Drainage of forest soils	N_2O	15,7	12,0	30	75	80,8	80,8	9,7

7.2.7 QA/QC and verification

A continuous focus on the measurements of carbon pools in forest will contribute to QA/QC and verification in the following submissions. As we gain more data through resampling of permanent plots in the NFI this will further support the verification of the data reported. These will be available for the reporting performed in 2013.

Ongoing development of the NFI in terms of sampling procedures and estimation methods is essential for the continued QA/QC process of the NFI.

Integration with multi phase and multi scale inventory - through e.g. other in-situ data like LiDAR scanning or remote sensing like satellite imagery will through research contribute to the continued QA/QC process of the NFI and the carbon stock estimates for forests.

7.2.8 Recalculations and changes made in response to the review process

As response to the UNFCCC expert review in 2010 a full recalculation of the forest carbon pools has been performed for the period 1990 to 2009.

The carbon stock change for forests has been estimated based on best available data - which include the following main data sources:

- National Forest Inventory - NFI - conducted by Forest and Landscape Denmark for the Danish Nature Agency, Ministry of Environment. The NFI started in 2002 and is a continuous forest inventory with partial replacement. The rotation is 5 years. (Nord-Larsen et al., 2008; Nord-Larsen et al., 2010) - See Chapter 7.1.2 for further details.
- Forest Census 1990 and 2000, conducted by Statistics Denmark - in cooperation with the Danish Nature Agency and Forest and Landscape Denmark. (Danmarks Statistik 1994, Larsen & Johannsen 2002) - See below for short description.
- Mapping of the forest area based on satellite images in 1990 and 2005, with support from ESA - GMES - FM and the Ministry of Climate and Energy. See Chapter 7.1 for further details.

Recalculation for 1990 - 2009

Based on mapped forest area in 1990 and in 2005 a recalculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated. The recalculation of carbon stock in 1990 and in 2000 used age distribution as reported in the census using 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes the current National Forest Inventory, the total standing carbon stock was calculated. For each of the years 1990 - 2000 a standing carbon stock was calculated as a moving average, corrected for the deforestation. Wind throws and the effects of these are included in the overall estimation of changes in carbon stock. As carbon stock is based on a moving average the annual effect is limited. For a more detailed description of the analyses see Johannsen et al. (2009).

The NFI was initiated in 2002 and the first full cycle of measurements was completed in 2006. Consequently, reliable estimates of forest carbon pools are available from 2006 and onwards. The estimation of forest carbon pools in year (t) is based on the measurements from year (t-4) to year (t). Firstly, the approach ensures available data in the reporting year. Secondly, as more data are collected for subsequent reporting estimates for previous years remain unchanged. Thirdly, forest development is generally slow, and the choice of reference year for an estimation – midpoint or end year – only leads to minor changes within the statistical uncertainty of the estimates. It is generally believed that the time series consistency obtained by using the end year of the measurement cycle compensates for any minor differences in estimates obtained by using the midpoints instead.

In the transition from the recalculated data for 1990 – 2006 (before the NFI) to the NFI based data a number of basic structural elements of the Danish forests appear to change. One issue is the significantly higher proportion of broadleaved trees, due to mixed stands that previously was reported as purely conifers. This causes the amount of carbon in the broadleaved category to increase steadily until 2006, after which the overall trend of the forest carbon pools result in first a slowdown of carbon accumulation and in the last year a decline. The main reasons for the change in pattern is a combination of gradual change in inventory and a gradual change in forest management and the current structure of the forests. A decline in conifers was recalculated for the period since 2000, as the proportion of conifers is lower based on the NFI and in the later years additionally influenced by the overall gradual change in forest management and structure of the forests.

The current structure of the forests is characterised by a high proportion of old stands, which face rejuvenation, i.e. large and old trees will be felled and replaced by young trees. The observed development in the forest carbon pools reflects mixed effects of growth, mortality and removals, with the focus on the stock changes.

7.2.9 Planned improvements

Below is a list of planned improvements.

- A further QA/QC of the Land Use matrix will be performed before the next submission.

- Further analysis of the changes in forest area - including afforestation and deforestation - and if possible more detailed information on these will be collected and analysed.

- Documentation for carbon pools in soil and litter is expected to be further improved in the next submission.

- Documentation for extent of restored natural hydrology will be included if available and will mainly refer to the period of the NFI since 2002, as no systematic information is available prior to this time and changes are first detectable based on the full analysis of the re-measurements performed in 2011. This is expected to confirm the reduced drainage of forest areas.

- Further analysis of uncertainty estimates for all the carbon pools in the forest areas.

7.3 Land converted to forests

7.3.1 Forest area

See section 7.2.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

7.3.2 Forest definition

See section 7.2.1 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix)

7.3.3 Methodological issues for land converted to forest

See also section 7.2.1

Living biomass

With respect to the option for distinguishing forest with and without harvesting, it is not possible with the available data. Data from the NFI is utilised based on the land use mapping to identify sample plots on afforested/reforested (AR) areas. It is - however not possible to determine the amount of harvesting. Furthermore, Denmark applies an approach utilising total carbon stock change, both growth and harvesting is included in the overall estimation.

When converting land to forest land the standing living above- and below ground biomass are removed from the land. In Table 7.10 the default values for the amount of living biomass is shown.

For land converted from cropland a standard default loss value of 9,577 kg DM (dry matter) per hectare in above-ground biomass and 2,298 kg DM per hectare in below-ground biomass is used. This value is equivalent to the average harvest of living biomass for all cereals grown in Denmark from 2000 to 2010, including straw, stubble and glumes. For conversion from DM to carbon a default fraction of 0.5 kg C per kg DM is used.

Table 7.10 Default values for the amount of DM (dry matter, kg per hectare) used for estimating carbon stock changes where land use conversions take place.

		Dry matter, kg DM pr hectare	
		Above ground biomass	Below ground biomass
Cropland		9 577	2 298
Grassland	Improved Grassland	2 400	6 720
	Unmanaged Grassland	2 200	6 160
Wetlands	Peat extraction	0	0
	Other Wetland	3 600	10 080
Settlements		2 200	2 200
Other land		4 000	4 000

Soils

The included soil carbon pool changes concerned only carbon sequestration due to development of forest floors, i.e. the organic layer on top of the mineral soil. Carbon sequestration was included in this layer since national scientific projects had indicated that this was the soil compartment mainly prone to changes following land-use change. The previous NIR reports did not account for possible changes in carbon pools of the mineral soil; based on chronosequence studies of afforested stands (http://www.sl.kvl.dk/afforest/), no consistent changes had been detected in mineral soil organic matter during the first 30 years following afforestation (Vesterdal et al., 2002a; Vesterdal et al., 2007). This is also supported by the finding that there was no significant difference in mineral soil carbon stocks in paired forest-cropland sites at 28 different sites in Denmark (Vesterdal et al., 2002b). These conclusions are supported by data from the new national forest soil inventory.

New data

New information on carbon pools in forest soils is available from the national project, SINKS. In this project forest soils are sampled in two grids, "Kvadratnettet" and the National Forest Inventory (NFI), see Section 7.2.1 for a description.

Apart from 108 plots in forests planted before 1990, the "Kvadratnet" included 15 plots in afforestation since 1990. The sampling took place together with the sampling in forests planted before 1990, and was thus complete for the period 2007-2009. Archived soil samples from 1990, when the plots were arable land, were missing for 1 plot.

The sampling, the sample preparation, chemical analyses and calculations were similar to that performed from forests planted before 1990, see 7.2.1

A few of the 277 plots sampled in the NFI grid are probably also located in forests planted since 1990. The data calculations are currently being performed, and these data will be reported in the next NIR.

7.3.4 Changes in forest soil carbon stocks in forests planted on arable land since 1990

The average carbon sequestration rates for forest floors for broadleaves and conifers were estimated from the information from scientific projects in afforestation chronosequences; the average annual sequestration of carbon in forests floors was 0.09 and 0.31 tonne C ha^{-1} yr^{-1} under broadleaves and conifers, respectively (Table 7.11.). These rates of change have been used for calculation of forest floor carbon sequestration in afforested land, however, the accumulation of conifer forest floors is assumed to start only after eight years based on observations from chronosequence and other field data.

Table 7.11 Forest floor carbon sequestration rates in afforestation areas for different species in national chronosequential studies.

Tree species category	Tree species	Study type	Age (yr)	Forest floor C sequestration (tonne C ha^{-1} yr^{-1})	Source*
Broadleaves	Oak	Chronosequence	29	0.08	1
	Oak	Stand	30	0.02	2
	Oak	Stand	30	0.05	2
	Oak	Stand	30	0.04	2
	Oak	Stand	30	0.02	2
	Oak	Stand	30	0.13	3
	Oak	Stand	40	0.09	3
	Beech	Stand	30	0.09	2
	Beech	Stand	30	0.10	2
	Beech	Stand	30	0.12	2
	Beech	Stand	30	0.13	2
	Beech	Stand	30	0.18	3
	Beech	Stand	40	0.14	3
	Average (SEM)			*0.09 (0.01)*	
Conifers	Norway	Chronosequence	30	0.35	1
	Spruce	Chronosequence	41	0.43	1
		Stand	30	0.21	2
		Stand	30	0.15	2
		Stand	30	0.20	2
		Stand	30	0.30	2
		Stand	30	0.30	3
		Stand	40	0.65	3
	Sitka spruce	Stand	30	0.43	2
		Stand	30	0.24	2
		Stand	30	0.22	2
		Stand	30	0.25	2
	Average (SEM)			*0.31 (0.04)*	

* 1) Vesterdal et al. (2007), 2) Vesterdal & Raulund-Rasmussen (1998), 3) Vesterdal et al. (2008).

The results from scientific projects have lately been checked by analysis of preliminary results from the "Kvadratnet". The afforested plots in the monitoring grid also revealed large variation in soil carbon pools among for both forest floors and mineral soils (Table 7.12). The mean carbon pool of the forest floor among the afforested sites was about 2.5 t C ha^{-1} in 2007-2009 (and supposedly 0 t C ha^{-1} at the time of the afforestation) while the mean carbon pools for mineral soils were 114 and 108 t C ha^{-1} in 1990 and 2007-2009 respectively (Table 7.18). A simple t-test on the mean change in mineral soils pools between 1990 and 2007-2009 (-1.87 t C ha^{-1} yr^{-1}) showed that the change was not significant (Table 7.12 and Figure 7.2) while there, as expected, was a significant sequestration of carbon in the forest floor due to litterfall inputs and subsequent build up of the organic layer (Table 7.13, Figure 7.3). The age of the afforested stands ranged from 8-19 years, so only the establishment phase was covered.

Table 7.12 Basic statistics on soil carbon pools measured in the "Kvadratnet".

	Mean C pool	Std	Min	Max
	(tonne C ha^{-1})			
Forest floor at the time of the afforestation	-	-	-	-
Forest floor 2007-2009	2.53	1.79	0.25	5.56
Mineral soil 1990	113.63	35.37	68.00	186.06
Mineral soil 2007-2009	107.83	41.25	52.82	220.06

Table 7.13 Statistics from a simple t-test on the change in soil carbon between ca. 1990 and 2009 for forests after 1990.

	Total number of sites	Number of sites in t-test	Mean change (tonne C ha^{-1})	Std (tonne C ha^{-1})	Min (tonne C ha^{-1})	Max (tonne C ha^{-1})	P-value
O-horizon	15	15	2.53	1.79	0.25	5.56	<.0001
Mineral soil	15	14	-1.87	17.59	-35.32	34.00	0.70

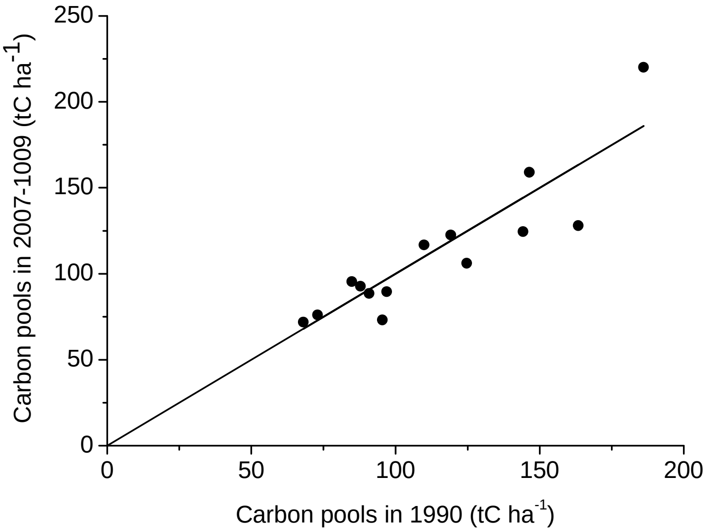


Figure 7.4 Carbon pools in mineral soils in 2009 versus 1990. Forests established on arable land since 1990. Line: y=x.

The amount of carbon in the forest floors increased with the age of the afforested stand (Figure 7.4), while this was not the case for the mineral soil (Figure 7.5).

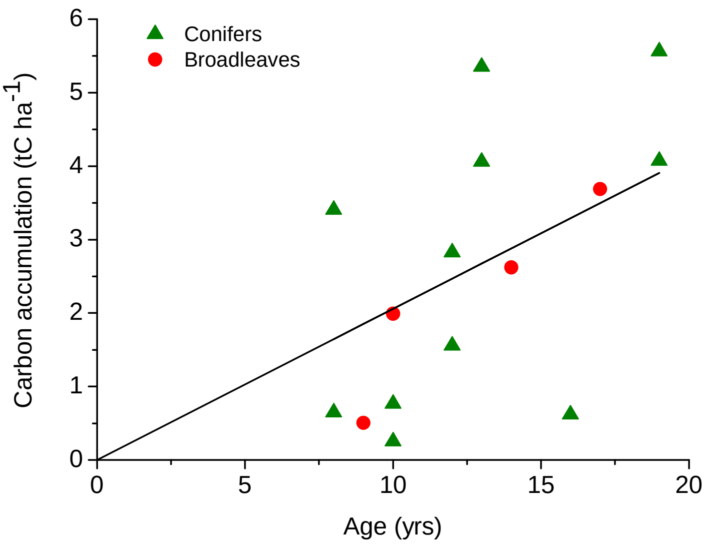


Figure 7.5 Forest floor carbon pools in forests afforested since 1990 in the "Kvadratnet". The regression was forced through (0,0) (C acc. = 0.2057 x age, R^2=0.3124, p<0.0001).

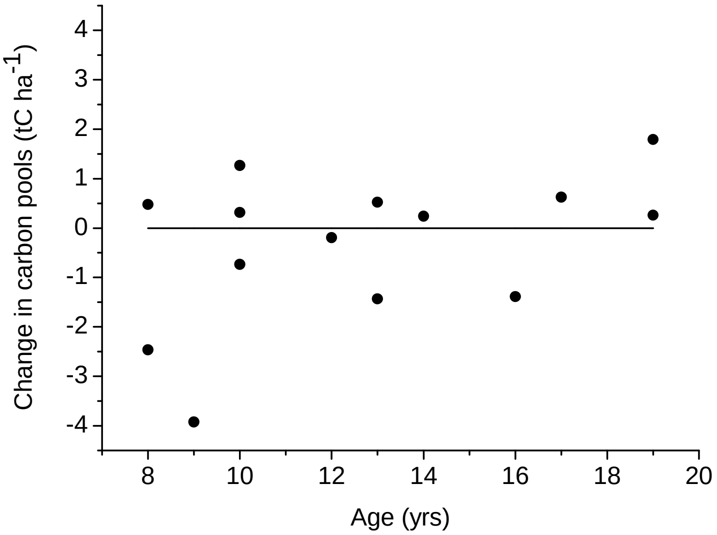


Figure 7.6 Change in mineral soil carbon stocks for forests since 1990. Line: y=0 (Regression line (not shown): R^r=0.0005, p=0.9356).

Average carbon sequestration rates for forest floors for broadleaves and conifers were also estimated from "Kvadratnettet" in order to check the forest floor carbon sequestration rates used in reporting; in this case the average annual sequestration of carbon in forests floors was 0.16 and 0.20 t C ha^{-1} yr^{-1} under broadleaves and conifers, respectively (Table 7.14). These values are lower compared to the values obtained from 30-40 yr-old stands. (Table 7.11).

Table 7.14 Forest floor carbon sequestration rates in afforestation areas for different species. Data from the "Kvadratnet".

Tree species category	Tree species	Study type	Age (yr)	Forest floor C sequestration (tonne C ha^{-1} yr^{-1})	Site
Broadleaves	Oak	Monitoring plots	14	0,19	837
	Oak	Monitoring plots	17	0,22	301
	Maple	Monitoring plots	9	0,06	485
	Lime	Monitoring plots	10	0,20	571
	Average (SEM)			*0.16 (0.07)*	
Conifers	Norway spruce	Monitoring plots	19	0,21	479
	Sitka spruce	Monitoring plots	13	0,41	335
	Sitka spruce	Monitoring plots	10	0,03	340
	Normann fir	Monitoring plots	13	0,31	31
	Normann fir	Monitoring plots	16	0,04	171
	Normann fir	Monitoring plots	12	0,13	235
	Normann fir	Monitoring plots	8	0,08	292
	Normann fir	Monitoring plots	12	0,24	689
	Silver fir	Monitoring plots	19	0,29	66
	Larch	Monitoring plots	8	0,43	334
	Mixed conifers	Monitoring plots	10	0,08	509
	Average (SEM)			*0.20 (0.14)*	

Lastly we combined all data to explore the trends in forest floor carbon stocks among broadleaves and conifers (Figure 7.7). The rates used seem reasonable, even if the inclusion of new data indicate that it might be too high for conifers in the stand establishment phase. Thus, accumulation of conifer forest floors is assumed to start after 8 years of chronosequences. This is reasonable since observations in chronosequences indicate that there is little litterfall in conifer stands to build up forest floors during the first 10 years.

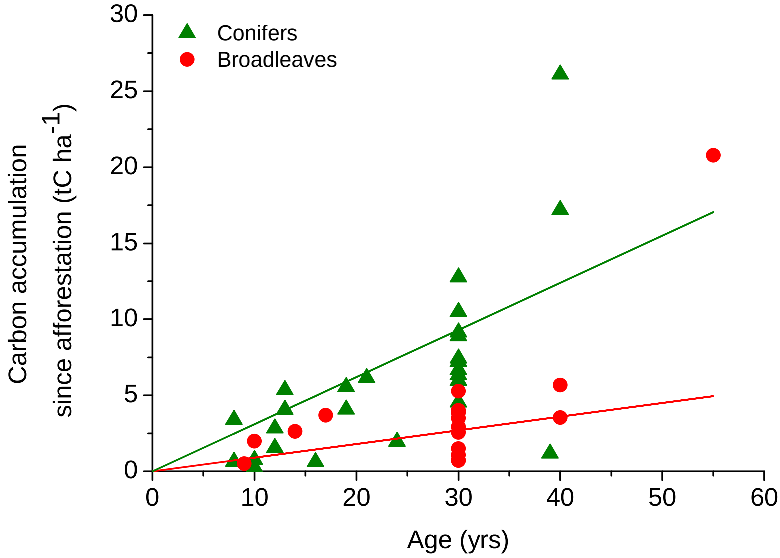


Figure 7.7 Forest floor carbon pools in afforested plots. All available data from chronosequential studies and the "Kvadratnet" are included. Lines show the carbon sequestration rates used in the reporting: 0.31 tonne carbon ha^{-1} yr^{-1} for conifers and 0.09 tonne carbon ha^{-1} yr^{-1} for broadleaves.

Several previous national field studies mentioned above (Vesterdal et al. 2002a, 2002b, 2007) did not suggest measurable decadal changes in mineral soil carbon following afforestation. In the Forest Soil Inventory (SINKS project), soil carbon content to 100 cm in forest land remaining forest land was compared with soil carbon in the same depth found in a parallel project for cropland soils (Table 7.15). These data also support that mineral soils are neither sinks nor sources for CO_2 following afforestation of former cropland. Using a transition time of 50 years, these soil carbon contents were used to calculate the small rates of soil carbon stock change for cropland to forest conversion.

Table 7.15 Mineral soil carbon content (Mg ha^{-1}) in cropland and forest land based on Kvadratnettet. N: number of plots, mean and standard deviation (std).

Land use	Sandy soils			Loamy soils		
	N	mean	std	N	mean	std
Cropland		137			158	
Forest land	261	154	79	116	164	103
Grassland and Other land	19	150	84		150a	84a
Settlements		120 b			120 b	

[a] Same data as for sandy soils.

[b] Agreed with the UFCCC-ERT during the 2011 review.

In conclusion, preliminary results from the Forest Soil Inventory project show no evidence that mineral soil carbon pools for forests on former arable land are neither sinks nor sources for CO_2. The data from the SINKS project support the conclusions drawn from Vesterdal et al. (2002, 2007), Vesterdal and Raulund-Rasmussen (1998), and Vesterdal et al. (2008) for forest floors. The comparison between Danish land-uses (Table 7.15) suggests that particularly sandy soils would sequester carbon following afforestation of cropland, whereas carbon stocks in loamy soils are quite similar between land uses. Thus, a no-source principle would be justified in case of land-use conversions to forest.

Until final results from the Forest Soil Inventory are available we continue to use the previously used average carbon sequestration rates: 0.09 tonne carbon ha^{-1} yr^{-1} for broadleaves and 0.31 for conifers.

The sequestration of CO_2 in forest floors in forests established since 1990 has gradually increased and the annual CO_2 sequestration will increase much more over the next decades when cohorts of afforestation areas enter the stage of maximum current increment.

The reporting of the forest floor in the afforestation in the 2008-2012 period is based on the NFI monitoring of forest floor depth as described above.

7.3.5 Uncertainties and time series consistency

See Section 7.2.1 and 7.2.2 for recalculation since 1990.

7.3.6 QA/QC and verification

A continuous focus on the measurements of carbon pools in land converted to forest will contribute to QA/QC and verification in the following submissions. See also Chapter 7.2.1

7.3.7 Recalculations, including changes made in response to the review process

As response to review UNFCCC expert comments a full recalculation of forest carbon pools have been performed for the period 1990 to 2010.

The carbon stock change for forests has been estimated based on best available data, which include the following main data sources:

- National Forest Inventory - NFI - conducted by Forest and Landscape Denmark for The Danish Nature Agency, Ministry of Environment. The NFI started in 2002 and is a continuous forest inventory with partial replacement. The rotation is five years. (Nord-Larsen et al 2008 and Nord-Larsen et al 2010) - See Chapter 7.1.2 for further details.
- Forest Census 1990 and 2000, conducted by Statistics Denmark - in cooperation with The Danish Nature Agency and Forest and Landscape Denmark. (Danmarks Statistik 1994, Larsen & Johannsen 2002) - See Chapter 7.2.1 for a short description.
- Mapping of the forest area based on satellite images in 1990 and 2005, with support from ESA - GMES - FM and the Ministry of Climate and Energy. - See Chapter 7.1 for further details.

Recalculation for 1990 - 2009

Based on mapped forest area in 1990 and 2005 a recalculation of carbon stored in afforestation since 1990 have been performed. Since the NFI was initiated in 2002, it is representative from 2006. Calculation of carbon stock in the period 2000-2005 is based on NFI in 2006 and carbon stock as calculated for 2000. For 2006 and onwards carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping.

For the afforestated/reforested (AR) areas a steady increase in carbon stocks is estimated. With the utilisation of the NFI since 2006 the data for the carbon pools under AR is based on direct measurements of change in total carbon stock.

7.3.8 Planned improvements

A QA/QC of the Land Use matrix will be performed before the next submission - including a consistent method and results for the mapping of the land use matrix for 2012.

The basic information utilised to give the data for the emission estimates for units of land subjected to afforestation/reforestation is based on National Forest Inventory (NFI) observations of stock change, specific related to the afforestated areas. This will include all changes in carbon pools - also if affected by harvest - including thinnings of young stands. Based on the NFI it will be possible - for the next reporting to provide some indications of the frequency of harvesting/thinning occurring on the afforestated areas. Given the fact that the afforestated area is still a relatively small part of the full forest area, there will be more uncertainty on the estimate related to afforestated areas compared to the area of forest remaining forest.

Documentation for carbon pools in soil and litter is expected to be further improved in the next submission.

7.4 Cropland (5B)

7.4.1 Cropland and cropland management (5B1)

The total Danish cropped agricultural area of approximately 2.7 million hectare can relate to approximately 700 000 individual fields, which again is located at 220 000 land parcels. This gives an average field size of less than four ha. The actual crop grown in each land parcel (LPIS) is known from 1998 and onwards. Since 1990 the agricultural area recorded by Statistics Denmark has decreased from 2.78 million hectare to 2.62 million hectare (Table 7.16). The total crop yield given as kernel, root fruits and grass as measured in dry matter (million kg dry matter per year) is, however, at the same level and increasing due to improved cropping techniques, Figure 7.8.

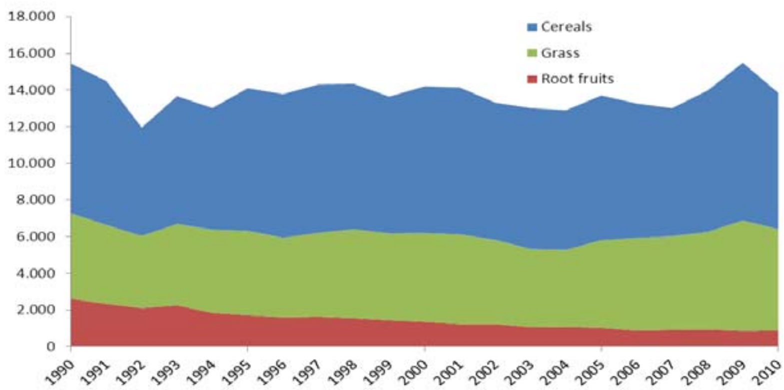


Figure 7.8 Total crop yield given as kernel, root fruits and grass as measured in dry matter (Million kg dry matter per year)

The main reason for the loss of land for agricultural purposes is urbanisation and afforestation. The major part of the agricultural area is grown with annual crops: cereals, grass in rotation, oilseed, sugarbeets, potatoes and temporarily set-a-side. Permanent grass outside rotation with none or very little fertiliser application rates (>25 kg N per ha per year) is reported under Grassland. All nitrogen consumption is reported under Agriculture 4D2.

Table 7.16 shows the development in the agricultural area from 1990 to 2010 (Statistics Denmark). A general trend is a continuous decrease of 6 000 - 7 000 ha per year in the agricultural area.

Table 7.16 Cropland area in Denmark 1990-2010 according to Statistics Denmark and the Land Use Matrix, hectares.

	1990	1995	2000	2005	2007	2008	2009	2010
Annual crops (CL) 1	2236535	1969275	1938633	1953306	1923448	1976815	2044954	2049304
Grass in rotation (CL)	306325	310568	330834	342417	352640	390536	310842	327319
Permanent grass (CL and GL)	217235	207122	166261	192968	196630	189962	191529	199859
Horticulture – vegetables (CL)	16428	12915	10803	9557	9978	11341	11563	10812
Perennial fruit trees – perennial wooden crops (CL)	10856	11258	10593	10817	11265	11581	11383	12386
Set-a-side and other land (CL)	3861	217801	192441	200751	171743	90947	57364	51309
Total agricultural land area reported by Statistics Denmark	2788276	2726048	2646982	2707236	2662761	2667895	2623975	2646400
Willow in the cropland for energy purposes (CL)	588	588	695	1320	1736	1832	2736	4049
Hedgerows (CL)	61326	61019	60554	60170	60039	59931	59840	59785
“Other agricultural land”	67760	95047	140123	46536	76209	63557	99923	68338

[1]CL refers to that the area is treated under Cropland. GL refers to Grassland.

Cropland area

The Cropland area is defined as the agricultural area as given by Statistics Denmark, Perennial wooden crops (fruit trees, orchards and willow), hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape and “Other agricultural land”. The latter is defined as the difference in the area between the total Cropland area as defined by the performed Remote Sensing (see Table 7.3) minus agricultural crops in rotation as given by statistics Denmark minus the area with fruit trees and the area with hedgerows. “Other agricultural land” is thus comparable small areas and probably without agricultural and wooden crops, which cannot be allocated to other land use categories. In the inventory carbon in living biomass for “Other agricultural land” is given the same value as for annual crops so than inter-annual changes in the cropland area from Statistics Denmark are eliminated.

The area with Perennial wooden crops are the area given by Statistics Denmark and for some categories it is split further down with data from the EU crop subsidiary system, which gives information on which crops are grown where on species level.

The main data for land use in Cropland (5.B.1) is the agricultural area given by Statistics Denmark. Both annual agricultural and wooden perennial crops are allocated into grids (climatic, soil type and municipality) with the help of the EU Land Parcel Information System (LPIS). LPIS contains information of the exact position of the field. The survey data from Statistics Denmark differs a little from the LPIS system (<±2% for the major crops). Area and yield data from each region is used for the calculations as reported by Statistics Denmark.

The area with hedgerows is based on analysis of aerial photos from 1990 and 2005 combined with planting and removal statistics of hedges from the Ministry of Food, Agriculture and Fisheries. The major part of the hedge erection is subsidies in Denmark and therefore monitored.

Cropland definition

The land area under "CL" consists of: Cropland with annual crops, cropland with wooden perennial crops, area with hedgerows and "Other agricultural area". The latter consists of small undefined areas lying inside the area, which is allocated as cropland in the cropland area.

For purposes of the calculations for annual crops a division as follows is used: Winter and spring wheat, rye, triticale, winter and spring barley, oat, winter and spring rape, grass for grass seed production, grassland in rotation, potatoes, sugar beets, peas, maize for silage, cereals for silage, vegetables and miscanthus.

For purposes of perennial wooden crops a division as follows is used: Apple, Pears, Cherries, Plumes, Rosehips, Elderberries, Hazel and Walnuts, Grapes, Other fruit trees, Black current, Other fruit bushes, Hedgerows and Willows.

Biomass from Christmas trees in the agricultural area is reported under forests.

Cropland - Methodological issues

The following data sources are used for determination of cropland area, for determination of any land-use changes, for allocation of natural and administrative parameters, for development of emission factors for soils and biomass and for calculation of carbon stocks in soils and biomass at various times.

- Agricultural area data from Statistics Denmark, 1980 to 2010
- Area and harvest surveys from Statistics Denmark, 1980 to 2010.
- Area with willow from the agricultural subsidiary system.
- EUs Land Parcel Information System, 2000 and onwards (grown crops on field and soil level).
- Digital soil map, 1:25.000.
- Arial photos of hedgerows in 1990 and 2005.
- Hedgerow planting data 1977 to 2010.
- Lime consumption data 1990 to 2010.

The model for carbon stock changes in hedges is based on a growth model from the National Forest Inventory (NFI) classified into plant and soil type and height.

Emissions from living biomass

For annual agricultural crops on cropland remaining cropland (5B1) it is assumed that no changes in above-ground, below-ground, dead biomass and litter are occurring cf. IPPC 2003 (3.3.1.1.1). The variations in the actual agricultural area collected by Statistics Denmark may be up to 100,000 hectares per year. When estimating the carbon stock in living biomass such changes may create large variations between years, which may be artefacts. As the amount of living biomass is defined according to the time where the peak of living biomass is occurring the variation in the area from Statistics Denmark create large fluctuations in the carbon stock in living biomass compared to other sources. To counteract this problem the sub-division "Other agricultural land" has been created with a default carbon stock of living biomass as in the designated agricultural area. The default carbon stock in living biomass is equivalent to an average spring barley crop with aboveground biomass of 9,577 kg DM (dry matter) pr hectare and a below ground DM of 2,298 kg pr hectare. Default dry matter values for the different crop categories used in the inventory was given in Table 7.10.

Fruit trees and other perennial wooden plants

Fruit trees, other perennial commercial wooden plants and durable horticultural plantations are reported separately under Cropland (Table 5.B). These are only of minor importance in Denmark. The total area for different main classes and the used carbon stock in above-ground and below-ground biomass are given in Table 7.17. Due to the limited area and small changes between years the CO_2 removal/emission is calculated without a growth model for the different tree categories. Instead the average stock figures are used in Table 7.17 multiplied with changes in the area to estimate the annual emissions/removals. Perennial horticultural crops account for approximately 0.07 % of the standing carbon stock. Christmas trees are reported under forest (5.A).

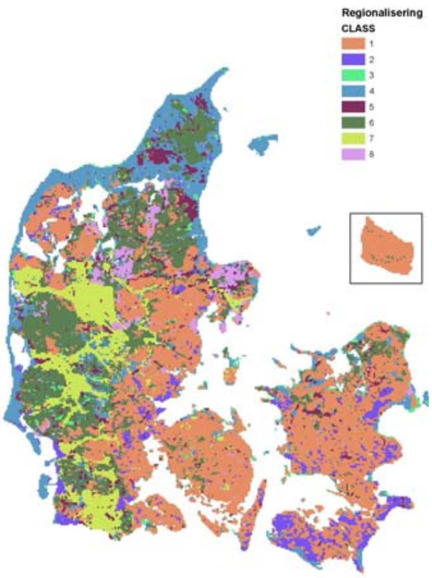
The carbon fraction of dry matter (DM) is assumed to be 0.5 for all species. For parameter estimation of living biomass, see Gyldenkærne et al. 2005 for fruit trees, for willow and Miscanthus:
http://www.nordicbiomass.dk/dansk/nye_afgroeder.asp

Table 7.17 Mg living biomass per hectare and area, ha, with perennial wooden trees and – bushes, 1988-2008.

	Living biomass, Mg DM per ha	1990	1995	2000	2005	2006	2007	2008	2009	2010
Black currant	5,20	1269	1828	1492	2001	1848	1856	2071	1848	1935
Other berries	5,20	663	547	611	698	641	708	589	578	533
Rosehip	13,99	0	0	0	0	0	0	120	159	197
Cherries	25,45	1787	2653	2804	2131	2129	2169	1951	1864	1743
Plumes	25,45	0	0	0	0	0	0	60	63	68
Hazelnut and Walnuts	25,45	0	0	0	15	12	13	45	14	14
Apples	33,76	2726	1658	1678	1751	1646	1812	1797	1730	1684
Pears	13,99	351	546	441	413	411	466	442	372	357
Elderberry	25,45	0	0	0	9	16	15	10	12	9
Grapes	5,20	0	0	0	18	14	22	31	37	45
Other fruit trees	13,99	0	0	0	110	89	125	21	48	60
Rowan-berries	33,76	0	0	0	0	0	0	14	16	16
Willow	17,43	588	588	695	1320	1506	1736	1832	2736	4049
Miscanthus	17,43	1	1	6	33	56	88	80	80	156
Total		7385	7821	7727	8499	8368	9010	9062	9556	10865

Hedgerows

Since the beginning of the early 1970s governmental subsidiaries have been given to increase the area with hedgerows to reduce soil erosion. Annually financial support is given to approximately 600-800 km of hedgerow. There are no figures on how many hedgerows have been removed in the same period as these to a large extend are not protected. Therefore 144 aerial photos on a 2x2 km^2 square for 1990 and 2005 have been analysed to monitor and detect changes in the landscape. The squares are distributed throughout Denmark in a stratified way according to primarily soil and wind conditions (Figure 7.9). A very large dynamic in the location of the hedges between 1990 and 2005 was observed (Figure 7.9). Only areas not meeting the definition of forests and areas not classified under Perennial Wooden crops (fruit trees, willows etc.) were included in the analysis. The hedges were further allocated into eight different regions, mainly according to soil type (e.g. growth pattern).



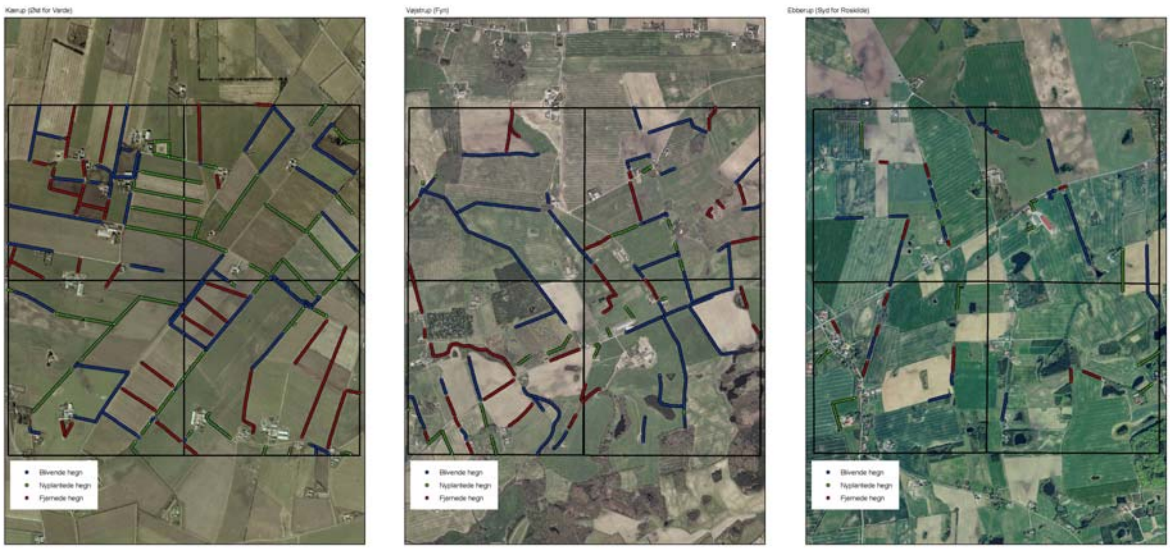


Figure 7.9 The dynamics of hedgerows in the Danish Landscape 1990 to 2005. Blue colour indicates no changes, red colours are removed hedges and green colours are new hedges (Source: M. Fuglsang, NERI).

The overall results from the analysis of hedges are shown in Table 7.18. The total area with hedges has decreased with 2 % but the total volume and the carbon stock has increased due to changed sizes and composition.

Table 7.18 Hedges in the cropland 1990 and 2005.

	1990	2005	Change in percent 1990-2005
Area, ha	61,326	60,093	-2.0
Volume, million. m3	4,139	4,402	6.4
Carbon stock, Gg	939	1,072	14.2

In Table 7.19 the actual planting and removal rates for hedgerows is shown. The 1970s and 1980s saw less concern to protect and maintain the hedgerows. Therefore there was a substantial loss in hedgerows. The governmental subsidiary is targeted broadleaved hedgerow replacing old single-rowed conifers (mainly *Picea glauca*). In 1990 75 % of the replaced conifers hedgerows were replaced with 3- to 6-rowed broad-leaved hedges. In 2005 only 20 % are replacements and the remaining is new hedges cf. Table 7.19. The Ministry of Food, Agriculture and Fisheries is responsible for all administration, registration and mapping of all subsidised hedgerow planting in Denmark.

Table 7.19 Hedges planted and removed under the governmental subsidiary system 1985 to 2010.

	1985	1990	1995	2000	2005	2008	2009	2010
Planted 3-rowed, km	1082	928	560	852	390	400	244	155
Planted 6-rowed, km	0	0	252	250	115	150	57	45
Planted small biotopes, ha							57	11
Percentage removed, %	75	75	36	27	20	20	20	20
Percentage new, %	25	25	64	74	80	80	80	80
Hedges removed, ha	608	522	218	219	76	83	45	30

The biomass estimation of the hedges is based on measurements made in the Danish NFI where plots with similar height and plant species are used as transfer functions (Figure 7.10).

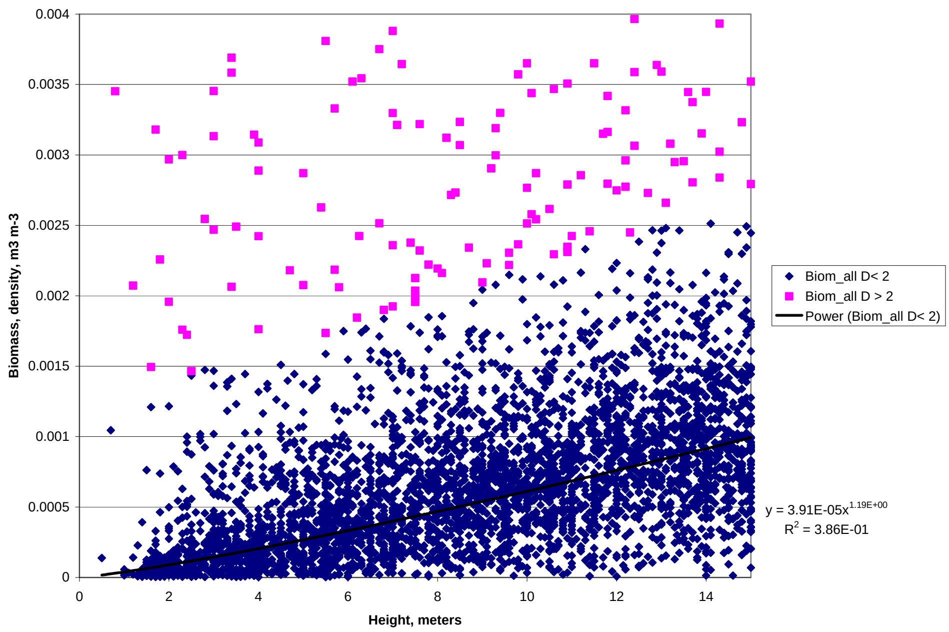


Figure 7.10 Biomass function estimated as m^3 biomass per m^3 versus tree height in NFI plots less than 15 meter (Courtesy Thomas Nord-Larsen, SL, LIFE, KU).

Emission from soils

Based on a GIS analysis of the data in the LPIS and a newly produced soil map of the organic soil the agricultural area is distributed between mineral soils and organic soils and subdivided into cropland and permanent grassland.

The updated version of C-TOOL is used for mineral soils (Petersen et al. 2010). C-TOOL were used with revised input parameters for the area outside annual crops. This has led to revised estimates for the whole time series.

Mineral soils – 5B1

For carbon changes in for agricultural crops a 3-pooled dynamic soil model is used (Petersen, 2003; Petersen et al. 2002, 2005, 2010, Gyldenkærne et al.

2005) to calculate the soil carbon dynamics in relation to the Danish commitments to UNFCCC. C-TOOL is only used in CL. No change in the carbon stock in soils under perennial wooden plants, hedgerows and "Other agricultural cropland" is expected and reported as IE. These areas are also only a very minor part of the cropland area. For agricultural crops C-TOOL is run on a regional level.

C-TOOL

C-TOOL is a 3-pooled dynamic model, where the approximate average half-live times for the three different pools, Fresh organic matter (FOM), Humified organic matter (HUM) and ROM (Resilient Organic Matter) are 0.6-0.7 years, 50 years and 600-800 years, respectively. The main part of biomass returned to soil each year is in the first and easiest degradable FOM pool. This pool consists of mainly fresh straw, fresh manure, root residues, fungi and small animals and fluctuates very much between years depending on the harvest yield and climatic conditions. A simple diagram of C-TOOL is shown in Figure 7.11.

C-TOOL is parameterised and validated against long-term field experiments (100-150 years) conducted in Denmark, UK (Rothamsted) and Sweden and is "State-of-the-art". A detailed description of C-TOOL can be found at www.agrsci.dk/c-tool/index.htmls. More recent investigations have shown that C-TOOL is not properly parameterised on soils having more than 6 % organic carbon. Soils having 6-12 % organic carbon is therefore treated as organic soils with an emission factor of 50 % of organic soils > 12 % organic carbon.

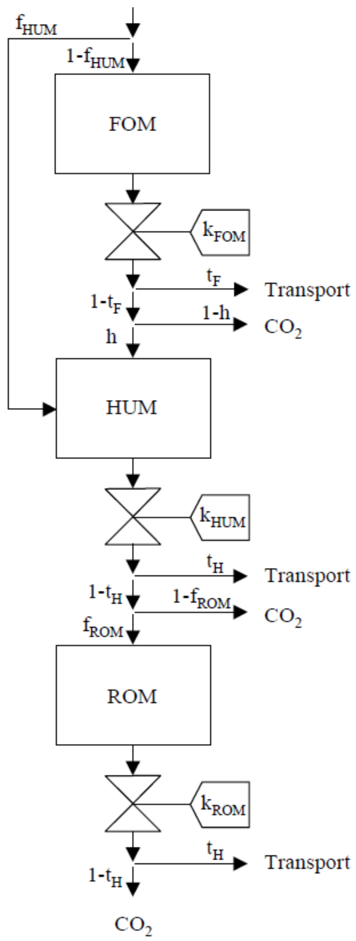


Figure 7.11 A simple diagram of C-TOOL. Please refer to www.agrsci.dk/c-tool for more information.

Input data to C-TOOL and out put

As carbon input to each region for each year is taken the actual crop area and crop yield from Statistics Denmark for that particular region and crop species as given by Statistics Denmark (www.dst.dk Table AFG, AFG07, HST7 and HST77). The dry matter content depends on the actual crop. For cereals it is 15 %.

The amount of agricultural residues returned to soil is the amount estimated by Statistics Denmark (www.dst.dk Table HALM and HALM1). The dry matter content depends on the actual crop. For cereals it is 16 %.

The overall input to C-TOOL varies between years (Figure 7.8) due to the actual growing conditions in that year. 2009 was the best cereal year ever whereas 2010 gave a very moderate crop yield. The variation in the input to C-TOOL gives a large inter-annual variation in the carbon input to the soil for all years of the time series. Combined with large inter-annual differences in the temperature this creates large inter-annual differences in the net carbon stock change in mineral soils, where low yields combined with high temperatures reduce the total amount of carbon in agricultural soils, whereas in years with a high yield and low temperatures the carbon stock in soils is increased.

The amount of animal manure produced and applied to soil is estimated with the same methodology as in the Agricultural sector for estimating CH_4 and N_2O emission where annually updated feeding and excreting data are provided for the regulation of the animal production in Denmark. Here detailed data on the number of animal, housing and manure type are available on farm level. This also includes data whether the manure has been biogassed or not. The manure data are used as input to C-TOOL.

In Figure 7.12 is shown the overall input of C to the agricultural soils. Due to a ban of field burning in 1990, increased management and demand on catch crops an increase in the C input to soils can be seen.

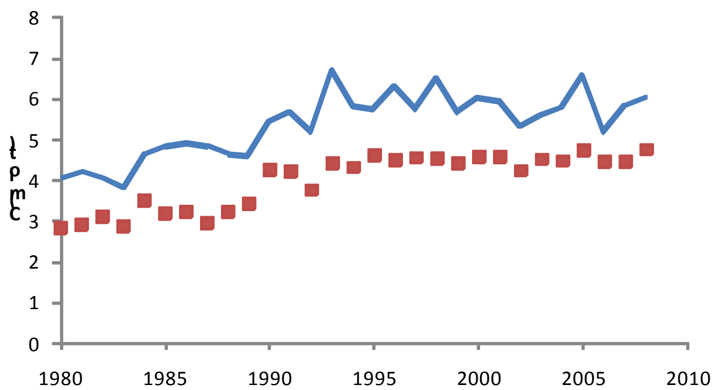


Figure 7.12 Calculated C input to the soil (red squares) and modelled (blue curve) development of the FOM pools, million tonnes C.

Since 1997 there has been a demand for growing N catch crops in Denmark in order to reduce N leaching. Besides reducing the N leaching these crops increase the carbon stock in the soil. Between 120 000 and 200 000 hectares of the agricultural area has this additional crop every year. The demand for catch crops has altered the way of farming in two main ways. For farmers with cattle the farmers are sowing grass seed in their normal cereal fields. This grass sword must not be ploughed into the soil before winter/next spring. For farmers growing grass seed, which is common in Denmark, old grass seed fields are not ploughed before next spring in contradiction to the current situation where it would be ploughed early autumn. It has been estimated that the obligatory catch crops are increasing the amount of C returned to soil with 0.36 to 2.14 tonnes carbon per hectare per year (Olesen et al. 2004). The area with catch crops in each region is estimated from each farms obligatory N accounting, in which the area of catch crops area given on farm level (www.pdir.dk).

C-TOOL is initiated with data from 1980 and run multipliable times until stability, before the emissions from 1980 and onwards was calculated. Actual monthly average temperatures are used as temperature driver. The main drivers in the degradation of soil biomass are temperature and humidity. The Danish climate is quite humid with winter temperatures around zero degrees Celsius and hence the importance of soil humidity on the model outcome is low in contradiction to temperature, which has a high effect on the emission. As mentioned, when biomass is returned to the soil the major part of it is quite easily degradable. Warm winters with unfrozen soils in connection with high inputs of biomass will therefore, as a result, yield high emissions from the soil compared to more cold years, which will yield low emissions.

In recent years (1999-2009) Denmark has experienced very warm winters although 2010 was very cold and below the average from 1961 to 1990. In 18 out of the last 20 years the annual average temperature has been above the average temperature from 1961 to 1990. Year 2009 was the eight warmest year ever registered in Denmark with an average temperature of 8.8 °C or 1.1 °C above the average from 1961 to 1990.

Year 2006 resulted in a high loss due to the warmest year up to now combined with a harvest yield 5 % below the average for 1997 to 2009 (measured as kernel yield from cereals) (Figure 7.11). In this year the organic matter input from crop residues and animal manure were not able to compensate for the loss (Figure 7.12). 2007 was not as warm, which led to an increase in the carbon stock. 2009 was cooler than 2008 but 2009 gave the highest cereal yield ever monitored in Denmark despite the fact that the agricultural area has decreased since 1980. This led to a very high input of organic matter into the soil, which again increased the soil carbon stock. 2010 were very cold with low harvest yields. This reduced the degradation in the soil, but the input was also very little, so the overall result was a fairly high loss from the mineral soils.

The FOM-pool (Fresh Organic Matter), which has a very fast turnover rate, consists of approx. 1.0 % of the total carbon content in the agricultural soil. Because of its large fluctuation between individual years and its small impact on the overall trend in the long-term development of the carbon stock in the soil, it has been agreed with the previous ERT during the in-country review in 2010, that all input sources are included in the modelling but in the reporting on the development an instant turnover of the FOM pool is used. The reported development is thus the two pools, HUM (Humified Organic Matter) and ROM (Resilient Organic Matter) which account for 99 % of the total amount of carbon in the soil. Figure 7.13 shows the development in the two pools. As can be seen there is a small increase in the total modelled carbon stock from 2008 to 2010 but a decrease in HUM and ROM. A new warm year with normal harvest yields will speed up the degradation of the FOM pool and as a consequence the two lines will get closer again.

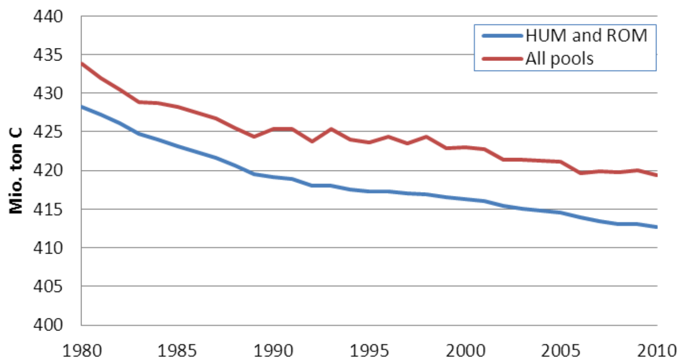


Figure 7.13 The development in the C-stock in agricultural soils, Tg C/million tonne C.

As a whole the modelled emissions are found to be the most realistic emissions estimates for Denmark. As described in the agricultural sector the Danish farmers have faced increased demands for lower environmental impact since the mid-1980s. The general effect on the carbon stock in soil is that the 1980s showed a decrease in the carbon stock. In the 1990s the carbon stock seemed to stabilise due to the higher input of organic matter. Due to the increased global warming a declining carbon stock was modelled between 2000 and 2010. Since 1990 C-TOOL has estimated a loss of 1.5 % of the total carbon stock in the mineral agricultural soils. No precise uncertainty calculation has been made. However, it must be assumed that uncertainty in the estimate in the annual loss/gain is around 25 %. As Denmark has very good data on harvest yields and area data the uncertainty in the trend is very low. The estimated annual amounts of carbon in the agricultural soils are given in Table 7.20.

Table 7.20 Modelled carbon stock (0-100 cm) in mineral soils from 1980 to 2010, Tg C.

Year	All pools	Fast FOM model
1980	433,795	428,295
1981	431,976	427,201
1982	430,412	426,068
1983	428,834	424,763
1984	428,764	423,954
1985	428,208	423,168
1986	427,508	422,382
1987	426,710	421,654
1988	425,496	420,625
1989	424,394	419,568
1990	425,419	419,182
1991	425,356	418,920
1992	423,752	418,029
1993	425,330	417,983
1994	423,994	417,545
1995	423,646	417,254
1996	424,436	417,329
1997	423,524	417,032
1998	424,346	416,949
1999	422,883	416,516
2000	423,050	416,266
2001	422,716	416,055
2002	421,398	415,406
2003	421,410	415,075
2004	421,323	414,798
2005	421,127	414,534
2006	419,695	413,975
2007	419,908	413,481
2008	419,754	413,113
2009	419,969	413,014
2010	419,354	412,700

Independent verification of C-TOOL

An independent validation of C-TOOL has been performed by soil sampling in the Danish Agricultural grid. The grid was established in 1987 and in a 7 x 7 km² grid square. In 1987 > 600 agricultural plots were sampled and analysed for carbon. Half of them were resampled in 1998 and a full resampling were made in 2008/2009. Figure 7.14 shows the development in the carbon stock in 0-50 cm depth in the paired plots. Although there is some variability the overall conclusion is that there is a small loss from the Danish agricultural soils.

The conclusion is therefore that the modelled outcome from C-TOOL represents a proper value for the development of the carbon stock in the Danish agricultural soils.

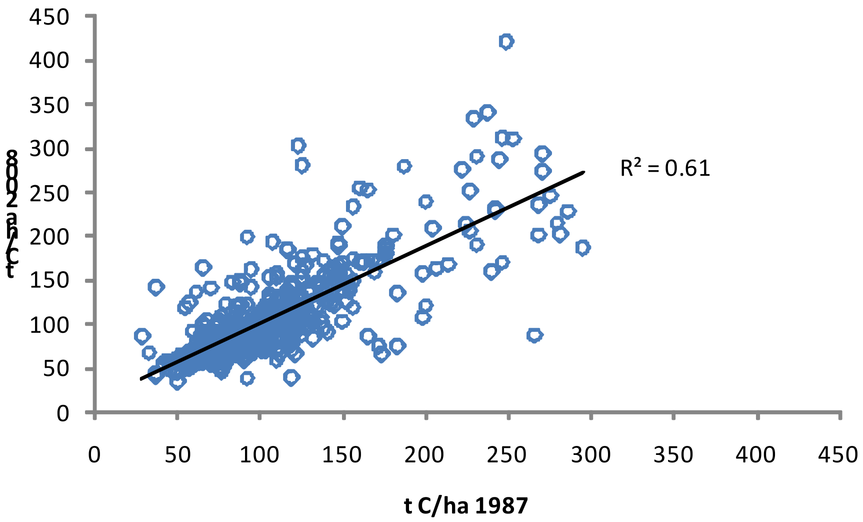


Figure 7.14 The change in carbon stock in soil (0 - 50 cm) in >600 paired agricultural plots from 1987 to 2009.

Organic soils - 5B1

A complete new soil map of the organic soils has been made for the inventory (Figure 7.15). The new soil map is a statistical map based on >10 000 soil samples down to the mineral soil in 30 cm intervals combined with a very detailed digital elevation map (DEM) for each 1.6 x 1.6 m² covering the entire Denmark, water table maps and old maps with organic soils. The definition of an organic soil in the new map is 20 % organic matter with a depth of minimum 30 cm (Greve et al., 2012, in prep.). The total area with organic soils has been estimated to approx. 106 642 ha in 2010 of which approximately 42 000 hectares have been located to cropland and 27 000 hectares to grassland (Figure 7.16).

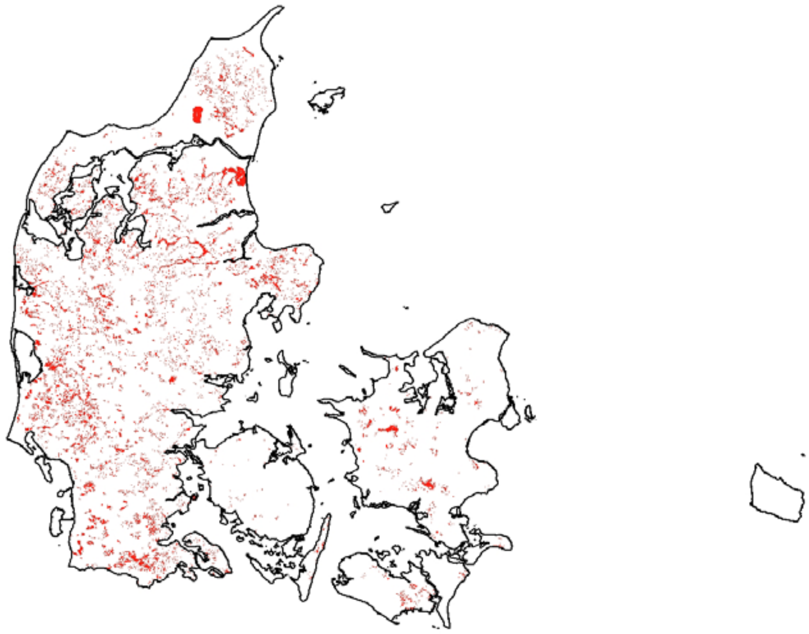


Figure 7.15 The new organic soil map for Denmark for year 2010, > 12 % OC (Greve et *al.* 2012, in prep).

On top of the organic soil map digital maps has been laid where 99 % of all Danish farmed fields (>670,000 fields) from the EU subsidiary system are precisely mapped with an uncertainty down to < ± 1.5 meter. The actual grown crop is known for each field. In total more than 240 different crop types or combination of crop and crop management are recorded.

The previous Danish soil classification was carried out in 1975. In 1975 it was estimated that there were 178,000 hectares of organic soils (>12 % C). Of this were 118,000 ha in the Cropland and the Grassland area and the remaining 60,000 ha were located in the Forests, Wetlands, Settlements and Other land. Overlay between the field map and the soil map has shown that only around 42,000 hectare in 2010 is farmed in the Cropland area and 27,000 hectare in Grassland and that the depth of the organic layer has become very shallow. The major reason for the drastic reduction is that Denmark is quite flat with shallow organic layers, which combined with intensive agricultural utilisation with high drainage rates has oxidized a major part of the organic matter.

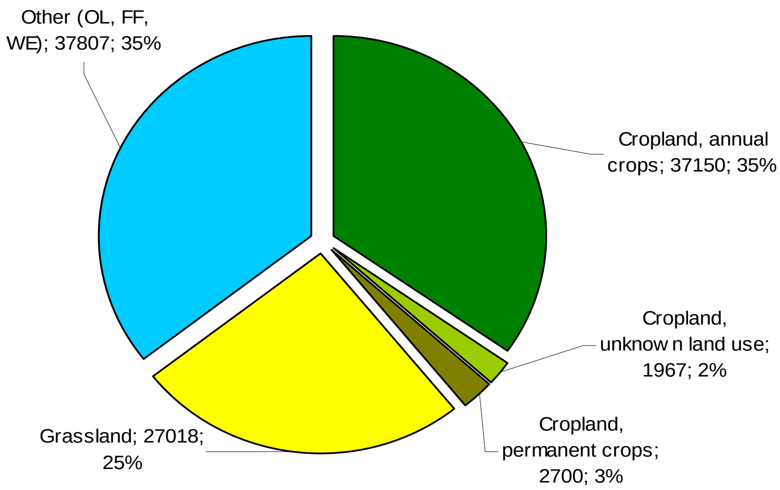


Figure 7.16 The distribution of organic soils on sectors in 2010. Figures are given in hectares and percentages.

The outcome is that during recent years more and more previously organic soils do not qualify to be organic by definition and that the area will decrease rapidly in future.

Emission factors for organic soils

An intensive research programme has been carried out to monitor the CO_2 emission from three organic soils in Denmark with annual crops in rotation and permanent fertilized grassland (Elsgaard et al. 2012, in prep). The overall result is shown in Table 7.21 compared with the IPCC default values. Maljanen et al. (2010) recently reviewed the GHG balance of managed organic peatlands in the Nordic countries. For areas with agricultural grasslands, the available studies suggested a net CO_2 emission of 4.9 ± 3.2 t C m^{-2} yr^{-1} (mean +/- standard deviation, n = 4). The available studies (n = 4) represented three Finnish and one Norwegian site (Lohila et al., 2004; Maljanen et al., 2001, 2004; Grønlund et al., 2008). The upscaled annual emission from the Danish declining carbon stock is in line with these figures when taking into account the differences in temperatures. Considering that the IPCC temperate cold zone covers the major part of Europe the measured Danish values also seems to be in line with the IPCC guidelines. Emissions from organic soils on permanent grassland are reported under Grassland (CRF Table 5.C.1).

The dominating use of the organic soils is fertilised annual crops and grass in rotation. As C-TOOL has shown not to be able to simulate the emissions from soils having >6 % organic carbon fixed emission factor have been used for this area. No data has been found in the literature as they in the scientific world do not qualify as organic and hence little attention has been paid to these soils. Normally mineral soils in equilibrium will have an organic matter of 1-4 % organic carbon. Soils having higher contents are most likely developed under humid conditions with low degradation rates. Drained and managed soils having > 6 % organic carbon can therefore not be seen as being in their equilibrium state and will evidently lose carbon. We have therefore decided to allocate an emission of 50 % of what we have measured for soils > 12 % organic carbon in an attempt to account for these losses. These emissions are reported under 5B organic soils.

Table 7.21 Emission factors from organic soils, tonne C per ha per year.

	Cropland		Grassland	Uncertainty
	Annual crops and grass in rotation	Fertilised permanent grass	Permanent grass	Percent
Soils > 12 % OC	8.7	5.17	1.25	90
Soils 6-12 % OC	4.36	2.59	-	90
IPCC, Cold temperate	5.0		1.25[a]	90
IPCC, Warm temperate	10.0		2.5	90

[a] There seems to be an error in the guidelines on the emission from grassland. It is assumed that the figure should be one fourth of the emission from annual crops (5 t C per ha).

As emission factor for N_2O the IPCC 2003 default value of 8 kg N_2O-N per ha per year is used for the area with > 12 % organic carbon. This emission is reported in the agricultural sector, 4D2.

To estimate the emission from the organic soils a linear decrease in the area with organic soils between 1975 and 2010 has been assumed. All CO_2 emissions from organic soils converted from other Land Use categories to Cropland are reported under 5.B.1 and not under the respective land use conversion classes 5.B.2.1 to 5.B.2.5. The related N_2O emission is reported in the agricultural sector in CRF Table 4.Ds1.

The total emissions from the organic soils are given in Table 7.22.

Table 7.22 Emissions from organic soils 1990 to 2010.

Greenhouse gas source and sink categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cropland, Gg C pr yr	-659,7	-612,6	-565,4	-518,3	-508,9	-499,5	-490,1	-480,7	-471,3
Grassland, Gg C pr yr	-49,7	-46,2	-42,8	-39,3	-38,6	-37,9	-37,2	-36,5	-35,8
Total organic soils	-709,4	-658,8	-608,2	-557,6	-547,5	-537,4	-527,3	-517,2	-507,1

Uncertainties and time series consistency

A Tier 1 uncertainty analysis has been made for part of the LULUCF sector cf. Table 7.21. The uncertainty in the activity data for the agricultural sector is very low. The highest uncertainty is associated with the emission factors. Especially the emission/sink from mineral soils and organic soils has a high influence on the overall uncertainty.

The LULUCF sector contributes to a large extend to the total estimated uncertainty. In recognition of the difficulties in analyses of uncertainty, the estimated uptake of CO_2 in the forestry sector must be treated with caution.

Table 7.21 Tier 1 uncertainty analysis for Cropland for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5.B Cropland		4022,5	3000,7				60,2	1805,4
Living biomass	CO_2	177,2	102,0	10	50	51,0	51,0	52,0
Dead organic matter	CO_2	7,0	1,2	10	50	51,0	51,0	0,6
Mineral soils	CO_2	1415,3	1151,6	10	75	75,7	75,7	871,4
Organic soils	CO_2	2419,8	1745,2	10	90	90,6	90,6	1580,3
Disturbance, Land converted to cropland	N_2O	3,2	0,6	50	75	90,1	90,1	0,6

The time series are complete.

QA/QC and verification

A general QA/QC plan is developed for cropland. The following Points of Measures (PM) are taken into account.

- Collection and error check on in-data.
- Control of sums.
- Comparison with other data.

Despite this, errors were found in the 2011 submission. Careful checking and considerations has been made to avoid these errors in the 2012 submission.

The area estimates for cropland and grassland in 2010 are very precise due to unrestricted access to detailed data from EUs Integrated Administration and Control System (IACS) on agricultural crops on field level and the use of the vector based Land Parcel Information System (LPIS). This access includes both Statistics Denmark and DCE. The total uncertainty in the major crop data is estimated by Statistics Denmark to be <2 %. Together with detailed soil maps this gives a unique possibility to estimate the agricultural crops on different soil types and hence track changes in land use. However, IACS and LPIS are only available from 1998 and onwards, and estimates for 1990 are therefore more uncertain. The QA of crop data is made by Statistics Denmark.

Data on newly planted and removed hedgerows are based on subsidised hedgerows and QA is carried out by the Ministry of Food, Agriculture and Fisheries, who is responsible for the administration of the subsidy scheme. The uncertainty in the number of plants used for the hedgerows is not estimated but is assumed to be very low because of the subsidy system.

There is an unknown uncertainty in the number of un-registered removal of hedgerows. A linear approach has therefore been made for “missing” hedges over the years. Establishment of wetlands is based on vector maps received from every county in Denmark. The uncertainty is not estimated but assumed to be very low due to the subsidised system.

As shown in Figure 7.12 and 7.13 the loss estimated by C-TOOL seems very close to the results from >600 paired soil samples.

A range of experts from the Faculty of Agricultural Sciences, Aarhus University, are repeatedly involved in discussions and report writings on topics related to the inventory.

Recalculations, including changes made in response to the review process

Recalculations have been made for all emission estimates for Cropland due the updating of the soil maps and the missing performance of C-TOOL for soils having 6-12 % organic carbon.

The UNFCCC expert review in 2010 recommended a sensitivity analysis of C-TOOL. This was presented during the in-country review in 2010. All other comments from the review has been reflected and incorporated in this submission.

Previously all three carbon pools were included in the carbon stock estimate for mineral soils. Based on an agreement with the UNFCCC expert review in 2010 only the emissions from the very slow acting HUM and ROM pools are included in the inventory and the FOM pool is assumed to be in transition state before it returns to the air. HUM an ROM pools represent 99 % of the carbon stock in the soil.

New area estimates for organic soils has been incorporated as well as national emission factors.

All changes have been implemented for all years.

Planned improvements

A more thorough investigation of the performance of C-TOOL will be made with a more detailed soil map for soils only having up to 6 % organic carbon.

7.4.2 Land converted to cropland (5B2)

Agriculture covers more than 63 % of the total area giving a large impact on the environment. As a consequence there are many initiatives to transfer agricultural land into natural habitats and forest, and the continuous development of infrastructure demands more land. Land converted to cropland is not very common. The land use matrix showed that 10,728 hectares were converted from 1990 to 2010. A major part is GL converted to CL. A small area seems to be converted from SE to CL. As this seems unlikely a thorough quality control will be performed before the next submission.

Approaches used for representing land

The area converted from Other land use to Cropland is based on remote sensing of the Danish area in 1990 and 2005 combined with data in LPIS on which crops are grown in each field. If the land use in a particular pixel is an annual crop or other cropland species the conversion is recorded as a conversion to Cropland.

Methodological issues

Change in carbon stock in living biomass

For land converted to cropland a standard default gain value of 9,577 kg DM (dry matter) per hectare in above-ground biomass and 2,298 kg DM per hectare in below-ground biomass is used. This value is equivalent to the average harvest of living biomass for all cereals grown in Denmark from 2000 to 2010, including straw, stubble and glumes. For conversion from DM to carbon a default fraction of 0.5 kg C per kg DM is used.

For conversion from cropland to other land use categories the same value is used but recorded as a loss of carbon in the respective category (5A2, 5C2, 5D2 and 5E2).

The loss in living biomass for conversion from another land use category into CL is estimated as the default value for DM in that particular land use category. I.e. for deforestated areas the average carbon stock per hectare for all deforestated areas is used.

Change in carbon stock in dead organic matter
When forest land is converted to cropland it is assumed that all dead organic matter will have an instant oxidation. The actual amount depends on which type of forest is converted. Based on the measured Danish data on the nitrogen content in the litter and by using an emission factor of 1.25 % is the N_2O emission from the litter layer 4.5 kg N_2O-N per ha from broadleaves and 9.1 kg N_2O-N from conifers. This emission is reported under Cropland 5(III) for all land use conversions cases despite the land use conversion are to other land uses, see Section 7.11.

Conversion from other categories is assumed as NO as no dead organic matter is reported for these categories.

Change in carbon stock in soils
The actual amount depends on which type of land it is converted from, see Table 7.22. To reach the new equilibrium state is used a default transition period of 50 years. The default IPCC-value of 20 years seems according to Danish investigations not to be applicable for Danish conditions.

Uncertainties and time series consistency
The time series are complete.

See uncertainties and time series consistency in Section 7.3.1.

QA/QC and verification
See QA/QC and verification in Section 7.3.

Recalculation
See recalculation in Section 7.3.

Planned improvements
See planned improvements in Section 7.3.

7.5 Grassland (5C)

7.5.1 Grassland remaining grassland (5C1)

Denmark is an intensive agricultural country with many small holders and small fields where CL and GL are mixed together making it difficult to distinguish between dedicated CL and dedicated GL. According to the Danish Land Parcel Information System (LPIS) there are approx. 63,000 fields of total 189,721 ha with permanent GL in 2008 giving an average size of three ha. Some of them cannot be regarded as permanent GL and are therefore included in CL.

Grassland area
The total area with grassland has been estimated in the Land Use matrix. In 1990 it was estimated to 117,000 ha increasing to 164,720 ha in 2010. This increase is mainly due to the fact that CL is turned into GL.

Grassland definition

The Danish definition of grassland is common grazing land according to the LPIS, heath land, which may or may not be used for sheep grazing as well as all other areas not meeting the definitions of forest land.

GL is defined as grassland in the LPIS reported as permanent and receiving zero or <25 kg N per ha per yr and land reported as grassland from the EO investigation as well as some heath land.

The grazing land area is sub-divided into strict “Grazing land” and “Other grassland”. Grazing land is areas where cattle and sheep are fenced (often common grassland) and only a small grass sword is available. The area with “grazing land” is limited to approx. individual 340 fields. In total common grazing land were 7,300 hectares in 2010. These areas are primarily located on islands and other low laying and remote areas. These areas do not have any wooden vegetation.

Other grassland includes heath land and other areas, e.g. scrub land, which may be grazed by cattle and sheep or land which is kept open for recreational purposes. “Other Grassland” may contain bushes and other wooden plants, which do not meet the thresholds for forest. This is land where the crown cover is below 10 % and where the height at maturity do not reach 5 meter.

Methodological issues for grassland

The area for grazing land is the area in the LPIS and the rest of the Grassland is the residual part of the grassland area.

Change in carbon stock in living biomass

No changes in living biomass are assumed for GL remaining GL except for a minor conversion between “Grazing land” and “Other grassland”.

Change in carbon stock in dead organic matter

No changes in dead organic matter are estimated as this is not occurring for this category.

Change in carbon stock in soils

No changes in the carbon stock in mineral soils are assumed. For organic soils the default IPCC 2003 EF of 1,250 kg C per ha per year is used (there is a likely error in the guidelines as the value is given as 0.25 kg C per ha per year).

Uncertainties and time series consistency

Table 7.22 Tier 1 uncertainty analysis for Grassland for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5.C.Grassland		405,9	185,9				71,2	132,4
Living biomass	CO_2	185,9	33,5	10	50	51,0	51,0	17,1
Dead organic matter	CO_2	36,7	2,4	10	50	51,0	51,0	1,2
Mineral soils	CO_2	0,5	5,0	10	75	75,7	75,7	3,8
Organic soils	CO_2	182,9	144,9	10	90	90,6	90,6	131,2

The time series are complete.

QA/QC and verification

See QA/QC and verification in Section 7.3.1.

Recalculations

Small changes in the area matrix have been made and the new soil map of the organic soils has been implemented in combination with a new emission factor for organic soils.

Planned improvements

The planned QA/QC of the land use matrix will very likely change the area with GL.

7.5.2 Land converted to grassland (5C2)

As agriculture covers more than 63 % and in order to reduce the environmental impact there is a strategy for turning CL into GL and where deforestation takes place it is often turned into GL.

Approaches used for representing land

The area converted from other land use to GL is based on remote sensing of the Danish area in 1990 and 2005 combined with data in LPIS on which crops are grown in each field.

Methodological issues

Change in carbon stock in living biomass

For land converted to "grazing land" a standard default gain value of 2,400 kg DM (dry matter) per hectare in above-ground biomass (IPCC 2006, Table 6.4) and 6,720 kg DM per hectare in below-ground biomass (IPCC 2006, Table 6.1) is used. For "Other grassland" not purely free of wooden trees/bushes it is assumed that there is a living biomass of 2,200 kg DM per ha in above ground biomass and 6,160 kg DM per ha in below ground biomass (R:S-factor of 2.8, IPCC 2003 default guideline). For conversion from DM to C a default fraction of fraction of 0.5 kg C per kg DM is used (Table 7.10).

For conversion from grassland to other land use categories the same value is used, but recorded as a loss of carbon in the respective category (5A2, 5B2, 5D2 and 5E2).

Change in carbon stock in dead organic matter

When forest land is converted to GL it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for this category.

Change in carbon stock in soils

The actual amount depends on which type of land it is converted from, see Table 7.15. To reach the new equilibrium state a default transition period of 50 years is used. The default IPCC-value of 20 years seems according to Danish investigations not to be applicable for Danish conditions.

Uncertainties and time series consistency

See Section 7.3.1.

7.6 Wetlands (5D)

Wetland includes:

- unmanaged fully water covered wetlands (lakes and rivers)
- unmanaged partly water covered wetlands (fens and bogs)
- managed water reservoirs (currently not occurring in Denmark)
- managed drained land for peat extraction
- managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland).

7.6.1 Wetlands remaining wetlands – peat extraction (5D1)

Until a more thoroughly QA/QC of the EO and other data sources has been performed WE remaining WE consists only of land for peat extraction. Due to environmental concerns the area used for peat extraction has been reduced since 1990 and no new peat excavations licences have been issued.

Wetland area

The total area with peat extraction is about 300 hectares open surface (Lykke Larsen, Pindstrup Mosebrug, personal comm.). Based on aerial photos it is etimated that 1 596 hectares are land connected to the peat extraction areas.

Approaches used for representing land areas

The area for wetlands remaining wetlands is a vector map layer made by DCE based on aerial photos of the four excavation sites (Figure 7.17). The actual three locations are Fuglsø mose on Djursland, Lille Vildmose and Store Vildmose – both in Northern Jutland. All four sites are nutrient poor raised bogs.

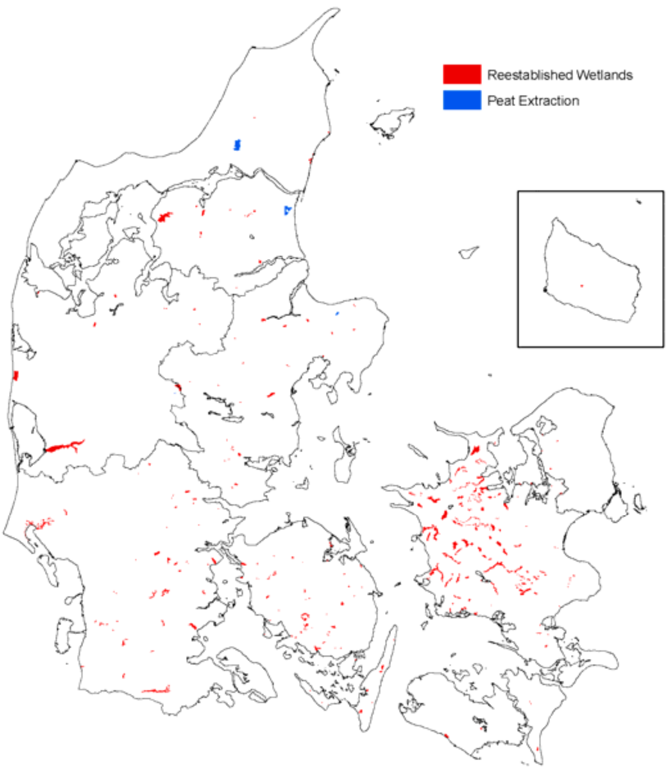


Figure 7.17 Areas with established wetlands, increased water tables and peat extraction in 2008.

Methodological issues for peat land

Change in carbon stock in living biomass

No living biomass is occurring on the peat extraction sites.

Change in carbon stock in dead organic matter

Dead organic matter is not occurring.

Change in carbon stock in soils

The surface emission from the open area is calculated according to Tier 1 (IPCC, 2003) for nutrient poor areas with an emission factor of 0.5 tonnes C per hectare land with peat extraction per year.

The amount of excavated peat (m^3 per year) is for each individual extraction site reported to and published by Statistics Denmark (www.dst.dk, Table RST). The total amount of peat excavated has since 1990 been reduced from 399,000 m^3 to 173,000 m^3 in 2010. For conversion to carbon a density factor of 200 kg per m^3 is used (personal comm. with Pindstrup Mosebrug, www.pindstrup.dk who is responsible for the majority of the extraction sites). Furthermore, a DM content of 0.5, an ash content of 0.02 (www.pdir.dk) and a carbon content of 0.58 kg C per kg OM are applied.

Nitrous oxide emission

The nitrous oxide emission from peat land is estimated from the total N-turnover multiplied with the default IPCC emission factor of 1.25 %. The C:N-ration in the peat is estimated to 36 in an analysis from the Danish Plant Directorate (www.pdir.dk). Hence the N_2O emission is estimated to 0.546 kg N_2O per tonnes C. Only nitrogen in the degradation of the surface is accounted for in the inventory. N_2O from N in the excavated peat is not estimated.

Uncertainties and time series consistency

Table 7.23 Tier 1 uncertainty analysis for WE remaining WEs and re-established WE for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 % Gg CO_2 eqv.
5.D Wetlands		86,8	0,0				54,3	0,0
Living biomass	CO_2	0,5	-5,3	10	50	51,0	51,0	2,7
Dead organic matter	CO_2	0,1	0,1	10	100	100,5	100,5	0,1
Soils	CO_2	86,1	5,1	10	100	100,5	100,5	5,1
Land for peat extraction	N_2O	0,1	0,1	10	100	100,5	100,5	0,1

The time series are complete.

QA/QC and verification

The peat excavation area has been verified with aerial photos and the amount of excavated peat is made by Statistics Denmark.

Recalculation

None.

Category-specific planned improvements

No improvements are planned.

7.6.2 Land converted to wetland (5D2)

In order to restore nature and reduce the environmental impact Denmark has actively re-established WE (Figure 7.16). The size of each restoration project range from less than 1 ha up to 2,500 ha. The benefit of the restoration programme is more nature but also a reduction in leaching of nitrogen into lakes, rivers and coastal water. The establishment of WE takes place either as large areas turned into lakes or low laying fens.

Since 1990 18,499 ha have been established. These are partly on land classified as OL, but also conversion on CL and GL are frequent. A major part is restored as a part of the Danish Action Plan for the Aquatic Environment part two (VMP II, running from 1997 to 2006) where land was bought for this purpose. It is accounted for that the establishment often takes place in connection to existing wetlands.

Water reservoirs for human purposes have not been established for the past 100 years and therefore currently reported as NO.

Approaches used for representing land areas

Geographical vector layers are available for almost all established WE.

Methodological issues

Change in carbon stock in living biomass

For land converted to partly covered wetland a standard default gain value of 4,000 kg DM (dry matter) per hectare in above-ground biomass and 1,200 kg DM per hectare in below-ground biomass is used. For conversion from DM to carbon a default fraction of 0.5 kg C per kg DM is used.

For conversion from wetland to other land use categories the same value but recorded as a loss of carbon in the respective category (5A2, 5B2, 5C2 and 5E2) are used.

Change in carbon stock in dead organic matter

When forest land is converted to wetland it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for this category.

Change in carbon stock in soils

A default carbon sequestration of 0.5 tonnes C per hectare is assumed for land converted to WE.

Nitrous oxide emission

No estimates for the N_2O emission from re-established wetlands have been made.

Methane emission

CH_4 emissions are not estimated due to lack of methodology.

Uncertainties and time series consistency

The time series are complete.

QA/QC and verification

No verification has been made yet.

Recalculation

A recalculation has been made due to new area data on the established WE has been obtained.

Planned improvements

A full WE map for the entire Denmark is planned where the area is subdivided into fully water covered and partly water covered areas for both WE remaining WE and land converted to WE. A literature study for updated values for living biomass as well as for an eventual gain in soil carbon for WE will be made and incorporated in the next submission.

7.7 Settlements (5E)

The annual changes in carbon stock in settlements are assumed to be negligible, and because no estimates have been made, most changes are reported as NE in the CRF Table 5.E. For reporting purposes for land use conversions a default biomass in low buildings, grave yards is established.

7.7.1 Settlements remaining settlement (5E1)

Settlement area

The total area with SE has been estimated to 385,447 hectares in 1990 increasing to 454,688 hectares in 2010 or approx. 10 % of the total Danish area.

Settlement definition

Settlements are defined as all areas with infrastructures, roads, grave yards, sport facilities etc.

Methodological issues

Change in carbon stock in living biomass

No changes in carbon stocks are reported for SE remaining SE.

Change in carbon stock in dead organic matter

No changes in carbon stocks are reported for SE remaining SE.

Change in carbon stock in soils

No changes in carbon stock in soils are assumed.

Uncertainties and time series consistency

Table 7.24 Tier 1 uncertainty analysis for Settlements for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5.E Settlements		104.4	134.4				51.0	68.5
Living biomass	CO_2	104.4	134.4	10	50	51.0	51.0	68.5

The time series are complete.

QA/QC and verification

No QA/QC has been performed.

Recalculations
A recalculation of the area has been made due to a QA/QC analysis.

Planned improvements
The planned QA/QC of the land use matrix will very likely change the area with SE.

7.7.2 Land converted to settlement (5E2)

Land converted to SE is mostly taking place around the big cities and primarily on cropland.

Settlement area
The area converted from other land use to SE is based on remote sensing of the Danish area in 1990 and 2005 combined with the cadastral maps and road vector maps. From 2005 and onwards the development in the number of houses and other buildings in the cadastral maps is used.

Methodological issues
Change in carbon stock in living biomass
For land converted to single-family houses a standard default gain value of 2,200 kg DM (dry matter) per hectare in above-ground biomass and 2,200 kg DM per hectare in below-ground biomass is used. For conversion from DM to carbon a default fraction of 0.5 kg carbon per kg DM is used.

For conversion from settlements to other land use categories the same value is used, but recorded as a loss of carbon in the respective category (5A2, 5B2, 5C2 and 5D2).

Change in carbon stock in dead organic matter
When forest land is converted to settlements it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for these categories.

The N_2O emission is estimated from an instant oxidation of the litter layer with an

Change in carbon stock in soils
A default value of 120 tonnes carbon per ha is assumed to be areas Settlements (Table 7.15). For all areas converted from other land use to Settlement is assumed that equilibrium state will be reached after 100 years from the carbon stock in the previous land use category. This is agreed with the UNFCCCs review team during the review in 2011.

N_2O emissions due to the degradation of carbon is estimated with a default C:N value of 15 and an emission factor of 1.25 % (N_2O-N)

Uncertainties and time series consistency
See uncertainties and time series consistency in Section 7.6.1

The time series are complete.

QA/QC and verification

No QA/QC has been performed.

Category-specific recalculations

The review team in 2011 argued that carbon losses due to deforestation into settlements should be included in the inventory despite there is no IPCC guidelines for this. During the review it was agreed on that an appropriate equilibrium carbon stock in Settlements could be 120 tonnes of carbon per ha (0-100 cm) which is approximately 20-25 % lower than found in FL, CL and GL. The resubmission in 2011 only included deforestation. In this submission emissions from all land use conversions to Settlements are estimated according to this rule.

Planned improvements

An updated land use matrix is planned for the next submission.

7.8 Other land

No permanent snow cover exists in Denmark and only a very small insignificant area with rocks and cliffs. OL is restricted to beaches and sand dunes. The official land area is 43 098 km^2. This area includes rivers and lakes.

No land use changes from 5A, 5B, 5C, 5D and 5E is reported. The total area with OL is reported to 342,685 hectares in 1990 decreasing to 304,843 hectares in 2010.

An updated land use matrix is planned for the next submission.

7.9 Direct N_2O emissions from N fertilization of Forest Land and Other land use – 5(I)

Only a very small amount of nitrogen fertilisers are used in the Danish forests and primarily to Christmas trees. All emissions are reported under Agriculture CRF Table 4.Ds1 since there is only one common national statistics for N fertilization in agriculture and forestry.

7.10 Non-CO_2 emissions from drainage of forest soils and wetlands – 5(II)

A large proportion of the Danish forest area may be considered as drained in the sense that the natural hydrology has been modified by establishment of ditches. Large forest areas have been drained in order to enable establishment of Norway spruce in depressions, fens and pond areas. As an example, a major state forest Gribskov in Northern Zealand by 1850 had an estimated wetland area 400 % larger than that of 1988 (http://www.skovognatur.dk/Ud/Beskrivelser/Hovedstaden/Gribskov/VandetTilbage.htm). During the recent years, there has been an effort to restore wetland habitat in the state forests and several drained areas have been restored by filling up ditches, and in many areas of the state forests ditches are no longer maintained and will be gradually more and more ineffective over time. This is a direct consequence of the strategic plan for the state forests to convert to more Close to Nature Forest Management with a specific aim to restore natural hydrology in as many places as possible.

Very few data exist for N_2O emissions in Danish forests. A national project and EU projects have provided data for hydrological gradients in mini-catchments in an old-growth forest and an afforestation area (Christiansen et al., in prep.) and data for one intensively studied beech forest plot (Skiba et al., 2009). For general application at the national level, tier 1 methods will be applied based on default emission factors (IPCC GPG). Emission factors will be compared with the few examples of emission factors data from national projects.

7.10.1 Methodological issues

Equation 3a.2.1 of IPCC GPG was used for estimation of direct N_2O emissions from drained forest soils (tier 1).

Default emission factors (IPCC GPG, Table 3a.2.1) were used for calculation of N_2O emissions. Danish organic soils were considered to be "Nutrient Rich" based on the general presence of fens (minerotrophic peat) and the relatively high N deposition to Danish forests. Rewetted forest soils were assumed to have an N_2O emission corresponding to the natural level and emissions were therefore by default set to zero in accordance with IPCC GPG.

7.10.2 Areas of drained forest soils

Based on expert judgement, the area of drained forest soils were 65 % of mineral forest soils and 75 % of organic forest soils in 1990. It is further judged that the amount of drained forest soils have decreased in the period until 2008 resulting in an area of drained forest soils with 55 % of mineral forest soils and 50 % of organic forest soils. Organic soils constituted 5 % of the forest area based on information on presence of peat from the NFI. A more detailed analysis of forest soils including a mapping is under preparation. A detailed analysis of the re-measurements of the NFI since 2002 will give some indications of the changes in that period, but no data exists prior to 2002. The combined analysis will be included in the next reporting.

7.10.3 Emissions of N_2O from drained forest soils

Estimates of N_2O emissions (Gg N_2O per year) from drained forest soils in 1990 and 2008 are based on the IPCC 2003 values. This means that for mineral soils is 0,06 kg N_2O-N per ha per year and for organic soils 0,6 kg N_2O-N per ha per year.

Emission factors are generally in reasonable accordance with those obtained in national projects. In mini-catchments Christiansen et al. (in prep.) found average annual emissions of 0.56±1.1 kg N_2O-N per ha per year for an afforested stand (30 years) and of 0.78±4.2 kg N_2O-N per ha per year for an old-growth forest. Both sites included hydrological gradients from wet/moist to well-drained conditions. For a well-drained Danish beech forest site, Skiba et al. (2009) reported average annual emissions of 0.45±0.48 kg N_2O-N per ha per year.

7.11 N_2O emissions from disturbance associated with land-use conversion to cropland – 5(III)

The main land-use conversion involving deforestation is the conversion from forest to grassland. This land-use change is expected to be a source for

N_2O emissions due to the decomposition of forest floors and corresponding increased mineralization of N. It is assumed that forest floors are completely decomposed during the conversion. Emissions of N_2O are based on default emission factors (IPCC, 2003).

7.11.1 Methodological issues

For all deforestated areas it is assumed that the forest floor disappears regardless if the land use conversion is into CL, GL, WE or SE. This is in contradiction to the guidelines and CRF Table 5(III), which is only related to disturbance associated with land-use conversion to CL.

Emissions of N_2O from deforestation were assumed to originate only from mineralization of forest floors since SOC-stocks in mineral soils are assumed constant following land-use change from forestry to grassland. The average nitrogen content of forest floors based on the repeated soil inventory was used to estimate the N mineralized for conifers and broadleaves, respectively. A proportion of 1.25 % of the N stock mineralized is assumed to be emitted as N_2O-N.

7.11.2 Emissions of N_2O from deforestation and land-use conversion

The average N content of broadleaf and conifer forest floors for Danish forest plots are given in Table 7.25 together with the estimated N fraction emitted as N_2O. According to IPCC (2003), a default fraction of 1.25 % is assumed emitted as N_2O-N during mineralization of the total N content following conversion.

Table 7.25 Total N content of forest floors in Denmark from the systematic grid "Kvadratnettet". The total N content is used for estimation of the amount of N (1.25%) emitted as N_2O during mineralization of the total forest floor N content following land-use change from forest to grassland.

Tree species	Number of plots	Mean N content (kg ha^{-1})	Standard dev. (kg ha^{-1})	Min N content (kg ha^{-1})	Max N content (kg ha^{-1})	N_2O-N, (kg ha^{-1})
Broadleaves	48	359	310	42	1472	4.5
Conifers	60	728	637	20	3447	9.1

In 1990, emissions of N_2O from deforestation were estimated at 0.0098 Gg N_2O for mineral soils and 0.0005 Gg N_2O for organic soils. In 2010 the figures were 0.0019 and 0.0001 Gg N_2O for mineral and organic soils, respectively.

7.12 CO_2 emissions from agricultural lime application – 5(IV)

Liming of agricultural soils has taken place for many years. Only a very little amount of lime is applied in forests (<0.5 %) and on permanent grassland. Therefore all liming is included in the inventory under cropland (CRF Table 5(IV)).

The Danish Agricultural Advisory Centre (DAAC) has published the lime consumption for agricultural purposes annually since 1960 (Table 7.26). DAAC are collecting data from all producers and importers. By legislation all producers and importers are obligated to have their products analysed for acid neutralisation content. The analysis is carried out by the Danish Plant Directorate and published annually (PDIR 2004). The published data from DAAC are corrected for acid neutralisation contents for each product and thus given in pure $CaCO_3$. For that reason there is no need to differ between lime and dolomite as made in the guidelines, as this has already been included in the background data. The data from DAAC includes all different products used in agriculture, including e.g. $CaCO_3$ from the sugar refineries.

The amount of lime used in private gardens has been estimated from the main supplier to private gardens. According to the company (Kongerslev Havekalk A/S, pers. comm.) they are responsible for 80 % of the sale to private gardens. Their sales figures have been used to estimate the total consumption in private gardens. Furthermore, the figures are corrected for acid neutralisation capacity according to the data from the Danish Plant Directorate. This gives an approximate amount of 2,300 tonnes $CaCO_3$ per year in private gardens. This figure has been used for all years.

A very small consumption of CAN (Calcium Ammonium Nitrate) and Urea is taking place in Denmark. The amount of CO_2 included in these two fertilisers is included in the lime consumption. Data is taken from the annual fertiliser statistics published by Statistics Denmark.

The amount of lime used for agricultural purposes has declined with 70 % since 1990. From 2000 to 2010 the consumption has been very stable around 400-500 Gg $CaCO_3$ although the sold amount of lime in 2009 fell to 412 Gg $CaCO_3$. 500 Gg is expected to be the lowest consumption needed to maintain appropriate pH values in the Danish agricultural soils at the moment. The main reason for the reduced lime consumption is a decreased need for acid neutralisation due to less SO_X deposition in Denmark (which also can be seen in the Norwegian inventory) and a reduced consumption of fertilisers containing ammonium. The inter-annual variation is primarily due to weather conditions (if it is possible to drive in the fields) and the economy in agriculture.

The amount of carbon is calculated according to the guidelines where the carbon content is 12/100 of the $CaCO_3$. It is assumed that all carbon disappear as CO_2 the same year as the lime is applied.

Table 7.26 Lime and CAN application to cropland and grassland and in forests, 1990-2010.

Greenhouse gas source and sink categories	1990	1995	2000	2005	2008	2009	2010
Agriculture, Gg $CaCO_3$	1283	1125	590	497	518	410	410[a]
Private gardens, Gg $CaCO_3$	2,3	2,3	2,3	2,3	2,3	2,3	2,3
CAN and Urea	131,4	149,9	89,9	4,3	2,9	8,3	9,0
Total, Gg $CaCO_3$	1417	1277	682	504	523	421	421
Total, Gg C pr yr	623	562	300	221	230	185	185

[a]Preliminary estimate

Table 7.27 Tier 1 uncertainty analysis for Liming for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5(IV) Liming	CO_2	622.9	185.3	5	50	50.2	50.2	93.1

The time series is complete.

The collected data is assumed to be very reliable. It is assumed that the uncertainty is in the range of 10 %. The emission factor may be overestimated due to expected leaching of CO_3^{--}, however no data is available on this issue.

7.13 Biomass burning – 5(V)

Biomass burning in the LULUCF sector is included for the first time. Burning of forest is prohibited as well as burning of wooden debris from hedgerows are very seldom. Only controlled burning of heathland of approximately 300 hectares per year is taking place. Due to the humid climate wildfires in the forest are very seldom and normally 0-10 hectares per year.

Data on wild and controlled fires has been collected by the Danish Nature Agency from the forest departments for the period 1990 to 2010. The emission factors are taken from the IPCC 2006 guidelines. As the burned forest is located on poor sandy soils are the default standing carbon stock assumed to be 150 Cubic meter per hectare, which is slightly lower than the average standing carbon stock in the Danish forests. The fraction burned for forest is taken from the guidelines whereas for heat land a factor of 0.33 is used. It is based on expert judgment made by the Danish Nature Agency who is responsible from for the controlled burning.

Table 7.27 Burned areas 1990 – 2010, ha per year.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Forestland area burned	150	1	0	0	6	0	0	0	0
Heathland area burned	47	53	122	638	202	270	282	296	359
Total burned area	197	54	122	638	208	270	282	296	359

Table 7.28 Tier 1 uncertainty analysis for Biomass burning for 2010.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 qv.
5(V) Biomass Burning	CH_4	0.5	0.0	50	30	58.3	58.3	0.0
5(V) Biomass Burning	N_2O	0.4	0.0	50	30	58.3	58.3	0.0

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8 Waste (CRF sector 6)

8.1 Overview of the sector

The waste sector consists of the CRF source categories: 6.A Solid Waste Disposal on Land, 6.B. Wastewater Handling, 6.C. Waste Incineration and 6.D. Waste Other.

For the CRF category 6.A. Solid Waste Disposal on Land, the CH_4 emissions reported in this chapter is a result of calculations in continuation of previously used and reported methodology. As a result of the analysis and investigations initiated as a result of the 2010 in-country review, new waste categories have been implemented.

For the CRF category 6.B. Wastewater Handling, improvements to the CH_4 methodology as well as N_2O emissions was introduced in last year's submission. The minor changes are due to an error in one of the activity references within in model in the 2011 submission. No methodological changes have occurred.

For the CRF source category 6.C. Waste Incineration, the main emissions are included in the energy sector since all incineration of municipal, industrial, medical and hazardous waste in Denmark is done with energy recovery. The Waste Incineration category includes CH_4 and N_2O emissions from the minor sources of cremation of corpses and carcasses.

The source sector 6.D. Waste Other covers emissions from combustion of biogas in biogas production plants (mentioned as Gasification of biogas in the CRF tables) for the years 1994-2005 where these emissions existed. This activity is not occurring in 2006 - 2010. The Waste Other category includes CO_2, CH_4 and N_2O emissions from the sources: accidental building fires, accidental vehicle fires and compost production.

Chapter 8.7 presents improved QA/QC procedures and recalculations reflecting the recommended improvements of the 2010 in-country review.

In Table 8.1.1, an overview of all emissions from the waste sector is presented. The emissions are taken from the CRF tables and are presented as rounded figures. The full time series is presented in Annex 3G, Table 3G-1.1.

Table 8.1.1 Emissions for the waste sector, Gg CO_2 equivalents.

		1990	1995	2000	2005	2006	2007	2008	2009	2010
6 A. Solid Waste Disposal on Land	CH_4	1530	1354	1183	942	976	931	894	851	777
6 B. Wastewater Handling	CH_4	66	69	74	74	74	75	75	75	75
6 B. Wastewater Handling	N_2O	109	115	99	94	81	93	111	81	84
6 C. Waste Incineration	CH_4	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
6 C. Waste Incineration	N_2O	0.20	0.21	0.22	0.24	0.27	0.28	0.28	0.29	0.29
6 D. Waste Other	CO_2	18	20	19	18	19	19	22	21	18
6 D. Waste Other	CH_4	28	36	62	66	70	78	72	76	82
6 D. Waste Other	N_2O	11	15	41	31	34	39	36	39	43
6. Waste	Total	1764	1610	1478	1227	1254	1235	1210	1144	1079

6.A. Solid Waste Disposal on Land is the dominant source in the waste sector with contributions in the time series varying from 86.7 % (1990) to 72.0 % (2010) of the total emission, given in CO_2 equivalents. Throughout the time series, the emissions are decreasing due to a reduction in the amount of waste deposited. Comparing 2010 and 2009 with 1990, the emissions from Solid Waste Disposal on Land have decreased with 49.2 % and 44.4 % respectively.

6.B. Wastewater Handling. For this source, N_2O contributes the most to the sectorial total, varying between contributions of 5.4 % (1992) and 9.2 % (2008). In 2010 the contribution is 7.8 %. CH_4 from this source contributes with between 3.7 % (1991) and 7.0 % (2010) of the sectorial total. The CH_4 emissions increase steadily over the time series. Comparing 2010 and 2009 with 1990, the emissions from Wastewater Handling have decreased with 9.4 % and 11.3 % respectively.

6.C. Waste Incineration. This source contributes with CH_4 and N_2O emissions from human and animal cremations. The contribution to CO_2-equivalent emissions from the sum of CH_4 and N_2O is for the time series 1990-2010 below 0.03 %. The trend for the total emissions 1990 - 2010 from this source is increasing; compared to 1990 the 2010 and 2009 emissions have increased with 48.6 % and 45.5 % respectively. This increase is almost entirely caused by the increase in animal cremation as this activity has risen with 966 % from 1990 to 2010.

6.D. Waste Other. This source contributes with CO_2, CH_4 and N_2O emissions from accidental fires and compost production. The contribution to the total emissions from the waste sector varies from 3.3 % (1990) to 13.2 % (2010). Throughout the time series, emissions from Waste Other are increasing; from 1990 to 2010 this category increases with 147.3 %. The great increase in emissions from 6.D is almost entirely caused by the increasing use of composting at municipal treatment sites.

As a result for the entire waste sector, the sectorial total emission in CO_2-equivalents, Table 8.1.1, decreasing throughout the time series, the emission in 2010 has, compared to 1990, decreased with 38.8 %.

Table 8.1.2 specifies the origin and type of the methods and emission factors applied in the Danish inventory.

Table 8.1.2 Reported emissions, calculated methods and type of emissions factors for the subcategory waste handling in the Danish inventory. (CS=country specific, D=default, OTH=other)

CRF	Source	Emissions reported	Method	Emission factor
6 A.	Solid Waste Disposal on land	CH_4	Tier 2,CS	CS,D
6 B.	Wastewater Handling	CH_4	CS	CS
		N_2O	CS	CS
6 C.	Waste Incineration	CH_4	Tier 1	OTH
		N_2O	Tier 1	OTH
6 D.	Waste Other	CO_2	Tier 1, CS	CS, OTH
		CH_4	Tier 1, CS	CS, OTH
		N_2O	Tier 1, CS	CS, OTH

8.1.1 Key category identification

In the key category analysis (KCA) the waste emissions are divided into nine categories. In the tier 1 and tier 2 KCA, two of the nine source categories are identified as key categories in 2010 (Table 8.1.3). The tier 1 key source identification is based on ranking of absolute quantitative emission, while the tier 2 KCA takes into account the uncertainties in the calculated emissions, cf. Chapter 1.5).

Off the nine categories, Solid Waste Disposal on Land is the only category identified as key source for level. According to the level assessment for both tier 1 and tier 2 KCAs Solid Waste Disposal on Land is a key source for level for both year 1990 and 2010. Solid Waste Disposal on Land is also a key category contribution to the trend of the national total of greenhouse gases, calculated in CO_2 equivalents, from 1900 to 2010 for both tier 1 and tier 2 KCAs.

CH_4 from Compost Production is a key source for trend when using the tier 2 trend assessment.

Identified key categories within the waste sector are presented in Table 8.1.3. For further information on the KCA level and trend assessments please refer to Chapter 1.5 and Annex 1.

Table 8.1.3 Key category identification tier1 and tier 2 from the waste sector 1990 and 2010.

		Tier 1			Tier 2		
		1990	2010	1990-2010	1990	2010	1990-2010
6 A. Solid Waste Disposal on Land	CH_4	Level	Level	Trend	Level	Level	Trend
6 B. Wastewater Handling, direct	CH_4	-	-	-	-	-	-
	N_2O	-	-	-	-	-	-
6 B. Wastewater Handling, indirect	N_2O	-	-	-	-	-	-
6 C. Incineration of corpses	CH_4	-	-	-	-	-	-
	N_2O	-	-	-	-	-	-
6 C. Incineration of carcasses	CH_4	-	-	-	-	-	-
	N_2O	-	-	-	-	-	-
6 D. Accidental fires, buildings	CO_2	-	-	-	-	-	-
	CH_4	-	-	-	-	-	-
6 D. Accidental fires, vehicles	CO_2	-	-	-	-	-	-
	CH_4	-	-	-	-	-	-
6 D. Compost production	CH_4	-	-	-	-	-	Trend
	N_2O	-	-	-	-	-	-

As may be observed from Table 8.1.3 category 6 B. and 6 C. are divided into two sub-categories, whereas category 6 D is divided into three sub-categories. Sub-categories are defined according to inventory reporting and emission models used and the outcome of the KCA influenced by the level of disaggregation into sub-categories.

8.2 Solid waste disposal on land (CRF source category 6A)

For many years, only managed waste disposal sites have existed in Denmark. Unmanaged and illegal disposal of waste is considered to play a negligible role in the context of this category. The amount of deposited waste has decreased markedly throughout the time series. The increase in waste deposited from 2005-2007 levels to 2008 is due solely to an increase in Ash and Slag deposited (cf. Table 8.2.3). The general development for solid waste is a result of action plans by the Danish government called the "Action plan for Waste and Recycling 1993-1997" and "Waste 21 1998-2004" (The Danish Government, 1999). The latter plan had, inter alia, the goal to recycle 64 %, incinerate 24 % and deposit 12 % of all waste. The goal for deposited waste was met in 2000. Further, in 1996 a municipal obligation to assign combustible waste to incineration was introduced. In 2003, the Danish Government set up targets for the year 2008 for waste handling in a “Waste Strategy 2004-2008” report (The Danish Government, 2003). According to this strategy, the target for 2008 is a maximum of 9 % of the total waste to be deposited. In the waste statistics report for the year 2004, data shows that this target was met, since 7.7 % of total waste was deposited in 2004 (DEPA, 2006a). The Danish Government in 2009 set up targets for 2012 according to which a maximum of 6 % of the total waste produced is to be deposited (The Danish Government, 2009). In 2009, it appears that this target has already been met as only 5.6 % of all produced waste was deposited. Data on this level of information from the ISAG database/waste statistics (1994-2009) is presented in Annex 3G, Table 3G-2.1.

8.2.1 Source category description

There are around 134 registered solid waste disposal sites (year 2001, DEPA 2006b) generating CH_4 according to the degradation rate of the deposited organic waste at these sites. The status for closed and still active solid waste disposal sites (SWDS) is that 81 of the 134 had been closed in 2003 and out of the 53 still active SWDS, methane collection for use in energy-producing installations occurs at 16 sites (DEPA, 2003a).

The CH_4 emission estimate has decreased with 49.2 % from 1990 to 2010. For this submission the methodology chapter, activity data, input parameters and uncertainties have been explained in more detail in order of increasing transparency in the emission inventory for this category.

A quantitative overview of this source category and its main data are shown in Table 8.2.1 presenting the amounts of landfilled waste, the annual generated CH_4, the recovered CH_4 collected at landfill sites and used for energy production, the amount of CH_4 oxidised in the top layers and the resulting net emissions. A full time series (1990-2010) of these data are shown in Annex 3G, Table 3G-2.2. The amount of waste and the resulting CH_4 emission can also be found in the CRF tables submitted (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php).

Table 8.2.1 Annual amounts of deposited waste, generated methane, recovered methane collected for biogas production, oxidised methane in the top layer and resulting net emission for the Danish SWDS.

Year	Landfilled waste	Gross methane emission	Recovered methane	Methane oxidised in the top layers	Net methane emission	
	Gg	Gg CH_4	Gg CH_4	Gg CH_4	Gg CH_4	Gg CO_2 eq
1990	3175	81,5	0,5	8,1	72,8	1530
1995	1957	79,7	8,0	7,2	64,5	1354
2000	1482	74,5	11,9	6,3	56,4	1183
2005	957	60,4	10,5	5,0	44,9	942
2006	975	57,6	5,9	5,2	46,5	976
2007	956	55,1	5,9	4,9	44,3	931
2008	1045	52,5	5,2	4,7	42,6	894
2009	753	50,1	5,1	4,5	40,5	851
2010	970	47,7	6,6	4,1	37,0	777

The decrease in the emission throughout the time series is not quite as steep as the general decrease in the amount of waste deposited. This is due to the time involved in the degradation processes generating the CH_4.

Methodological issues

The estimation of CH_4 emission from Danish SWDSs is based on a First Order Decay (FOD) model equivalent to the IPCC tier 2 methodology (IPCC 1997, 2000 and 2006). The model calculations are performed using national statistics on landfill waste categories reported in the national waste statistics. In this year's submission the eight waste categories (Annex 3G, Table 3G-2.3a and b) has been assessed according to the waste types in units of mass fractions (Annex 3G, Table 3G-2.4a and h) and of individual content of degradable organic matter and half-life´s.

Modelling of decay processes as first order kinetics is described as exponential decay. When a quantity N is the subject to this type of decay, the mathematical formulation is

$$\frac{dN}{dt} = -k \cdot N \qquad \text{Eq. 8.2.1}$$

where k is the decay constant. Equation 8.2.1 can be solved for the simple case of a momentarily single deposition at time t (W_t) yielding:

$$N(t) = W_t \cdot e^{-k\,t} \qquad \text{Eq. 8.2.2}$$

where k relates to the half-life time for the content of degradable organic carbon (DOC) in the bulk waste, as:

$$t_{1/2} = \frac{ln2}{k} \Rightarrow k = \frac{ln2}{t_{1/2}} \qquad \text{Eq. 8.2.3}$$

The content of degradable organic carbon (DOC), half-life times ($t_{½}$) and the corresponding methane generation constants (k) are presented in Table 8.2.2.

Table 8.2.2 Half-life times ($t_{½}$) and degradation rates constants (k) and content of degradable organic matter (DOC_i) according to waste type.

Waste type[1]	DOC_i, %[4]	$t_{½}$, yr	k, yr^{-1}
Food waste	15[2,3]	4[2,3]	0.17
Cardboard	40[3]	12[3]	0.06
Paper	40[3]	12[3]	0.06
Wet cardboard and paper	20[4]	12[3]	0.06
Other combustible	20-57[4]	14[2]	0.05

[1]Waste types which decomposes
[2]Default IPCC, 2000, page 5.7
[3]Default IPCC, 2006 (page 3.18 for $t_{½}$.)
[4]For further details see table 8.2.4 and 8.2.5

The amount of generated methane decreases exponentially over time according to first order degradation kinetics of the content of degradable organic carbon in the deposited waste.

At a given year (t) the amount of degradable organic carbon (D*DOCm*(t))which decomposes is a result of accumulated contributions from all former years deposit of waste ($W(x)$), where x is year since depositing. The residue of organic matter, i.e. decomposable DOC, left from waste deposited at landfill sites x years ago, is calculated using the exponential decomposition rule (Eq. 8.2.4).

$$DDOCm(t) = W_t \cdot DOC \cdot DOC_f \cdot MCF + DDOCm(t-1) \cdot e^{-k} \qquad \text{Eq. 8.2.4}$$

where the methane conversion factor, MCF, has been set to the default value of 1 for managed SWDS, which is the situation in Denmark (page 3.14, IPCC 2006). *DOC* is the mass fraction of degradable organic carbon in the waste deposited (Table 8.2.2, 8.2.4 and 8.2.5) and DOC_f , the fraction of *DOC* that can decompose depending on pH, temperature, waste composition etc.; for Denmark the default DOC_f value is set to 0.5 (IPCC 2006, page 3.13).

Eq. 8.2.4 assumes that the deposition of degradable organic carbon takes place momentarily once a year and just after the time t, where t is defined as whole years (integer: t=1,2,..), so Eq. 8.2.4 consists of two overall contributions that may be expressed as

$$DDOCm(t) = New\ deposit + \text{Remaining part}\ of\ \ former\ years\ deposit$$

The total amount of degraded organic matter during year t ($DDOCm\ decomp_T$) is assumed to be equal to the degradation during year t of the organic matter that was deposited at the beginning of the year ($DDOCm(t\text{-}1)$):

$$DDOCm\ decomp_T = DDOCm(t-1) \cdot (1 - e^{-k}) \qquad \text{Eq. 8.2.5}$$

Based on Equation 8.2.4 and 8.2.5 it is possible to calculate the degraded amount of organic matter in a step wise manner based on last year result. This degraded amount of organic matter is assumed to generate the CH_4 as described by

$$CH_4\ generated_T = DDOCm\,decomp_T \cdot F \cdot 16/12 \qquad \text{Eq. 8.2.6}$$

where F, which is the fraction of methane in the gas from landfills, is set equal to 0.41 (DGC, 2009) and 16/12 is the conversion factor from units of C to CH_4

For deriving the net emissions, the amount of recovered or collected methane as well as the amount of oxidised methane in the SWDS top layers needs to be subtracted from the generated methane:

$$CH_4\ Emissions = \left(\sum_x CH_4\ generated_{x,T} - R_T \right) \cdot (1 - OX_T) \qquad \text{Eq. 8.2.7}$$

Where CH_4 *Emissions* is the methane emitted in year T, in units of Gg. T is the inventory year, x is the waste category or type.
R_T is the amount of recovered CH_4 at the Danish disposal sites which are used for energy production. Energy producing installations at 16 sites (DEPA, 2003a) are registered. The Danish Energy Agency registers the biogas amounts recovered at disposal sites in energy units (TJ) (DEA, 2011). The amount of gas in energy unit is converted to volume of gas using the net calorific value of 15.19 MJ per Nm^3 (DGC, 2009; Vattenfall, 2010; Verdo, 2011). As for the FOD model, the content of CH_4 in the gas recovered is estimated to 41 % and the density of CH_4 is 0.718 kg per m^3.
OX_T is the assumed oxidation of CH_4 in the top layer. The amount oxidised is uncertain and varies according to SWDS characteristics and management practices. For the Danish model an oxidation factor (OX) of 0.1 used; i.e. the default value for industrialised countries with well-managed disposal sites (IPCC, 2000 and 2006).

The amount of CH_4 recovered, $R(t)$, is calculated as:

$$R_T = \frac{B \cdot 0.41 \cdot 0.718}{15.19}$$

where B is the collected amount of biogas as reported by the DEA.

The CH_4 recovered is reported in Table 8.2.1 in units of Gg.

In the following section, the methane generation potentials per unit mass of individual waste categories, total amount of degradable organic carbon present at the Danish landfills, annual degraded amounts of organic carbon and resulting annual CH_4 emissions are presented in more detail.

Activity data

The data used for the amounts of municipal solid waste deposited at managed solid waste disposal sites are (according to the official registration) worked out by the Danish Environmental Protection Agency (DEPA) in the so-called ISAG database. The ISAG data system provides landfill data for the years 1994-2009 (DEPA, 1996a, 1998a, 1999a, 2001a, 2001b, 2002a, 2004a, 2004b, 2005a, 2006a, 2006b, 2008, 2010a, 2011a).

The amounts of waste deposited are registered and published in the national ISAG database according to eight categories as provided in Table 8.2.3.

Table 8.2.3 Waste amounts divided between eight waste categories, Gg.

Year	Domestic Waste	Bulky Waste	Garden Waste	Commercial & Office Waste	Industrial Waste	Building & Construction Waste	Sludge	Ash & Slag	Total Landfilled Waste
1990	198.9	250.7	85.2	109.3	822.4	951.4	222.1	535.0	3175.1
1995	190.0	286.0	17.0	128.0	779.0	321.0	101.0	135.0	1957.0
2000	85.0	264.0	7.0	152.0	611.0	269.0	94.0	0.0	1482.0
2005	11.9	164.5	5.4	152.4	352.2	207.7	34.6	28.0	956.7
2006	13.5	156.4	5.7	150.8	375.3	203.9	39.4	30.6	975.5
2007	19.0	146.2	6.4	160.4	364.1	171.9	43.4	44.4	955.6
2008	20.0	109.0	7.0	152.0	389.0	177.0	33.0	158.0	1045.0
2009	12.8	88.3	2.6	121.5	336.5	126.2	25.1	39.7	752.8
2010	16.5	113.8	3.4	156.6	433.7	162.7	32.4	51.1	970.1

The new data system that is to replace the ISAG database was expected in 2011 (starting with 2010 data). The new system is however not yet functional and the 2010 data in this inventory has therefore been selected from the projection (Nielsen et al., 2011b).

Data for the entire basis of calculation time series, 1960-2010, are provided in Annex 3G, Table 3G-2.3a and b and based on the below data availability and assumptions.

The report from DEPA (1993) gives data for landfilled waste in 1985; the data are presented in the same eight waste categories as in Table 8.2.3. Activity data for deposited municipal waste between 1985 and 1994 (the start of the ISAG data system) have been calculated by interpolation using a linear regression of the individual waste categories.

The total deposited amount of waste is known for the year 1970 (DEPA, 1993) and the individual waste fractions are estimated based on the assumption that the waste category distribution is similar to 1985. Data for 1971-1984 have been determined by assuming a linear development between 1970 and 1985.

1960-1969 data are assumed constant at the 1970 level.

For the entire time series 1960- 2010, the eight waste categories (Annex 3G, Table 3G-2.3a and b) has been assessed according to the waste types in units of mass fractions (Annex 3G, Table 3G-2.4a and h) and the resulting waste amounts according to waste types are provided in Table 8.2.4.

Table 8.2.4. Waste amounts divided between the nine waste types, Gg.

Waste types		1990	1995	2000	2005	2006	2007	2008	2009	2010
Food Waste		68,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cardboard		32,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paper		64,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wet Cardboard and Paper		33,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Plastics		18,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other Combustible	Domestic Waste	97,3	172,7	80,6	3,3	4,9	4,0	1,9	1,2	1,6
	Bulky Waste	107,4	126,2	116,5	2,9	4,9	13,0	2,6	2,1	2,8
	Garden Waste	57,9	6,2	1,9	0,0	0,2	0,5	0,3	0,1	0,2
	Commercial & Office Waste	23,8	44,2	67,0	10,8	12,3	25,3	11,2	9,0	11,6
	Industrial Waste	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Building & Construction Waste	66,7	26,9	18,5	5,3	9,4	5,6	4,3	3,1	3,9
	Sludge	174,9	73,0	72,7	9,5	12,0	17,2	10,9	8,3	10,7
	Ash & Slag	97,3	172,7	80,6	3,3	4,9	4,0	1,9	1,2	1,6
Glass		27,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Metal		82,9	0,0	0,0	48,7	47,1	10,1	7,1	6,2	8,0
Other Not Combustible		2221,3	1355,7	1031,2	863,9	869,6	860,6	992,2	710,3	915,4
Total Waste according to waste types*		3173,8	1977,6	1469,0	947,6	965,3	940,2	1032,5	741,5	955,6

* The differences in the reported total amount of waste in Table 8.2.3 and 8.2.4 are within the estimated uncertainties in activity data included in the tier 1 and 2 uncertainty analysis.

As may be observed from Table 8.2.4, the reporting of waste deposited at landfills have only been reported for two of the nine waste types since 1994, i.e. the "Other combustible" and "Other Not Combustible waste". To overcome the missing knowledge of the actual waste types deposited in the national waste statistics we continued applying the survey from 1993 (DEPA, 1993) in this year's inventory. As mentioned above, we expect to have more detailed reporting on deposited waste types as a result of the new data system from next year (personal communication with the Danish EPA).

Emission factors

The organic carbon content of the waste types is a key parameter for estimating the CH_4 emission. Data on the degradable organic carbon (DOC_i) content in the Danish waste types are available for 1985 from DEPA (1993). The data are in good agreement with IPCC default values for the waste types "food waste", "cardboard" and "paper" (Table 8.2.2). The DOC content in the Danish landfilled waste covers the waste types listed below:

- Food waste
- Cardboard
- Paper
- Wet cardboard and paper
- Plastics
- Other combustible
- Glass
- Other, not combustible

For every waste category (domestic-, bulky-, garden-, commercial & office-, industrial-, building & construction waste, sludge and ash & slag) reported in the yearly waste statistics (DEPA, 1996a, 1998a, 1999a, 2001a, 2001b, 2002a, 2004a, 2004b, 2005a, 2006a, 2006b, 2008, 2010a, 2011a), compositions according to waste types (food waste, cardboard, paper, wet cardboard and paper, plastics, other combustible, glass and other not combustible) are known for 1985 and 1994-2008 . Waste types have been assigned to waste categories as this allow us to implement separate half-life's according to the individual waste types and content of degradable organic matter, DOC_i.

For the period 1994-2008 a separate data extraction on waste types has been performed for each of the waste categories reported in the National waste statistics. Waste type compositions in 1986-1993 have been interpolated assuming a linear increase from 1985 to 1994 and the compositions in 1960-1984 are assumed to equal those of 1985. The full data set for 1985-2008 is presented in Annex 3G, Table 3G-2.4a-h.

National waste statistics for 2009 were not available in the ISAG web database early enough for the individual waste types to be calculated and reported in this year's inventory.. The composition according to waste types for both 2009 and 2010 were therefore set to equal those for 2008. Table 8.2.5 presents the fractional distribution of nine identified waste types of known DOC values according to the eight ISAG waste categories reported in the Danish waste statistics.

Table 8.2.5 Fractional distributions of waste types, *i*, and DOC_i content according to waste categories, *j*, given in units of mass fraction for the year 2008.*

Waste types, *i* / Waste categories, *j*	Food waste	Cardboard	Paper	Wet Cardboard and paper	Plastics	Other Combustible	Glass	Metal	Other not Combustible	Total
Domestic Waste	0.000	0.000	0.000	0.000	0.000	0.094	0.000	0.000	0.906	1.00
Bulky Waste	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.976	1.00
Garden Waste	0.000	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.955	1.00
Commercial & Office Waste	0.000	0.000	0.000	0.000	0.000	0.074	0.000	0.000	0.926	1.00
Industrial Waste	0.000	0.000	0.000	0.000	0.000	0.037	0.000	0.018	0.945	1.00
Building & Constr. Waste	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.976	1.00
Sludge	0.000	0.000	0.000	0.000	0.000	0.331	0.000	0.000	0.669	1.00
Ash & slag	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
DOC content, DOC_i	0.15	0.40	0.40	0.20	-	0.20-0.57	-	-	-	

*The waste types plastics, glass, metal and other not combustible are considered inert, i.e. $DOC_f = 0$, and no information on the carbon content is provided.

Waste types was assessed according to the national waste statistics reported each year in the ISAG database as shown for the year 2008 in Table 8.2.5. The DOC contents in food waste, cardboard and paper are set equal the default value from IPCC (1997 and 2006) and for wet cardboard and paper the value from the Danish survey from 1993 (DEPA, 1993) was used. As may be observed from Table 8.2.5, the main part of the landfilled waste are reported under the waste types "Other Combustible" and "Other not Combustible". For the ISAC waste type "Other combustible", DOC_i values have therefore been derived based on the Danish waste characterisation survey reported by DEPA (DEPA, 1993). The DOC_i values of each waste type included in the type "Other combustible" is shown separately in Table 8.2.6.

Table 8.2.6 DOC content, given in units of mass fraction, for the waste type "Other combustible" (DEPA, 1993).

	Domestic Waste	Bulky Waste	Garden Waste	Commercial & office Waste	Industrial Waste	Building & construction Waste	Sludge	Ash & slag
DOC content, DOC_i	0.20	0.40	0.25	0.40	0.35	0.40	0.57	0.0

The DOC content for each waste type, as provided in Table 8.2.5 and Table 8.2.6, have been kept constant for the whole time series.

The methane generation potential per unit waste type i may be obtained from the equation:

$$\frac{L_{o,i}}{W_i} = DOC_f \cdot MCF \cdot F \cdot 16/12 \cdot DOC_i$$
$$\Downarrow \qquad \text{Eq. 8.2.8}$$
$$\frac{L_{o,i}}{W_i} = 0.27 \cdot DOC_i$$

Where the yearly decomposable fraction of the organic carbon content, DOC_f, are set equal to 0.5, the methane conversion factor, MCF are set equal to 1 and the volume fraction of CH_4 in generated landfill gas, F, are 0,41 (DGC, 2009).

Waste amounts are reported annually for the waste categories, j, and a methane generation potential per unit waste category, $L_{o,j}$, may be expressed as:

$$L_{o,j} = W_j \cdot \sum_{i=1}^{i=9} f_{i,j} \cdot \frac{L_{o,i}}{W_i} \qquad \text{Eq. 8.2.9}$$

Where $f_{i,j}$ is the fraction of waste type i =1 to waste type i =9; each waste types contributing to each waste category j and $L_{o,j}$ the resulting methane generation potential mass per unit waste category j. The methane generation potential per unit waste for each of the waste category from 1990 to 2010 is presented in Table 8.2.7. The full time series is shown in Annex 3G, Table 3G-2.5.

Table 8.2.6 Methane generation potential for the individual waste categories, Gg CH_4 per Gg waste.

$L_{o,j}/W_j$	1990	1995	2000	2005	2006	2007	2008	2009	2010
Domestic Waste	0.0574	0.0606	0.0632	0.0185	0.0243	0.0140	0.0063	0.0063	0.0063
Bulky Waste	0.0755	0.0588	0.0588	0.0023	0.0042	0.0118	0.0032	0.0032	0.0032
Garden Waste	0.0566	0.0306	0.0225	0.0002	0.0032	0.0063	0.0038	0.0038	0.0038
Commercial & office Waste	0.0585	0.0461	0.0588	0.0094	0.0109	0.0210	0.0099	0.0099	0.0099
Industrial Waste	0.0210	0.0228	0.0179	0.0041	0.0047	0.0062	0.0043	0.0043	0.0043
Building & constr. Waste	0.0093	0.0112	0.0092	0.0034	0.0061	0.0043	0.0032	0.0032	0.0032
Sludge	0.1496	0.1373	0.1469	0.0519	0.0578	0.0753	0.0628	0.0628	0.0628
Ash & slag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The annual change in, the methane generation potential reported in Table 8.2.6 are due to the annual change in the composition of waste categories according to waste types. The methane generation potentials per unit mass waste for each of the eight categories are multiplied by the mass of the individual waste categories deposited annually to derive at the total organic degradable waste deposited at Danish landfills in units of potential CH_4 emission.

The constant methane generation potential according to waste types are reported in Table 8.2.7.

Table 8.2.7 Methane generation potential for the nine waste types, Gg CH_4 per Gg waste.

Waste types, *i*		$L_{o,i}/W_i$
Food waste		0,041
Cardboard		0,108
Paper		0,108
Wet cardboard and paper		0,054
Plastics		0
Other Combustible:	Domestic Waste	0,054
	Bulky Waste	0,108
	Garden Waste	0,068
	Commercial & Office Waste	0,108
	Industrial Waste	0,095
	Building & Construction Waste	0,108
	Sludge	0,154
	Ash & Slag	0
Glass		0
Metal		0
Other not Combustible		0

Model Results

The annual amounts of the different waste categories (Table 8.2.3) and their emission generation potentials per mass unit (Eq. 8.2.9 and Table 8.2.6) are used to calculate the deposited CH_4 generation potential and the actual generated CH_4 emission from the annually amount of deposited waste (Eq. 8.2.6). The CH_4 recovered and utilised by biogas combustion installations at some of the sites, as well as the amount of oxidised methane in the SWDS top layers, is subtracted from the generated methane emission to derive at the net CH_4 emission (Eq. 8.2.7).

The annual total amounts of deposited waste amounts accumulated degradable organic waste and annual degraded organic matter and the calculated CH_4 emissions are presented in Table 8.2.7.

Table 8.2.7 Waste deposited, total organic degradable matter, amounts of annual degraded organic matter and resulting CH_4 emissions for 1990-2010.

Year	Total Deposited Waste	Accumulated amount of decomposable DDOCm Eq. 8.2.4	Annual amount of degraded DDOCm, Eq. 8.2.5	Annual deposited CH_4 potential	Annual Gross CH_4 emission, Eq. 8.2.6	Recovered methane	Annual net emission before oxidation	Annual net emission after oxidation. Eq. 8.2.7	Implied emissions factor	
		[Gg]				[Gg CH_4]			Gg CH_4/Gg waste	Gg CH_4/Gg DDOCm
1990	3 175	2124	110	88.1	81.5	0,5	80.9	72,8	0.023	0,0331
1995	1 957	2023	107	74.4	79.9	8,0	71.6	64,5	0,033	0,0297
2000	1 482	1868	99	62.1	74.4	11,9	62.6	56,4	0.038	0,0268
2005	957	1436	82	6,4	60,4	10,5	49,8	44,9	0,047	0,0269
2006	975	1426	78	7,6	57,6	5,9	51,6	46,5	0,048	0,0294
2007	956	1365	74	11,4	55,1	5,9	49,2	44,3	0,046	0,0291
2008	1 045	1301	71	7,1	52,5	5,2	47,3	42,6	0,041	0,0295
2009	753	1238	68	6,3	50,1	5,1	45,0	40,5	0,054	0,0294
2010	970	1180	65	5,0	47,7	6.6	41,1	37,0	0,038	0,0280

The total waste amount in the second column of Table 8.2.6 is the sum of the amounts of the different waste categories (Table 8.2.2) and thereby includes Industrial Waste, Building and Construction Waste. The total waste amount is reported as the activity data for the Annual Municipal Solid Waste (MSW) at SWDSs in the CRF Table 6.A.

The implied emission factor (IEF) in the CRF tables reflects an aggregated emission factor for the model so far calculated as the net methane emission divided by the total amount of waste deposited in the current year (tenth column in Table 8.2.6).

The total amount of decomposable degradable organic matter, D*DOCm*, might be a more appropriate measure of activity in the calculation of the aggregated IEF. Implied emission factor calculated by use the D*DOCm* as activity data shows an overall decrease through the time series from 1990 to 2010 and is presented in the last column of Table 8.2.6.

The time trend for the total decomposable DOC and annual degraded organic matter are provided in the third and fourth column in Table 8.2.6.

8.3 Wastewater handling (CRF source category 6B)

The Danish wastewater treatment system is characterised by few big and advanced wastewater treatment plants (WWTPs) and many smaller WWTPs. From 1993 to 2010 the amount of wastewater treated at the most advanced technological WWTPs in Denmark has increased from 53 % to more than 90 %. 10 % of the population are not connected to the collective sewer system and for this part of the population, i.e. scattered houses, sludge from septic tanks are collected once per year or as appropriate by judgement of the local authorities (DEPA, 1999b). Municipal collection and transportation of sludge from septic tanks for treatment at the centralised WWTPs occurs to some extent, the frequency set by the authorities and in general septic tanks are emptied one time each year. Improvements of the decentralised wastewater treatment system as well as the sewer system are on-going in Denmark (DEPA, 2010b).

A presentation of methodological approach, emission factors, activity data and recalculations are presented in the following sub-chapters.

8.3.1 Source category description

This source category includes an estimation of the emission of CH_4 and N_2O from wastewater handling; i.e. wastewater collection and treatment. CH_4 is produced during anaerobic conditions and treatment processes, while N_2O may be emitted as a bi-product from nitrification and denitrification processes under anaerobic as well as aerobic conditions (e.g. Adouani et al., 2010; Kampschreur et al., 2009).

No distinction between emissions from industrial and municipal WWTPs is made, as Danish industries to a great extent are coupled to the municipal sewer system. Wastewater streams from households and industries are therefore mixed in the sewer system prior to further treatment at centralised WWTPs. The contribution from the industry to the influent wastewater at the centralised WWTPs has increased from zero to around 40% from 1987 to 2010 with the highest influent contribution occurring at the biggest and most advanced technological WWTPs in Denmark (Thomsen & Lyck, 2005; ASEP 2010). Monitoring data on the biological oxygen demand (BOD) for the mixed household and industrial influent are available for all WWTPs with a capacity above 30 PE treating more than 90 % of the Danish wastewater (DEPA, 1989,1999c, 2001d, 2003c, 2004d, 2009)

It should be mentioned that no activity data are available for industrial WWTPs. Therefore, the emissions from industries having separate wastewater treatment is unknown and i.e. not included in the Danish inventory for category 6.B. Wastewater handling. Only the indirect N2O emissions are included as effluent N data are available from DEPA reports (DEPA. 1994, 1996b, 1997, 1998b, 1999b, 2000, 2001c, 2002b, 2003b, 2004c, 2005b, 2005c and ASEP 2007, 2010, 2011).

Methane emission

The unspecified fugitive methane emission has this year been specified according to the identified systems and processes contribution to the fugitive methane emission from wastewater handling in Denmark. Fugitive methane releases from the municipal and private WWTPs have been divided into contributions from 1) the sewer system, primary settling tank and biological N and P removal processes, 2) from anaerobic treatment processes in closed systems with biogas generation and combustion for energy production and 3) septic tanks. The individual contribution to the net methane emission is given in Table 8.3.1 and Annex 3G, Table 3G-3.1.

Table 8.3.1 Produced, recovered and emitted CH_4 from wastewater treatment, Gg.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CH_4 produced	16.64	20.08	34.58	30.50	29.84	30.30	29.53	30.21	29.76
CH_4 recovered	16.48	19.88	34.24	30.19	29.54	30.00	29.24	29.90	29.47
CH_4 emitted from sewer system	0.17	0.21	0.25	0.27	0.26	0.27	0.26	0.27	0.26
CH_4 emitted from septic tanks	2.81	2.86	2.91	2.96	2.97	2.98	3.00	3.00	3.03
CH_4 emission from anaerobic treatment	0.17	0.20	0.35	0.30	0.30	0.30	0.30	0.30	0.30
Net CH_4 emission	3.15	3.27	3.51	3.54	3.53	3.55	3.55	3.57	3.59

Based on the data shown in Table 8.3.1, the amount of recovered methane for energy production has increased 79 % in 2010 compared to 1990. The emission from the sewer system and primary settling tanks and biological N and P removal processes has increased by 51 % and for the emission from the scattered houses, i.e. people not connected to the sewer system, an increase of 8 % is observed from 1990 to 2010.

Nitrous oxide emission

N_2O formation and releases both during the treatment processes at the WWTPs and also from discharged effluent wastewater are included.

The emission of N_2O from wastewater handling is calculated as the sum of contributions from wastewater treatment processes at the WWTPs and from sewage effluents. The emission from effluent wastewater, i.e. indirect emissions, includes separate industrial discharges, rainwater-conditioned effluents, effluents from scattered houses, from mariculture and fish farming. In Table 8.3.2, emission of N_2O from effluent and the contribution from direct N_2O emissions to the total N_2O emission, i.e. the sum of indirect and direct N_2O emissions, is presented.

Table 8.3.2 shows the total N_2O emission originating from treatment processes at the Danish WWTPs (direct emissions) and effluents to the Danish surface waters (indirect emissions). The full time series 1990-2010 is shown in Annex 3G, Table he full time series 1990-2010 is shown in Annex 3G, Table G-3.2

Table 8.3.2 N_2O emissions from wastewater, Mg.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
N_2O, indirect	265	238	157	111	109	116	103	108	104
N_2O, direct	88	134	161	193	152	185	256	153	165
N_2O, total	353	372	318	304	261	301	359	261	269

Regarding the calculated time trend in indirect N_2O emission from 1990 to 2010 has decreased 61 % N_2O, and the direct N_2O emission has increased 88 %. In absolute figures the indirect emission is a major contributor and the resulting total N_2O emission has decreased 24 % from 1990 to 2010.

8.3.2 Methodology and data

The methodology developed for this submission for estimating emission of methane and nitrous oxide from wastewater handling follows the IPCC Guidelines (IPCC, 1997) and the IPCC Good Practice Guidance (IPCC, 2000). No methodological changes have occurred compared to 2010 (Nielsen et al., 2011a). This section is divided into methodological issues related to the CH_4 and N_2O emission calculations, respectively.

Methane emissions from private and municipal WWTPs

The methane emissions from WWTP are divided into a contribution from the sewer system, primary settling tank and biological N and P removal processes, $CH_{4,\ sewer+MB}$ and from anaerobic treatment processes in closed systems with biogas extraction for energy production, $CH_{4,AD}$:

$$CH_{4,WWTP} = CH_{4,sewer+MB} + CH_{4,AD} \qquad \text{Eq. 8.3.1}$$

<u>The fugitive emissions from the sewer system, primary settling tank and biological N and P removal processes, $CH_{sewer+MB}$, are estimated as:</u>

$$CH_{4,sewer+MB} = EF_{sewer+MB} \cdot TOW_{inlet}$$
$$\Downarrow \qquad \text{Eq. 8.3.2}$$
$$CH_{4,sewer+MB} = B_o \cdot MCF_{sewer+MB} \cdot TOW_{inlet}$$

where

TOW_{inlet} equals the influent organic degradable matter measured as biological oxygen demand (BOD) in the influent wastewater flow,

Bo is the default maximum CH_4 producing capacity, i.e. 0.6 kg CH_4 per kg BOD (IPCC, 1997),

$MCF_{sewer+MB}$ is the fraction of DOC that is anaerobically converted in sewers and WWTPs. MCF_{WWTP} equals 0.003 based on an expert judgement (personal communication: Professor Jes Vollertsen) of a conservative estimate of the fugitive methane emission from the primary settling tanks and biological treatment processes is well below 0.1% of influent BOD, while the fugitive emission from the sewer system is unknown.

The emission factor, ***$EF_{sewer+MB}$***, for these three processes and systems equals **0.00018 kg CH_4 per kg BOD.**

<u>The methane emission from anaerobic digestion is calculated as:</u>

$$CH_{4,AD} = EF_{AD} \cdot TOW_{inlet} \cdot (1 - MR_{AD})$$
$$\Downarrow \qquad \text{Eq. 8.3.3}$$
$$CH_{4,AD} = B_o \cdot MCF_{AD} \cdot f_{AD} \cdot TOW_{inlet} \cdot (1 - MR_{AD})$$

where

Bo is the default maximum CH_4 producing capacity, i.e. 0.6 kg CH_4 per kg BOD (IPCC, 1996),

MCF_{AD} is extent to which degradation occurs under anaerobic conditions = 1,

TOW_{inlet} equals the influent organic degradable matter measured as biological oxygen demand (BOD) in the influent wastewater flow,

f_{AD} is the fraction of sludge treated in anaerobic closed systems.

MR_{AD} is the methane generation and combustion efficiency = 99 %

The methane recovery, MR_{AD}, for the anaerobic wastewater treatment with biogas production has been set to 99% according to expert knowledge (personal communication, Professor Jes Vollertsen and ASEP, 2010).

Methane emissions from septic tanks

In Denmark 10 % of the population are not connected to the municipal sewer system. For this part of the population, decentralised wastewater handling is occurring in the form of septic tanks. Only little knowledge is available about the frequency of collection and no measurements of the methane emissions from septic tanks and the pumping and management of septage, including its transportation to a wastewater treatment facility exist. Methane emission from septic tanks is calculated as:

$$
\begin{aligned}
&CH_{4,st} = EF_{st} \cdot f_{nc} \cdot P \cdot DOC_{st} \\
&\Downarrow \qquad\qquad\qquad\qquad\qquad\qquad \text{Eq. 8.3.4} \\
&CH_{4,st} = B_o \cdot MCF_{st} \cdot f_{nc} \cdot P \cdot DOC_{st}
\end{aligned}
$$

where

Bo is the default maximum CH_4 producing capacity, i.e. 0.6 kg CH_4 per kg BOD (IPCC, 1996).

MCF_{st} is the methane conversion factor. It depends on the extent to which BOD settles in the septic tanks. MCF_{st} has been set equal to 0.5 (IPCC, 2006) assuming that degradation for the settled DOC occurs under 100% anaerobic conditions.

F_{nc} is the fraction of the population that are not connected to the sewer system, i.e. scattered houses which equals 10 %.

DOC_{st} is the per capita produced degradable organic matter (DOC) which equals 18 250 kg BOD per 1000 persons per year (IPCC, 2000).

P is the population number

Using the default maximum methane producing capacity and a methane conversion factor of 0.5 (IPCC guidelines, 2006, Table 6.3) results in an emission factor, EF_{st}, equal to 0.03.

Annual activity data and emission factors used for calculation the net methane emission

Monitoring data on the influent biological oxygen demand (BOD) are available for mixed industrial and household wastewater, which are used for calculating the total organic waste (TOW) in the influent wastewater. From 1990 to 1998, the IPPC default methodology for household wastewater has been applied by accounting and correcting for the industrial influent load (Thomsen & Lyck, 2005). For the years 1999 to 2009 monitoring data from the national monitoring program exists (cf. Table 8.3.9). For the year 2009 the national total TOW data are calculated based on monitoring data from approximately 1000 municipal WWTPs; each WWTP represented by an average of 12 measurements. Annual BOD data are calculated from measured BOD per litre influent wastewater multiplied by the influent amount of water. The time series for activity data on TOW are presented in Table 8.3.3.

Table 8.3.3 presents the total degradable organic waste (TOW) calculated by use of the default IPCC method corrected for contribution from industry to the influent TOW (1990-1998) and country-specific data (1999-2010). The full time series is presented in Annex 3G, Table 3G-3.3.

Table 8.3.3 Calculated total degradable organic waste in the influent wastewater (TOW).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Contribution from industrial inlet BOD	2.5	22.2	42	40.5	40.5	40.5	40.5	40.5	40.5
Population (1000)	5140	5228	5322	5411	5427	5447	5476	5511	5535
TOW [Gg] corrected IPCC method	96.62	116.59							
TOW [Gg]; country-specific data			141.49	149.83	146.59	148.88	145.11	148.41	145.64

*TOW = (1+I/100) x (P x D_{dom}), where P is the Population number, D_{dom}= 18 250 kg BOD per 1000 persons per year and I is the per cent contribution from industry to the influent wastewater TOW content.

A country-specific emission factor for calculating the amount of methane produced during anaerobic treatment processes, the gross methane emission (cf. Table 8.3.1), at the Danish WWTPs has been derived. From this emission factor the fugitive emissions from anaerobic treatment processes has been calculated according to Equation 8.3.3. The emission factor varies according to the national statistics on the fraction of wet weight sludge treated anaerobic as reported in the Danish sludge database and presented in Table 8.3.4.

Table 8.3.4 shows the country-specific emission factor for estimating the methane generated during anaerobic treatment processes. The full time series is presented in Annex 3G, Table 3G-3.4.

Table 8.3.4 Emission factor for estimating the methane generation, kg CH_4/kg BOD.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Fraction of wet weight sludge treated in anaerobic processes , F_{AD}	0.29	0.29	0.41	0.34	0.34	0.34	0.34	0.34	0.34
EF =MCF*f_{AD}*B_o	0.17	0.17	0.24	0.20	0.20	0.20	0.20	0.20	0.20

The Danish sludge database have incomplete statistics due to lack of facility reporting for the years 2006-2009 why the fraction of sludge treated anaerobic have been set equal to the reported fraction in 2005.

Overall methane emission time trends

The trends in the CH_4 emission from the Danish WWTPs, as summarised in Table 8.3.1, are presented graphically in Figure 8.3.1.

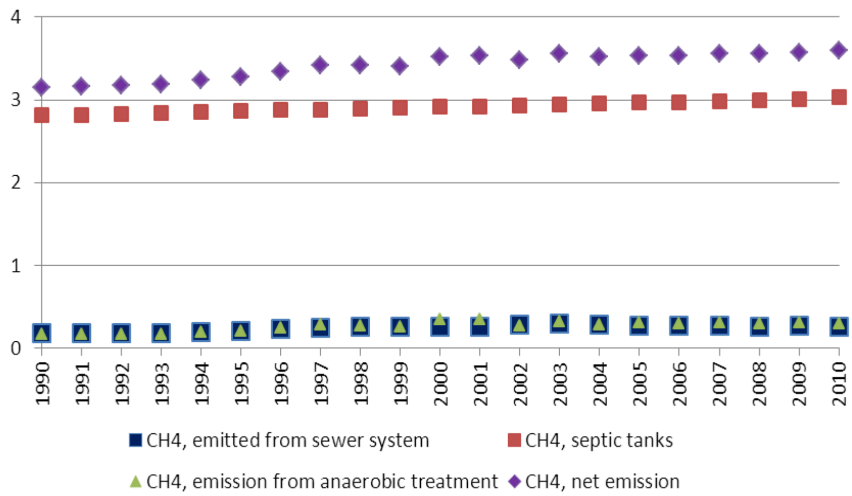

Figure 8.3.1 Time trends for net methane emission, methane emission from sewer systems, from septic tanks and from anaerobic treatment processes.

The net methane emissions has increased from 3.15 Gg in 1990 to 3.59 Gg methane in 2010 corresponding to an increase in net methane emissions from wastewater handling of 14 %.

N_2O emissions from WWTPs

N_2O may be generated by nitrification (aerobic processes) and denitrification (anaerobic processes) during biological treatment. Starting material in the influent may be urea, ammonia and proteins, which are converted to nitrate by nitrification. Denitrification is an anaerobic biological conversion of nitrate into dinitrogen. N_2O is an intermediate of both processes. A Danish investigation indicates that N_2O is formed during aeration steps in the sludge treatment processes as well as during anaerobic treatments; the former contributing most to the N_2O emissions during sludge treatment (Gejlsberg et al., 1999). A review by Kampschreur et al. (2009) documents that around 90% of the emitted N_2O originates from activated sludge processes. Based on this review an average of two highest EF values, i.e. 0.6 % N_2O (Wicht et al., 1995) and 0.035 % (Czepiel et al., 1995), both reported in units of per cent N load in the influent wastewater ,was used to derive a national EF for the direct emission of nitrous oxide.

The direct N_2O emission from wastewater treatment processes is calculated according to Equation 8.3.5:

$$E_{N_2O} = EF_{N_2O,direct} \cdot m_{N,\inf luent} \cdot \frac{M_{N_2O}}{2 \cdot M_N} \qquad \text{Eq. 8.3.5}$$

where

$EF_{N2O,direct}$ is set equal to a fraction of 0.0032 of the N load in the influent wastewater.

$m_{N,influent}$ is the annually reported N load in the Danish Water Quality Parameter Database provided in Table 8.3.5.

M_{N2O}/M_{N2} is the mass ratio i.e. 44/28 to convert the fraction of discharged N emitted as nitrous oxide from total N.

The country-specific EF value of 0.0032 may be expressed as $EF_{N2O,direct}$ = 4.99 g N_2O per kg N load in the influent wastewater by reducing eq. 8.3.5 to:

$$E_{N_2O} = EF_{N_2O,direct} \cdot m_{N,\inf luent} \qquad \text{Eq. 8.3.6}$$

The methodology here adopted for estimating the direct N_2O emission only relies on the influent N load as activity data.

The indirect N_2O emission from WWTPs is calculated according to Equation 8.3.7:

$$E_{N_2O,WWTP,effluent} = D_{N,WWTP} \cdot EF_{N_2O,WWTP,effluent} \cdot \frac{M_{N_2O}}{2 \cdot M_N} \qquad \text{Eq. 8.3.7}$$

where

$D_{N.WWTP}$ is the effluent discharged sewage nitrogen load consisting of contributions from municipal wastewater treatment plants, the separate industry, effluent from mariculture and fish farming, rainwater conditioned effluents and scattered houses not connected to the sewage system (cf. Table 8.3.5).

$EF_{N2O,WWTP,effluent}$ is the IPCC default emission factor of 0.01 kg N_2O-N per kg sewage-N produced (IPCC, 1997, p 6.28)

M_{N2O}/M_{N2} is the mass ratio i.e. 44/28 to convert the fraction of discharged N emitted as nitrous oxide from total N.

Annual activity data and emission factors for calculating the nitrous oxide emission

Data on the N content in the influent and effluent wastewater flows are provided in Table 8.3.5. The effluent data provided in the table constitute a sum of the N content in effluent wastewater from municipal wastewater treatment plants, the separate industry, effluent from mariculture and fish farming, rainwater conditioned effluents and scattered houses. For the entire time series 1990-2010 cf. Annex 3G, Table 3G-3.5.

Table 8.3.5 Nitrogen content in the influent and effluent wastewater, Mg.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Influent wastewater from municipal WWTPs*	17 614	26 808	32 342	38 746	30 481	37 079	51 370	30 623	33 137
Effluent wastewater, total**	16 884	15 152	10 005	7038	6 935	7 382	6 589	6 899	6 600
% N reduction in effluent N from municipal WWTP	4	67	86	90	88	88	93	87	89

*Data on the influent wastewater N load from municipal WWTPs are available from the Danish Water Quality Parameter Database held by the Agency for Spatial and Environmental Planning ** Effluent wastewater, total includes separate industrial discharges, rainwater conditioned effluent, scattered houses, mariculture and fish farming and effluents from WWTPs (DEPA. 1994, 1996b, 1997, 1998b, 1999b, 2000, 2001c, 2002b, 2003b, 2004c, 2005b, 2005c and ASEP 2007, 2010, 2011).

The significant reduction in the effluent wastewater content of nitrogen is a driver for the increasing direct N_2O emission.

Overall nitrous oxide emission trends

The trends in the direct N_2O emission from WWTPs, the indirect emission from wastewater effluent and the total, as summarised in Table 8.3.2, are presented graphically in Figure 8.3.2.

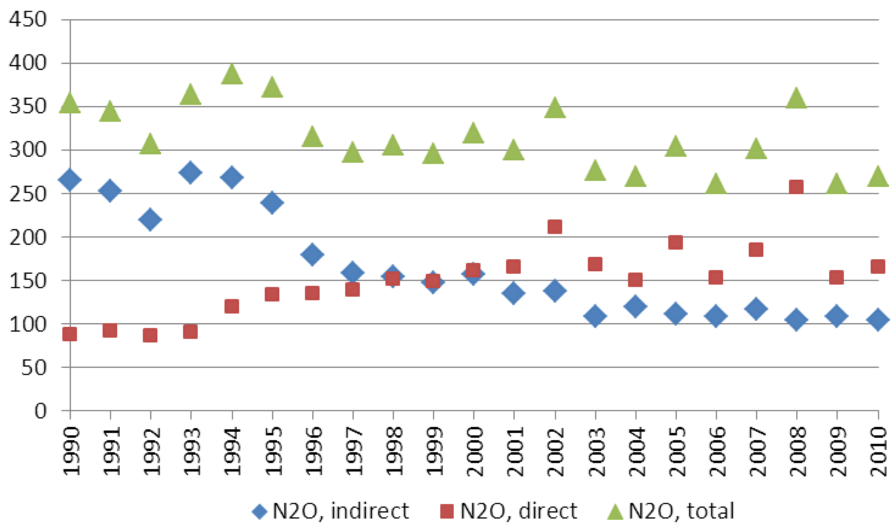

Figure 8.3.2 Time trends for direct emission of N_2O, indirect emission, i.e. from wastewater effluents, and total N_2O emission.

The annual fluctuations may be caused by several factors such as e.g. climatic condition such as variations in precipitation and as a result varying contributions to the influent N and varying characteristics of especially the industrial contributions to the influent. Furthermore, infiltration of groundwater, as well as exfiltration of wastewater (DEPA. 1994, 1996b, 1997, 1998b, 1999b, 2000, 2001c, 2002b, 2003b, 2004c, 2005b, 2005c; ASEP 2007, 2010, 2011;

Vollertsen et al., 2002), may contribute to the "noise" or fluctuation in the trend of the calculated indirect N_2O emission.

The direct emission trend increases slightly, reaching a stable but fluctuating level from 2002 onwards. The decrease in the emission from effluent wastewater is due to the technical upgrade and centralisation of the Danish WWTPs following the adoption of the Action Plan on the Aquatic Environment in 1987. The decrease in the indirect emission from wastewater effluent from 265 tonnes N_2O in 1990 to 103 tonnes N_2O in 2010 is caused by a reduction in the nitrogen loads in the wastewater effluent from around 4 % in 1990 to approx. 90 % in 2010. The indirect emission is the major contributor to the emission of nitrous oxide in the period 1990-1997. However, from around year 2000, the direct N_2O emission is the major contributor to the total N_2O emission.

8.4 Waste incineration (CRF source category 6C)

The CRF source category 6.C. Waste Incineration, includes cremation of human bodies and cremation of animal carcasses.

Incineration of municipal, industrial, clinical and hazardous waste takes place with energy recovery, therefore the emissions are included in the relevant subsectors under CRF sector 1A. For documentation please refer to Chapter 3.2. Flaring off-shore and in refines are included under CRF sector 1B2c, for documentation please refer to Chapter 3.5. No flaring in chemical industry occurs in Denmark.

Table 8.4.1 gives an overview of the Danish greenhouse gas emission from the CRF source category 6.C waste incineration.

CO_2 emissions from cremations of human bodies and animal carcasses are biogenic.

While emissions from human cremations have been steady over the last two decades, emissions from animal cremations have increased. In 1990, incineration of animal carcasses stood for 5 % of the total emission of CO_2-eqv. from cremations. In 2010 this number has increased to 35 %. GHG emissions from cremations are very small; 0.21 Gg in 1990 and 0.31 Gg in 2010. GHG emissions are shown in Table 8.4.1, for the full time series, see Annex 3G, Table 3G-4.1.

Table 8.4.1 Overall emission of greenhouse gases from the incineration of human bodies and animal carcasses.

Year		1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 emission from										
Human cremation	Gg	2.05	2.19	2.08	2.04	2.06	2.09	2.09	2.12	2.10
Animal cremation	Gg	0.12	0.15	0.34	0.59	0.86	0.99	1.03	1.03	1.12
Total biogenic	Gg	2.17	2.35	2.43	2.63	2.92	3.08	3.12	3.15	3.22
CH_4 emission from										
Human cremation	Mg	0.48	0.52	0.49	0.48	0.48	0.49	0.49	0.50	0.49
Animal cremation	Mg	0.03	0.04	0.08	0.14	0.20	0.23	0.24	0.24	0.26
Total	Mg	0.51	0.55	0.57	0.62	0.69	0.72	0.73	0.74	0.76
N_2O emission from										
Human cremation	Mg	0.60	0.64	0.61	0.60	0.61	0.61	0.61	0.62	0.62
Animal cremation	Mg	0.03	0.05	0.10	0.17	0.25	0.29	0.30	0.30	0.33
Total	Mg	0.64	0.69	0.71	0.77	0.86	0.90	0.92	0.93	0.95
6C. Waste incineration										
CO_2 equivalents excl. CO_2	Gg	0.21	0.23	0.23	0.25	0.28	0.30	0.30	0.30	0.31

8.4.1 Human cremation

The incineration of human bodies is a common practice that is performed on an increasing part of the annually deceased. All Danish incineration facilities use optimised and controlled burnings, with temperatures reaching 800-850 °C, secondary combustion chambers, controlled combustion air flow and regulations for coffin materials.

Emissions from human cremation are calculated for greenhouse gases CH_4 and N_2O.

Methodological issues

There are 31 crematoria in Denmark, some with multiple furnaces, 21 facilities are run by the Church of Denmark and 10 by the local authorities (DKL, 2011; Kirkeministeriet, 2006).

During the 1990es all Danish crematoria were rebuilt to meet new standards. This included installation of secondary combustion chambers and in most cases, replacement of old primary incineration chambers (Schleicher et al., 2001). All Danish cremation facilities are therefore performing controlled incinerations with a good burn-out of the gases, and a low production of pollutants. But only a few crematoria were equipped with flue gas cleaning (bag filters with activated carbon) in 2010.

Following the development of new technology, the emission limits for crematoria were lowered again from 1/2011. These new standard terms were originally expected from 1/2009 but were postponed two years for existing crematoria. Table 8.4.2 shows a comparison of the emission limits from 2/1993 and the new standard limits.

Table 8.4.2 Emission limit values mg per Nm^3 at 11 % O_2 (Schleicher et al., 2008).

Component	Report 2/1993	Standard terms (1/2011)
	Emission limit value mg per normal m^3 at 11 % O_2	
CO_2	500	500
Other demands:		
Stack height	3 m above rooftop	3 m above rooftop
Temperature in stack	Minimum 150 °C	Minimum 110 °C
Flue gas flow in stack	8 – 20 m/s	No demands
Temperature in after burner	850 °C	800 °C
Residence time in after burner	2 seconds	2 seconds

Activity data

Table 8.4.3 shows the time series of total number of nationally deceased persons, number of cremations and the fraction of cremated corpses in relation to the total number of deceased. Data for the total number of nationally deceased persons is collected from Statistics Denmark (2011). Data describing the number of cremations and the cremation fraction are gathered from the Association of Danish Crematoria (DKL, 2011). See Annex 3G, Table 3G-4.2 for the entire time series 1990-2010.

Table 8.4.3 Data human cremations (DKL, 2011).

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
Nationally deceased	60926	63127	57998	54962	55477	55604	54591	54872	54368
Cremations	40991	43847	41651	40758	41233	41766	41788	42408	42050
Cremation fraction, %	67.3	69.5	71.8	74.2	74.3	75.1	76.6	77.3	77.3

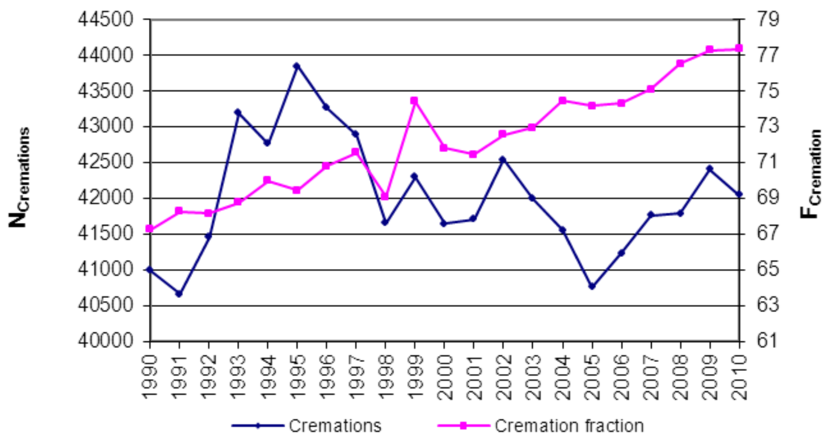

Figure 8.4.1 The number of cremations ($N_{cremations}$) and the cremation per cent ($F_{cremations}$), showing the share of bodies being cremated, from the year 1990 to 2010.

Even though the total number of annual cremations is fluctuating, the cremation per cent has been increasing since 1990, and is likely to continue to increase.

The average body weight is assumed to be 65 kg.

Figure 8.4.2 presents the trend of the national number of deceased persons together with the activity data for human cremation. The figure shows a direct connection between the number of deceased and the activity of human cremation as the two trends are quite similar. Figure 8.4.2 also shows the effect of the increasing fraction of cremated bodies per deceased, as the number of cremations is not decreasing along with the number of deceased. The cremation fraction has increased from 67 % in 1990 to 77 % in 2010; the trend of this fraction is shown in Figure 8.4.1.

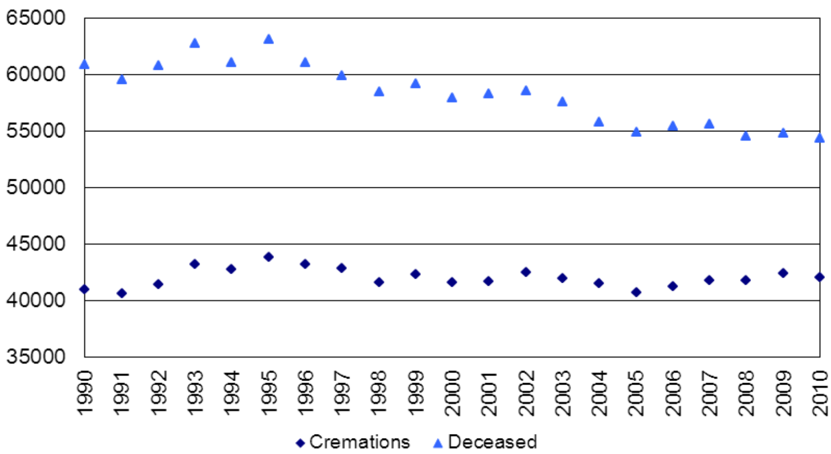

Figure 8.4.2 Trends of the activity data for cremation of human corpses and the national number of deceased persons.

Emission factors

For crematoria, emissions are calculated by multiplying the total number of cremations by the emission factors. Since there are no measurements available of the annual emission from Danish crematoria, the estimation of emissions is based on emission factors from literature. The estimation is based on the measurements performed in countries that are comparable with Denmark. By comparable is meant countries that use similar incineration processes, similar cremation techniques including support fuel and have a similar composition of sources to lifetime exposure, lifetimes and coffins.

A literature search has provided emission factors for CO_2, CH_4 and N_2O from the two sources Fontelle et al. (2008) and Aasestad (2008). It has not been possible to find any additional data to validate the emission factors.

Table 8.4.4 lists the emission factors and their respective references.

Table 8.4.4 Emission factors for human cremation with references.

Pollutant name	Unit	Emission factor	Reference
CO_2, biogenic	kg/body	50.1	Fontelle et al., 2008
CH_4	g/body	11.8	Aasestad, 2008
N_2O	g/body	14.7	Aasestad, 2008

8.4.2 Animal cremation

The burning of animal carcasses in animal crematoria follows much the same procedure as human cremation. Animal cremation facilities use similar two chambered furnaces and controlled burning. However animals are burned in special designed plastic (PE) bags rather than coffins.

Emission from animal cremation is also similar to that of human cremation.

Animal cremations are performed in two ways, individually where the owner often pays for receiving the ashes in an urn or collectively which is most often the case with animal carcasses that are left at the veterinarian.

Methodological issues

Open burning of animal carcasses is illegal in Denmark and is not occurring, and small-scale incinerators are not known to be used at Danish farms. Livestock that is diseased or in other ways unfit for consumption is disposed of through rendering plants, incineration of livestock carcasses is illegal and these carcasses are therefore commonly used in the production of fat and soap at Daka Bio-industries.

The only animal carcasses that are approved for cremation in Denmark are deceased pets and animals used for experimental purposes, where the burning must take place at a specialised animal crematorium. There are four animal crematoria in Denmark but one of these is situated at a waste incineration company in northern Jutland called AVV. The special designed cremation furnaces are at this location connected to the flue gas cleaning equipment of the waste incineration plant with energy recovery and the emission from the cremations are included in the annual inventory from AVV and consequently included under the energy sector in this report. Therefore only three animal crematoria are discussed in this section.

Animal by-products are considered waste, and emission from animal crematoria must therefore comply with the EU requirements for waste incineration. The EU directive (2000/76/EC) on waste incineration has been transferred into Danish law (Statutory order nr.162[1]).

The incineration of animal carcasses is, as the incineration of human corpses, performed in special furnaces. All furnaces at Danish pet crematoria have primary incineration chambers with temperatures around 850 ºC and secondary combustion chambers with temperatures around 1100 ºC. The fuel used at the Danish facilities is natural gas.

Emissions from pet cremations are calculated for CO_2, CH_4 and N_2O.

Activity data

Activity data for the amount of animal carcasses incinerated are gathered directly from the pet crematoria. There is no national statistics available on the activity of animal crematoria. The precision of activity data therefore depends on the information provided by the crematoria.

Table 8.4.5 lists the four Danish crematoria, their foundation year and provides each crematorium with an id letter.

Table 8.4.5 Animal crematoria I Denmark.

Id	Name of crematorium	Founded in
A	Dansk Dyrekremering ApS	May 2006
B	Ada's Kæledyrskrematorium ApS	Unknown, existed in more than 30 years
C	Kæledyrskrematoriet	2006
D	Kæledyrskrematoriet v. Modtage-station-Vendsyssel I/S	

Crematoria D is situated at the AVV waste incineration site and the emission from this site is, as previously mentioned, included in the annual emission reporting from AVV and consequently included in the energy sector in this report. Only crematoria A-C are considered in this chapter.

[1] Bekendtgørelse nr. 162 af 11. marts 2003 om anlæg der forbrænder affald.

Table 8.4.6 lists the activity data for crematoria A, B and C. The entire dataset for 1990-2010 is available in Annex 3G, Table 3G-4.3.

Table 8.4.6 Activity data. Source: direct contact with all Danish crematoria.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Crematorium A, Mg	-	-	-	-	300	450	450	450	475
Crematorium B, Mg	150	200	443	762	798	802	848	853	934
Crematorium C, Mg	-	-	-	-	18	32	40	36	40
Total, Mg	150	200	443	762	1116	1284	1338	1339	1449

Crematorium A delivered activity data for 2007-2009 as the interval 400-500 Mg, the exact value is assumed to be the average of this interval and the rate is assumed to be constant back to the year 2006. The activity data for Crematoria A in 2006 is rated according to the founding of the site in May of 2006.

Crematorium C delivered exact annual activity data for the years 2006-2010.

Crematorium B delivered exact annual activity data for the years 1998-2010. They were not certain about the founding year but believe to have existed since the early 1980es. The estimated activity data for 1990-1997 are shown as the thick line in Figure 8.4.3.

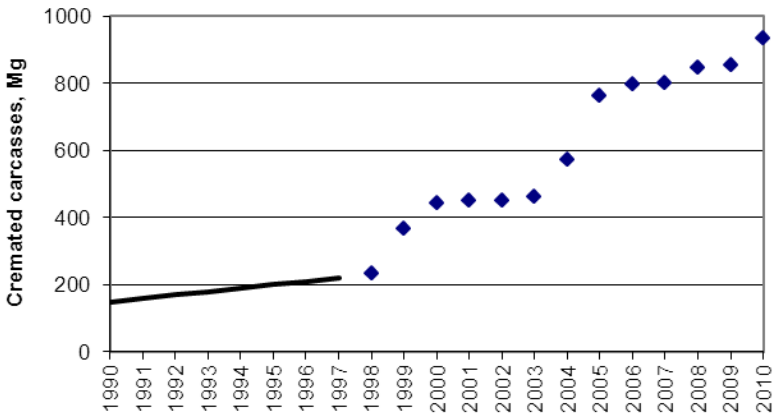

Figure 8.4.3 The amount of cremated carcasses in Mg at crematorium B, the oldest and largest crematorium in Denmark. Data from 1998-2010 are delivered by the crematorium and is considered to be exact; these data are marked as points. Data from 1990-1997 are estimated and are shown as the thick line in the figure.

It is not possible to extrapolate data back to 1990 because the activity, due to the steep trend line, in this case would become negative from 1993 and back in time.

Statistic data describing the national consumption for pets including food and equipment for pets was evaluated as surrogate data. These statistic data show an increase of consumption of 6 % from 1998 to 2000, in the same period the national amount of cremated animal carcasses increased with 89 % and no correlation seems to be present. Since there are no other available data on the subject of pets, it is concluded that there are no surrogate data available. The activity data for the period of 1990-1997 are estimated by expert judgement. The estimated data are shown in Table 8.4.6, Annex 3G, Table 3G-4.3 and in Figure 8.4.3.

Emission factors

Concerning the burning of animal carcasses in animal crematoria there is not much literature to be found.

Emission factors for CO_2, CH_4 and N_2O are collected from the literature search on human cremation, and it is assumed that humans and animals are similar in composition for this purpose. Emission factors from human cremation are recalculated to match the activity data for animal cremation, emission per Mg.

Table 8.4.7 lists the emission factors and their respective references.

Table 8.4.7 Emission factors for animal cremation.

Pollutant name	Unit	Emission factor	Reference
CO_2, biogenic	kg/Mg	770	Fontelle et al., 2008
CH_4	g/Mg	182	Aasestad, 2008
N_2O	g/Mg	226	Aasestad, 2008

8.5 Waste Other (CRF Source Category 6D)

This category is a catch all for the waste sector. Emissions in this category could stem from accidental fires, sludge spreading, compost production and biogas production. In the Danish inventory emissions from accidental fires, compost production and biogas production are included in this category.

Table 8.5.1 gives an overview of the Danish greenhouse gas emission from the CRF source category 6.D waste other.

CO_2 emissions from compost production are considered to be biogenic. For accidental fires in buildings, there is a high content of wood both in the structure and in the interior; this leads to 82 % of the CO_2 emission from accidental building fires to be biogenic, see Table 8.5.1.

Emissions from accidental fires are quite constant, with a peek in 2008 of 23 Gg CO_2 equivalents. Compost production is the largest source of greenhouse gas emissions in this sector. In 1990 composting stood for 65 % (38 Gg CO_2 equivalents) of the total greenhouse gas emission in CO_2 equivalents from the other waste category, in 2010 this number has increased to 86 % (123 Gg CO_2 equivalents). The full time series is shown in Annex 3G, Table 3G-5.1a-c.

Table 8.5.1 Overall emission of greenhouse gasses from accidental fires and composting.

		1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 emission from										
Accidental building fires	Gg	63.18	72.31	63.86	62.48	64.24	76.38	72.67	69.72	61.73
- of which non-biogenic	Gg	11.46	13.11	11.58	11.34	11.66	13.71	13.41	12.65	11.14
Accidental vehicle fires	Gg	6.88	7.06	7.24	6.92	7.12	5.61	8.09	8.43	7.11
Total, non-biogenic	Gg	18.34	20.17	18.82	18.26	18.77	19.32	21.50	21.08	18.24
CH_4 emission from										
Compost production	Mg	1268.8	1632.0	2882.6	3086.7	3269.4	3646.1	3323.4	3539.3	3829.5
Accidental building fires	Mg	64.16	73.36	64.88	63.78	65.63	75.18	74.64	71.35	64.62
Accidental vehicle fires	Mg	14.34	14.70	15.08	14.42	14.82	11.70	16.85	17.56	14.80
Total	Mg	1347.3	1720.0	2962.6	3164.9	3349.9	3733.0	3414.9	3628.2	3909.0
N_2O emission from										
Compost production	Mg	36.17	49.53	130.90	100.56	109.60	125.24	116.79	127.27	137.57
Total	Mg	36.17	49.53	130.90	100.56	109.60	125.24	116.79	127.27	137.57
6D. Waste other										
CO_2-eqvivalents	Gg	57.85	71.64	121.61	115.89	123.09	136.54	129.42	136.73	142.98

8.5.1 Compost production

This section covers the biological treatment of solid wastes called composting. Greenhouse gasses that are emitted from this treatment are methane (CH_4), nitrous oxide (N_2O) and biogenic carbon oxide (CO_2).

Methodological issues

There is neither methodological guidance for this source category in the Revised 1996 IPCC Guidelines (IPCC, 1997) nor the IPCC 2000 Good Practice Guidance (IPCC, 2000). Emissions from composting have been calculated according to a country specific method.

In Denmark, composting of solid biological waste includes composting of:

- garden and park waste (GPW),
- organic waste from households and other sources,
- sludge and,
- home composting of garden and vegetable food waste.

In 2001, 123 composting facilities treated only garden and park waste (type 2 facilities), nine facilities treated organic waste mixed with GPW or other organic waste (type 1 facilities) and 10 facilities treated GPW mixed with sludge and/or "other organic waste" (type 3 facilities). 92 % of these facilities consisted entirely of windrow composting which is a low technology composting method with natural access to air. It is assumed that all facilities can be considered as using windrow composting. (Petersen & Hansen, 2003)

Composting in Denmark is primarily performed with a primitive technology, this means that temperature, moisture and aeration is not consistently controlled and regulated. Temperature is measured but not controlled, moisture is regulated by watering the windrows in respect to weather conditions and aeration is assisted by turning the windrows.
(Petersen & Hansen, 2003)

During composting a large fraction of the degradable organic carbon (DOC) in the waste material is converted into CO_2. Even though the windrows are regularly turned to support aeration, anaerobic sections are inevitable and will cause emissions of CH_4. (IPCC, 2007)

Activity data

All Danish waste treatment plants are obligated to statutory registration and reporting of all wastes entering and leaving the plants. All waste streams are weighed, categorised with a waste type and a type of treatment and registered to the ISAG waste information system (DEPA, 2006a)

Figure 8.5.1 illustrates the nationally composted amount of waste divided in the four categories mentioned earlier.

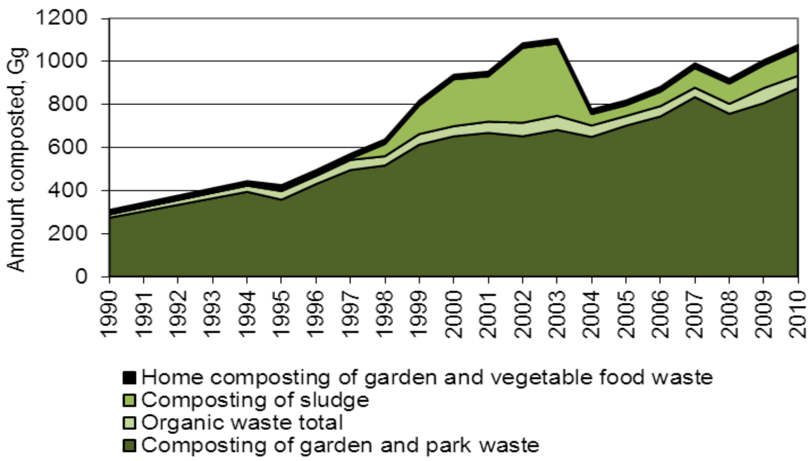

Figure 8.5.1 National amount of composted waste, these data are also shown in Table 8.5.3.

The Danish legislation on sludge (DEPA, 2006c) was implemented in the summer of 2003. This stated that composted sludge may only be used as a fertilizer on areas not intended for growing foods of any kind for at least 2-3 years after. This restriction caused the amount of composted sludge to drop drastically from 2003 to 2004.

Activity data for the years 1995-2009 are collected from ISAG data for the categories: organic waste from households and other sources and sludge. Activities for 2010 are calculated by using the trend from previous years.

The development in composting of sludge does not demonstrate a convincing trend that can be used for estimation of activity data for previous years. Since there is no surrogate data available for the years 1990-1994, activity data for these years cannot be estimated.

The amounts of organic waste from households composted in the years 1990-1994 are estimated by multiplying the number of facilities treating this type of waste with the average amount composted per facility in the years 1995-2001 (2.6-3.8 Gg per facility per year). The following Table 8.5.2 shows the number of composting sites divided in the three types described in "Methodological issues".

Table 8.5.2 Number of composting facilities in the years 1990-2001.

Facility type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Type 1	5	6	7	8	9	13	14	13	14	13	11	9
Type 2	38	54	70	86	102	113	108	99	102	111	115	123
Type 3	1	2	2	3	4	9	9	11	10	10	7	10
Total	44	62	79	97	115	136	133	126	130	139	138	149

Type 1 waste treatment sites normally includes biogas producing facilities, but these have been excluded in Table 8.5.2.

The waste statistics provides the development in "composting and wood chipping of GPW" for 1995-2009, and by looking at the trend of this development the remaining years 1990-1994 and 2010 are estimated. This data series is used as surrogate data for the estimation of activity data for composting of GPW.

Petersen (2001) and Petersen & Hansen (2003) provide 1997-2001 activity data for the composting of garden and park waste (GPW). Activity data for

GPW for the years 1990-1996 and 2002-2010 are estimated from the surrogate data gathered from the waste statistics reports (DEPA, 1996; DEPA, 1998; DEPA, 1999; DEPA, 2001a; DEPA, 2001b; DEPA, 2002; DEPA, 2004a; DEPA, 2004b; DEPA, 2005; DEPA, 2006a; DEPA, 2006b; DEPA, 2008; DEPA, 2010a; DEPA, 2011a).

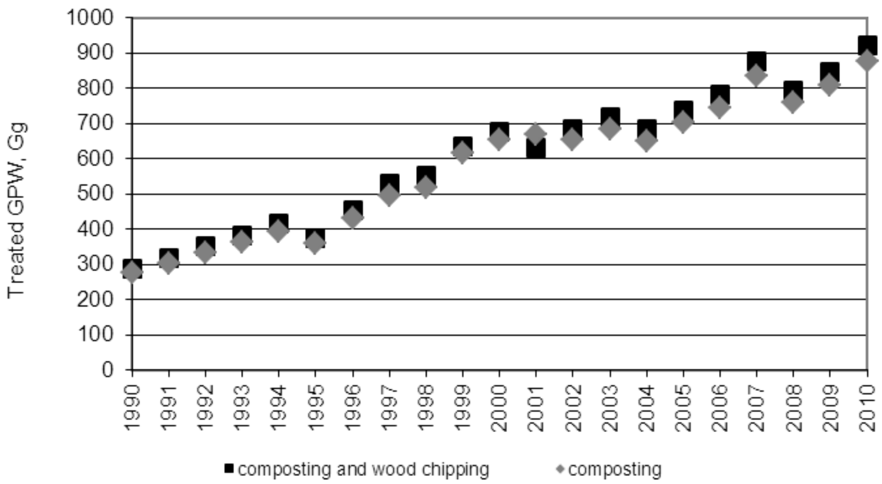

Figure 8.5.2 Composted amount of GPW.

The last waste category involved in composting is home composting of garden waste and vegetable waste. The activity data for this category are known from Petersen & Kielland (2003) to be 21.4 Gg in 2001. It is assumed that the following estimates made by Petersen & Kielland (2003) are valid for all years 1990-2010.

- 28 % of all residential buildings with private gardens (including summer cottages) are actively contributing to home composting.
- 14 % of all multi-dwelling houses are actively contributing to home composting.
- 50 kg waste per year will in average be composted at every contributing residential building.
- 10 kg waste per year will in average be composted at every contributing multi-dwelling house.

Multi-dwelling houses include apartment buildings, it is very un-common for people in these types of buildings to compost their bio waste and the average amount of composted waste is therefore lower in spite of the higher number of residents. The total number of occupied residential buildings, summer cottages and multi-dwelling houses are found at the Statistics Denmark website.

The calculated activity data for composting are shown in Table 8.5.3 and in Annex 3G, Table 3G-5.2.

Table 8.5.3 Activity data composting, Gg.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Composting of garden and park waste	274	358	653	702	745	835	757	807	877
Composting of organic waste from households and other sources	16	40	47	45	48	44	46	70	58
Composting of sludge	NAV	7	218	50	67	91	94	107	120
Home composting of garden and vegetable food waste	20	21	21	22	22	22	22	23	23
Total	310	426	939	819	882	992	920	1007	1077

NAV = Not available

Emission factors

The emissions from composting strongly depend on both the composition of the treated waste and on process conditions such as aeration, mechanical agitation, moisture control and temperature pattern. (Amlinger et al., 2008).

The emission factors stated in Table 8.5.4 are considered the best available for the calculation of Danish national emissions from composting.

Table 8.5.4 Composting emission factors.

	Garden and park waste (GPW)	Organic waste from households and other sources	Sludge	Home composting of garden and vegetable food waste
Unit	kg per Mg	kg per Mg	kg per Mg	kg per Mg
CH_4	4.2	0.268	0.041	5.625
N_2O	0.12	0.072	0.216	0.105
Source	Boldrin et al., 2009a	Amlinger et al., 2008	Amlinger et al., 2008	Boldrin et al., 2009a

Emission factors for composting of GPW and for home composting of garden and vegetable food waste are derived from Boldrin et al. (2009a). No other sources were found that describe the emission from home composting.

Emissions from Boldrin et al. (2009a) are given in per cent of total degraded carbon or nitrogen respectively. The factors shown in Table 8.5.4 are calculated by assuming 37.5 % DOC in dry matter, 2 % N in dry matter and 50 % moisture in the waste (Boldrin et al., 2009a).

The CO_2 produced and emitted during composting is short-cycled C and is therefore normally regarded as CO_2 neutral. (Boldrin et al., 2009a).

Emission factors for composting of organic municipal waste and sludge are given by Amlinger et al. (2008).

8.5.2 Accidental building fires

Emissions from accidental fires are categorised under 6D Other Waste. Emissions that escape from building fires are CO_2 and CH_4.

Methodological issues

Emissions from building fires are calculated by multiplying the number of building fires with selected emission factors. Six types of buildings are separated with different emission factors: detached houses, undetached houses, apartment buildings, industrial buildings, additional buildings and containers.

Activity data

In January 2005 it became mandatory for the local authorities to register every rescue assignment in the *online data registration- and reporting system* called ODIN, ODIN is developed and run by the Danish Emergency Management Agency (DEMA, 2007).

Activity data for accidental building fires are given by The Danish Emergency Management Agency (DEMA). Fires are classified in four categories: full, large, medium and small. The emission factors comply for full scale fires and the activity data are therefore recalculated as a full scale equivalent where it is assumed that a full, large, medium and a small scale fire leads to 100 %, 75 %, 30 % and 5 % of a full scale fire respectively.

In practice, a full scale fire is defined as a fire where more than three fire hoses were needed for extinguishing the fire, a full scale fire is considered as a complete burnout. A large fire is in this context defined as a fire that involves the use of two or three fire hoses for fire extinguishing and is assumed to typically involve the majority of a house, an apartment, or at least part of an industrial complex. A medium size fire is in this context defined as a fire involving the use of only 1 fire hose for fire-fighting and will typically involve a single room in an apartment or house. And a small size fire is in this context defined as a fire that was extinguished before the arrival of the fire service, extinguished by small tools or a chimney fire.

The total number of registered fires is known for the years 1990-2010. For the years 2007-2010 the total number of registered building fires is known with a very high degree of detail.

Table 8.5.5 shows the occurrence of all types of fires and the occurrence of building fires registered at DEMA. In 2007-2010 the average per cent of building fires, in relation to all fires, was 60 %. The total numbers of building fires 1990-2006 are calculated using this per cent. The full time series is presented in Annex 3G, Table 3G-5.3.

Table 8.5.5 Occurrence of all fires and building fires.

Year	All fires	Building fires
1990	17025	10187
1995	19543	11694
2000	17174	10276
2005	16551	9903
2006	16965	10151
2007	18263	12527
2008	20643	12124
2009	18930	10652
2010	16728	9325

The total number of building fires is quite higher this year than last year. This is due to the addition of additional building fires and container fires in this year’s inventory.

The building fires that occurred in the years 2007-2010 are subcategorised into six building types; detached houses, undetached houses, apartment buildings, industrial buildings, additional buildings and container fires.

Table 8.5.6 states the registered activity data for building fires for the years 2007-2010, divided in both damage size and building type. The calculated averages describes the average share of building fires from 2007-2010 of a certain type and size, in relation to all building fires in the same four years period.

Table 8.5.6 Registered occurrence of building fires. (DEMA).

	Size	Detached	Undetached	Apartment	Industry	Additional	Container	All building fires
	full	263	32	24	65	35	11	430
	large	446	112	107	155	358	162	1340
	medium	553	193	601	255	373	1484	3459
	small	1385	394	1260	464	277	316	4096
2010	all	2647	731	1992	939	1043	1973	9325
	full	270	47	35	81	52	8	493
	large	497	111	145	191	355	203	1502
	medium	574	193	654	299	447	2046	4213
	small	1212	393	1464	610	276	489	4444
2009	all	2553	744	2298	1181	1130	2746	10652
	full	312	71	34	82	73	18	590
	large	419	130	119	190	329	239	1426
	medium	638	294	783	312	557	2469	5053
	small	1375	419	1500	566	713	482	5055
2008	all	2744	914	2436	1150	1672	3208	12124
	full	239	77	47	100	39	43	545
	large	391	156	108	218	307	257	1437
	medium	550	379	697	445	550	2300	4921
	small	1189	700	1367	758	967	643	5624
2007	all	2369	1312	2219	1521	1863	3243	12527
	full	2.46	0.50	0.31	0.73	0.44	0.17	4.61
	large	4.01	1.14	1.09	1.69	3.08	1.92	12.93
	medium	5.24	2.33	6.15	2.92	4.30	18.46	39.40
	small	11.77	4.24	12.64	5.36	4.79	4.27	43.06
Average, %	all	23.47	8.21	20.19	10.70	12.61	24.82	100.00

It is assumed that the average per cent provided by the years 2007-2010 shown in Table 8.5.6 are compliable for the years 1990-2006. Hereby, similar activity data for building fires can be estimated back to 1990.

By applying the damage rates of 100 %, 75 %, 30 % and 5 % corresponding to the damage sizes full, large, medium and small, a full scale equivalent can be determined. Table 8.5.7 shows the calculated full scale equivalents (FSE). The full time series is shown in Annex 3G, Table 3G-5.4.

Table 8.5.7 Accidental building fires full scale equivalent activity data.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Container fires	781	897	788	759	778	979	1004	841	623
Detached house fires	777	892	784	755	774	757	886	876	833
Undetached house fires	231	265	233	224	230	343	278	208	194
Apartment building fires	367	421	370	357	366	405	433	413	348
Industry building fire	320	368	323	311	319	435	346	344	281
Additional building fires	437	501	440	424	435	483	523	466	429

The numbers of FSE of the different building categories are lower in this year's submission compared to last year's. This is due to two different changes that were implemented this year. Firstly, the introduction of the additional buildings category means that buildings like e.g. garages and sheds have been moved from detached houses to additional buildings. Secondly, the damage rates have been changed from large, medium and small of respectively 100 %, 50 % and 5 % to full, large, medium and small of respectively 100 %, 75 %, 30 % and 5 %.

The amount of detailed activity data is still limited due to the few years of reported data in the ODIN system, during the next years more data will become available providing a better basis for extrapolating back in time.

Emission factors

For building fires, emissions are calculated by multiplying the number of full scale equivalent fires with the emission factors. The estimation of emissions is based on emission factors from literature. The estimation is based on the measurements and estimations performed in countries that are comparable to Denmark. By comparable is meant countries that have similar building traditions, in relation to the material used in building structure and interior.

In the process of selecting the best reliable emission factors for the calculation of the emissions from Danish accidental building fires, a range of different sources have been studied. Unfortunately it is difficult to do an interrelated comparison of the different sources because they all establish emission factors on different assumptions and many of these assumptions are not fully accounted for. Table 8.5.8 lists the emission factors that were chosen for 2010 as the best reliable and their respective references.

Table 8.5.8 Emission factors building fires, per FSE fire, 2010.

Compound	Unit /fire	Detached house	Undetached house	Apartment building	Industrial building	Additional building	Container	Source
CO_2 - total	Mg	32.0	26.2	15.1	78.1	3.9	1.8	Blomqvist et al., 2002
CO_2 - biogenic	Mg	26.1	21.4	12.3	67.6	3.2	0.2	Blomqvist et al., 2002
CO_2 - non-biogenic	Mg	5.9	4.9	2.8	10.5	0.7	1.7	Blomqvist et al., 2002
CH_4	kg	42.3	34.7	20.0	52.0	2.1	0.3*	NAEI, 2009

*Container fires have a different source than the other five categories; Blomqvist et.al 2002

Emission factors for detached, undetached and apartment fires depend on the annual average floor space; see Table 8.5.9. Industrial, additional and container fires on the other hand are assumed to have a constant size/volume throughout the time series. Emission factors for detached, undetached and apartment fires for 1990-2010 are shown in Annex 3G, Table 3G-5.5a-c.

Emission factors from the EMEP/EEA Guidebook (EEA, 2009) are already specified for four of the six building types; detached houses, undetached houses, apartment buildings and industrial buildings. The EMEP/EEA Guidebook and all other considered sources were altered to match the six building types.

This alternation was performed simply by adjusting the average floor space for each of the building types respectively, whereas factors like loss rate and pounds of combustible contents per square foot are not altered.

The average floor space in Danish buildings is stated in Table 8.5.9. The data are collected from Statistics Denmark and takes into account possible multiple building floors but not attics and basements. For the full time series see

Annex 3G, Table 3G-5.6. The average floor space in industrial buildings, schools etc. is estimated to 500 square meters for all years and the average floor space for additional buildings, sheds etc. is estimated to 20 square meters for all years.

Table 8.5.9 Average floor space in building types.

Year	Detached	Undetached	Apartment
1990	156	129	75
1995	155	129	75
2000	156	131	75
2005	162	131	76
2006	163	132	76
2007	160	132	76
2008	161	133	77
2009	162	133	77
2010	163	134	77

Statistics Denmark.

Emission factors for container fires cannot de calculated based on an average floor space but on an average mass. The average mass of a container is set to 1 Mg and covers all types of containers, from small residential garbage containers to large shipping containers.

Persson et al. (1998) gives for Swedish conditions an emission factor for CO_2 expressed as kg per Mg of object burned and divided in three different objects; house, apartment and schools of average Swedish sizes. The data is based on the distribution of combustible material in the interior of the different building types, and does not take into account the combustible material in the structure itself. These emission factors are recalculated using Danish data for average building sizes, resulting in the subdivision of building types in detached, undetached, apartment, industrial and additional buildings.

Persson et al. (1998) sets a rate of weight loss at 12.4 %, but does not specify any further on different building types. It seems quite unrealistic that the same rate of weight loss applies for houses and industrial buildings, resulting in the conclusion that there is most likely an overestimation on the emission factors for industrial buildings.

In 2002 a report on the further development of this data was published in Blomqvist et al. (2002), this report added data for the amount of combustible material in the building structure. The emission factors from this source is calculated by combining the estimated amount of combustible material in the building structure itself, with the amount of combustible interior estimated in Persson et al. (1998) for the different building types. Again, Danish data for the average floor space in different building types is used to divided the emission factors into the six categories; detached houses, undetached houses, apartment buildings, industrial buildings, additional buildings and container fires.

The emission factors from both Persson et al. (1998) and Blomqvist et al. (2002) are probably overestimated due to building traditions, because wood is use to a further extent in Sweden and Norway contra Denmark.

Being that Persson et al. (1998) and Blomqvist et al. (2002) are the only sources to CO_2 emission factors, Blomqvist et al. (2002) is the best available source as this provides a more recent and more detailed method. The biogenic CO_2 emission stem from the burning of wood, this emission is calculated from the estimated wood contents in an average house. Blomqvist et al. (2002) specifies that an average house of 120 square meters has a structure that consists of 9000 kg wood and an interior that consists of 2780 kg wood. With a CO_2 yield factor of 1.63 kg per kg wood and a Danish average floor area of 163 square meters, the biogenic CO_2 emission from the burning of wood in a full scale detached house fire in 2010 is 26.1 Mg per FSE fire.

NAEI (2009) represents the UK National Atmospheric Emissions Inventory; this is the only source that provides an emission factor for CH_4, the factor is delivered in mass emission per mass burned. For the calculation of this emission factor to a unit that matches the activity data, the building masses are estimated using the data from Table 8.5.10.

Table 8.5.10 Building mass per building type.

	Unit	Detached house	Undetached house	Apartment building	Industry building	Additional building	Container
Average floor area*	m^2	163	134	77	500	20	-
Building mass per floor area	kg per m^2	40	40	35	30	30	-
Total building mass	Mg per fire	6.5	5.3	2.7	15.0	0.6	1

* 2010 numbers

No data was available for N_2O.

8.5.3 Accidental vehicle fires

Emissions that escape from vehicle fires are CO_2 and CH_4.

Methodological issues

Emissions from vehicle fires are calculated by multiplying the number of vehicle fires with selected emission factors. Emission factors are not available for different vehicle types, whereas it is assumed that all the different vehicle types leads to similar emissions. The activity data are calculated as an annual combusted mass by multiplying the number of different full scale vehicles fires with the Danish registered average weight of the given vehicle type.

Activity data

As with accidental building fires, data for accidental vehicle fires are available through the Danish Emergency Management Agency (DEMA). DEMA provides very detailed data for 2007-2010; the remaining years back to 1990 are estimated by using surrogate data.

There are fourteen different vehicle categories. The activity data is categorised in passenger cars (lighter than 3500 kg), buses, light duty vehicles (vans and motor homes), heavy duty vehicles (trucks and tankers), motorcycles/mopeds, other transport, caravans, trains, ships, airplanes, bicycles, tractors, combined harvesters and machines.

Table 8.5.11 shows the occurrence of fires in general and vehicle fires registered at DEMA. In 2007-2010 the average per cent of vehicle fires, in relation to all fires, was 20 %. The total numbers of vehicle fires in 1990-2006 are calculated using this per cent. The full time series is presented in Annex 3G, Table 3G-5.3.

Table 8.5.11 Occurrence of all fires and vehicle fires.

Year	All fires	Vehicle fires
1990	17 025	3 354
1995	19 543	3 850
2000	17 174	3 383
2001	16 894	3 328
2002	16 362	3 223
2003	18 443	3 633
2004	15 927	3 137
2005	16 551	3 260
2006	16 965	3 342
2007	18 263	3 223
2008	20 643	4 068
2009	18 930	3 930
2010	16 728	3 459

The total number of vehicle fires is higher this year than last year. This is due to the addition of the new vehicle categories of other transport, train, ship, airplane, bicycle, tractor, combined harvester and machine fires in this year's inventory.

In the same manner as accidental building fires, the 2007-2010 data from DEMA can be divided in four categories according to damage size. It is assumed that a full scale fire is a complete burnout of the given vehicle, and that a large, medium and small scale fire corresponds to 75 %, 30 % and 5 % of a full scale fire respectively. The total number of full scale equivalent (FSE) fires can be calculated for each of the fourteen vehicle categories for 2007-2010.

The total number of registered vehicles is known from Statistics Denmark. By assuming that the share of vehicle fires in relation to the total number of registered vehicles, of the every category respectively, can be counted as constant, the number of vehicle fires is estimated for the years 1990-2006. Table 8.5.12 states the total number of national registered vehicles and the number of full scale equivalent vehicle fires. The full time series 1990-2010 is shown in Annex 3G, Table 3G-5.7a-c.

Table 8.5.12 Number of nationally registered vehicles and full scale equivalent vehicle fires.

	Passenger Cars		Buses		Light Duty Vehicles		Heavy Duty Vehicles	
	Registered	FSE fires	Registered	FSE	Registered	FSE fires	Registered	FSE fires
1990	1645587	479	8109	12	192321	19	45664	58
1995	1733405	505	14371	21	228076	22	48077	61
2000	1916686	558	15051	22	272387	26	50227	64
2005	2012399	586	15131	22	372674	36	49311	63
2006	2064005	601	15180	22	414454	40	50691	64
2007	2151344	518	15013	16	402464	19	51758	46
2008	2182235	666	14830	24	398552	44	50528	71
2009	2199453	729	14752	23	383148	48	46510	67
2010	2247021	646	14577	23	362389	38	44812	60

Continued

	Motorcycles/Mopeds		Caravans		Train		Ship	
	Registered	FSE fires	Registered	FSE	Registered	FSE fires	Registered	FSE fires
1990	164111	58	86257	24	7156	9	2324	26
1995	165313	58	95831	26	6854	8	1911	21
2000	233695	83	106935	29	4907	6	1759	19
2005	274264	97	121350	33	3195	4	1792	20
2006	287672	102	126011	35	3002	4	1789	20
2007	302914	99	131708	36	2617	2	1755	20
2008	308546	122	136905	45	2588	3	1728	20
2009	307373	128	140366	34	2489	5	1742	22
2010	301766	83	142354	37	2740	2	1773	16

Continued

	Airplane		Tractor		Combined Harvester		Bicycle	Other	Machine
	Registered	FSE fires	Regis-	FSE fires	Registered	FSE fires	FSE fires	FSE fires	FSE fires
1990	1055	1	135980	82	35118	57			
1995	1058	1	134277	81	29291	47			
2000	1070	1	115692	70	24128	39			
2005	1073	1	107867	65	21436	35			
2006	1039	1	105865	64	20976	34			
2007	1058	1	106025	52	20507	19	2	85	75
2008	1077	1	106025	62	20046	34	4	97	135
2009	1122	1	106025	64	19584	43	3	93	111
2010	1152	1	106025	77	19354	32	4	58	94

The average weights of a passenger car, bus, light commercial vehicle, truck and motorcycle/moped are known for every year back to 1993 (Statistics Denmark, 2011). The corresponding weights from 1990 to 1992 and the average weight of the units from the remaining categories are estimated by an expert judgment, see Table 8.5.13 and Annex 3G, Table 3G-5.8.

Table 8.5.13 Average weight of different vehicle categories, kg.

	Cars	Buses	Vans	Trucks	Motorcycles/ Mopeds
1990	850	10000	2000	15000	80
1995	923	10807	2492	14801	107
2000	999	11195	3103	15214	107
2005	1068	11560	3793	13258	111
2006	1086	11684	4120	13179	113
2007	1105	11753	4505	13268	114
2008	1122	11700	4710	13246	116
2009	1134	11642	4682	12802	116
2010	1144	11804	4498	11883	117

It is assumed that the average weight of a bus equals that of a ship. That vans and tractors weigh the same and that trucks have the same average weight as trains, airplanes and combined harvesters.

Bicycles, machines and other transport can only be calculated for the years 2007-2010 due to the lack of surrogate data (number of nationally registered vehicles). The average weight of a bicycle, caravan, machine and other transport is set as 12 kg, 90 % of a car, 50 % of a car and 40 % of a car respectively.

By multiplying the number of full scale fires with the average weight of the vehicles respectively, the total amount of combusted vehicle mass can be calculated. The result is shown in Table 8.5.14 and in Annex 3G, Table 3G-5.9.

Table 8.5.14 Burnt mass of different vehicle categories, Mg.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Passenger cars	407	466	557	626	653	572	748	827	739
Buses	117	223	242	251	255	182	283	264	266
Light duty vehicles	37	55	82	137	165	86	207	223	171
Heavy duty vehicles	870	903	970	830	848	608	936	863	715
Motorcycle, moped	5	6	9	11	11	11	14	15	10
Other transport	-	-	-	-	-	47	54	53	33
Caravan	18	22	26	32	34	36	45	34	38
Train	128	121	89	51	47	33	39	63	24
Ship	257	228	218	229	231	234	230	253	189
Airplane	12	11	12	10	10	8	13	13	7
Bicycle	-	-	-	-	-	0.02	0.05	0.03	0.05
Tractor	164	201	216	246	263	235	290	301	347
Combine harvester	854	702	595	460	448	255	450	552	378
Machine	-	-	-	-	-	33	61	50	43
Total	2867	2940	3016	2884	2965	2339	3371	3512	2960

The total burnt mass of vehicle has changed compared to last year's inventory due to the changes in methodology. Last year the damage rate was set to 70 % for all fires, but this year the damage rate was divided in four categories according to the measure of fire extinguishing.

Also the activity data now includes other transport, trains, ships, airplanes, bicycles, tractors, combined harvesters and machines. The activity of the eight new categories has a descending trend, whereas activities that were also included in last year's inventory are increasing. The resulting new total activity has a relatively constant trend.

The joint effect of these two changes in methodology is an increase in activity for 1990-1991 and a decrease for 1992-2009. The largest increase is +4 % in 1990 and the largest decrease is -33 % in 2007, the change in 2009 is -16 %.

Emission factors

In the process of selecting the most reliable emission factors for the calculation of the emissions from Danish vehicle fires, different sources have been studied. Unfortunately it is difficult to do an interrelated comparison of the different sources because they all establish emission factors on different assumptions and many of these assumptions are not fully accounted for. Table 8.5.15 lists the accepted emission factors and their respective references.

Table 8.5.15 Emission factors for vehicle fires.

	Unit	Emission factor	Source
CO_2	Mg/Mg	2.4	Lönnermark et al., 2006
CH_4	kg/Mg	5	NAEI, 2009
N_2O	-	NAV	-

NAV = not available

Persson et al. (1998) and Lönnermark et al. (2006) are the only available sources to CO_2 emission factors for vehicle fires. Since Lönnermark et al. (2006) is the more resent source and establishes its emission factors on experimental data, this is chosen as the best reliable source.

No data was available for N_2O.

8.5.4 Sludge spreading

Sludge from wastewater treatment plants is only spread out in the open with the purpose of fertilising crop fields. Greenhouse gas emissions from this activity are included in the agricultural sector, see Chapter 6.

8.5.5 Biogas production

Emissions from biogas production are divided and reported in different sections of this inventory according to use.

For the biogas production from organic waste with the purpose of energy production, the fuel consumption rate of the biogas production plants refers to the Danish energy statistics. The applied emission factors are the same as for biogas boilers. See this Chapter 3, Energy.

Biogas production from manure is included in Chapter 6, Agriculture.

The fugitive emissions of CH_4 from the production of biogas from sludge from wastewater treatment have been set to 1% of the biogas production. The methodology used for estimation the CH_4 and N_2O emissions from wastewater handling are described in Chapter 8.3, Wastewater Handling.

Biogas production in this section only covers fugitive emissions from the handling of biological waste, sludge and manure. This includes activities like storage, pre- and after-treatment and fugitive emissions from the anaerobic digestion that is the actual production. However, emissions on these activities are considered negligible.

8.5.6 Other

Other waste types under Waste Other are the open burning of yard waste and bonfires.

Occurrence of wild fires and crop burnings are categorised under Chapters 7 LULUCF and 6 Agriculture respectively.

In Denmark, the open burning of private yard waste is under different restrictions according to the respective municipality. These restrictions involve what can be burned but also the quantity, how, when and where or in some cases a complete banning (DEPA, 2011b). There is no registration of private waste burning and the activity data on this subject are very difficult to estimate. People are generally appealed to compost their yard waste or to dispose of it through one of the many waste disposal/recycling sites.

The occurrence of bonfires at midsummer night and in general are likewise not registered, therefore it has not been possible to obtain activity data.

8.6 Uncertainties and time series consistency

Two set of uncertainty estimates are made for the Danish emission inventory for greenhouse gases based on tier 1 and tier 2 methodology, respectively. The uncertainty models follow the methodology in the IPCC Good Practise Guidance (IPCC, 2000). Tier 1 is based on the simplified uncertainty analysis and tier 2 is based on Monte Carlo simulations.

8.6.1 Input data

Solid Waste Disposal on Land

The waste amounts for solid waste disposal on land are registered in a national database held by the Danish EPA and assessed to be of high quality resulting in the adoption of an uncertainty for reported waste amounts of 10 %.

Input parameter uncertainties for SWDS considered in the tier 1 uncertainty analysis are based on the IPCC (IPCC 2000, page 5.12, Table 5.2) default values and provided in Table 8.6.1.

Table 8.6.1 Tier 1 input parameter uncertainty, %.

Parameter	Parameter ID	Uncertainty %	Note
The Waste amount sent to SWDS	*W*	10	Since the amounts are based on weighing at the SWDS the lower value in IPCC (2000), is used
Degradable Organic Carbon	DOC_i	50	Highest value, IPCC 2000, page 5.12, Table 5.2
Fraction of DOC dissimilated	DOC_f	30	Highest value, IPCC 2000, page 5.12, Table 5.2
Methane Correction Factor	*MCF*	10	IPCC, 2006
Fraction of CH_4 in landfill gas		10	Medium value, IPCC 2000, page 5.12, Table 5.2
Methane Generation Rate Constant	*k*	100	IPCC 2000, page 5.12, Table 5.2

The waste amounts for solid waste disposal on land are registered in a national database held by the Danish EPA and assessed to be of high quality resulting in the adoption of an uncertainty for reported waste amounts of 10 %. The default uncertainty range for the methane generation constant, k, is: -40 % to +300 %.; for the tier 1 uncertainty calculation it has been set to 100% (Limpert et. al., 2001). For the remaining parameters default uncertainties are used until country-specific parameters becomes available.

The uncertainty on the implied emission factor, U_{ief}, is based on uncertainty estimates in Table 8.6.1 and is approximated with IPCC (2000) Equation 6.4 equals

U_{ief} % = SQRT($50^2+30^2+10^2+10^2+100^2$) = 117.9 %

These uncertainties give the combined tier 1 uncertainty on the emission from SWDS of: SQRT($10^2+117.9^2$) = 118.3 %.

Wastewater Handling

The uncertainty levels used in the tier 1 model are shown in Table 8.6.2.

Table 8.6.2 Estimated uncertainty rates for activity data and emission factors, %.

95 % confidence interval uncertainties	CH_4	N_2O, direct	N_2O, indirect
Wastewater Handling			
Activity data	44	37	59
Emission factor	78	98	39

Uncertainty levels for activity data and emission factors for wastewater handling are listed in Table 8.6.3. Uncertainty levels are given in per cent related to the 95 % confidence interval assuming a normal distribution.

Default IPCC values are assumed to be given at 95 % confidence level. For the country-specific activity data, the standard deviation of different data sources has been used for deriving per cent uncertainty estimates. Annex 3G, Table 3G-3.6 elaborates on the different values and their references.

Table 8.6.3 Input parameter uncertainties in year 1990 and 2010, for activity data and emission factors used in the tier 2 uncertainty model, %.

Source	Uncertainties value for activity data, %		Uncertainties value for emission factor, %	
	1990	2010	1990	2010
CH_4, sewer system and WWTP	33	33	32	32
CH_4, septic tanks	31	31	36	36
CH_4, emission from anaerobic treatment, Gg	33	33	34	34
N_2O, indirect	45	16	17	17
N_2O,direct	38	12	27	27

Uncertainties have been derived from IPCC default values and uncertainties in country-specific parameters, respectively (cf. Annex 3G, Table 3G-3.6).

Waste Incineration

The uncertainty of the number of human cremations is miniscule, however for the purpose of uncertainty calculation it has been set to 1 %. The uncertainty of the activity data from animal cremations is also minimal for the most recent years (1998-2010) but is increasing back in time (to 67 % in 1990). The uncertainty is set to 40 % for all years (Authors expert judgement).

Table 8.6.4 lists the 95 % confidence interval uncertainties for activity data and emission factors used in this inventory and at the present level of available information. The uncertainties are assumed valid for all years 1990-2010.

Table 8.6.4 Estimated uncertainty rates for activity data and emission factors, %.

95 % confidence interval uncertainties	CO_2	CH_4	N_2O
Human cremation			
Activity data	-	1	1
Emission factor	-	150	150
Animal cremation			
Activity data	-	40	40
Emission factor	-	150	150

Waste Other

The uncertainty of the total number of accidental fires is miniscule, but the division into building and transportation types might lead to a small uncertainty, primarily caused by the category "other". The uncertainty for both building and vehicle activity data is therefore set to 10 %. The uncertainty is lowest for recent years, 2007-2010. (Authors expert judgement).

Table 8.6.5 lists the 95 % confidence interval uncertainties for activity data and emission factors used in this inventory and at the present level of available information. The uncertainties are assumed valid for all years 1990-2010.

Table 8.6.5 Estimated uncertainty rates for activity data and emission factors, %.

95 % confidence interval uncertainties	CO_2	CH_4	N_2O
Compost production			
Activity data	-	40	40
Emission factor	-	100	100
Accidental building fires			
Activity data	10	10	-
Emission factor	300	500	-
Accidental vehicle fires			
Activity data	10	10	-
Emission factor	500	700	-

The input parameter uncertainties are at the same aggregation level as reported in last year's NIR (Nielsen et al., 2011a).

8.6.2 Tier 1 uncertainty results

The tier 1 uncertainty estimates for the waste sector are calculated from 95 % confidence interval uncertainties, results are shown in Table 8.6.6.

The overall uncertainty interval for greenhouse gases (GHG) is estimated to be ±86.2 % and the trend in GHG emission is -38.8 % ±14.0 %. The main source of uncertainty in the trend in GHG emission is 6 D. Waste Other, even though this category only provides a maximum of 13 % (in 2010) of the total GHG emissions from waste, the trend uncertainty of this individual category is 147.2 % ± 157.4 %.

The lowest overall uncertainty for an individual waste category is 57.1 % for wastewater treatment. The contribution to the total emission uncertainty is highest for methane followed by the indirect N_2O emission and direct N_2O emission. Regarding the time trend, the largest uncertainty is observed for the direct N_2O which also shows the largest increasing trend.

With contributions to the total GHG emissions from the waste sector of between 72 % and 87 %, SWDS is the most important waste category. The individual uncertainty of this category is ±118.3 % and -49.2 % ±7.2 % for the trend.

Table 8.6.6 National tier 1 uncertainty estimates for the waste sector.

Pollutant	National emission, 2010, Gg	Total emission uncertainty, %	Trend 1990-2010, %	Trend uncertainty, %
GHG	1079.46	±86.2	-38.8	±14.0
CO_2	18.24	±267.4	-0.5	±13.1
CH_4	44.50	±99.1	-42.5	±11.7
N_2O	0.41	±60.1	4.9	±82.0

GHG emissions are calculated in CO_2-equivalents.

8.6.3 Tier 2 uncertainty results

The tier 2 uncertainty estimates for the waste sector are calculated from the input data presented in Section 8.6.1; results are shown in Table 8.6.7. The calculations are based on a Monte Carlo approach as described in Chapter 1.7.

Table 8.6.7 National tier 2 uncertainty estimates for the waste sector.

	1990 National emission Uncertainty interval	2010 National emission Uncertainty interval	2010 Trend Uncertainty
GHG	1717.8 Gg (-57 %, +163 %)	988.0 Gg (-49 %, +132 %)	682.8 Gg (-92 %, +164 %)
CO_2	27.7 Gg (-67 %, +381 %)	27.3 Gg (-67 %, +394 %)	0.2 Gg (-18 %, +14 %)
CH_4	76.4 Gg (-62 %, +179 %)	41.1 Gg (-55 %, +153 %)	32.7 Gg (-100 %, +180 %)
N_2O	0.4 Gg (-26 %, +37 %)	0.4 Gg (-22 %, +45 %)	0.03 Gg (-42 %, +40%)

Greenhouse gas (GHG) emissions are calculated in CO_2-equivalents.

The medians for the national emissions from waste calculated with the tier 2 method are similar to those calculated with the tier 1 method. This is an example of how uncertainties can cause small. The medians for the national emissions from the waste category calculated with the tier 2 method, are in general higher than those shown in Table 8.5.1.

The following Figures 8.6.1, 8.6.2 and 8.6.3 show the graphical comparison of tier 1 and tier 2. Figure 8.6.1 and 8.6.2 show the uncertainties of the national emissions for waste from 1990 and 2010 respectively and Figure 8.6.3 shows the uncertainties of the trend.

The tier 1 uncertainties are the same for 1990 and 2010 because the uncertainty input data in this model are the same for both years. The only input data that vary in the tier 1 model are the activity data and for tier 2, results will vary slightly due to the calculation method.

The largest uncertainties lie with the accidental fires, and since the entire emission of non-biogenic CO_2 stems from accidental fires, this is the compound with the highest uncertainty; cf. Figure 8.6.1, Figure 8.6.2, Table 8.6.6 and Table 8.6.7.

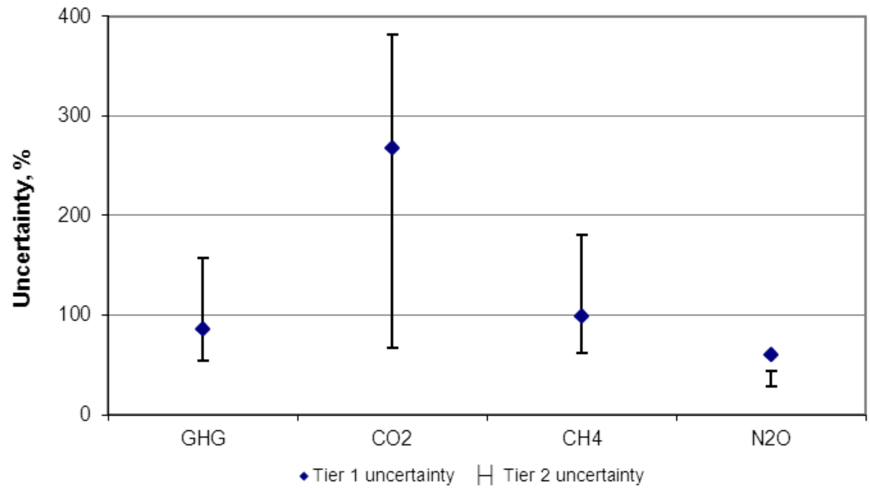

Figure 8.6.1 A graphical comparison of tier 1 and tier 2 uncertainties for 1990.

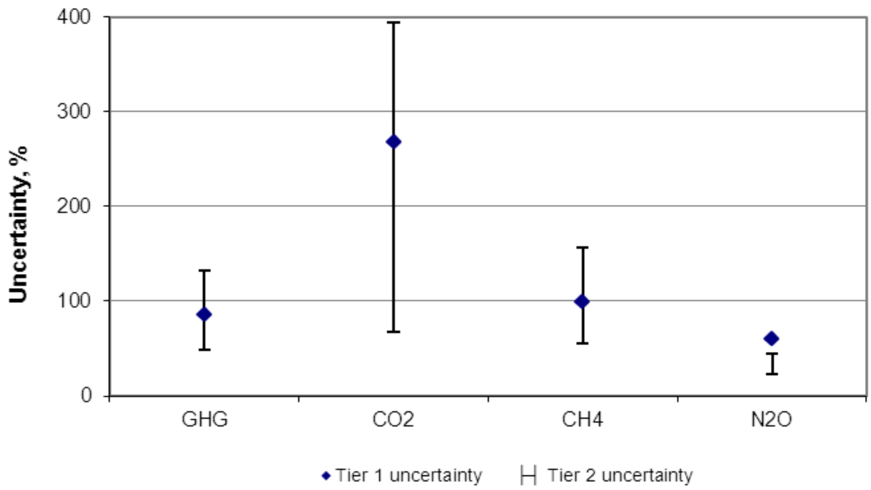

Figure 8.6.2 A graphical comparison of tier 1 and tier 2 uncertainties for 2010.

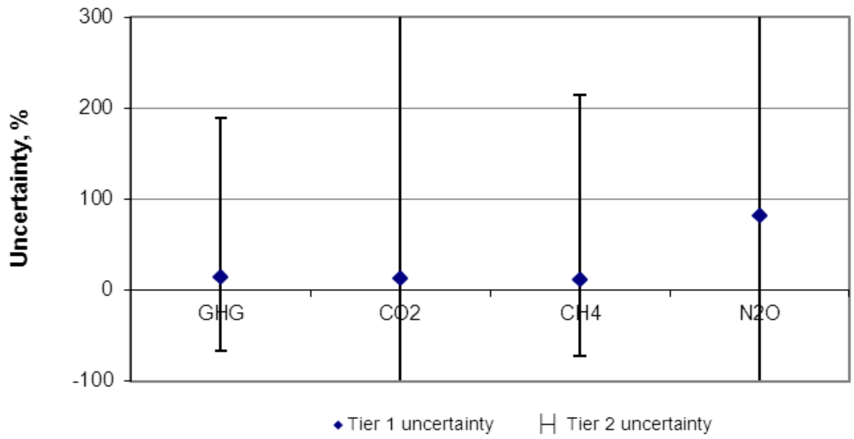

Figure 8.6.3 A graphical comparison of tier 1 and tier 2 trend uncertainties for 1990-2010, tier 2 uncertainties for CO_2 and N_2O are shown in Table 8.6.7.

8.6.4 Time series consistency and completeness

Solid Waste Disposal on Land

Registration of the amount of waste has been carried out since the beginning of the 1990s in order to measure the effects of action plans. The activity data is, therefore, considered to be consistent through the time series to make the activity data input to the FOD model reliable.

The consistency of the emissions and the emission factor is a result of the same methodology and the same model used for the whole time series. The parameters in the FOD model are the same for the whole time series. The use of a model of this type is recommended in IPCC (1997) and IPCC (2000).

As regards completeness, the waste amounts used, as registered in the ISAG system, do not only include traditional Municipal Solid Waste (MSW), but also non-MSW such as Industrial Waste, Building and Construction Waste and Sludge. The composition of these waste types is, according to Danish data, used to estimate DOC values for the waste types (refer IPCC 2000, page 5.10).

Wastewater Handling

Registration of the activity data needed for the calculation of nitrous oxide emission from the effluent water has been registered as a measure of the effectiveness (distance to target) of the Action Plan on the Aquatic Environment since 1987, whereas the sludge database is based on voluntary reporting.

Consistency and completeness have been improved by access to the Danish Water Quality Parameter Database (www.miljoeportal.dk) and the Danish Sludge Database held by DEPA.

At this point, data regarding industrial on-site wastewater treatment processes is not available at a level that allows for calculation of the on-site industrial contribution to CH_4 or N_2O emissions. The degree to which industry is covered by the estimated emission is, therefore, dependent on the amount of industrial wastewater connected to the municipal sewer system. Any direct emissions from pre-treatment on-site are not covered in this inventory.

Waste Incineration

Activity data for human cremation is considered to be consistent as these data have been collected by DKL throughout the time series. Activity data for animal cremation on the other hand is not fully consistent. Data for 1998-2010 are gathered directly from the crematoria and data for 1990-1997 are estimated by the author's expert judgement, no surrogate data or data regression is possible.

Emission factors and calculation method are consistent throughout the time series for both human and animal cremation.

Cremation of both corpses and carcasses is considered to be complete. Open burning of carcasses is illegal and therefore not occurring in Denmark, and small-scale incinerators are not known to be used at Danish farms.

Waste Other

For compost production, activity data is not consistent as data are only available for 1995-2009. Data for 1990-1994 and data for home composting are estimated through linear regression and with surrogate data respectively. Emission factors and calculation method is consistent throughout the time series.

Emissions from compost production are believed to be complete, calculations include composting at all nationally registered sites and best available estimated for home composting.

For accidental fires, DEMA provides detailed data for 2007-2010 and the total number of nationally registered fires for 1990-2010. Activity data for accidental fires are there for believed to be consistent. Both emission factors and calculation method are also consistent throughout the time series.

Emissions from accidental fires are believed to be complete. Field burning of agricultural residue is included in Chapter 6 Agriculture.

8.7 QA/QC and verification

In general terms, for this part of the inventory, the Data Storage (DS) Level 1, 2 and 4 and the Data Processing (DP) Level 1 can be described as follows.

8.7.1 Data Storage Level 1

The external data level refers to the placement of the original input data used for estimating annual activity and emission factors in the waste sector. Data references in terms of reports and databases used for deriving input for the emission calculations. Reports and a list of links to external data sources are stored in a common data storage system including all sectors of the annual NIRs.

Table 8.7.1a Overview of annually stored external data sources at DS level1.

http, file or folder name	Description	AD or EF	Reference	Contact	Data agreement/ Comment
DCE data-exchange folder I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_ Waste\Level_1a_Storage*	Inventory data storage system	AD and EF	DCE		
Report series published and available from the Danish Environmental Protection Agency www.mst.dk	Reported sludge and water quality parameters	AD	Report series from DEPA: "*Wastewater sewage sludge from municipal and private wastewater treatment plants*" (1997-2005) "*Point sources*" (1993-2005)	Marianne Thomsen (mth@dmu.dk)	Public available reports
Report series published by the Agency for Spatial and Environmental Planning (ASEP) and available from the Danish Nature Agency (DNA): www.nst.dk			Report series: "*Point sources*" (2006-2010)	Anna Gade Holm (angho@nst.dk) Marianne Thomsen (mth@dmu.dk)	Public available reports
Danish Water Quality parameter Database	Annually reported wastewater characteristics at plant level which includes all years 1990- 2010	AD	www.miljoeportalen.dk		Authorised access
Danish Sludge Database	Annually reported sludge characteristics at plant level	AD	DEPA	Linda Bagge (bagge@mst.dk) Marianne Thomsen (mth@dmu.dk)	none
I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_ Waste\Level_1a_Storage\6A Solid Waste Disposal	Basic data DS1 Report on 2007 and 2008 amounts according to the waste fractions.	Activity data	Danish Environmental Protection Agency (DEPA), Waste Statistics (Affaldsstatistik)	Unit for Soil and Waste Martin Sune Møller (masmo@mst.dk)	The amounts are registered due to statutory requirequirements
I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_ Waste\Level_1a_Storage\6A Solid Waste Disposal	Basic data DS1 Dataset for energy-producing SWDS	CH_4 recovery data	The Danish Energy Agency (DEA)	Peter Dal (pd@ens.dk)	Prepared due to the obligation of DEA
I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_ Waste\Level_1b_Processes\6A Solid Waste Disposal	Excel file with the FOD model swds_fod_model.xls DP1	Parameters of the FOD model	IPCC 1997 and 2000		
http://www.dkl.dk	Number for cremations	AD	Association of Danish Crematories	Hanne Ring hr@dkl.dk	Public access
http://www.statistikbanken.dk	Statistics for humans, buildings and vehicles	AD	Statistics Denmark		Public access

*The data storage level 1 consists of DEPA reports and data extracted from other sources listed in the Table.

Table 8.7.1b Overview of annually stored external data sources at DS level1 (Continued).

I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_Waste\Level_1a_Storage\6C Waste Incineration	Cremated animal carcasses	AD	Dansk Dyrekremering ApS	Knud Ribergaard info@danskdyrekremering.dk	Personal contact
I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_Waste\Level_1a_Storage\6C Waste Incineration	Cremated animal carcasses	AD	Ada's Kæledyrskrematorium ApS	Anders Oxholm anders@adakrem.dk	Personal contact
I:\ROSPROJ\LUFT_EMI\Inventory\2010\6_Waste\Level_1a_Storage\6C Waste Incineration	Cremated animal carcasses	AD	Kæledyrskrematoriet	Annette Laursen dyrepension@skylinemail.dk	Personal contact
https://statistikbank.brs.dk	Categorized fires	AD	The Danish Emergency Management Agency	Steen Hjere Nonnemann shn@beredskabs styrelsen.dk	Public access
http://www2.mst.dk/udgiv/publikationer/2010/978-87-92668-21-9/pdf/978-87-92668-22-6.pdf	Waste categories for composting	AD	Danish Environmental Protection Agency (DEPA), Waste Statistics		Public access

8.7.2 Data Processing Level 1

This level comprises a stage where the external data are treated internally. For SWDS data are prepared for the DCE First Order of Decay model, see Section 8.2.1. The model runs are carried out and the output stored. For Wastewater Handling data are prepared for the input to the country-specific models. Programming as to automatically calculations based on activity data and emission factors are not yet fully operational. Calculations are carried out and the output stored in a not editable format each year. The DP at level 1 has been improved to fit into a more uniform and easily accessible data reporting format. Regarding the derivation of activity data and emission factors used in the model calculations, this year's improvements are documented in Chapter 8.3.1.

For the CRF categories 6C and 6D, the activity data and emission factors are recalculated to match each other by using national average data like the average floor space in houses etc.

8.7.3 Data Storage Level 2

Data Storage Level 2 is the placement of selected output data from the calculation of emissions as inventory data on SNAP levels in the Access (CollectER) database.

8.7.4 Data Storage Level 4

Data Storage Level 4 is the placement of the calculated output data from the calculation of emissions as data on SNAP levels in the CRFs.

8.7.5 Points of measurement

The present stage of QA/QC for the Danish emission inventories for the waste sector is described below for DS level 1, 2 and 4 and DP level 1 Points of Measurement (PMs). This is to be seen in connection with the general

QA/QC description in Section 1.6 and, especially, 1.6.10 on specific description of PMs common to all sectors, general to QA/QC.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

The sources of data described in the methodology sections and in DS.1.2.1 and DS.1.3.1 are used in this inventory. It is the accuracy of these data that define the uncertainty of the inventory calculations.

With regard to the general level of uncertainty for SWDS, the amounts in waste fractions/categories are reasonably certain (per cent uncertainty set equal to 10 %, cf. Table 8.6.1. Due to the statutory environment for these data, while the distribution of waste fractions according to waste type and their content of DOC is more uncertain (per cent uncertainty set equal to 50%, cf. Table 8.6.1). It is generally accepted that FOD models for CH_4 emission estimates offer the best and the most certain way of estimation. The half-life in the FOD models is an important parameter with some uncertainty (cf. Table 8.6.1).

The input parameter uncertainties for Wastewater Handling have been derived from standard deviations between activity data extracted from national databases and reported national statistics as shown in Table 8.7.1a and b. Uncertainties on defaults numbers are taken from the IPCC (1997 and 2000). Uncertainty of activity data are based on simple standard deviations accompanying the annual reported monitoring data.

For Waste Incineration and Waste Other the level of uncertainty is generally low for activity data but higher for emission factors, cf. Table 8.6.4 and 8.6.5. Expert judgments are used whenever default uncertainties are not available.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the emission factors/calculation parameters with data from international guidelines, and evaluation of major discrepancies.

Comparison of Danish data values from external data sources with corresponding data from other countries has been carried out in order to evaluate discrepancies.

For many countries SWDS waste amounts do not – as for the Danish data – include waste from industrial sources, which presents a difficulty with regard to comparison.

Comparison of Danish data values with data sources from other countries has been carried out as presented in the national verification report by Fauser et al., 2006 and the methodology report by Thomsen & Lyck, 2005 and Nielsen et al., 2011a.

Data Storage level 1	3.Completeness	DS.1.3.1	Ensuring that the best possible national data for all sources are included, by setting down the reasoning behind the selection of datasets.

The following external data sources are used for the inventory on waste (refer also to the Table 8.7.1a and b):

SWDS

- Danish Environmental Protection Agency (DEPA), ISAG database: amounts of the various waste fractions deposited (refer to Section 8.2.1).
- A Danish investigation on the waste types in waste fractions and the content of degradable organic carbon in waste types.
- Danish Energy Agency (DEA): Official Danish energy statistics: CH_4 recovery data.

The selection of sources is obvious. The ISAG database is based on statutory registrations and reporting from all Danish waste treatment plants for all waste entering or leaving the plants. Information concerning waste in the previous year must be reported to the DEPA each year, no later than January 31. Registration is made by mass for the individual waste categories. For recovery data, the DEA registers the energy produced from plants where installations recover CH_4 for the energy statistics.

For the parameters of the FOD model, references are made to IPCC (1997, 2000 and 2006).

WWT

- The Danish sludge database (Table 8.3.4)
- The Danish Water Quality Parameter Database (www.miljoeportal.dk)

Waste Incineration

- Tables from Association of Danish Crematories available online
- Direct contact with the Danish animal crematories
- Emission factors from literature

Data from the Association of Danish Crematories is based on annual reporting from all Danish crematories. Specific reported data is available for the complete time series.

Waste Other

- Waste Statistics (DEPA, 1996, 1998, 1999, 2001a, 2001b, 2002, 2004a, 2004b, 2005, 2006a, 2006b, 2008, 2010a, 2011a)
- Danish Emergency Management Agency (DEMA) database
- Emission factors from literature

The waste statistics are based on data from the ISAG database which is the only Danish registration of waste amounts. Also the DEMA database is the only provider of data on accidental fires; data for newer years (2007-2010) are extremely detailed.

Data Storage level 1	4.Consistency	DS.1.4.1	The original external data has to be archived with proper reference.

Data are predominantly extracted from the internet (ISAG, Water Quality Parameter, sludge, Statistics Denmark, DEMA database, human cremation). The origin of external activity data has been preserved as much as possible by saving them as original copies in their original form. Files are saved for each year of reporting, in this way changes to previously received data and calculations is reflected and explanations are given. Specific information from reports, industries and experts are saved as e-mails and pdf files.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and DCE about the conditions of delivery.

As stated in DS.1.4.1 most data are obtained from the internet. It is a statutory requirement that amounts of waste are reported annually to DEPA, no later than January 31 for the previous year. No explicit agreements have been made with external institutions.

However for Wastewater Handling, this point may still be critical due to the missing timing full reporting and completeness of the databases held by the ASEP and DEPA respectively with respect to the submission date of the annual NIR.

Data Storage level 1	7.Transparency	DS.1.7.1	Listing of all archived datasets and external contacts.

Contact persons related to the delivery of specific data are provided in Table 8.7.1a and b.

For a listing of all archived external datasets, see DS 1.3.1.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source not part of DS.1.1.1 as input to Data Storage level 2 in relation to type and scale of variability.

No data are used in addition to those included in DS.1.1.1. Uncertainties are reported in Section 8.6.1.

Data Processing level 1	2.Comparability	DP.1.2.1	The methodologies have to follow the international guidelines suggested by UNFCCC and IPCC.

The methodological approach is based on the detailed methodology as outlined in the Emission Inventory Guidebook. The calculation used for SWDS is a tier 2 methodology from IPCC (1997, 2000 and 2006). For WWT the calculations follow the IPCC (1997 and 2000). Exemptions have been documented whenever occurring. The inventory calculations for Waste Incineration and Waste Other are a simple multiplication of activity data and emission factors. See also DS.1.3.1.

Data Processing level 1	3.Completeness	DP.1.3.1	Identification of data gaps with regard to data sources that could improve quantitative knowledge.

For SWDS there is no quantitative knowledge in the methodology on either (1) the shift in waste fractions within waste categories for 1960-1984 and 1986-1993, (2) the development over time of the DOC content in individual waste fractions or (3) possible individual conditions relating to the SWD sites. On-going research might change this lack.

Data on separate industrial WWTPs. Information on methane emissions for separate industries may be of importance.

Emission factors for cremation and accidental fires are gathered from literature studies. There is no Danish literature or measurements available on greenhouse gas emissions from these categories.

Activity data for accidental fires for the years 1990-2006 are not subcategorised into vehicles, buildings or sizes.

Data Processing level 1	4.Consistency	DP.1.4.1	Documentation and reasoning of methodological changes during the time series and the qualitative assessment of the impact on time series consistency.

There is no change in calculation procedure during the time series and the activity data is, as far as possible, kept consistent for the calculation of the time series. Any changes in calculation procedures are noted for each year's inventory, cf. Section 8.6.4.

Data Processing level 1	5.Correctness	DP.1.5.1	Verification of calculation results using time series

The time series of activities and emissions in the model output, in the SNAP source categories and in the CRF format have been prepared. The time series are examined and significant changes are checked and explained. Comparison is made with the previous year's estimate and any major changes are verified.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using other measures

The correct interpretation in the model/calculation of the methodology and the parameterisation has been checked as far as possible.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle, the equations used and the assumptions made must be described.

The calculation principle and equations are described in "Methodological issues", Section 8.2.1, 8.3.2, 8.4.1, 8.4.2, 8.5.1, 8.5.2 and 8.5.3.

Data Processing level 1	7.Transparency	DP.1.7.2	Clear reference to dataset at Data Storage level 1

Refer to the table at the start of this Section and DS.1.1.1 (8.7.1a and b).

The calculation principle and equations are described in "Methodological issues", Section 8.2.1, 8.3.2, 8.4.1, 8.4.2, 8.5.1, 8.5.2 and 8.5.3.

Data Processing level 1	7.Transparency	DP.1.7.3	A manual log to collect information about recalculations.

Recalculation and changes in the emission inventories are described in the NIR whenever occurring. The logging of the changes takes place in the annual model file.

Data Storage level 2	5.Correctness	DS.2.5.1	Check if a correct data import to level 2 has been made

The transfer of emission data from level 1, storage and processing, to data storage level 2 is manually checked. This check is performed, comparing model output and report files made by the CollectER database system.

Data Storage level 4	4. Consistency	DS.4.4.3	The IEFs from the CRF are checked both regarding level and trend. The level is compared to relevant emission factors to ensure correctness. Large dips/jumps in the time series are explained.

See DP.1.5.1 and DP.1.5.2.

8.8 Source specific recalculations

Table 8.8.1 presents the recalculations to the waste sector for this year's inventory. Tables with the full time series 1990-2010 are shown in Annex 3G, Table 3G-6.1, 3G-6.2, 3G-6.3, 3G-6.4 and 3G-6.5.

Table 8.8.1 Changes in greenhouse gas emissions from the waste sector compared with last year.

	Unit	1990	1995	2000	2005	2006	2007	2008	2009
Solid Waste Disposal on Land									
CH_4, previous inventory	Gg	52.9	52.6	0.57	48.5	51.4	50.6	50.3	49.5
CH_4, recalculated	Gg	72.8	64.5	0.57	44.9	46.5	44.3	42.6	40.5
Change, CO_2 equivalents	Gg	418.9	250.2	0.71	-76.9	-104.5	-133.0	-162.6	-188.0
Change	%	37.7	22.7	0.71	-7.5	-9.7	-12.5	-15.4	-18.1
Wastewater Handling									
CH_4, previous inventory	Gg	3.15	3.27	3.51	3.52	3.52	3.54	3.55	3.56
CH_4, recalculated	Gg	3.15	3.27	3.51	3.54	3.53	3.55	3.55	3.57
N_2O, previous inventory	Gg	0.35	0.37	0.32	0.30	0.26	0.30	0.36	0.26
N_2O, recalculated	Gg	0.35	0.37	0.32	0.30	0.26	0.30	0.36	0.26
Change, CO_2 equivalents	Gg	0.00	0.00	0.13	0.42	0.28	0.35	0.18	0.30
Change	%	0.00	0.00	0.08	0.25	0.18	0.21	0.10	0.19
Waste Incineration									
CH_4, previous inventory	Gg	0.51	0.55	0.57	0.62	0.69	0.72	0.73	0.74
CH_4, recalculated	Gg	0.51	0.55	0.57	0.62	0.69	0.72	0.73	0.74
N_2O, previous inventory	Gg	0.64	0.69	0.71	0.77	0.86	0.90	0.92	0.93
N_2O, recalculated	Gg	0.64	0.69	0.71	0.77	0.86	0.90	0.92	0.93
Change, CO_2 equivalents	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change	%	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
Waste Other									
CO_2, previous inventory	Gg	22.02	25.41	24.33	23.96	25.05	25.99	28.48	27.67
CO_2, recalculated	Gg	18.34	20.17	18.82	18.26	18.77	19.32	21.50	21.08
CH_4, previous inventory	Gg	1.40	1.78	3.02	3.22	3.41	3.80	3.48	3.86
CH_4, recalculated	Gg	1.35	1.72	2.96	3.16	3.35	3.73	3.41	3.63
N_2O, previous inventory	Gg	0.04	0.05	0.13	0.10	0.11	0.13	0.12	0.13
N_2O, recalculated	Gg	0.04	0.05	0.13	0.10	0.11	0.13	0.12	0.13
Change, CO_2 equivalents	Gg	-4.80	-6.57	-6.71	-6.86	-7.52	-8.05	-8.26	-12.41
Change	%	-7.67	-8.39	-5.23	-5.59	-5.76	-5.57	-6.00	-8.32
Total Waste									
CO_2, previous inventory	Gg	22.0	25.4	24.3	24.0	25.1	26.0	28.5	27.7
CO_2, recalculated	Gg	18.3	20.2	18.8	18.3	18.8	19.3	21.5	21.1
CH_4, previous inventory	Gg	57.5	57.6	57.4	55.3	58.4	58.0	57.3	56.9
CH_4, recalculated	Gg	77.3	69.5	62.8	51.6	53.3	51.6	49.5	47.7
N_2O, previous inventory	Gg	0.4	0.4	0.5	0.4	0.4	0.4	0.5	0.4
N_2O, recalculated	Gg	0.4	0.4	0.5	0.4	0.4	0.4	0.5	0.4
Change, CO_2 equivalents	Gg	414.1	243.7	107.9	-83.3	-111.7	-140.7	-170.7	-200.1
Change	%	30.7	17.8	7.9	-6.4	-8.2	-10.2	-12.4	-14.9

8.8.1 Solid waste disposal on land recalculations

The recalculation of emissions from Solid Waste Disposal on Land is primarily caused by the change in half-life times. In last year's submission all waste fractions were set to have a half-lift time of 14 years, but this year the half-life times are defined according to the different waste fractions, cf. Table 8.2.2. This decrease of half-life times for some waste fractions results in an earlier release of CH_4 from deposited waste and thereby an increased emission for earlier years (1990-2002) and a decrease for the latest years (2003-2009).

In last year's inventory emissions were calculated from eight different waste categories, each of which had a composition of different waste fraction. However, these waste fractions were based on a waste study from 1985 and are therefore not accurate for all deposited waste, 1960-2010. Based on the very detailed data available through the ISAG database for 1994-2008, every waste category is allocated with new country specific waste fractions for 1994-2008, cf. Table 8.2.4 and Annex 3G, Table 3G-2.4a-h.

Other changes were made to the calculation of emissions from SWDS, although these do not affect the calculated emissions as gravely as the half-lives. One of these changes is the adjustment of the CH_4 content in biogas, this has in this year's inventory been changed from the default 50 % to the country specific 41.11 %. The reduction of CH_4 in the recovered biogas increases the amount of emitted CH_4 for the years where recovery has taken place (1990-2009). This change alone gives an increase between 0.1 % (1990) and 5.3 % (2004); the increase for both 2008 and 2009 is 2.5 %.

Another change made to the calculation of emissions from SWDS is the adjustment of the net calorific value of biogas from the default value of 20 MJ per m^3 to the country specific value of 15.2 MJ per m^3. The reduction in net calorific value results in a decrease in the CH_4 emission for the years where biogas was recovered (1990-2009). This change alone gives a decrease between 0.2 % (1990) and 5.3 % (2004); the increase for both 2008 and 2009 is 2.6 %. The joint effect of the introduction of country specific CH_4 content and net calorific value in biogas is a decrease between 0.1 % (1990) and 1.7 % (2004); the decrease for both 2008 and 2009 is 0.8 %.

Lastly, the DOC value for food waste was revised from 20 % to 15 % according to IPCC (1997). This change alone has caused the CH_4 emission from SWDS to decrease throughout the time series. Following the general decrease in emission, the effect of the lowered DOC value is decreasing with time. In 1990 the decrease is 2.0 % and in both 2008 and 2009 the decrease is 0.2 %.

The joint effect of all changes made to the calculation of emissions from SWDS is stated in Table 8.8.1.

8.8.2 Wastewater Handling recalculations

For Wastewater Handling no recalculations have been made to the N_2O emission.

For 1999-2009, an error in the calculation of CH_4 has been corrected. The correction induces a small increase of emission of between 0.1 % (2000) and 1.0 % (2003). The change in 2009 was an increase of 0.2 %.

The effect of the correction is shown in Table 8.8.1.

8.8.3 Waste Incineration recalculations

The numbers of decimals have been reduced for emission factors for animal cremation. Since animal cremation makes up for an increasing part of the

Waste Incineration category, this change has caused a miniscule decease in emissions for 2006-2009 of 0.01 %.

8.8.4 Waste Other recalculations

For compost production no changes were made, however the correct amounts of composted waste in 2009 are now available and have now replaced the estimates that were produced for last year's submission. The effect is a reduction in emissions of 160 Mg CH_4 and 3 Mg N_2O corresponding to reductions of 4 % and 3 % respectively.

Changes have been made to the methodology of accidental building and vehicle fires. For accidental building fires, the different building categories now also include additional buildings (sheds, greenhouses etc.) and container fires. Also there are now four damage categories; full, large, medium and small scale fires, corresponding to 100, 75, 30 and 5 % damage rate respectfully. The effect of these changes is a reduction between 44 % (2007) and 47 % (2009) for CH_4 and between 22 % (2007) and 28 % (2009) for CO_2.Even though the number of included building fires is higher in this year's inventory, the total emissions are lowered. In earlier years buildings like carports, sheds and greenhouses were categorised as detached houses and emissions from these fires were calculated based on average floor space and content masses that were much too high. The addition of the category additional buildings is the main reason for the lowered total emissions from accidental building fires.

For accidental vehicle fires, similar changes were made. Last year the damage rate was set to 70 % for all fires, but this year the damage rate was divided in four damage categories according to the measure of fire extinguishing; full, large, medium and small scale fires, corresponding to 100, 75, 30 and 5 % damage rate respectfully. These new damage categories give an average burnout for all vehicle categories in 2007-2010 of 34 % and thereby a reduction in emission of about 50 % compared with the 70 % burnout used in last year's inventory. Also the activity data now includes other transport, trains, ships, airplanes, bicycles, tractors, combined harvesters and machines. The activity of these eight new categories has a descending trend, whereas activities that were also included in last year's inventory have an increasing trend. The resulting new total emission from accidental vehicle fires has a relatively constant trend. The joint effect of these two changes in methodology is an increase in emissions for 1990-1991 and a decrease for 1992-2009. The largest increase is 4 % (1990) and the largest decrease is 33 % (2007) for both CO_2 and CH_4 emissions, the change in 2009 data is -16 %.

All per cent changes stated in this section are calculated in relation to the emission from the same category (e.g. accidental building fires) from last year's inventory. They are therefore not directly comparable with the percentages presented in Table 8.8.1.

8.9 Source specific planned improvements

A new waste database being developed by the Danish Environmental Protection Agency should be ready during 2012. This new database is expected to contain very detailed data on all nationally deposited waste starting from 2010. Work will be put into handling any inconsistencies between the new reporting system and the old ISAG.

There are no other planned improvements for the waste sector.

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9 Other (CRF sector 7)

In CRF Sector 7, there are no activities and emissions for the inventories of Denmark. Until the 2009 submission in the inventories of the Kingdom of Denmark (Denmark, Faroe Islands and Greenland) emissions from Faroe Islands and Greenland were reported in Sector 7. This has been changed so that Greenland and Faroe Islands are included in full CRF's.

For further detail on the emissions from Greenland and the Faroe Islands please see Chapter 16 and Annex 9.

10 Recalculations and improvements

Previously the recalculation tables in the CRF have been incorrect due to the different geographical scopes of the inventory and technical limitations in the CRF Reporter software. However, by running five different installations of the CRF Reporter software, the data presented in Table 8 of the CRF are accurate. Explanations for the recalculations of the Danish inventory are included in Chapter 10.1.1.

The overall impact of recalculations is shown in Table 10.1. A more detailed overview is provided in tables 10.2 – 10.5.

In connection with the centralised review of the Danish GHG emission inventory in September 2011, Denmark resubmitted the inventory in October 2011. The numerical recalculations presented in this chapter are recalculations carried out between the October 2011 submission and the present submission. The changes between the April 2011 reporting and the October 2011 reporting were limited to the agricultural sector and the LULUCF sector.

Information on recalculations for the aggregated submission of Denmark and Greenland under the Kyoto Protocol are included in Chapter 17.

10.1 Explanations and justifications for recalculations

Explanations and justifications for the recalculations performed for this submission and since submission of data in the CRF-format for submission to UNFCCC due April 15, 2012 for Denmark are given in the following sector chapters:

Energy:	
• Stationary Combustion	Chapter 3.2.8
• Transport	Chapter 3.3.7
• Fugitive emissions	Chapter 3.5.8
Industry:	
• Mineral products	Chapter 4.2.5
• Chemical industry	Chapter 4.3.4
• Metal production	Chapter 4.4.4
• Food and drink	Chapter 4.5.4
• Consumption of f-gases	Chapter 4.7
Solvents and Other Product Use	Chapter 5.6
Agriculture	Chapter 6.10
LULUCF	
• Forest Land	Chapter 7.2.1, 7.2.2
• Cropland	Chapter 7.3
• Grassland	Chapter 7.4
• Wetlands	Chapter 7.5
• Settlements	Chapter 7.6

Waste

- Solid Waste Disposal on Land Chapter 8.8.1
- Wastewater Chapter 8.8.2
- Waste incineration Chapter 8.8.3
- Waste, Other Chapter 8.8.4

KP-LULUCF

- ARD Chapter 11.3.5
- FM Chapter 11.4.5
- CM Chapter 11.5.5
- GM Chapter 11.6.4

The main recalculations since the 2012 submission are:

10.1.1 Energy

Stationary Combustion

For stationary combustion plants, the emission estimates for the years 1990-2009 have been updated according to the latest energy statistics published by the Danish Energy Agency. The update included both end use and transformation sectors as well as a source category update.

The relatively large recalculations for CO_2 emission from the fuel category "Other fuels" is a result of a revised CO_2 emission factor for fossil waste incineration. This emission factor has been recalculated based on a large number of measurements performed at Danish plants in 2010-2011. The CO_2 emission factor is 17 % higher than the emission factor applied last year. The estimated emission from the fuel category "Other fuels" in 1A1a Public electricity and Heat production in 2009 has increased 14 % corresponding to 170 Gg CO_2.

The disaggregation of emissions in 1A2 Manufacturing industries and construction has been recalculated based on a new improved methodology. Thus, the changes of the estimated CO_2 emission for gaseous fuels and liquid fuels in the sectors 1A2c, d, e and f are considerable, but the change in total CO_2 emission in sector 1A2 is low (<1.5 % for 2009) for both fuel categories. Correspondingly, some considerable recalculations for CH_4 and N_2O in the subsectors do not result in large changes in the aggregated sector 1A2.

The recalculations in CO_2 emission from biomass (+174 Gg CO_2 for 1A2 and +419 Gg for sector 1A4) are a result of revised CO_2 emission factors for wood and straw. Both emission factors now refer to the IPCC Guidelines.

The CH_4 emission from residential wood combustion has been recalculated based on improved technology disaggregation data. This has resulted in a 21 Gg CO_2 eq. lower emission in 2009 than reported last year.

The CH_4 emission factor for refineries has been included or revised for several years. This results in improved time-series consistency but also in large relative changes for some years. However, the emission level is low and the recalculation for 2009 is below 0.5 Gg CO_2 eq.

The N_2O emission from gaseous fuels in sector 1A1c has been recalculated resulting in a decrease of 10 Gg CO_2 eq. The N_2O emission factor for off shore gas turbines now follows the emission factor for on shore gas turbines.

Mobile sources

The following recalculations and improvements of the emission inventories have been made since the emission reporting in 2011.

Road transport

The total mileage per vehicle category from 1985-2009 has been updated based on new data prepared by DTU Transport. Important changes are a different split of total mileage between gasoline and diesel passenger cars based on data for the year 2008 from the Danish vehicle inspection and maintenance programme. Also updated mileage for foreign vehicles driven on Danish roads has been included.

The percentage emission change interval and year of largest percentage differences (low %; high %, year) for the different emission components are: CO_2 (0.2 %; 2.6 %, 2009), CH_4 (0.6 %; 1.6 %, 2009) and N_2O (-0.9 %; 4.6 %, 1994).

Agriculture/forestry/fisheries

The sales distribution into engine sizes for harvesters has been updated for the years 2002, 2003 and 2009. The following largest percentage differences (in brackets) for agriculture/forestry/fisheries are noted for: CO_2(-0.3 %), CH_4 (0 %) and N_2O (-0.2 %).

Military

Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2009.The following largest percentage differences (in brackets) for military are noted for:CO_2(0 %), CH_4 (0.6 %) and N_2O (0.5 %).

Aviation

Emission changes occur for the years 2007-2009, due to a correction in the representative aircraft type for new aircraft used for flying in Denmark. Due to an error F28 was previously used as a representative aircraft type for the new aircraft types CRJ9, E70, E170 and E175. However, F28 is a very old aircraft, which cannot represent these new aircraft types. Instead new fuel consumption and emission factors have been calculated for the CRJ9, E70, E170 and E175 jets. The following largest percentage differences (in brackets) are noted for the year 2009: CO_2(-1.7 %), CH_4(-46.3 %), N_2O (-0.6 %).

Fugitive emissions

In the 2012 emission inventory submission there have been some recalculations as listed below.

New sources

CO_2 emissions have been included in the inventory for offshore extraction, pipeline transport and storage of oil, transmission of natural gas, and distribution of natural gas and town gas. This has increased the total fugitive CO_2 emission in 2009 by 1.4 % and in 1990 by 0.6 %.

Refineries

Emissions of CH_4 and NMVOC have been changed for the years 1994-2000 and 2002-2009 according to VOC measurements carried out in 2001. This is the result of an extended communication with one refinery leading to a recommendation to use measured emissions, and not an estimated emission calculated by weighting the measured emissions by the annual processed crude oil amount as done in previous inventories. The fugitive emissions are more related to other conditions than the processed amounts. The split of VOC emissions provided by the refineries have been revised in order to apply a similar approach for the two refineries. For both refineries annual emissions of NMVOC and CH_4 are not available, and emissions are calculated based on the provided VOC emissions and assumptions for the part of VOC being NMVOC and CH_4, respectively. Assumptions are based on information from the refineries and on literature study of international proportions/conditions.

The CH_4 recalculation has increased the total fugitive emission by 1 % in 2009. The largest recalculation is in 2007 (3 %).

Updated SO_2 emissions for the years 2005-2009 provided by a refinery are included in the inventory. The recalculation has increased the total fugitive SO_2 emissions by 6 % in 2009.

Gas distribution

Emission factors for CH_4 and NMVOC for town gas distribution have been corrected for an error. Distribution of town gas is a minor source and the recalculation is insignificant for all years (max. 0.003 % of the total fugitive CH_4 emission in 2009).

Offshore flaring

Activity data has been corrected for 2008 for two offshore installations. The calorific value has been corrected for the whole time series according to the average calorific value in the EU ETS reports for 2008-2010 which affects the emission factor for CO_2 and NMVOC. Further the emission factor for NMVOC has been corrected by including a conversion from Sm^3 to Nm^3. For 2007 the emission factor is changed to the average CO_2 emission factor from EU ETS for 2008-2010 as the 2007 EU ETS reports are not as detailed for 2007 as for the following years. The activity data has been updated according to the latest figures from the Danish Energy Agency.

The recalculation has increased the fugitive CO_2 emission by 1 % in 2009 and 8 % in 1990.

Flaring in refineries

The CO_2 emission factor has been updated for the years 1990-2006 for flaring in refineries. The emission factor applied is estimated as the average emission factor from the EU ETS reports for the years 2006-2010 and 2007-2010 for the two refineries.

The recalculation has decreased the fugitive CO_2 emission by 0.2 % in 2009 and 0.4 % in 1990.

10.1.2 Industry

F-gas – Hard foam: A few changes have been made in the CRF-tables regarding activity data for consumption of HFCs and "IEF" as a consequence of the findings by the UNFCCC expert review team in 2011.

SF_6 double glazed windows: The model for calculation of SF_6 emission has been revised for 1998/1999 resulting in small changes all the following years as SF_6 from double glazed windows is emitted with 1% of stock per year.

10.1.3 Solvents and Other Product Use

Historic production, import and export data for NMVOCs have been included for the period 1990 to 1994. Data are collected from Statistics Denmark and the methodology is now consistent for the entire 1990 to 2010 period. N_2O sales figures for 2000 to 2010 have been adjusted for export. N_2O for use in race cars and in laboratories has been included. The N_2O use in fire extinguishers has been investigated and no use is reported.

Emissions from charcoal use for barbeques and tobacco smoking have been included in this category.

10.1.4 Agriculture

Some changes of emissions from the agricultural sector have taken place. These changes reflect increased emissions in the years 1990-2008 up to 1 % and decreased emissions in 2009 of 0.7 % compared to the total CO_2 equivalent emission from the agricultural sector. The increase in 1990-2008 is due to an increase in the emissions of CH_4 and the decrease in 2009 is due to a decrease in the emission of N_2O.

The increase in CH_4 emission is due to changes in both CH_4 from enteric fermentation and manure management. As recommended by the UNFCCC expert review team (ERT) an error in the calculation of CH_4 from enteric fermentation from swine is corrected. For CH_4 from manure management changes are made for sows, where the data have been updated for all years and for dairy cattle a correction of an error in the calculation has been made.

For the N_2O emission a range of small changes have been made which have both increasing and decreasing effect. Due to changes in the emission factor for NH_3 the N_2O emission from manure on soil and synthetic fertilisers increased, while the N_2O emission from atmospheric deposition decreased. Data for histosols have been updated for all years and this have caused an increased N_2O emission in the years 1990-1999 and a decreased emission in 2000-2009.

10.1.5 Waste

For the category Solid Waste Disposal on Land (SWDS), each of the former waste categories have been sub-categorised into 9 fractions (waste food, cardboard, paper, wet cardboard & paper, plastics, other combustible, glass, metal and other not combustible). The SWDS model has been extended to include sub-fraction specific half-lives and carbon content. Lastly, the methane content of the collected landfill gas has been changed from 50 % to 41 % according to new documented knowledge. These recalculations result in an increase of CH_4 emissions for 1990 to 2002 and a decrease for 2003 to 2009. The largest changes are an increase of 38 % in 1990 and a decrease of 18 % in 2009.

For wastewater handling recalculations were made for CH_4 emissions for 1999 to 2009; the result is an increase between 0.2 % (2000) and 1.3 % (2003). The increase in 2009 is 0.4 %. The minor changes are due to an error in one of the activity references within in model in the 2011 submission. No methodological changes were made.

There are no recalculations in the waste incineration category.

For the category waste other; emissions of CO_2 and CH_4 have decreased throughout the time series due to changes in the methodology. Changes have been made for both vehicle and building fires. For building fires these changes include two new categories of container fires and additional building fires (such as sheds and garages). Furthermore, the full scale equivalents are now calculated from 4 damage categories of 100 %, 75 %, 30 % and 5 % instead of just 3 categories in the last submission. For vehicle fires the changes include new categories of caravan-, train-, ship-, airplane-, bicycle-, tractor-, combined harvester-, other transport- and machine fires. In the 2011 submission, an average burnout of 70 % was assumed for all vehicle fires. This year, full scale equivalents are calculated using the same 4 damage categories as for building fires.

The 2009 activity data for composting are now available. The activity data reported last year were overestimated, and the correction has caused a decrease in CO_2, CH_4 and N_2O for 2009.

CO_2 equivalent emissions from the waste other category has decreased between 4.84 % (2002) and 8.67 % (1995). For 1990 and 2009 the decrease was 7.96 and 8.31 % respectively

The total sectoral change is an increase for 1990-2000 and a decrease for 2001-2009. The largest changes are an increase of 31 % in 1990, and the decrease of -20 % in 2009.

10.1.6 LULUCF

Forestry

Since the NFI was initiated in 2002 and have a 5-year rotation, a full measurement is available from 2006. Calculation of carbon stock in the period 2000-2005 is based on interpolation between the carbon stock observed in the NFI in 2006 and the carbon stock as calculated for 2000. For 2006-2011 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping. Reported values from the NFI correspond to the last year of a five year measurement cycle (i.e. reported values for 2010 rely on data from 2006-2010). This differed from previous reporting where reported values corresponded to the midpoint of a five year rotation (i.e. reported values for 2008 rely on data from 2006-2010). This was done to enable timely and consistent reporting, as data for 2010 would otherwise not be available before winter 2012.

The recalculations have resulted in that Forestry has affected the single year values but the overall development of the forest area in 2008-2010 is the same. N_2O is only slightly affected.

Cropland, grassland, wetlands and settlements

The major change come from our study on the area with organic soils where our data has shown that today only 42 000 hectares in Cropland and 28 000 hectares in Grassland qualify as true organic soils. Furthermore, our analysis on the organic soils has shown that since 1975 the area with organic soils in cropland has decreased rapidly with an average annual decrease of 1 400 hectares. The reason for this is the intensive cultivation of our very thin and shallow organic soils so they are now having 5-10 % organic carbon and not > 12 %.

The emission estimate from mineral agricultural soils is made with a Tier 3 dynamic modelling tool (C-TOOL). More thorough analysis of C-TOOL has shown that the model do not satisfactorily estimate the emissions from soils having 6-12 % organic carbon. As a consequence a fixed emission factor has been introduced for soils with 6-12 % organic carbon. This area is around 40 000 hectares in 2010. The overall emission estimates for organic agricultural soils as well as the mineral soils have therefore been recalculated.

A minor change in the default soil carbon stock for mineral soils in Cropland has been introduced. This affects all emission estimates for land use conversion to and from cropland for the whole period.

In the previous submissions no losses in mineral soils for land use conversion to Settlements has been included as there is no guidance from the IPCC on this issue. In the current submission a default C-stock of 120 t C/ha (0-100 cm) in mineral soils in Settlements has been introduced for all land use conversion to and from Settlements. This affects all emissions from mineral soils due to land use conversion to Settlements.

Biomass burning

Wildfires in forests and grassland and controlled burning of heath land have been implemented for the first time. Wildfires and controlled burning are very limited in Denmark with 0-50 hectares of open forest annually (up to 300 ha in a single year) and app. 300 hectares of controlled burning of heath land per year with the purpose of regenerating the heath. The emissions from biomass burning are very small.

10.1.7 KP-LULUCF

A recalculation for KP-LULUCF has been performed for all areas as a consequence of the new data and the review process.

10.2 Implications for emission levels

For the national total CO_2 equivalent emissions without Land-Use, Land-Use Change and Forestry, the general impact of the improvements and recalculations performed is small and the changes for the whole time-series are between -0.40 % (2009) and +0.93 % (1990). Therefore, the implications of the recalculations on the level and on the trend, 1990-2009, of this national total are small, refer Table 10.1.

For the national total CO_2 equivalent emissions with Land-Use, Land-Use Change and Forestry, the general impact of the recalculations is larger due to recalculations in the LULUCF sector. The changes vary between –3.17 % (2007) and +7.90 % (2008), refer Table 10.1.

Table 10.1 Recalculation performed in the 2012 submission for 1990-2009. Differences in pct of CO_2 eqv between this submission and the October 2011 submission for DK, excluding Greenland and Faroe Islands.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total CO_2 Eqv. Emissions with Land-Use Change and Forestry	2.59	3.11	3.58	3.48	2.70	2.73	1.83	2.29	2.78	2.15
Total CO_2 Eqv. Emissions without Land-Use Change and Forestry	0.85	0.82	0.83	0.72	0.62	0.49	0.34	0.39	0.34	0.38
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total CO_2 Eqv. Emissions with Land-Use Change and Forestry	4.52	3.82	4.55	3.84	4.02	1.67	-1.28	-3.31	7.76	-0.15
Total CO_2 Eqv. Emissions without Land-Use Change and Forestry	0.32	0.25	0.27	0.31	0.20	0.12	0.04	0.10	-0.20	-0.54

10.3 Implications for emission trends, including time series consistency

It is a high general priority in the considerations leading to recalculations back to 1990 to have and preserve the consistency of the activity data and emissions time-series. As a consequence activity data, emission factors and methodologies are carefully chosen to represent the emissions for the time-series correctly. Often considerations regarding the consistency of the time-series have led to recalculations for single years when activity data and/or emission factors have been changed or corrected. Furthermore, when new sources are considered, activity data and emissions are as far as possible introduced to the inventories for the whole time-series based on preferably the same methodology.

The implication of the recalculations is further shown in tables 10.2-10.5.

Table 10.2 Recalculation for CO_2 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for DK. Excluding Greenland and Faroe Islands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	1423	2082	2327	2251	1893	1901	1477	1707	2017	1556
1. Energy	202	254	221	194	202	170	148	173	168	223
1.A. Fuel Combustion Activities	177	204	169	151	158	135	110	118	128	139
1.A.1. Energy Industries	194	240	252	274	171	117	106	199	448	263
1.A.2. Manufacturing Industries and Construction	-27	-50	-96	-125	15	24	-1	-2	-2	-2
1.A.3. Transport	0	0	0	0	0	0	0	0	0	0
1.A.4. Other Sectors	11	14	14	3	-28	-6	5	-79	-318	-122
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	25	50	52	43	44	35	38	54	40	84
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
2.A. Mineral Products	-	-	-	-	-	-	-	-	-	-
2.B. Chemical Industry	-	-	-	-	-	-	-	-	-	-
2.C. Metal Production	-	-	-	-	-	-	-	-	-	-
2.D. Other Production	-	-	-	-	-	-	-	-	-	-
2.G. Other	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-43	-26	-15	-26	-7	-	-	-	-	-
4. Agriculture	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	1267	1858	2125	2087	1701	1737	1335	1539	1855	1339
5.A. Forest Land	-121	134	-221	180	-177	48	-87	-35	422	-153
5.B. Cropland	1442	1650	2253	1852	1792	1631	1353	1515	1374	1360
5.C. Grassland	-68	62	73	37	60	31	39	25	22	78
5.D. Wetlands	0	0	0	3	0	3	0	3	3	0
5.E. Settlements	15	13	21	15	26	23	29	30	34	54
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-4	-4	-4	-4	-4	-5	-5	-5	-5	-6
6.C. Waste Incineration	-	-	-	-	-	-	-	-	-	-
6.D. Other	-4	-4	-4	-4	-4	-5	-5	-5	-5	-6
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	3165	2794	3312	2995	2913	1252	-764	-1992	5018	325
1. Energy	192	206	208	294	233	212	225	296	123	92
1.A. Fuel Combustion Activities	135	145	156	240	166	168	171	170	106	84
1.A.1. Energy Industries	129	130	143	228	241	272	248	174	182	134
1.A.2. Manufacturing Industries and Construction	8	17	13	20	13	21	21	15	6	66
1.A.3. Transport	0	0	0	0	0	0	0	0	-67	32
1.A.4. Other Sectors	-2	-2	0	-8	-88	-125	-98	-19	-14	-148
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	58	61	52	54	68	44	54	126	16	8
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
2.A. Mineral Products	-	-	-	-	-	-	-	-	-	-
2.B. Chemical Industry	-	-	-	-	-	-	-	-	-	-
2.C. Metal Production	-	-	-	-	-	-	-	-	-	-
2.D. Other Production	-	-	-	-	-	-	-	-	-	-
2.G. Other	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	0	0
4. Agriculture	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	2978	2593	3110	2706	2685	1046	-983	-2281	4902	240
5.A. Forest Land	1390	1166	1495	1311	1298	1133	-2175	-3379	3857	-866
5.B. Cropland	1484	1327	1549	1309	1307	-157	1131	1036	981	1043
5.C. Grassland	52	46	16	28	19	7	-2	-5	-7	-11
5.D. Wetlands	0	0	0	0	0	0	0	0	0	0
5.E. Settlements	51	54	50	58	60	61	63	67	71	74

Continued										
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-6	-5	-5	-6	-5	-6	-6	-7	-7	-7
6.C. Waste Incineration	-	-	-	-	-	-	-	-	-	-
6.D. Other	-6	-5	-5	-6	-5	-6	-6	-7	-7	-7

Table 10.3 Recalculation for CH_4 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for DK. Excluding Greenland and Faroe Islands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	358.6	350.7	344.3	328.9	228.2	177.4	124.1	105.2	57.8	34.9
1. Energy	-3.2	-0.3	10.6	47.9	-9.1	-9.4	-9.9	-9.1	-5.0	-5.3
1.A. Fuel Combustion Activities	-3.2	-0.4	10.6	47.9	-10.7	-10.7	-11.2	-11.1	-7.0	-7.4
1.A.1. Energy Industries	3.8	8.2	15.1	45.8	0.0	0.1	0.5	0.5	0.6	0.5
1.A.2. Manufacturing Industries and Construction	-0.7	-1.5	-2.3	-2.8	0.0	0.0	0.0	0.0	-0.1	-0.1
1.A.3. Transport	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3
1.A.4. Other Sectors	-6.6	-7.4	-2.6	4.6	-11.0	-11.1	-12.0	-11.9	-7.9	-8.2
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	1.6	1.3	1.3	2.1	2.1	2.1
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	-	-
4. Agriculture	-4.0	12.2	29.2	17.0	24.2	30.8	24.2	46.0	33.1	40.1
4.A. Enteric Fermentation	-21.2	-13.5	-3.6	-14.6	-9.8	-6.7	-12.7	-3.1	-15.9	-10.4
4.B. Manure Management	17.2	25.6	32.8	31.5	34.0	37.5	36.9	49.1	49.0	50.5
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Waste	365.2	338.9	304.4	264.0	213.1	156.0	109.8	68.3	29.6	0.1
6.A. Solid Waste Disposal on Land	366.4	340.1	305.7	265.2	214.2	157.3	111.2	69.6	30.8	1.2
6.B. Waste-water Handling	-	-	-	-	-	-	-	-	-	0.1
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-1.1	-1.2	-1.3	-1.1	-1.1	-1.3	-1.3	-1.3	-1.1	-1.2
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	14.9	-40.9	-29.8	-57.4	-76.9	-83.3	-112.2	-210.7	-214.5	-317.4
1. Energy	-7.5	-9.4	-9.7	-12.7	-14.7	-19.1	-23.2	-25.8	-24.4	-16.2
1.A. Fuel Combustion Activities	-10.3	-11.9	-12.2	-15.1	-17.2	-21.3	-25.4	-30.2	-24.5	-17.9
1.A.1. Energy Industries	0.5	0.5	0.4	0.4	0.4	1.6	1.5	1.7	1.2	1.3
1.A.2. Manufacturing Industries and Construction	0.0	0.0	-0.4	-0.5	-0.6	-1.8	-1.5	-1.5	-1.3	-1.0
1.A.3. Transport	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.1	0.0	0.2
1.A.4. Other Sectors	-11.1	-12.7	-12.5	-15.4	-17.4	-21.3	-25.7	-30.5	-24.4	-18.4
1.A.5. Other	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B. Fugitive Emissions from Fuels	2.8	2.5	2.5	2.5	2.5	2.2	2.2	4.4	0.1	1.8
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	-	-
4. Agriculture	42.8	12.9	60.7	65.4	81.5	109.9	111.4	44.8	62.8	-22.2
4.A. Enteric Fermentation	-14.0	-34.3	-2.8	-3.7	5.8	-0.2	1.2	-2.2	8.3	-63.8
4.B. Manure Management	56.8	47.3	63.5	69.1	75.7	110.1	110.2	47.0	54.4	41.6
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
6. Waste	-20.4	-44.5	-80.9	-110.1	-144.3	-174.1	-200.4	-229.7	-252.9	-279.1
6.A. Solid Waste Disposal on Land	-19.3	-43.7	-80.6	-109.9	-143.7	-173.4	-199.5	-228.7	-251.7	-274.6
6.B. Waste-water Handling	0.1	0.4	0.8	1.0	0.6	0.4	0.3	0.3	0.2	0.3
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-1.2	-1.2	-1.1	-1.3	-1.1	-1.2	-1.2	-1.4	-1.3	-4.8

Table 10.4 Recalculation for N_2O performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for DK. Excluding Greenland and Faroe Islands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	64.9	66.1	57.0	45.4	70.3	31.0	32.0	36.9	32.3	26.5
1. Energy	1.3	0.8	-0.1	0.6	3.0	3.9	3.8	3.6	5.5	1.5
1.A. Fuel Combustion Activities	1.3	0.8	-0.1	0.6	3.0	3.9	3.8	3.6	5.5	1.5
1.A.1. Energy Industries	0.7	1.3	1.7	3.7	0.0	0.0	1.3	1.9	5.8	1.5
1.A.2. Manufacturing Industries and Construction	1.3	0.3	-1.0	-2.0	4.0	4.8	3.4	3.6	4.5	2.2
1.A.3. Transport	-0.7	-0.8	-0.8	-0.9	-1.0	-0.9	-0.9	-0.8	-0.7	-0.6
1.A.4. Other Sectors	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	-1.1	-4.1	-1.6
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4. Agriculture	62.8	65.0	56.8	44.5	67.0	26.8	27.8	33.0	26.5	24.7
4.A. Enteric Fermentation	-	-	-	-	-	-	-	-	-	-
4.B. Manure Management	-4.3	-3.1	-1.3	-3.7	-2.7	-2.6	-4.0	-2.0	-5.4	-4.4
4.D. Agricultural Soils	67.1	68.0	58.1	48.2	69.7	29.4	31.9	35.0	31.9	29.0
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
5.A. Forest Land	0.4	-	0.0	-	0.0	0.0	-	-	0.0	-
5.B. Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.C. Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.D. Wetlands	-	-	-	-	-	-	-	-	-	-
5.E. Settlements	-	-	-	-	-	-	-	-	-	-
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-	-	-	-	-	-	-	-	-	-
6.B. Waste-water Handling	-	-	-	-	-	-	-	-	-	-
6.C. Waste Incineration	-	-	-	-	-	-	-	-	-	-
6.D. Other	-	-	-	-	-	-	-	-	-	-
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	18.5	12.4	16.6	0.8	-10.7	-43.3	-78.7	-12.4	-26.4	-96.6
1. Energy	3.1	1.6	0.7	-1.0	-3.5	-5.1	-6.4	-7.6	-8.0	-5.2
1.A. Fuel Combustion Activities	3.1	1.6	0.7	-1.0	-3.5	-5.1	-6.4	-7.8	-8.0	-5.2
1.A.1. Energy Industries	0.0	-1.5	-2.5	-3.9	-5.3	-6.0	-8.3	-10.5	-10.5	-10.0
1.A.2. Manufacturing Industries and Construction	3.6	2.8	2.8	2.8	2.3	2.2	2.6	2.7	2.6	3.3
1.A.3. Transport	-0.5	0.3	0.4	0.5	0.7	0.8	0.8	0.4	-0.3	0.7
1.A.4. Other Sectors	-0.1	-0.1	0.0	-0.4	-1.2	-2.1	-1.5	-0.4	0.2	0.8
1.A.5. Other	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	0.3	0.3	0.3	0.4	0.4	-3.1	-26.5	-24.0	-16.8	-19.3
4. Agriculture	15.1	10.5	15.5	1.3	-8.1	-35.2	-46.0	19.2	-1.7	-71.2
4.A. Enteric Fermentation	-	-	-	-	-	-	-	-	-	-
4.B. Manure Management	-5.7	-11.9	-2.9	-2.7	0.9	-26.7	-35.4	3.8	7.7	-3.3
4.D. Agricultural Soils	20.8	22.4	18.4	4.1	-9.0	-8.5	-10.6	15.4	-9.4	-67.9
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.1	0.1	0.1	0.1	0.6	0.1	0.1	0.1	0.1	0.1
5.A. Forest Land	-	-	-	-	0.5	-	0.0	-	-	-
5.B. Cropland	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5.C. Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.D. Wetlands	-	-	-	-	-	-	-	-	-	-
5.E. Settlements	-	-	-	-	-	-	-	-	-	-
5.F. Other Land	-	-	-	-	-	-	-	-	-	-

Continued	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	0.0	0.0	-1.0
6. Waste	-	-	-	-	-	-	-	-	-	-
6.B. Waste-water Handling	-	-	-	-	-	-	-	-	-	-
6.C. Waste Incineration	-	-	-	-	-	-	-	0.0	0.0	-1.0
6.D. Other	18.5	12.4	16.6	0.8	-10.7	-43.3	-78.7	-12.4	-26.4	-96.6

Table 10.5 Recalculation for HFCs, PFCs and SF_6 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for DK. Excluding Greenland and Faroe Islands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC	-	-	-	-	-	-	-	-	-	-
PFC	-	-	-	-	-	-	-	-	-	-
SF_6	-	-	-0,001	-	-	-	-	-	-	-0,45
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HFC	-	-	-	-	-	-	-	0,0001	-	-
PFC	-	-	-	-	-	-	-	-	-	-
SF_6	-0,45	-0,45	-0,44	-0,44	-0,43	-0,43	-0,42	-0,42	-0,42	-0,41

10.4 Recalculations, including those in response to the review process, and planned improvements to the inventory (e.g. institutional arrangements. inventory preparations)

The review on the submissions in 2007 and 2008 was finalised and the report was published April 15, 2009. For the 2009 submission the review report was finalised and published April 15 2010. The review report of the in-country review of the 2010 submission was published March 3 2011.

The draft review report for the review of the 2011 submission was available February 9, 2012. To the extent possible the recommendations have been included in this submission. However, not all recommendations and suggestions of the reviewers in the main findings etc. have been implemented in the time available between the availability of the draft report and the deadline for preparation of the NIR. The main recommendations from the reviews of the 2008, 2009, 2010 and 2011 submissions are listed in Table 10.6.

To keep the table transparent the recommendations that have been completed from the review of the 2008 and 2009 submissions have been deleted.

The recommendations listed from the draft review report for the 2011 submission excludes paragraphs where discussions were still ongoing between Denmark and the ERT at the time of finalisation of the NIR (March 1 2012).

CRF	ERT Comment	Denmark's response	Reference
2008 submission (Review report: http://unfccc.int/resource/docs/2009/arr/dnk.pdf)			
Energy, road transport – Paragraph 41	The change of non-CO_2 EFs associated with the use of bioethanol in gasoline blends has not been taken into account when estimating the corresponding emissions. The ERT suggests that Denmark assess probable changes to these EFs in its next annual submission.	No data has previously been available indicating different CH_4 and N_2O emission factors for blends of fossil and biogenic fuels. This issue is being followed in case new research indicates otherwise.	Chapter 3.3.2.
2009 submission (Review report: http://unfccc.int/resource/docs/2010/arr/dnk.pdf)			
CRF	ERT Comment	Denmark's response	Reference
Industrial Processes, cement production – Paragraph 61	The NIR states that all IEFs are based on measurements using the 'loss of ignition' method, which estimates CO2 emissions by calculating the weight loss during the reactions to form clinker and cement and which result from loss of CO2 from carbonates. During the centralized review, the Party provided sufficient explanation for the 1990–1997 period that the recent decreases in the IEF may be the result of changes in stock of clinker or changes in the product mix and raw materials consumption, but no quantitative supporting information was provided. The ERT noted that the information provided by Denmark is not sufficient to explain the changes in the EFs since 1998 and that the emission estimates for 2005–2007 are not underestimated, and recommends that Denmark provide more detailed information in the NIR, in the next annual submission, about the different sources of EFs, methodologies used for each period, more detailed information used to calculate the EFs by the 'loss of ignition' method (e.g. the quantity of raw materials used and their carbonate content) and on how the consistency was ensured and compliance with the IPCC good practice guidance is achieved.	The inventory group has established a dialogue with the company in order to get better data.	
Industrial Processes, limestone and dolomite use – Paragraph 62	The ERT noted that estimates for more recent years could be underestimated in comparison to previous years in the time-series, and the full time-series may not be consistent. Besides, the ERT also found some potential inconsistencies	The sector (2A3) comprises a number of different processes: consumption of $CaCO_3$ to flue gas cleaning at power plants and waste incineration plants, production of mineral wool and refining of sugar. The activity data are not comparable or even confidential or lacking for part of the period. The inventory team are working on improvement of the	

CRF	ERT Comment	Denmark's response	Reference
	in the time-series of AD: an increase of 28.1 per cent in 2005–2006 and a 28.8 per cent decrease in 2006–2007.The ERT recommends that Denmark provide in the NIR of its next annual submission information on the specific procedures and verifications the Party used.	documentation of AD.	
Solvent and other product use, use of N_2O – Paragraph 64	The ERT encourages the Party to provide estimates of emissions of N2O from use as anaesthesia for the period 1990–2004 in order to complete the time-series.	The producers and distributors of N2O will be contacted again and if data cannot be given for 1990-2004 this will be clearly explained in the report.	
Agriculture, manure management – Paragraph 74	Denmark treats some of its animal slurries in biogas plants, capturing the CH4 generated and using it for electricity and CHP production. In response to a question from the ERT, Denmark stated that some of the information in table 6.12 of the NIR might be misleading with regard to the energy production values expressed in TJ, as they are not directly related to the estimation of CH4 captured, but rather were obtained independently from the Danish Energy Agency. The ERT recommends that the Party report estimates of energy production and CH4 recovery in a consistent way, and correct table 6.12 in the next annual submission. The ERT recommends that Denmark, for the sake of improving transparency, provide plant-specific data regarding energy output and quantities of slurry treated from one or more of the larger biogas plants. The ERT also recommends that Denmark use the energy output from plants to assess the validity of the CH4 reduction potentials for cattle and swine slurry as an additional QC check.	DK agree that the information on the energy production can be misleading. The calculation of the lower CH_4 emission as a consequence of biogas treatment is based on the amount of biogas treated slurry, which is received from the Danish Energy Agency. Table 6.1 includes data concerning the amount of slurry, the VS content in the treated slurry and the reduced emission. DK has planned to improve the possibilities to verify the calculation of the reduced emission from biogas treated slurry. This could be done by contacting a biogas plant in preparation for potential data based on measurement from slurry.	
2010 submission (Review report: http://unfccc.int/resource/docs/2011/arr/dnk.pdf)			
General – Paragraph 25	The process for the official approval of the inventory was not described in the NIR. However, during the review, Denmark provided this information, indicating that the inventory was finalised by 15 March 2010 and sent for official	Denmark has included a description of the procedure for official approval in the NIR.	Chapter 1.2

CRF	ERT Comment	Denmark's response	Reference
	approval to the Ministry of Climate and Energy. The ERT recommends that the Party provide this information in the NIR of the next annual submission.		
General – Paragraph 26	The ERT recommends that Denmark include the information concerning the emissions from Greenland at least as a separate chapter in the NIR instead of as an annex, as this is a substantial part of the submission.	Denmark has included the documentation for the Greenlandic greenhouse gas emissions in Chapter 16 of the NIR.	Chapter 16
General – Paragraph 26	Denmark also informed the ERT that, in the 2011 submission, it will expand the information in the NIR to also include information on recalculations and quality assurance/quality control (QA/QC) of the integrated emissions of mainland Denmark and Greenland under the Kyoto protocol. The ERT welcomes these plans, encourages their timely implementation and recommends that this chapter include a discussion on the procedures used by NERI to integrate both inventories, particularly those aspects that are not solved by merely adding figures, such as the treatment required for part of the data reported in the CRF sectoral background tables.	Denmark has as indicated during the review included information on recalculations and QA/QC procedures for the aggregated submission of Denmark and Greenland. Additionally at the request of the ERT, Denmark has included a technical description of the aggregation process.	Chapters 17.5-17.7
General – Paragraph 28	The NIR lacks a unifying discussion of the approach employed by the Party regarding the use of these data (EU ETS). To improve transparency, the ERT recommends that Denmark include a brief discussion about this approach in the NIR (e.g. under the section presenting the general description of methodologies and data sources used) focusing on those aspects associated with the IPCC good practice guidance requirements.	Denmark has included a general description of the use of EU ETS data including the quality of the available data and how this is in accordance with the IPCC good practice guidance.	Chapter 1.4.10
General – Paragraph 37	The ERT recommends that Greenland completes the QA/QC plan and implement it in the next annual submission and that Denmark document the QC checks performed during the integration of the Greenlandic inventory into the NIR.	The QA/QC plan for the Greenlandic greenhouse gas inventory is described in Chapter 16 of the NIR. The QC checks performed on the aggregated inventory of Denmark and Greenland are described in Chapter 17.	Chapter 16 & 17
Energy, Use of EU ETS data – Para-	It is recommended that Denmark discuss more	The documentation in NIR has been improved.	Chapter 3.2.5

CRF	ERT Comment	Denmark's response	Reference
graph 46	clearly the selection of those plants that are taken from the database under the EU ETS and the QC checks performed to allow the input of these data.		
Energy, Country-specific issues – Paragraph 55	To improve accuracy, the ERT recommends that Denmark make efforts to estimate CO_2 emissions from gas oil used in Greenland by using country-specific EFs that are already available.	This issue will be investigated further with the aim of revising the CO_2 emissions factor for gas oil combusted in Greenland.	
Energy, Use of EU ETS data – Paragraph 57	The ERT recommends that Denmark improve the discussion of the use of plant-specific information under EU ETS by providing a more transparent and self-contained explanation about the scope of tier 3 methods for stationary combustion within this framework in such a way that the reader is not forced to consult the EU decision document to understand the implications in the selection of these data.	The documentation in NIR has been improved and reference to tiers and standards included.	Chapter 1.4.10 and Chapter 3.2.5
Energy, Use of EU ETS data – Paragraph 58 & 59	The ERT recommends that, through DEA, Denmark corroborate the accuracy of the reported NCV. After having confirmed the validity of the NCV reported by DEA, the ERT recommends that Denmark: (a) Include a QC check for the data reported under the EU ETS that uses the NCV of the fuel to detect the possible existence of unusual values and bias; (b) Explore the possibility of obtaining a correlation between the carbon content and the NCV of coal reported by the selected facilities that have used tier 3 methods under the EU ETS, taking into account the recent scientific literature (e.g. Fott, 1999; Mazumdar, 2000; Mesroghli et al., 2009) If a satisfactory correlation is obtained, the ERT further recommends that Denmark use this correlation to generate the time-series 1990–2005 of CO_2 EFs and recalculate the corresponding emissions.	The correspondence between NCV and CO_2 emission factor in the applied EU ETS data for coal has been analysed. The analysis and discussions with the Danish Energy Agency and power plant owners will continue in 2011. An improved CO_2 emission factor time-series (1990-2005) have been implemented. The QC check for outliers performed by NERI is now mentioned in NIR.	Chapter 1.4.10 and Chapter 3.2.5 and Annex 3A.10

CRF	ERT Comment	Denmark's response	Reference
Energy, Use of EU ETS data – Paragraph 60	The ERT recommends that Denmark explore the relationship between the CO_2 EFs for residual fuel oil and gas oil reported under the EU ETS and the corresponding NCV reported by DEA. The ERT also notes that the recommendations for coal-fired power plants provided in para. 59 above apply to liquid fuels.	This will be included in the future discussions with DEA. Improved emission factor time-series for source sector 1A1a based on EU ETS data have been implemented for residual oil. The emission factor for other sectors now refers to IPCC (1996).	Chapter 3.2.5
Energy, Stationary combustion – Paragraph 63	To improve transparency, the ERT recommends that Denmark provide background information in the next NIR on the incineration of medical and hazardous wastes for energy purposes.	This information is now provided in the NIR.	Chapter 3.2.5
Energy, Stationary combustion – Paragraph 64	The emissions arising from fuels used in cement production are reported under the subcategory other (manufacturing industries and construction). The ERT recommends that Denmark revise the variability of CO2 EFs, particularly before and after the introduction of plant-specific data under the EU ETS. To improve transparency, the ERT recommends that Denmark include in the NIR an explanation of the different fuels covered under other fuels.	A description of the "Other fuels" will be included in the NIR.	Chapter 4.2.2
Energy, Navigation – Paragraph 66	Journeys between ports in mainland Denmark and Greenland and between ports in mainland Denmark and the Faroe Islands are reported under international marine transport. During the review, Denmark informed the ERT that the inventory team has contacted the shipping companies operating the routes from mainland Denmark to Greenland and the Faroe Islands to collect the necessary data to estimate the AD for these journeys. The ERT welcomes these efforts, which will improve accuracy and completeness, and encourages their prompt implementation.	Denmark has included fuel consumption and emissions from navigation between Denmark, Greenland and the Faroe Islands under national navigation in accordance with the IPCC good practice guidance.	Chapter 3.3.4 and CRF
Energy, Oil and natural gas - Paragraph 67	CO_2 emissions from flaring in refineries, offshore installations and natural gas plants were estimated using plant-specific CO_2 EF data available under the EU ETS. To improve transparency, the ERT recommends that Denmark provide brief background information about the nature of the estimation of these CO_2 EFs	A general description of the EU ETS data is included in chapter 1.4.10 in the 2011 NIR. Chapter 3.5.2 in the NIR 2011 include a short description of the methodologies behind the EU ETS data for fugitive emissions. As only EU ETS data on higher Tiers are applied in the national emission inventory data are found highly adequate in relation to the IPCC Good Practice Guidance.	Chapter 3.5.2

CRF	ERT Comment	Denmark's response	Reference
	under the EU ETS, focusing on their adequacy in relation to the IPCC good practice guidance.		
Energy, Oil and natural gas - Paragraph 70	Denmark has updated CH_4 and N_2O EFs from flaring in refineries. The NIR reports that N_2O EFs were adopted from the recently published reference by the European Environment Agency. However, the ERT noted that this reference does not provide EF values for N_2O from flaring in oil refineries. To improve transparency, the ERT recommends that Denmark provide sufficient and accurate background information for the selection of these EFs.	The correct reference for the N_2O emissions factor is EMEP/CORINAIR, 2007: Emission Inventory Guidebook, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections, 2007 update. The emission factor refers to flaring offshore as no emission factor is given in the reference for flaring in refineries.	Chapter 3.5.4
Industrial processes, Cement production – Paragraph 77	On the basis of the information provided in the EU ETS reports, the ERT recommends that Denmark derive a country-specific EF that could be used throughout the whole time-series. In order to allow comparability among Parties, it is essential that AD for clinker production be investigated more deeply, as well as providing information on the calcium oxide content of the clinker. The ERT also recommends that a qualitative explanation be included in the NIR regarding the changing nature of the raw materials or the products, wherever decreasing trends are found in the implied EF.	The EF varies as a consequence of variation in product mix. Therefore, it makes no sense to use one national EF during the time period. In the NIR the possibilities for getting more precise clinker data back in time has been described. The inventory team has established a dialogue with the cement factory in order to improve the data for the recent years as well as establishing a qualitative explanation on the decreasing trend in IEF during the last 5 years.	Chapter 4.2.2
Industrial processes, Consumption of HFCs – Paragraph 78	Emissions are estimated using a complex model that was made available to the ERT during the review. The NIR does not provide sufficient information regarding AD, EFs, quantity of gas in equipment, and basic assumptions. This information, which is needed to understand the input data to the model, is only provided in the report by PlanMiljø. The ERT recommends that Denmark improve the background information for this model in future NIRs.	The work is ongoing.	
Industrial processes, Consumption of HFCs – Paragraph 79	The F-gases report indicates that the comparison between potential and actual emission estimates has been only partly completed. The ERT recommends that the Party improve transparency with regard to this particular key cate-	The inventory group has prioritised improvement of the estimate of actual emissions and do not consider the comparison between potential and actual emissions to be relevant.	

CRF	ERT Comment	Denmark's response	Reference
	gory, as well as for the F-gases in general, by providing more detailed information in the NIR and completing the documentation of the model.		
Industrial processes, Consumption of HFCs – Paragraph 80	According to the F-gases report, no QA/QC plan specific for the F-gas calculation has been developed, although some QC procedures are carried out in the model. The ERT recommends that Denmark improve QA/QC for F-gases.	The work is ongoing.	
Industrial processes, Consumption of HFCs – Paragraph 82	Figures in the NIR (table 4.16) do not reflect those in the CRF tables from the 2010 submission, except for the year 2008. The ERT recommends that Denmark check its reporting in the NIR and CRF tables for consistency in the next submission.	The tables in the NIR (Chapter 4) are based on the CRF for Denmark (excluding Greenland and the Faroe Islands).	
Industrial processes, Limestone and dolomite use – Paragraph 84	Completely different time-series for AD and EFs were presented in the 2010 submission compared with the 2009 submission, with no explanation regarding the recalculation. The ERT recommends that, in the NIR, the Party explain the changes in assumptions and provide the description of the AD in sectoral background CRF table 2(I).A-G. The ERT also recommends that Denmark ensure time-series consistency, because a different method has been used for the last three years.	The activity: consumption of $CaCO_3$ for refining of sugar was transferred from 2A to 2D. This change was only mentioned in section 4.5.4 Recalculations (in sector 2D) and unfortunately not in section 4.2.5 Recalculations (in sector 2A).	
Industrial processes, Other mineral products – Paragraph 85	Emissions from the production of yellow bricks and expanded clay products are estimated and reported under this category. Both of the emission time-series are inconsistent because the tier 1 method has been used for the period 1990–2005, while plant specific data reported under the EU ETS have been used for 2006–2008. The ERT recommends that Denmark use this plant-specific information under the EU ETS as a basis for deriving country-specific EFs to be applied for the whole time-series.	Yellow bricks: The EF applied from 1990-2005 is based on an assumption on a fixed average $CaCO_3$ content of the clay used for yellow bricks. Regarding AD no information on share of yellow bricks or the actual yellow colours is available. The NIR present two scenarios: 1) the methodology applied so far and 2) the recommended methodology.	Chapter 4.2.4
Industrial processes, Other mineral products – Paragraph 86	The production of yellow bricks is not well documented and the total production of bricks is not reported in the NIR. The ERT recommends that Denmark improve transparency in this	Table 4.6 will be elaborated. The basic statistical information on consumption of bricks as well as assumptions and the estimated consumption of yellow bricks will be presented in the NIR	Chapter 4.2.2

CRF	ERT Comment	Denmark's response	Reference
	regard.		
Industrial processes, Solvent and other product use – Paragraph 87	Emissions are estimated using a model that crosschecks two sources of data: SPIN (Substances in Preparations in Nordic Countries), for bottom-up approach, and Statistics Denmark, for top-down approach, using a mass balance method for consumption of species and EFs for four categories of solvents. Estimations for total emissions before 1995 are not well documented. The ERT recommends that the Party work on the assumptions needed for completing the time-series using consistent methodologies.	Production, import and export data for 1990 -1994 will be compiled for next reporting. At present the completeness of data for the period is not known so there may be data gaps for some chemicals and/or products.	This improvement was carried out in the 2012 submission. See Chapter 5.
Agriculture, General – Paragraph 93	The ERT noted that most of the AD (including the number of animals by subcategory, the amount of feed and manure, area and productivity of crops) are not provided in the NIR. The ERT recommends that Denmark provide all the data used for the emissions calculations, at least for the latest year of reporting, in its next NIR. The ERT further noted that constant values of average weights of animals are indicated in the CRF tables for all years. In order to increase the transparency of emission trends, the ERT recommends that Denmark provide actual annual data on average weight of animal categories. Methodologies for estimating gross energy (GE) values, volatile solids (VS) production, nitrogen excretion (Nex), N losses during housing and storage are not clear from the NIR. The ERT recommends that the Party improve transparency related to the estimation of these parameters in the next annual submission.	An improvement of information concerning AD is provided. Submission 2011 in NIR Annex includes table 3E Table 2 covering number of animal on subcategory level. In Annex 3E Table 5 is provided data feed intake given in Feed Units (FU) for all subcategories. More information on crops is provided in Table 6.35 and Annex Table 3E Table 13. Annual weight is provided for fattening pigs 1990-2009 – see CRF table 4B(a). Data of the animal weight is not used in the estimation of CH4 from manure management, because the calculation is based on the manure production. However, it is planned to search for data covering the annual average weight for the other animal categories. Improvements in description of estimation of GE I submission NIR 2011 Table 6.2.2 The transparency for estimation of GE (Chapter 6.2.2), VS, Nex (Chapter 6.1.1) and N losses from housing and storage is provided in Annex 3E Table 3 and4.	Chapter 6.1.1 & 6.2.2 Annex 3E
Agriculture, General – Paragraph 94	The ERT recommends that the Party provide more explanatory information for trends of key parameters and emissions in the NIR of the next annual submission	Improvements in information for trends of key parameters are provided. Improvements in explanation of the correlation between IEF and e.g GE, VS, weight and Nex.	Chapter 6.2 & 6.3
Agriculture, General – Paragraph 97	The ERT recommends that the Party include the recommendations made by reviewers and actions undertaken to address these in the next NIR.	In submission 2011 NIR section 6.1.2 the text are supplemented with description of reviewer's most important comments and recommendations.	Chapter 6.1.2
Agriculture, Enteric fermentation –	In the course of the review, Denmark provided	The data of feed intake provided during the review was unfortunately	Annex 3E

CRF	ERT Comment	Denmark's response	Reference
Paragraph 99	the ERT with AD on feed unit intake by animal subcategories. The ERT noted that, for heifers, feed intake increased by 50 per cent for years in the period 1990–2008. However, the corresponding GE values increased by only 20 per cent. The ERT recommends that Denmark remove any inconsistencies in the estimation of emissions from heifers for 1990–2002 in the next annual submission.	not correct. In submission 2011 Annex 3E Table 5 is provided data for feed intake given as feed unit and in Annex 3ETable 8b is listed estimates of GE. These data shows a good correlation in trends for feed intake and GE from 1990 to 2009. Feed intake and GE has been increased by 19% and 21%, respectively.	
Agriculture, Manure management – Paragraph 103	The ERT noted that the IEF for N_2O emissions from liquid MMS is decreasing within the period. During the review, Denmark clarified that the reduction of N_2O emissions from the application of biogas-treated slurry in agricultural soils is considered within this category. The ERT recommends that Denmark provide more explanatory information on the nature of the reduction in N_2O emissions from treated slurry in the next annual submission, and encourages the Party in its intention to further verify the rates of N_2O reduction in different environmental conditions. The ERT recommends that Denmark includes uncertainty of scientific knowledge concerning the calculation of reduced N_2O emission from biogas treated slurry. The ERT further noted that the Nex rates of animals reported in table 4.B(b) represent data for mainland Denmark only; however, AD and emissions are reported for mainland Denmark and Greenland. The ERT recommends that Denmark correct its reporting in the CRF tables in the next annual submission.	A better description and explanation of the lower N_2O emission from biogas treated slurry is provided in submission 2011 NIR chapter 6.3.2 – section "A lower N2O emission from biogas treated slurry". The estimate concerning the lower N2O emission are subject to a relatively high uncertainty, which is taken into account in the overall uncertainty calculation of the agricultural sector (NIR chapter 6.7). CRF Table 4.B(b) is corrected. The Nex and AD covering the sum data from Denmark and Greenland.	Chapter 6.7
Agriculture, Agricultural soils - Paragraph 104	The ERT further noted that Denmark applied an additional country-specific parameter on ploughing frequency for the estimation of N in crop residues, which may lead to an underestimation of N_2O emissions. During the review, Denmark clarified that AD used for this category are not annual and represent total N input from aboveground biomass during the production cycle. The ERT recommends that the Party provide explanatory information on this issue in	Previous, the N content for perennial crops where provided for a production cycles and incorporated in the estimation with a variable called ploughing frequency. This is now changed and the N content for all crops represent annual estimates (submission 2010, NIR annex 3E Table13).	Annex 3E

CRF	ERT Comment	Denmark's response	Reference
	the next annual submission.		
LULUCF, General – Paragraph 110	For the LULUCF sector, Denmark has used various tier 3 methods involving the use of models and inventory-based approaches. Although the NIR generally contains transparent information on these models and inventories, it lacks transparent information on the model outputs and their relationship with the entries in the CRF tables. The ERT recommends that Denmark provide transparent information in the NIR on the model outputs and their relationship with the entries in the CRF tables in the next annual submission.	Documentation has been improved in the NIR for the 2011 submission.	Chapter 7
LULUCF, General – Paragraph 111	The use of notation keys was found to be incorrect and misleading in many places in the CRF tables, leading to lack of transparency. The ERT recommends that Denmark report using the correct notation keys in the CRF tables in the next submission.	In the 2011 submission, Denmark has considered the notation keys used in the LULUCF reporting and corrected and harmonised the use of notation keys.	CRF
LULUCF, General – Paragraph 114	Denmark has performed a key category analysis at tier 1 and 2 levels using both trend and level assessments. However, only the tier 1 level assessment has been used for identifying the key categories and guiding methodological choice. The ERT recommends that Denmark use the results of both level and trend key category analysis in identifying key categories and guiding methodological choice in the next annual submission.	Denmark has from the 2011 submission considered key sources identified due to both level and trend.	
LULUCF, General – Paragraph 115	The ERT found many errors and discrepancies in the CRF tables for the LULUCF sector submitted by Denmark. This indicates that there are problems with the QA/QC procedures for the LULUCF sector in the Danish national inventory system. For example, the ERT found that in the Danish national inventory system, the inventory compilation for forestland is done separately by the Centre of Landscape and Planning, University of Copenhagen and the data are transmitted to NERI (Aarhus University), the main body responsible for compiling the na-	An intensive and improved QA/QC has been performed. This includes that all data transfers are checked by a person not directly involved with the preparation of the LULUCF inventory.	Chapter 7. Included under all activities.

CRF	ERT Comment	Denmark's response	Reference
	tional inventory, where it is integrated with the rest of the LULUCF sector. The ERT noted that there may be issues with QA/QC procedures used in the transfer of data between these organizations. The ERT strongly recommends that Denmark improve the QA/QC processes for the LULUCF sector in order to eliminate such inconsistencies in its reporting in the next annual submission.		
LULUCF, Cropland remaining cropland – Paragraph 120	Denmark uses a tier 3 model (C-TOOL) based on modelled dynamics for carbon turnover in soil to estimate carbon stock changes in mineral soils in cropland. The model operates with three different pools: FOM (fresh organic matter), HUM (humified organic matter) and ROM (resilient organic matter). In the course of the review, in response to a recommendation from the ERT, Denmark provided revised estimates for carbon stocks in mineral soils in cropland using a new approach – ignoring the FOM pool and taking into account only the changes in HUM and ROM pools. The ERT recommends that Denmark provide information on validation of the model predictions using this new approach with field measurements of changes in HUM and ROM pools in the next annual submission.	All pools are dynamical modelled/estimated. The FOM pool consist of only app. 1% of the total C-stock and are responsible for the large inter annual variability but not the long term development in the C-stock. The estimated long term loss from 1990 to 2009 is app. 0.75% of the total C-stock in the mineral soils. Independent verification by soil sampling for > 600 paired plots taken in 1987 and resampled in 2009 been performed. Despite the well-known large variability in results from soil sampling, the data shows that no or almost no changes in the C-stock in soil have taken place. We therefore conclude that the modelled results are in line what can be measured. As FOM, HUM and ROM are dynamical modelled, and especially for the FOM pool has a very large variability and based on long term experiments (>100 years) combined with the large variation in soil sampling it is not possible to measure these fractions.	Chapter 7.3.
LULUCF, Land converted to cropland – Paragraph 123	For land converted to cropland, net carbon stock change of mineral and organic soils is reported as "IE" for many conversions. During the review, Denmark explained that these have been included in cropland remaining cropland. To improve transparency, the ERT recommends that Denmark report net carbon stock change of mineral and organic soils separately under cropland remaining cropland and land converted to cropland in the next annual submission.	The recommendation from the ERT is difficult to follow. Although we have very detailed information on the individual fields it will be a very time consuming task with little effect. The area with soil in agricultural use is based on the detailed information on the position of the field and the actual crop grown in that field. The minor areas which is converted to cropland and its use is included in the modelling with C-TOOL and for the organic soils we use an overlay of the current used fields to see their position in relation to the organic soil map.	
Waste, General – Paragraph 131	QC procedures have been developed and performed for all categories, except for waste incineration; and are described in the NIR.	QA/QC procedures to all categories have been implemented and documented in the NIR	Chapter 8

CRF	ERT Comment	Denmark's response	Reference
	Verification of CH_4 emissions from solid waste disposal on land has been performed as a QA procedure. No other QA procedures have been performed for the sector, regardless changes in methodologies and/or data in assessment of all the categories of the sector. The ERT recommends that Denmark extends its QA/QC procedures to all categories and ensure the relevant level of rigour of QA/QC procedures for categories where they are required, according to the IPCC good practice guidance.		
Waste, Solid waste disposal on land – Paragraph 136	Denmark has made some changes in the parameters used in the FOD model (oxidation factor, half-life time, fraction CH_4 in emitted gas, degradable organic carbon content for plastics, fraction of degradable organic carbon dissimilated) according to previous recommendations. The ERT considers that some of these changes need further justification and/or investigation. For example, the value for the oxidation factor set to 0.1 requires further justification than that solid waste disposal to land is being well managed. The ERT reiterates the previous recommendations that Denmark further investigate landfill practices and choose the value for the oxidation factor parameter according to recent scientific literature.	Updated documentation of the Danish solid waste disposal on land being well managed has been implemented in the NIR to support the value for the oxidation factor as set to 0.1. However, an in depth investigation of the individual landfill practices have not yet been realised – improvements at this level are ongoing.	Chapter 8.2
Waste, Solid waste disposal on land – Paragraph 138	The ERT was unable to follow the logic of the calculations and assessments of CH_4 emissions from solid waste disposal on land as presented in the NIR. The ERT reiterates the recommendation from the previous review that the Party provide a table in the NIR showing the different waste types disposed of as municipal solid waste or incinerated, together with their main characteristics, to increase transparency. The ERT appreciates Denmark's efforts in using a tier 2 uncertainty analysis. However, due to the complexity of the FOD estimation method for CH4 emissions, the ERT encourages the Party to further investigate relevant distributions for different parameters in order to increase accu-	The methodology and activity data has been described and provided at a more detailed level that should increase the transparency and ability for the ERT to follow stepwise the calculation procedure and results. An extended version of the Tier 2 uncertainty analysis has been performed applying defined uncertainty ranges for all input parameters. Details are shown in the NIR.	Chapter 8.2

CRF	ERT Comment	Denmark's response	Reference
	racy.		
Waste, Wastewater handling – Paragraph 140	There is a considerable discrepancy between the final CH_4 recovered for energy purposes and the corresponding value in the statistical database (DEA, 2009). Data on the sludge fraction treated anaerobically have been verified with sludge database values contained in (DEA, 2009), and the Party is planning to reflect the difference and to use an updated (increased) value for the fraction of anaerobically treated sludge in the next annual submission. The ERT encourages the Party to do so and to make recalculations with the new EF. Further the ERT recommends to improve the description of the EF for calculating CH_4 emissions in the NIR, correct the formula used and the corresponding text in order to give a clear explanation of its components and their values, and thus to make possible to follow the logic of calculations.	Yearly emission factors for the anaerobic treatment processes have been calculated based on the Danish Sludge Database, which have resulted in an increase in the EF ranging from 15-63%. Recalculation for the EF for anaerobic processes is presented in the NIR. The above improvement has resulted in a discrepancy between the amount of recovered methane calculated based on the National Sludge statistics and the DEA statistical database corresponding to an average of 22%.	Chapter 8.3
Waste, Waste incineration – Paragraph 142	Hazardous waste is not mentioned in the NIR, during the review Denmark informed the ERT that incineration of hazardous waste is done with energy recovery and that emissions therefore are reported in the energy sector. The ERT appreciates Denmark's efforts in obtaining data and assessing the emissions from this category to such a disaggregated level, but recommends that the Party to improve transparency includes a description on hazardous waste incineration in the next annual submission.	It has been specified in the waste incineration section that hazardous waste is included in the energy section.	2011 NIR section 8.4
Waste, Waste incineration – Paragraph 143	The documentation box of CRF table 6.C references particular categories of the energy sector where the recovered emissions are reported. However, the values reported in the referenced categories of the energy sector (public electricity and heat production, manufacturing industries and construction, and commercial/institutional, amounting to 16,937.56 TJ) differ from the figure from DEA for energy con-	This inconsistency has been corrected in the 2011 NIR	

CRF	ERT Comment	Denmark's response	Reference
	sumption from incinerated waste (16,501 TJ). Denmark is recommended to double-check the figures in the CRF tables for the energy sector with the data from energy statistics for the next annual submission.		
2011 submission (Based on the draft review report)			
General	The ERT recommends that Denmark provide a complete set of CRF tables in its next annual submission, including providing information in CRF tables 7 and 8(b)	By mistake the recalculation explanations in CRF Table 8(b) had not been included in the aggregated submission of Denmark and Greenland for 2011. This will be corrected in the 2012 submission.	CRF Table 8(b)
General	Responding to the ERT during the review, Denmark provided additional information on the legal status of the formal agreements for data provision between NERI and other agencies, and stressed that all data exchange agreements do specify the deadlines for when NERI has to receive the data. The ERT recommends that Denmark provide this additional information in the NIR of its next annual submission.	A sentence has been added to the NIR, that the data delivery agreements include deadlines for when data should be supplied.	Chapter 1.2.
General	The ERT noted that in the previous review report Denmark was recommended to investigate the suitability of using log-normal distribution in Monte Carlo simulations for all categories. During the review, Denmark informed the ERT that the use of log-normal distributions is a reasonable choice, since it is possible to truncate the log-normal distribution, thus ensuring that the uncertainty estimates remain within realistic limits. Denmark also informed the ERT that such an approach has been applied for the first time for the 2011 annual submission and for mainland Denmark only. The ERT recommends that Denmark include these explanations in the NIR of its next annual submission.	Some further text has been included in the NIR on this issue.	Chapter 1.7.3
General	Denmark provided to the ERT, during the review, information on planned improvements to its QA/QC procedures, including: the development and implementation of further checks to address specific issues identified during internal or external reviews; and ensuring that	The updated Quality Manual is expected to be finalised at the end of 2012. The possible changes to the QA/QC system will be documented in the 2013 submission.	

CRF	ERT Comment	Denmark's response	Reference
	all additional information for CRF tables is aggregated and reported correctly. Denmark informed the ERT that these improvements will be reflected in a revised version of its Quality Manual for the GHG Inventory, which is expected to be published in 2012. The ERT appreciates the efforts made by Denmark in developing and implementing quality checks and recommends that the Party update the related information in the NIR to reflect the implemented improvements.		
Energy, reference approach	Denmark indicates, in section 3.4 of the NIR, that the differences for 1998 and 2009 are due to large statistical differences in the official energy statistics for these years, and that the Danish Energy Agency is working on these issues and expects the statistical difference for 2009 to be lower in the next published energy statistics. The ERT commends the efforts that Denmark is making and recommends that the Party include information on the result of these efforts in its next annual submission.	This has been included in the NIR.	Chapter 3.4.
Energy, Feedstocks and non-energy use of fuels	Denmark reports in CRF table 1.A(d) three fuel types used for non-energy purposes: bitumen, white spirit and lubricants. The total non-energy use of fuels is 10,564.31 PJ, and 746.94 Gg CO_2 is not emitted. In the same table, Denmark indicates that some CO_2 emissions are included under the categories mineral products (bitumen), other industrial processes (lubricants) and solvent and other product use (white spirit), but the quantities emitted are not reported (the notation keys NO and included elsewhere (IE) are used) and no explanations are provided either in the NIR or in the CRF tables. The ERT recommends that Denmark provide in the NIR information on how it determines the final carbon storage factors that are reported in CRF table 1.A(d), in order to improve the transparency of the reporting.	Text has been added in the NIR. In addition the implementation of data for associated CO_2 emissions in CRF table 1A(d) is now part of the planned improvements.	Chapter 3.4.
Energy, Road transportation	There are discrepancies between the CO_2	It has been checked that the activity data and emissions reported in the	

CRF	ERT Comment	Denmark's response	Reference
	implied emission factors (IEFs) for gasoline and diesel for 2009 and those for 1990: the 2009 IEF for diesel (74.00 t/TJ) is higher than the value for 1990 (73.99 t/TJ), while the 2009 IEF (72.99 t/TJ) for gasoline is lower than the value for 1990 (73.00 t/TJ). Denmark explained to the ERT during the review that these small deviations were due to a rounding error made by the reporting software. The ERT recommends that Denmark correct the error and improve its QC procedures for its next annual submission.	CRF and hence the IEFs are correct.	
Energy, Stationary combustion	The N_2O EF for refinery gas used by Denmark for 2009 for the subcategory petroleum refining (0.1 kg/TJ) is low when compared to IPCC defaults for liquid fuels (0.3 - 0.4 kg/TJ). During the review, Denmark informed the ERT that it uses two different N_2O EFs for refinery gas, one when the gas is used in gas turbines and one for its use in boilers. The EF for gas in gas turbines is based on national references, while the EF for gas in boilers is from the Revised 1996 IPCC Guidelines. Denmark states that refinery gas has similar properties to natural gas, namely a similar nitrogen content in the fuel, which means that N_2O formation, as well as that of other nitrogen compounds such as nitrogen oxides (NO_x), is assumed similar under similar combustion conditions. That is the reasoning behind choosing the EFs for natural gas for both turbines and boilers. The ERT recommends that Denmark include the rationale for its selection of this EF in the NIR of its next annual submission.	The rationale for selection of the N_2O emission factor has been added in the NIR.	Chapter 3.2.
Energy, Stationary combustion	For 2008, in Denmark's 2011 annual submission, the N_2O EF for use of liquid fuels in manufacturing industries and construction (2.56 kg/TJ) has decreased by about 16.0 per cent when compared with that reported in the 2010 annual submission (3.05 kg/TJ). The ERT noted that Denmark has moved from the use of the EF from the EMEP/CORINAIR Emission Inventory Guidebook 2007 to the use of the default EF	The IPCC Guideline values have been preferred for all emission factors that are not nationally referenced. The IPCC Guidelines are considered a better reference for greenhouse gases than the EMEP/EEA Guidebook. Furthermore, the EMEP/EEA Guidebook was revised in 2009, so it no longer contains any guidance on greenhouse gases, therefore the emission factors will never be updated and as such can be considered obsolete.	

CRF	ERT Comment	Denmark's response	Reference
	from the Revised 1996 IPCC Guidelines, but that it has not provided the rationale for this change in the NIR. Therefore, the ERT recommends that Denmark provide the rationale for changing the EF used in the NIR of its next annual submission.		
Energy, Civil aviation	Emissions from aviation were calculated using a tier 2 approach for mainland Denmark and a tier 1 approach for Greenland. The ERT recommends that Denmark improve the description of the methodology used for estimating emissions from aviation, such as the EF for the representative aircraft types and the number of movements per aircraft type, and additional details on how movements between Greenland and Denmark are considered and provide complementary data on landing and take-off (LTO) and EFs.	Due to the limited time available from the reception of the draft review report to the deadline for finalisation of the NIR, it was not possible to include this information in the 2012 submission. The requested information will be included in the 2013 submission.	
Industrial processes, cement production	The ERT also questioned the Party, during the review, as to whether it accounts for imports and exports for the early years of the time series, which are required to be taken into account when using a tier 1 approach. The Party responded to the ERT that it believes that clinker production at that time was solely for the company's own use, but that it will research this further and confirm in its next annual submission. The ERT recommends that Denmark conduct this research to ensure that the tier 1 approach is being implemented in accordance with the IPCC good practice guidance for estimating emissions for the early years of the time series.	The work is on-going.	
Industrial processes, cement production	The ERT further questioned Denmark on its consideration of cement kiln dust (CKD) in the time series of emission estimates, in particular for the earlier years. Denmark responded that, although it is known that the emission estimates are based on the different types of clinker used, there is no information to indicate whether CKD is included in the emission esti-	The ERT has been informed that no further information is available for the years1990-1997. The work with including CKD in the emission estimates is on-going.	

CRF	ERT Comment	Denmark's response	Reference
	mates. The ERT recommends that Denmark continue to pursue any information that could clarify whether CKD is included in the emission estimates for all years of the time series.		
Industrial processes, Consumption of halocarbons	The ERT concluded that Denmark has provided complete estimates for these disposal emissions. However, the ERT recommends that Denmark be more transparent and provide the rationale for this determination in the NIR of its next annual submission.	This work is on-going.	
Industrial processes, Consumption of halocarbons	The Party also observed some inconsistencies earlier in the time series that it intends on investigating further and, as appropriate, correcting in its next annual submission. The ERT welcomes the improvements in the estimates for the later years of the time series and recommends that the Party recalculate the full time series for the next annual submission, if additional errors are identified through the intended QC process.	Corrections have been made for activity data for consumption of HFCs for hard foam.	Chapter 4.7.3
Industrial processes, Consumption of halocarbons	Previous review reports have provided recommendations on cross-cutting issues related to this category, in particular related to improving QA/QC and transparency in the NIR.14 The ERT reiterates these recommendations: with respect to QA/QC, the ERT continues to recommend that Denmark develop QA/QC procedures for the F-gas emission calculations; while, regarding transparency, the ERT reiterates previous recommendations that the Party improve the documentation of methods and assumptions for the F-gas model in the NIR, recognizing that not all model documentation needs to be included for transparency.	The presentation of activity data, emission factors and expected lifetimes has been improved in the present NIR. The work with improving description of QA/QC in the NIR is still on-going.	Chapter 4.7.2, 4.7.3, 4.7.4, and 4.7.5
Industrial processes, Solvent and other product use	The previous review report described the approach that Denmark takes to estimate emissions from solvent and other product use, but indicated that the estimations of total emissions for prior to 1995, which were based on extrapolation, were not well documented, and therefore recommended that Denmark work to	This improvement was carried out in the 2012 submission.	Chapter 5.

CRF	ERT Comment	Denmark's response	Reference
	improve the data source and time series.15 The current ERT detected no evident implemented changes in the 2011 annual submission, but Denmark indicated during the review that the data sources and methods used to estimate emissions for the years 1990–1994 will be made consistent with the methods used to estimate emissions for after 1994 and that information thereon will be provided in the 2012 annual submission. The ERT welcomes this improvement and recommends that Denmark reflects the planned changes in its next annual submission.		
Agriculture, general	Since the previous annual submission, Denmark has improved the transparency of its reporting and has provided more detailed AD and explanations of methodologies, but the ERT considers that some of the necessary information (e.g. on treated slurry from biogas) was not included in the NIR. Responding to the ERT during the review, the Party provided more information on the methodology for estimating emissions from treated slurry from biogas, and the ERT recommends that Denmark provide this more detailed explanation in the NIR of its next annual submission, together with a description of the use of the biogas and the energy output of the use of the biogas.	Chapter 6.4 of the NIR describing the estimation of lower emission of CH_4 and N_2O includes more information and furthermore another table in Annex 3E showing the basic data from Sommer et al. (2001) is provided.	Chapter 6.4 and Annex 3E.
Agriculture, general	Denmark has developed and implemented tier 2 country-specific methodologies to estimate emissions for most categories, in accordance with the IPCC good practice guidance. Denmark also applies a number of country-specific parameters and EFs for the key categories. The ERT commends the Party's efforts in this respect and encourages Denmark to explain in more detail the country-specific methodologies in the NIR. As an example, the methodology that is used to convert manure into volatile solid (VS) values is not described in the NIR: Denmark is using feeding units (FUs), which cannot easily be converted into energy content and	More information describing the VS content in manure and the methodology converting the Danish feed units (FU) to gross energy (GE) is provided in the 2012 NIR submission to improve the transparency for use of national values as recommended by the ERT.	Chapter 6.3.

CRF	ERT Comment	Denmark's response	Reference
	are therefore not directly comparable to the default methodology and parameters described in the IPCC good practice guidance. The ERT recommends that the Party provide more explanation of the derivation of the FU data, in order to enhance transparency, in its next annual submission.		
Agriculture, general	In addition, during the review, the ERT identified a recalculation not explained by the Party in the NIR, namely a new method for the calculation of emissions from treated slurry from biogas, for which explanations are not provided in the recalculations section of the NIR. The ERT recommends that the Party provide explanations in relation to this issue in its next annual submission.	During the in country review in September 2010 an extra quality control process was provided for some emission sources, among these the calculation of lower emission as a consequence of biogas treated slurry. Unfortunately, an error concerning the basic data for CH_4 reduction potential was found and corrected in submission 2011. Thus, the methodology is unchanged and the calculation is still based on the same reference (Sommer et al., 2001). Unfortunately this recalculation was not mentioned in the 2011 NIR submission.	
Agriculture, Enteric fermentation	The ERT found that Denmark calculated the IEF for dairy cattle using a value for gross energy intake estimated using a milk yield of 22.50 kg/day for 2008, but in CRF table 4.A the reported milk yield for 2008 is 23.53 kg/day. Responding to the ERT during the review, the Party explained that the value for milk yield reported in the CRF tables is an error, but that the incorrect value does not influence the calculation of the emission estimates. The ERT recommends that Denmark report the correct value in CRF table 4.A in its next annual submission and improve the QC procedures to detect such issues.	The calculation of emissions is not dependent on milk yield values, therefore this issue has no relevance for the emission calculation. For the 2012 submission it has been ensured that the additional information provided in the CRF is correct.	CRF table 4.A
Agriculture, Manure management	Denmark assumes that N_2O emissions from slurry treated for biogas production are at a lower level than emissions from untreated slurry. The Party considers a potential reduction in emissions of 36 per cent for cattle slurry and 40 per cent for pig slurry. In a manner similar to that described for CH_4 emissions, the Party informed the ERT during the review that a potential N_2O reduction of 41 per cent for swine should be used in the calculations. The ERT recommends that Denmark provide im-	Chapter 6.4 of the NIR describing the estimation of lower emission of CH_4 and N_2O includes more information and furthermore another table in Annex 3E showing the basic data from Sommer et al. (2001) is provided.	Chapter 6.4 and Annex 3E.

CRF	ERT Comment	Denmark's response	Reference
	proved explanations in its next NIR, including a table with these potential emission reductions.		
Agriculture, Direct N_2O emissions from agricultural soils	During the review, the ERT requested the Party to justify the claim that the decrease in the N_2O emissions from agricultural soils was due to a reduction in the agricultural area of N-fixing crops. Responding to the ERT, the Party provided a complete table showing the emission trend for the area of N-fixing crops. The ERT recommends that Denmark include this table in its next annual submission.	Denmark has included this table in the NIR for the 2012 submission.	Annex 3E
Agriculture, Indirect N_2O emissions from agricultural soils	Indirect N_2O emissions from atmospheric deposition include different sources of volatilized N: However, the ERT found that the NIR (table 6.40) does not show the quantity of NH_3 due to N excreted on grass by grazing animals (2,000 t/year in 2009). The Party explained during the review that those emissions are included in the data on emissions from livestock manure. The ERT recognizes that the emissions have not been underestimated, but recommends that this be clarified in the NIR of the Party's next annual submission.	The table has been modified specifying the N excretion by grazing animals.	Chapter 6.5.2.
LULUCF, General	The ERT reiterates the recommendation made in the previous review report that Denmark improve the QA/QC processes for the LULUCF sector and report on the improvements made, in its next annual submission.	The QA/QC procedure has been increased with by using independent people in the inventory process as quality controllers.	
LULUCF, Forest land remaining forest land	However, the ERT recommends that Denmark further improve the transparency of its reporting by including in its NIR additional information on forests that could be useful to explain the carbon stock changes in forest land remaining forest land (i.e. information on changes in tree species composition and the age structure of forest stands; the area and volume of clear cutting; and the area subjected to destructive disturbances).	Information on tree species composition and age structure has been included in the NIR reporting. Due to the late reception of the draft review report, it was not possible to implement information on area and volume of clear cuttings or disturbance in the 2012 submission. The recommendation has been noted as a planned improvement and will be implemented in the 2013 submission based on the available data.	Chapter 7.2.
LULUCF, Forest land remaining forest land	The ERT noted that the time series of net CO_2 emissions/removals is not stable. Responding to questions raised by the ERT, Denmark at-	The time series from 2006 and onwards are now stable. Some more information on the data from 1990 - 2005 have been included in the NIR report to provided best possible consistency over time. Interpola-	Chapter 7.2.6.

CRF	ERT Comment	Denmark's response	Reference
	tributed this variation over the time series to the use of different sources of data and to changes in the age structure of the forests, and added, as an explanation, that it was difficult to obtain consistency using different data sources. The ERT reiterates the recommendation made in previous review reports that Denmark make efforts to ensure consistency in the time series by addressing issues arising from the use of different data sources (i.e. by using interpolation).	tions have been applied where justifiable.	
LULUCF, Forest land remaining forest land	The trend in net carbon stock change in organic soils shows a decrease in emissions. Responding to questions raised by the ERT during the review, Denmark attributed the decreasing trend to the reduction of drainage in Danish forests. The ERT recommends that Denmark provide explanations for this trend, including the underlying reasons for it, in the NIR of its next annual submission.	Supplementary explanations have been included in the 2011 NIR	Chapter 7.2.
LULUCF, Cropland remaining cropland	The trend in net CO_2 emissions/removals is unstable and large inter-annual changes have been identified for all years of the time series. In a similar manner, the trend in net carbon stock change in mineral soils is unstable. Denmark provided justifications for this to the ERT during the review, explaining that the high level of fluctuation in emissions from cropland is related to the actual yearly crop yield and variable climatic conditions: low yields combined with high temperatures reduce the total amount of carbon in agricultural soils, whereas in years with a high yield and low temperatures the carbon stock in soils is increased. In addition, the Party stated that for 1990 onwards a general decrease in the emissions from cropland is reported owing to a higher incorporation of straw (as a side effect of the ban on field burning), growing quantities of catch crops in the autumn, a change from low-yielding spring barley to high-yielding winter wheat, an increase in carbon stocking in	A figure with total input data has been included in the NIR as well as description.	Chapter 7.4.

CRF	ERT Comment	Denmark's response	Reference
	hedgerows, and a reduced consumption of lime. The ERT recommends that the Party include these explanations, together with the underlying data, in its next annual submission.		

More information on the specific responses to the review has been given in the sectoral chapters of this report.

10.5 Explanations, justifications and implications of recalculations for KP-LULUCF inventory

10.5.1 Recalculations

Almost all sectors in the KP-LULUCF have been recalculated.

This is due to:
- Updated data from the Danish National Forest Inventory (NFI) for carbon stock changes in above/below ground, dead wood and litter,
- The new soil map for organic soils,
- That the tool which estimates the emission from mineral soils has not shown to be suitable for soils having 6-12% organic carbon (OC).
- New and updated data on carbon stock in mineral soils from our research (0-100 cm depth).

For deforestation the main reason is a small change in living biomass and updated values on C-stock in mineral soils.

For forest management the major change is due to updated values from the NFI on C-stocks in living biomass.

For cropland management and grazing land management the changes are primarily due to the new soil map for organic soils and the new emission factors for organic soils. Analysis has shown that C-TOOL is not reliable on soil having 6-12% OC. These soils has been given a fixed emission factor of 50% of true organic soils (>12 % OC).

Further analysis of the new soil map has shown that the area with organic soils (>12 % OC) is decreasing rapidly. The effect of this has been implemented in the inventory.

In total this has increased the base emission from agricultural soils with approximately 1 000 Gg CO_2 equivalents

Loss in C stock in soils due to conversion to Settlements from all other land use categories has been implemented with a default C stock in Settlements of 120 ton C per ha.

For more information on KP-LULUCF recalculations please refer to Chapter 11.

Table 10.7 Effect of the recalculations in the KP-LULCUF sector for 1990 and 2009, Net CO_2 eqv.

	Net CO_2 equivalent emissions/removals					
	1990			2009		
GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	2011 submission	2012 submission	Change, %	2011 submission	2012 submission	Change, %
A. Article 3.3 activities	251.7	308.9	22.7	-110.6	-502.2	354.2
A.1. Afforestation and Reforestation	10.5	8.4	-19.8	-145.3	-542.1	273.0
A.2. Deforestation	241.2	300.4	24.6	34.7	39.8	14.6
B. Article 3.4 activities	2.793.0	4027.9	44.2	-1024.2	-386.5	-62.3
B.1. Forest Management	-709.3	-827.7	16.7	-2579.1	-3048.4	18.2
B.2. Cropland Management	3.188.6	4650.4	45.8	1369.3	2488.5	81.7
B.3. Grazing Land Management	313.6	205.1	-34.6	185.6	173.4	-6.6

10.5.2 Review recommendations

The main recommendations for KP-LULUCF are included in Table 10.8.

The recommendations listed from the draft review report for the 2011 submission excludes paragraphs were discussions were still ongoing between Denmark and the ERT at the time of finalisation of the NIR (March 1 2012).

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.

CRF	ERT Comment	Denmark's response	Reference
2010 submission (Review report: http://unfccc.int/resource/docs/2011/arr/dnk.pdf)			
KP-LULUCF, General – Paragraph 176	The ERT strongly recommends that Denmark increase the transparency of the inventory by further documenting the relationship between convention reporting and Kyoto accounting in the next annual submission.	The NIR has been updated with more information.	Chapter 11
KP-LULUCF, General – Paragraph 177	The ERT notes that Denmark's has used consistent, complete remote sensing to identify areas of forest and forest change. This is a significant achievement and the ERT commends Denmark's efforts in this area, but recommends that the Party provides further detail on the programme in the next annual submission. In particular, issues such as how Denmark ensures that the minimum mapping unit derived from the remote sensing data meets the 0.5 ha minimum forest area criteria applied by Denmark for classifying forests under the Kyoto Protocol need to be addressed.	The NIR has been updated with more information.	Chapter 7.1.2
KP-LULUCF, Afforestation/reforestation – Paragraph 179	The ERT notes that Denmark does not currently identify areas of afforestation which have been subject to harvest. During the review Denmark explained to the ERT that this is because the majority of areas subject to afforestation are on long rotations (>50 years) and therefore will not be harvested during the commitment period. The ERT recommends that Denmark provide further information to explain this in the next annual submission, or provide estimates of the harvested areas and the associated emissions and removals.	The NIR has been updated with more information.	Chapter 11.3.2
KP-LULUCF, Afforestation/reforestation – Paragraph 180	The ERT noted inconsistencies between the living biomass pools reported under the Convention reporting and the above- and belowground biomass pools reported for afforestation and reforestation. During the review Denmark provided revised estimates. However, the ERT found that the revised carbon stock change numbers for living biomass (Convention) and afforestation and reforestation still differed by 0.09 Gg C. The ERT therefore strongly recommends that QC procedures be strengthened in future annual submissions to ensure consistency in reported numbers. The	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year.	

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.			
CRF	ERT Comment	Denmark's response	Reference
	ERT also strongly recommends that Denmark transparently document the improved QC procedures in the next annual submission.		
KP-LULUCF, Deforestation – Paragraph 182	During the review the ERT found a lack of consistency between the emission estimates reported under deforestation and the equivalent LULUCF conversion categories for mineral soil, organic soil and dead organic matter (DOM). During the review, Denmark provided the ERT with a revised estimate for deforestation. However, the ERT noted that the results were still inconsistent in both dead organic matter (1.55 Gg C) and mineral soil (0.33 Gg C). The ERT strongly recommends that Denmark improve its QC procedures on data entry and checking of the CRF tables prior to the next annual submission and that the Party provide information on these procedures in the next annual submission.	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year.	
KP-LULUCF, Forest management – Paragraph 183	The ERT found a lack of consistency between the emission estimates reported under forest land remaining forest land and forest management. During the review Denmark provided the ERT with revised estimates for forest management. However, the ERT found that the revised estimates of carbon fluxes were still inconsistent. In particular, the forest management emission estimates include 1.4 Gg C loss in litter that is not included under forest land remaining forest land. While this does not represent a potential underestimate of emissions in forest management, the ERT strongly recommends that Denmark implement further QC checks and document these checks in the next annual submission.	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year.	
KP-LULUCF, Cropland management – Paragraph 184	Denmark has used the tier 3 model C-TOOL to estimate emissions from mineral soils under cropland management. To establish the 1990 base for cropland management for the purposes of net-net accounting Denmark applied a five-year average of emissions from mineral soils from 1988 to 1992. While the use of a five-year average to remove the effect of climate variability is consistent with the IPCC good practice guidance for LULUCF, the ERT noted that this period	The emission from mineral soils under cropland is estimated with a tier 3 model, C-TOOLs. The reported emissions are in accordance with the methodology accepted by the ERT in 2010. Further descriptions on the model calculations are given in the NIR. C-TOOL is a three pooled model called: FOM (Fresh Organic Matter), HUM (Humified Organic Matter) and ROM (Resilient Organic Matter). The two latter accounts for 99 % of the total carbon stock in agricultural soils.	Figure 7.12 and Table 7.24

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.			
CRF	ERT Comment	Denmark's response	Reference
	also included a significant change in management practice. During the review Denmark proposed a new method to reduce variability while still including management effects that excluded the fast turnover pools from the reporting. The ERT accepted the proposed method and recommends that Denmark provide additional information on this method in the next annual submission, including data on the change in each pool within the C-TOOL model.	The FOM pool consists of newly incorporated straw, thin roots, fungi, bacteria etc. having a half-life in the soil of 6-7 months. This pool is responsible for the high variability between years. Table 7.24 in the NIR gives the total amount of all three pools and the two slow reacting pools (HUM and ROM).	
KP-LULUCF, Cropland management – Paragraph 185	During the review, Denmark provided the ERT with revised estimates for cropland management. In these revised estimates the areas reported under cropland management and the relevant Convention subcategories no longer match. There is also a difference in the emissions estimates for living biomass (0.18 Gg C) and soil (89.96 Gg C). The ERT strongly recommends that Denmark improve its QC procedures on data entry and checking of the CRF tables prior to the next annual submission and that the Party provide information on these procedures in the next annual submission.	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year.	
KP-LULUCF, Cropland management – Paragraph 186	During the review, Denmark provided the ERT with additional information on the Convention subcategories which correspond to the activities under Article 3, paragraphs 3 and 4. Upon reviewing this information and the related CRF submission, the ERT noted that some areas and emissions may have been double counted. In particular, the forest land converted to cropland area appears to have been included in the deforestation reporting as well as in the cropland management reporting. The ERT recommends that Denmark review the inclusion of each relevant Convention subcategory to activities under Article 3, paragraphs 3 and 4, to ensure that there is no double counting of emissions and to ensure the consistent representation of lands as per the IPCC good practice guidance for LULUCF, in the next annual submission. In particular, the ERT strongly recommends that Denmark provide a detailed land area matrix that clearly shows the land-areas and the transfers between categories	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year. We have not found any double counting in the 2011 submission.	

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.			
CRF	ERT Comment	Denmark's response	Reference
	under the Convention and relation of those to land accounted under the Kyoto Protocol.		
KP-LULUCF, Grazing land management – Paragraph 187	Denmark provided the ERT, during the review, with revised estimates for grazing land management. In these revised estimates, the areas reported under grazing land management and the relevant Convention sub-categories do not match. There is also a difference in the emission estimates for living biomass (14.99 Gg C) and soil (0.05 Gg C). The ERT strongly recommends that Denmark improve its QC procedures on data entry and checking of the CRF tables prior to the next annual submission and that the Party provide information on these procedures in the next annual submission.	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year.	
KP-LULUCF, Grazing land management – Paragraph 188	During the review, Denmark provided the ERT with additional information on the Convention sub-categories which correspond to the activities under Article 3, paragraphs 3 and 4. Upon reviewing this information and the related CRF submission, the ERT noted that some areas and emissions may have been double counted. In particular, the forest land converted to grassland area appears to have been included in the deforestation reporting as well as the grazing land management reporting. The ERT recommends that Denmark review the inclusion of each relevant Convention subcategory to activities under Article 3, paragraphs 3 and 4, to ensure that there is no double counting of emissions and to ensure the consistent representation of lands as per the IPCC good practice guidance for LULUCF in the next annual submission. In particular, the ERT strongly recommends that Denmark provide a detailed land-area matrix that clearly shows the land areas within each category and the transfers between categories.	A thorough QA/QC procedure has been implemented and several errors have been corrected. We have found no further discrepancies between the UNFCCC and the KP reporting. A more intensive cooperation with Inst. of Forest and Landscape which is responsible for the Forest data and NERI, who is responsible for the other parts of the inventory as well as the reporting to UNFCCC, has been carried out throughout the year. We have not found any double counting in the 2011 submission.	
2011 submission (Based on the draft review report)			
KP-LULUCF, General	The ERT noted that Denmark has used consistent and complete remote sensing to identify areas of forest land and forest land change. However, it provided incorrect land transition matrices in its original 2011	The problem occurred during the aggregation of information from Denmark and Greenland. Following the review, Denmark has implemented additional QC checks to the aggregated submission, to prevent this type of errors from occurring in the future.	Chapter 17.

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.			
CRF	ERT Comment	Denmark's response	Reference
	annual submission: in table NIR-2 for 2008 Denmark reported an area under cropland management at the end of 2008 of 401.48 kha, while in table NIR-2 for 2009 it reported an area of 4.33 kha at the beginning of 2009. In addition, in table NIR-2 for 2008 Denmark reported an area under grazing land management at the end of 2008 of 0.26 kha, while in table NIR-2 for 2009 it reported an area of 401.27 kha at the beginning of that year. Responding to questions raised during the early stages of the review process, Denmark provided a correct table NIR-2 (land-use conversion matrix) for 2008 and 2009, and it incorporated these revised tables in its resubmission of 16 October 2011. The ERT strongly recommends that Denmark improve its QA/QC procedures for KP-LULUCF in order to avoid such problems in the next annual submission.		
KP-LULUCF, Afforestation and reforestation	Denmark has reported changes in carbon stock for units of land subjected to afforestation/reforestation and harvested since the beginning of the commitment period as "IE" (reported under units of land not harvested since the beginning of the commitment period), which the ERT considers not to be in accordance with the UNFCCC reporting guidelines. Denmark explained to the previous ERT that this is because the majority of areas subject to afforestation are on long rotations (>50 years) and therefore will not be harvested during the commitment period. The ERT reiterates the recommendation made in the previous review report that Denmark provides further information to explain this in its next annual submission, or provide estimates of the harvested areas and the associated emissions and removals.	The basic information utilised to give the data for the emission estimates for units of land subjected to afforestation/reforestation is based on National Forest Inventory (NFI) observations of stock change, specific related to the afforestated areas. This will include all changes in carbon pools - also if affected by harvest - including thinnings of young stands. Based on the NFI it will be possible - for the next reporting also to give some indications of the frequency of harvesting/thinning occurring on the afforestated areas. Given the fact that the afforestated area still is a relatively small part of the full forest area - there will be more uncertainty on the estimate related to afforestated areas compared to the area of forest remaining forest. The recommendation has been noted, and with the above supplementary information combined with more information in the next submission we aim to address the recommendation from the ERT.	

Table 10.8 Recommendations from the UNFCCC review process concerning KP-LULUCF.			
CRF	ERT Comment	Denmark's response	Reference
KP-LULUCF, Deforestation	In addition, N_2O emissions associated with the land-use conversion from forest land to settlements and the decrease in organic matter in soils have been included in the emission estimates. For 2009, CO_2 emissions from mineral soils as a result of deforestation have decreased in the revised estimates from 3.25 to 2.12 Gg CO_2 eqv. while N_2O emissions increased from 0.41 to 0.54 Gg CO_2 eq. The ERT considers that the efforts made by the Party have solved the issue, and recommends that Denmark include the underlying information supporting the revised estimates in the NIR of its next annual submission.	Information included in the NIR as text and table 7.25.	Chapter 7.4 Chapter 7.11.2
KP-LULUCF, Deforestation	During the review, the ERT found that there is not full consistency between the emission estimates reported under deforestation and under the equivalent LULUCF conversion categories for all pools; for example, a gain of 0.30 Gg carbon in soils in forest land converted to other land uses was reported (CRF tables 5.B-F), but a loss of 0.10 Gg carbon from soils under deforestation was also reported (CRF table 5(KP-I)A.2). No explanations for this difference are provided in the NIR. The ERT recommends that Denmark provide explanations for this difference in its next annual submission or make efforts to achieve consistency within its reporting.	In the 2012 submission Denmark has corrected this inconsistency. The data on forest land converted to other land uses reported in CRF tables 5.B-F are now fully consistent with the data reported in CRF table 5(KP-I)A.2.	

11 KP-LULUCF

11.1 General information

In the following text the abbreviations is used in accordance with definitions in the IPCC guidelines:

A:	Afforestation
R:	Reforestation
D:	Deforestation
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the Danish definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

11.1.1 Definition of forest and any other criteria

For the estimation of anthropogenic emissions by sources and removals by sinks associated with afforestation (A), reforestation (R) and deforestation (D) since 1990 under Article 3.3 and forest management (FM) under Article 3.4 of the Kyoto Protocol, the following forest definition will be applied:

- Minimum values for tree crown cover: 10 % tree crown cover for forests.
- Minimum values for land area: 0.5 ha.
- Minimum value for tree height: trees must be able to reach a minimum height of 5 m in the site.

In addition, the forest area includes temporarily unstocked areas, smaller open areas in the forest needed for management purposes and fire breaks. Forests in national parks, reserves, or areas under special protection are included. Windbreaks and groves covering more than 0.5 ha and with a minimum width of 20 m are also considered as forests. Farmlands, fruit plantations for commercial purposes, orchards, gardens (houses and summer houses) are NOT included in the forest area. Willow plantations on agricultural soils for bioenergy purposes are included in Cropland (CL).

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

As regards the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, it has been decided to include emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM). The Danish territory covers mainland Denmark and Greenland and not the Faroe Islands.

The tables given below covers only the Danish territory and not data from Greenland and thus only data, which shall be included in the submission

to the European Union (EU). The Danish CRF and KP tables are named: DNM

For Greenland separate CRF and KP tables are produced, see Chapter 15. The Greenlandic tables are named: **GRL.**

The Greenlandic impact on the overall estimates is very low: <0,01 % and thus the figures given below can be regarded as very proximate values for both Denmark and Greenland.

The Danish and the Greenlandic CRF and KP tables are merged into one set of CRF and KP tables and named: **DKE**.

The Faroe Islands has not signed the Kyoto-Protocol and has therefore not submitted KP tables or been included in the Danish and the Greenlandic submission.

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of Land Parcel Information System (LPIS) from the EU subsidiary system as well as the Greenlandic subsidiary system, detailed crop information data on field level, soil mapping and sample plots from the national forest inventory (NFI).

Inventories of emissions and removals under Article 3.3 and Article 3.4 are prepared for 2010, and reported annually in 2012 together with the other greenhouse gas inventory information.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The definition of afforestation, reforestation and deforestration is in accordance with the GPG (IPCC 2003).

Afforestation or reforestation is identified when areas have wooded tree cover and fulfils the forest definition given above. The time of the A is given by the time of action - e.i. planting of trees. For R the time is given by the first spontaneous regeneration of tress, typically either by absence of management or by management inducing natural regeneration. All types of establishment of forest (A or R) is considered human induced, as all land area of Denmark is under management or as minimum specifically left for spontaneous revegetation. Regulations and support for A and R include natural revegetation as a specific method, often supplementing already existing forest areas. (Danish Forest and Nature Agency, Support for Sustainable Forestry - active until 2010.
http://www.skovognatur.dk/Skov/Privat/Tilskud/Baeredygtig/)

Deforestation is identified where areas in 1990 were covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have another land use. Deforestation occurs for a number of reasons, e.g. nature restoration which in the period 1990 - 2010 have been the predominant reason. Other reasons can be urban or infrastructure development.

Temporarily unstocked areas - as integral part of forest management or as result of windthrow - which is expected to continue in forest management is not considered deforestation.

As for the forest management (Article 3.4) - the forest areas fulfilling the definition given above are included under this activity. All forest areas are considered managed due to the intense utilisation of the land area of Denmark. All inventories apply this approach. The Forest Act in Denmark gives the frame for most of the forest area ('Fredskov') - thereby ensuring continued forest cover - or by deforestation at least afforestation of a similar area or in most cases the double area. As described in Chapter 7 the changes in forest floor and mineral soils pools are not significant in the period observed (1990-2010) and are hence not considered being a source of emissions.

For Cropland and Grassland the area accounted for under Art. 3.4 has been estimated with the EO mapping combined with agricultural data from Statistics Denmark, Statistics Greenland and the EU agricultural subsidiary system. Only areas which are reported as CL and GL are included in the accounted area.

11.1.4 Description of precedence conditions and/or hierarchy among article 3.4 activities and how they have been consistently applied in determining how land was classified

All Forest activities have precedence, after this Cropland activities and then Grassland activities.

Afforestation has precedence. All land converted to forest are included as afforested area. Deforestated areas are reported under D. The following categories in the Convention reporting are included under afforestation:

- 5A21 CL to A
- 5A22 GL to A
- 5A23 WE to A
- 5A24 SE to A
- 5A25 OL to A

Deforestation is estimated as:
- 5B21 to CL
- 5C21 to GL
- 5D21 to WE
- 5E21 to SE
- 5F21 to OL

FM activities are only related to:
- 5A1 Forest remaining Forest

CM activities are related to:
- 5B1 CL remaining CL
- 5B22 GL to CL
- 5B23 WE to CL (not occurring)
- 5B24 SE to CL
- 5B25 OL to CL
- 5D22 CL to WE
- 5E22 CL to SE
- 5F22 CL to OL (not occurring)

GM activities are related to:

- 5C1 GL remaining GL
- 5C22 CL to GL
- 5C23 WE to GL (not occurring)
- 5C24 SE to GL
- 5C25 OL to GL
- 5D23 GL to WE
- 5E23 GL to SE
- 5F23 GL to OL (not occurring)

No elected land has left land, which is accounted for. Land conversion between elected activities (FM, CM and GM) has been allowed. FL, CL and GM, which has been converted to WE and SE is still included in the accounted area. No land elected under 3.4 activities has been converted to Other Land. Other land converted to elected activities is included in the respective category. As a consequence there has been a steady increase in land, which is accounted for under Art. 3.3 and Art. 3.4 (Table 11.1) with 26 063 hectares from 1990 to 2010.

Table 11.1 The development in the different land areas, which are included in the accounting.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
AF	711	9795	21 590	31 393	34 394	36 577	39 998	43 420	46 841
D	884	2557	4745	6353	6467	6581	6694	6808	6922
FM	538 903	537 231	535 043	533 435	533 321	533 207	533 093	532 979	532 865
CM	2 920 903	2 906 334	2 890 202	2 875 219	2 871 601	2 867 734	2 863 868	2 860 001	2 856 134
GM	119 373	130 561	141 666	152 831	155 080	157 329	159 577	161 826	164 074
Total area, Hectares	3 580 775	3 586 478	3 593 245	3 599 231	3 600 863	3 601 428	3 603 231	3 605 034	3 606 837

The Land Use matrix developed for the purpose of reporting Art. 3.3 and 3.4 activities for 2010 are shown in Table 11.2.

Table 11.2 Land Use matrix for art. 3.3 and 3.4 activities in 2010.

To current inventory / From previous inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	44,00	NO						44,00
	Deforestation		6,81						6,81
Article 3.4 activities	Forest Management (if elected)		0,11	532,87					532,98
	Cropland Management(4) (if elected)	2,00	NO		2.855,67	2,33	NA		2.860,00
	Grazing Land Management(4) (if elected)	0,05	NO		0,30	161,48	NA		161,83
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		1,38	NO	NO	0,17	0,26	NA	702,38	704,19
Total area at the end of the current inventory year		47,42	6,92	532,87	2.856,13	164,07	NA	702,38	4.309,80

The above given information in the hierarchy between the Contention and the KP-LULUCF activities ensures that emission from activities under article 3.4 are not double counted under both article 3.3 and 3.4 activities.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the areas of the units of land under Article 3.3

Afforestation and reforestation is identified where areas in 1990 were not covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have forest cover fulfilling the forest definition. Even though the definition for A and R refers to the time of establishment, there may be a slight time delay in the actual recording of the A/AR. This will be improved through more frequent land use mapping and improved methods for mapping in the coming years.

Deforestation is identified where areas at the beginning of the commitment period were covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have another land use. The identification of the areas is in most cases supported by reports on e.g. nature restoration or establishment of settlements.

11.2.2 Methodology used to develop the land transition matrix

A land use/land cover map was produced for the Kyoto reference year 1990 and for the year 2005 based on EO data (23 August 1990) and other data produced from 1992-2005. The primary data used is Landsat imagery mainly Landsat 5 (TM) and 7 (ETM+) data to classify and estimate the area. These data has been combined with different vector layers such as cadastral maps, road maps, wetland areas, agricultural land use data, vector layers of established wetlands, gravel maps etc. as well as aerial photos. Portions of seven scenes covering the whole country were classified into forest and non-forest classes. The approach involved the integration of sampling, image processing, and estimation. The product is specified by a Minimum Mapping Unit (MMU) of 0.5 ha, a geometric accuracy of < 15 m RMS and a thematic accuracy of 90% +/- 5% for the six major Kyoto classes: Forest, Cropland, Grassland, Wetland, Settlements, and Other. Forest has a 0.5 ha MMU.

In Chapter 7, Table 7.1 shows the overall development from 1990 to 2010. The preliminary result is an increase in the afforested area of 46,841 hectares, but also that deforestation has taken place of approximately 6,922 ha. Afforestation is mainly taking place on CL and OL not previously classified as forest. Areas, which are deforestated, are mainly converted to GL and to a less extend into CL. Since 1990 almost 70,000 hectares have been changed into SE and other infrastructures. No FF, CL and GL are converted into OL by definition.

Based upon the combination of the satellite image classified land use map and the combined vector layer of know information a full land use map for 1990 and 2005 was produced. The maps were transformed into a pixel based relational data base - SINKPIX - with each of the 25 x 25 m pixels giving a full dataset for the entire Danish land area in 1990 and 2005. Based upon this database the extraction of the land use matrix and the land use changes could be performed.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The entire Danish territory except the Faroe Islands is included. This chapter includes only the territory of Denmark without Greenland. Denmark is reported as one unit and no sub-geographical locations are used.

Greenland is submitting a full separate NIR and CRF to be included in the submission to UNFCCC (Chapter 16).

11.3 Afforestation, Reforestation & Deforestation (ARD)

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

For afforestation the carbon stock change in the period 1990 - 2010 is based both on the area of afforestation, the information on species composition from the Forest Census 2000 and from the NFI.

In the afforestation a steady increase in carbon stock is found. The species composition is based on the information from the 2000 Forest Census for the period 1990-2000. Subsequently the NFI provides information on the afforestation area and the carbon pools in these areas - up till 2007. The estimates for the carbon pools in the afforestation are similar to previous estimates, with a slight increase due to the new knowledge on species composition and average carbon stock in those areas based on the NFI data.

Carbon stock change caused by deforestation is estimated based on the deforestated area and the mean values of carbon stock in the total forest area. This is due to the fact that no specific knowledge is available on the carbon pools of the deforested areas.

Where deforestation is taking place is the living and dead biomass removed and oxidized instantly. This includes also the litter layer in the forest. For the litter layer is further more included a N_2O-emission from nitrogen in the litter layer as well as changes in the C stock in mineral soils multiplied with a C:N ratio of 15 and a EF of 1.25 %.

Further details are available in Johannsen et al. 2009.

11.3.2 Description of the methodologies and the underlying assumptions used

The climate in Denmark is cold and wet, which gives limitations to the growth of the forests and therefore afforestation in Denmark are on long rotations (>50 years) to give a reasonable amount of wood and wood products. Furthermore, the afforested areas are in many cases protected against deforestation. Therefore, afforested areas under article 3.3. will seldom be harvested during the commitment period. In the current submission is no estimates for "Units of land harvested since the beginning of the commitment period" in table 5(KP-I)A.1.2 given and stated as IE.

The basic information utilised to give the data for the emission estimates for units of land subjected to afforestation/reforestation is based on National Forest Inventory (NFI) observations of stock change, specific related to the afforestated areas. This will include all changes in carbon pools - also if affected by harvest - including thinnings of young stands.

Based on the NFI it will be possible - for the next reporting also to give some indications of the frequency of harvesting/thinning occurring on the afforestated areas. Given the fact that the afforestated area still is a relatively small part of the full forest area - there will be more uncertainty on the estimate related to afforestated areas compared to the area of forest remaining forest.

11.3.3 Justification when omitting any carbon pool or GHG emissions/ removals from ARD

When deforestation occurs it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest is converted.

11.3.4 Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out has been performed in the emission and removal estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

Some recalculations have been made as updated values from the NFI and have become available; also minor changes in the Land Use Matrix have occurred.

11.3.6 Uncertainty estimates

The uncertainty has been estimated based on the net changes in the different carbon stock with the IPCC Tier 1 methodology, Table 11.3 and Table 11.4.

The uncertainty in 2010 for Afforestation has been estimated to ± 0.1 Gg CO_2 equivalents and for Deforestation to ± 12.7 Gg CO_2 equivalents. The low uncertainty for afforestation is associated with that the figure is around zero.

Table 11.3 Uncertainty assessment for Afforestation.

KP A.1.1 Afforestation and Reforestation	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
Area subject to the activity, Kha	46,8					
Area of organic soils, Kha	1,8					
Net CO_2 emissions/ removals	0,4				24,4	0,1
Carbon stock change in above-ground biomass	9,1	15	50	52,2	52,2	4,8
Carbon stock change in below-ground biomass	2,5	15	50	52,2	52,2	1,3
Net carbon stock change in litter	-8,4	15	50	52,2	52,2	4,4
Net carbon stock change in dead wood	-9,4	15	50	52,2	52,2	4,9
Net carbon stock change in soils, mineral soils	6,7	15	50	52,2	52,2	3,5
Net carbon stock change in soils, organic soils	-0,6	15	90	91,2	91,2	0,6

Table 11.4 Uncertainty assessment for Deforestation.

KP A.2 Deforestation	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
Area subject to the activity, Kha	6,9					
Area of organic soils, Kha	0,3					
Net CO_2 emissions/ removals	40,1				31,8	12,7
Carbon stock change in above-ground biomass	-6,1	15	50	52,2	52,2	3,2
Carbon stock change in below-ground biomass	-1,3	15	50	52,2	52,2	0,7
Net carbon stock change in litter	-1,4	15	50	52,2	52,2	0,7
Net carbon stock change in dead wood	-0,1	15	50	52,2	52,2	0,1
Net carbon stock change in soils, mineral soils	-1,3	15	50	52,2	52,2	0,7
Net carbon stock change in soils, organic soils	-0,7	15	90	91,2	91,2	0,6

11.3.7 Information on other methodological issues

See Chapter 7.

11.3.8 The year of the onset of an activity, if after 2008

Not applicable.

11.4 Forest Management (FM)

11.4.1 Methods for carbon stock change and GHG emission and removal estimates

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.2 Methodologies and the underlying assumptions

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.3 Omission of pools from FM

No pools omitted.

11.4.4 Factoring out

No factoring out has been made.

11.4.5 Recalculations

Some recalculations have been made due to updated values from the NFI on carbon stocks.

11.4.6 Uncertainty estimates

The uncertainty has been estimated based on the net changes in the different carbon stock with the IPCC Tier 1 methodology. The uncertainty in 2010 for Forest Management has been estimated to ± 2075.3 Gg CO_2 equivalents and ± 9.7 Gg CO_2 equivalents from drainage of organic soils in the forest.

Table 11.5 Uncertainty assessment for Forest Management.

KP B.1 Forest Management	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95%, Gg CO_2 eqv.
Area subject to the activity, Kha	532,9					
Area of organic soils, Kha	26,6					
Net CO_2 emissions/ removals	-5689,3				36,5	2075,3
Carbon stock change in above-ground biomass	1039,5	15	50	52,2	52,2	542,6
Carbon stock change in below-ground biomass	213,7	15	50	52,2	52,2	111,5
Net carbon stock change in litter	275,1	15	50	52,2	52,2	143,6
Net carbon stock change in dead wood	32,5	15	50	52,2	52,2	16,9
Net carbon stock change in soils, mineral soils	NO	15	50	52,2	-	-
Net carbon stock change in soils, organic soils	-9,1	30	90	94,9	94,9	8,6

Table 11.6 Uncertainty assessment associated with drainage of forest soils.

KP-II 2 N_2O from drainage of soils	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95%, Gg CO_2 eqv.
Area of drained soils, Kha	291,8					
Emission	12,0				80,8	9,7
N_2O, Gg CO_2 eqv.	12,0	30	75	80,8	80,8	9,7

11.4.7 Information on other methodological issues

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.8 The year of the onset of an activity, if after 2008

Not applicable.

11.5 Cropland Management (CM)

11.5.1 Methods for carbon stock change and GHG emission and removal estimates

CL is subdivided in four classes: agricultural CL, wooded perennial fruit plantations, hedgerows and “other agricultural CL”.

11.5.2 Methodologies and the underlying assumptions used

The area with agricultural CL are given as the agricultural area in Statistics Denmark for cereals, fodder crops, grass for seed, sugar beets, potatoes and other root crops.

Land converted from other Land use categories to CL is included under CL. Land converted to forest is reported under forest (AR). Land which according to the land use matrix is converted to WE and SE are still included in CM. Land conversion to OL is not allowed.

The same methodology as used in the Convention reporting, is used in the KP reporting.

11.5.3 Omission of pool from CM

Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under CL as this is seen as not occurring or as very insignificant as it is only related to the small area with fruit plantations and hedges. Only above- and belowground living biomasses for perennial fruit plantations, hedgerows and willow plantations for bioenergy purposes on agricultural land are therefore reported under cropland. Christmas trees are reported under FL.

11.5.4 Factoring out

The dramatic increase in the temperature in the latter years results in a higher turn-over rate of organic matter in soils leading to an increased emission from soils compared to pre 1990. For agricultural soils Denmark is using a dynamical temperature dependent model (Tier 3), which is expected to give the best estimate of the actual emission from soils compared to most other methods. If Denmark had used the default IPCC Tier 1 or 2 there would likely have been a *negative* factoring out, because the emission factor (EF) in these methods are based on long-term scientific data and thus not having the recent increase in temperatures included. Therefore by using the actual temperature in the Tier 3 no factoring out has been made.

11.5.5 Recalculations

Recalculations has been made due to an updated map of organic soils and that it was shown that C-TOOL was not able to estimate the CO_2 emission from mineral soils having a C content of 6-12 % organic carbon satisfactorily.

The new data map of the organic soils has shown a sharp decrease in the area with organic soils since the last mapping in 1975. This is mainly because that the Danish organic soils are very shallow. The reduced area since 1975 has been taken into account with a linear decrease in the area.

As C-TOOL was shown not to be able to estimate the emission for soils having a carbon content of 6-12 % organic carbon. The elevated soil carbon content in these soils are caused by water saturation as the normal carbon content in mineral soils are 2-3 % organic matter under Danish conditions. These areas have been given a fixed emission factor, which is half of the emission from organic soils due to their elevated carbon content. This has increased the basic emission in the base year and through the whole time series with app. 1000 Gg CO_2 equivalents per year.

The previous review recommended Denmark to include losses in soil for land use conversion into settlements due to deforestation. In this submission have losses from all land use changes into other land use categories have been implemented. This has a special impact on the emission from CM as a large area has been converted from CL to SE.

11.5.6 Uncertainty estimates

The uncertainty has been estimated based on the net changes in the different carbon stock with the IPCC Tier 1 methodology. The uncertainty in 2010 for Cropland Management has been estimated to ±1829.9 Gg CO_2 equivalents, ± 0.5 Gg CO_2 equivalents associated with disturbance from land use change and ± 93.1 Gg CO_2 equivalents from lime application, Table 11.7, 11.8 and 11.9, respectively.

Table 11.7 Uncertainty assessment for Cropland Management.

KP B.2 Cropland Management	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95%, Gg CO_2 eqv.
Area subject to the activity, kha	2856,1					
Area of organic soils, kha	43,1					
Net CO_2 emissions/ removals	3099,3				59,0	1829,9
Carbon stock change in above-ground biomass	-37,7	10	50	51,0	51,0	19,2
Carbon stock change in below-ground biomass	IE	10	50	51,0	-	-
Net carbon stock change in soils. mineral soils	-331,6	10	75	75,7	75,7	250,9
Net carbon stock change in soils. organic soils	-476,0	10	90	90,6	90,6	431,0

Table 11.8 Uncertainty assessment for N_2O associated with land use conversion.

KP-II 3 N2O associated from disturbance of land use change	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95%. Gg CO_2 eqv.
Land area converted, Kha	6,9					
Emission	0,6				76,5	0,5
N_2O Gg CO_2-eqv	0,6	15	75	76,5	76,5	0,5

Table 11.9 Uncertainty assessment for lime consumption.

KP-II 4 Lime consumption	Emission	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95%. Gg CO_2 eqv.
Total amount of lime applied	421340,8					
Emission	185,3				50,2	93,1
CO_2	185,3	5	50	50,2	50,2	93,1

11.5.7 Information on other methodological issues

None.

11.5.8 The year of the onset of an activity. if after 2008

Not applicable.

11.6 Grazing land management (GM)

11.6.1 Methods for carbon stock change and GHG emission and removal estimates

Grazing land is defined as land used for permanent grazing as well as dry land not meeting the definitions for FF, CL, WE or SE. GL is subdivided into two types: Land strictly used for grazing and other grassland. Land used for grazing has no wooden vegetation whereas other grassland may have some wooden vegetation that does not meet the forest definition. The area with strict grazing land is given as the area recorded as “common grassland” in the EU agricultural subsidiary system. Other grassland is estimated as the difference between the grazing land and the area classified as Grassland with remote sensing.

11.6.2 Description of the methodologies and the underlying assumptions used

As all the grazed grassland is more or less unimproved without fertiliser no changes in management practice has been applied. This is in accordance with IPCC GPG 2003 (3.4.1.2.1.2).

For land converted to GL and not purely free of wooden trees/bushes it is assumed that there is a living biomass of 2.200 kg DM per ha in above ground biomass and 6.160 kg DM per ha in below ground biomass (IPCC. 2003). In Grassland it is assumed that no changes in soil carbon stock in mineral soils are occurring. For organic soils is assumed an emission as reported in Section 7.

11.6.3 Factoring out

No factoring out has been made.

11.6.4 Recalculations

See section 10.5.5 as this also affect GM.

11.6.5 Uncertainty estimates

The uncertainty has been estimated based on the net changes in the different carbon stock with the IPCC Tier 1 methodology. The uncertainty in 2010 for Grassland Management has been estimated to ± 130.8 Gg CO_2 equivalents.

Table 11.10 Uncertainty assessment for Grassland Management.

KP B.3 Grassland Management	Emission	Activity data. %	Emission factor. %	Combined uncertainty	Total uncertainty. %	Uncertainty 95 %. Gg CO_2 eqv.
Area subject to the activity, Kha	164,1					
Area of organic soils, Kha	31,5					
Net CO_2 emissions/ removals	171,3				76,4	130,8
Carbon stock change in above-ground biomass	-6,1	10	50	51,0	51,0	3,1
Carbon stock change in below-ground biomass	IE	10	50	51,0	-	-
Net carbon stock change in soils. mineral soils	-1,4	10	75	75,7	75,7	1,0
Net carbon stock change in soils. organic soils	-39,2	10	90	90,6	90,6	35,5

11.6.6 Information on other methodological issues

None.

11.6.7 The year of the onset of an activity, if after 2008

Not applicable.

11.7 Article 3.3

11.7.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

The land use mapping in 1990, 2005 and again at the end of the period 2012 is the documentation that activities under Article 3.3 began after 1.1.1990. As all land area is under management all changes are evaluated as direct human induced. This also includes A and R, which are based on approved methods of establishing new forest - both planting and natural revegetation. In some cases the absence of removal of tree growth is an easy and cheap method for establishing new forest. Hence this method has also been supported through public support for establishment of new forest areas.

11.7.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Deforestation is detected by analysis of satellite images. Furthermore deforestation of larger areas is confirmed by e.g. projects on nature restoration. Temporarily unstocked areas are typically located within larger forest areas and will in most cases be reforestated within a period of 10 years as according to the Forest Act of Denmark, which applies to all Legal Forest Reserves

(Fredsskov) and equals approximately 75 % of the total forest area. Clearcuts outside forests - e.g. small plantations of conifers on former cropland - is considered deforestation.

Most forest areas - including new forest areas - are subject to intermediate thinnings - harvesting of small trees. This is done with the purpose of reducing stem number and often to produce firewood or wood chips. Clearcuts of new forest areas occurs in most cases first at maturity of the stand – after 50-100 years. A subset of the new forest area are managed as coppice like management. e.g. for production of Christmas trees.

11.7.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

This information will be available after the QA/QC analysis of the land use maps of 1990 and 2005, which will be performed during 2012.

11.7.4 Uncertainty on article 3.3 activities

A Tier 1 uncertainty analysis has been performed for Article 3.3 activities according to the GPG 2000. In total, the overall uncertainty in the year has been estimated to 50.94 %.

Table 11.11 Uncertainty assessment for Article 3.3. activities inclusive trend uncertainty.

		Year 2010 emission Gg CO_2 eqv.
A. Article 3.3 activities		41,1
KP A.1.1 Afforestation and Reforestation		0,4
KP A.2 Deforestation		40,1
Total uncertainties	Overall uncertainty in the year (%):	50,94

11.8 Article 3.4

11.8.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forest Management

In FM all forest area is under management and changes in carbon stock are hence seen as human induced. The baseline for 1990 is estimated as documented in Johannsen et al. 2009.

Cropland Management

Since 1990 major changes in Danish Agriculture has taken place. Due to environmental demands for "green crops during winter" the previous major crop, spring barley, has been replaced by primarily winter wheat. Furthermore, a ban on field burning was implemented in January 1990 (Executive order NO. 142 of 08/03/1989). This has reduced the burning of field residues, which were widely occurring until then. Furthermore, as part of reducing the leaching of nitrogen, executive order NO. 624 of 15/07/1997 demands of the farmers that a certain percentage of the area shall be grown with an extra crop after harvest of annual crops. Currently about eight per cent of the agricultural area is having an extra crop. From 2003 agricultural areas has been taken out of rotation due to demanded borders along watersheds to protect the watersheds.

Grassland Management

No specific activities have taken place in Grassland to increase or decrease the carbon stock. GM was elected so that all human induced activities affecting the carbon stock in the landscape are included in the Danish commitments under the Kyoto Protocol. Furthermore, it is very difficult to distinguish between activities in CM and GM in the heterogenic patchy Danish landscape.

11.8.2 Information relating to Cropland Management. Grazing Land Management and Revegetation, if elected, for the base year

No further information is available.

11.8.3 Information relating to Forest Management

No further information is available.

11.8.4 Uncertainty on article 3.4 activities

An Tier 1 uncertainty analysis has been performed for Article 3.3 activities according to the GPG 2000. In total the overall uncertainty in the year has been estimated to 170.50 % and the trend uncertainty to 117.52 %.

Table 11.12 Uncertainty assessment for Article 3.4. activities inclusive trend uncertainty.

	Base year 1990 emission	Year 2010 emission	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO_2 eqv.	Gg CO_2 eqv.	%	%	%
B. Article 3.4 activities	4.027,86	-2.221,40			
KP B.1 Forest Management	-724,92	-5.689,31	-75,72	-29,96	81,44
KP B.2 Cropland Management	2.565,70	3.099,30	83,53	10,88	84,23
KP B.3 Grassland Management	313,65	171,28	6,41	0,60	6,43
KP-II 2 N_2O from drainage of soils	15,66	12,03	0,38	0,13	0,41
KP-II 3 N_2O associated from disturbance of land use change	3,19	0,62	0,04	0,00	0,04
KP-II 4 Lime consumption	622,92	185,27	6,55	0,33	6,56
Total uncertainties	Overall uncertainty in the year (%):				170,50
	Trend uncertainty (%):				117,52

11.9 Other information

11.9.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

According to the IPCC Good Practice Guidance for LULUCF a category that is identified as key in the UNFCCC inventory should also be considered key under the Kyoto Protocol (IPCC GPG. 2003).

The following LULUCF categories were identified as key categories in the UNFCCC reporting:

- Cropland remaining cropland – organic soils.
- Cropland remaining cropland – mineral soils.
- Cropland converted to forest land – conifers.
- Cropland converted to forest land – broadleaves.
- Forest land remaining forest land.

According to Table 5.4.4 in the IPCC GPG for LULUCF this means that the following Kyoto Protocol activities are initially considered key.

Table 11.13 Relationship between activities in the UNFCCC LULUCF and the KP-LULUCF.

LULUCF activity	KP-LULUCF activities
Forest land remaining forest land	FM, GM, CM
Land converted to forest land	AR
Cropland remaining cropland	CM
Grassland remaining grassland	GM

For Denmark the relevant KP-LULUCF activity corresponding to forest land remaining forest land identified as being a key category in the UNFCCC reporting is FM. For land converted to forest afforestation/reforestation is a key category. For cropland remaining cropland the relevant KP-LULUCF activity is CM. For grassland remaining grassland the relevant KP-LULUCF activity is GM.

Therefore AR, FM, CM and GM are considered key categories in the Danish KP-LULUCF inventory.

For the full list of identified key categories please refer to Annex 1.

11.10 Information relating to Article 6

There are no Article 6 projects (Joint Implementation) on the Danish territory.

12 Information on accounting of Kyoto units

Referring to Decision 15/CMP.1 on Guidelines for the preparation of the information required under Articles 7 of the Kyoto Protocol (UNFCCC, 2006), this chapter and chapters 14 and 15 include information and references to Denmark's and Greenland's annual non-inventory information under the Kyoto Protocol.

12.1 Background information

In accordance with paragraph 10 of the annex to Decision 15/CMP.1 information on emission reduction units, certified emission reductions, temporary certified emission reductions, long-term certified emission reductions, assigned amount units and removal units will be reported for the first calendar year in which these units will be transferred or acquired.

12.2 Summary of information reported in the SEF tables

The information required is contained in the UNFCCC Standard Electronic Format (SEF) application version 1.2.1.

12.3 Discrepancies and notifications

Annex 1 parties are also required to submit four reports according to paragraphs 12 to 16 of the annex to decision 15/CMP.1. These reports are:

- Paragraph 12 – List of discrepancies identified by the ITL.
- Paragraph 13/14 – List of notifications from the CDM Executive Board regarding lCERs.
- Paragraph 15 – List of non-replacement identified by the ITL.
- Paragraph 16 – List of invalid Kyoto units.

The list described in paragraph 12 is contained in Annex 6 as "Report – List of discrepancies identified by the ITL according to paragraph 12 of the annex to decision 15/CMP.1".

The lists described in paragraph 13-15 are not included in this NIR, as there are no tCERs or lCERs in the Danish Registry. For paragraph 16, the Danish Registry has yet to receive invalid Kyoto units. This also renders this list unnecessary to submit. The discrepancies have been found in the daily reconciliation and have all been solved by manual intervention by either the Danish Registry or the CITL/ITL depending on which stage the transaction was in.

12.4 Publicly accessible information

Information to be publically available from the SEF is included in Annex 6 (SEF 2011 Denmark). The SEF report that is attached in Annex 6 will also be publically available on the Danish Energy Agency website

(http://www.ens.dk/en-US/ClimateAndCO2/emissiontradingscheme/DETR/)

Other information that is required to be publically available can be found on the Danish Energy Agency's registry website: https://www.kvoteregister.dk/

This information includes information on each account as required in paragraph 45 of the annex to Decision 13/CMP.1. Please note that the contact information (paragraph 45 (e)) requires the consent of the account holder according to EU law. Thus, all of this information is not publically available.

Information on article 6 projects is not available as Denmark to this date has not approved any Joint Implementation projects in Denmark.

12.5 Calculation of the commitment period reserve

The calculation of the Commitment Period Reserve (CPR) is based on the assigned amount of 276,838,955 tonnes of CO_2 equivalents. Subsequently, the CPR calculated as 90 % of the assigned amount is 249,155,060 tonnes CO_2 equivalent, during the commitment period and has not changed since the Report of the review of the initial report of Denmark published on 2 November 2007. The commitment period reserve has not changed since the previous submission, as 100 % times the most recent inventory times five would amount to a higher value.

The software still checks if the CPR is respected before a transaction from the Danish Registry can be carried out.

The CR Software that the Danish Emission Trading Registry is using as registry software was approved by the UNFCCC in the Independent Assessment Report the 16th of October 2007. Changes in the software have not been of a significance that has required a new Independent Assessment Report and software testing since then.

12.6 KP-LULUCF accounting

At the time of preparation for this report Denmark has issued 624 109 RMU units and cancelled 335 864 RMU units with 288245 RMU units as the final net-result equal to the net removal figure mentioned in paragraph 195 of IDR report of 3 March 2011.

Referring to the KP-LULUCF inventory (Denmark only) the accounting quantity is 6 347 596 tonnes CO_2 equivalent as RMUs on the basis of activities in 2008, 2009 and 2010 under Articles 3.3 and 3.4 of the Kyoto Protocol.

The accounting of RMUs based on the 2012 submission will not begin until after publication of the review report from the review of the 2012 submission.

Table 12.1 Information on accounting for activities under articles 3.3 and 3.4 of the Kyoto Protocol.

Greenhouse gas source and sink activities	Base year	Net emissions/-removals 2008	2009	2010	Total	Accounting Parameters	Accounting Quantity
		(Gg CO_2 equivalent)					
A. Article 3.3 activities							
A.1. Afforestation and Reforestation							-855,26
A.1.1. Units of land not harvested since the beginning of the commitment period		-313,57	-542,06	0,37	-855,26		-855,26
A.1.2. Units of land harvested since the beginning of the commitment period							IE,NO
Denmark		IE,NO	IE,NO	IE,NO	IE,NO		IE,NO
A.2. Deforestation		39,47	39,82	40,69	119,98		119,98
B. Article 3.4 activities							
B.1. Forest Management		-691,61	-3048,41	-5677,27	-9417,29		-916,67
3.3 offset							0,00
FM cap						916,67	-916,67
B.2. Cropland Management	4650,44	3577,85	2488,50	3284,56	9350,91	13 951,33	-4600,42
B.3. Grazing Land Management	205,08	175,31	173,39	171,31	520,02	615,24	-95,23
Total[1]		-2068,07	-2920,93				-6347,60

[1] The FM cap is fully accounted in 2008.

Table 12.2 shows the average accounting quantity for 2008, 2009 and 2010.

Table 12.2 Annual average accounting quantity, Gg CO_2 equivalent.

	Average for 2008-2010
Afforestation and Reforestation	-285,09
Deforestation	39,99
Forest Management	-183,33[1]
Cropland Management	-1533,47
Grazing Land Management	-31,74
Total	-1993,64

[1] Calculated as the FM cap divided by five.

References

EC, 2004: COMMISSION REGULATION (EC) No 2216/2004 of 21 December 2004 for a standardised and secured system of registries pursuant to Directive 2003/87/EC of the European Parliament and of the Council and Decision No 280/2004/EC of the European Parliament and of the Council. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:386:0001:0077:EN:PDF

DEA, 2010: Publically available information on the Danish Energy Agency's Registry website. Available at: https://www.kvoteregister.dk/

DEA, 2010: Publically available information on the on the Danish Energy Agency's general website. Available at:

http://www.ens.dk/en-US/ClimateAndCO2/emissiontradingscheme/DETR/

UNFCCC, 2006: Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005. Available at: http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf

UNFCCC, 2007: Report of the review of the initial report of Denmark. Available at: http://unfccc.int/resource/docs/2007/irr/dnk.pdf

13 Information on changes in the national system

On June 30 2011 the National Environmental Research Institute (NERI) under Aarhus University ceased to exist. In its place is now DCE – Danish Centre for Environment and Energy under Aarhus University.

The scientific staff in the former NERI departments was split between two departments of the Faculty of Science and Technology under Aarhus University. The staff associated with the task of preparing emission inventories became part of the Department of Environmental Science.

The contract to prepare the emission inventories is now between the Danish Centre for Environment and Energy, Aarhus University and the Ministry of the Environment and the Ministry of Climate, Energy and Building. The Department of Environmental Science, Aarhus University is responsible for the calculation and reporting of the Danish national emission inventory to EU and the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (Convention on Long Range Transboundary Air Pollution) conventions.

No changes have been made concerning the staff carrying out the work, nor has the change in administrative structure caused changes to the available resources.

14 Information on changes in the national registry

Referring to paragraph 22 of the annex to Decision 15/CMP.1, information on any changes that have occurred in the national registry, compared with information reported in the last submission should be included in this report.

The Danish Emission Trading Registry is updated and the software is continuously patched in an ongoing effort to make the registry as safe and secure as possible. One thing of special notice is the work that has been carried out in 2010 on the development of a 2 factor security system in the Registry. The first factor is login via a personal password for each registry user. The second factor is a login via a code, which the registry user has received by sms to a single telephone number which is connected to the user account. The 2 factor is connected to log-in, transactions and some of the registry administrator functions. This new 2 factor security system was implemented in February 2011. During the year we have had 2 penetration tests and had updated the software accordingly.

Features implemented during 2011 to improve the security are:

- Cookies have been secured
- Autocompletion of fields for username and password has been deactivated
- TLSv1.0 has been enforced as cypher for the registry
- Protection against "man in the browser" attacks
- secret question and answer to be used, when account representatives request a new password for log-in

Changes following the last SIAR report include:

- A note is inserted on which information cannot be shown due to request from the Account representative in the list of account representatives.
- A note is inserted on which information cannot be shown due to national or EU legislation in the list of Transactions.

The Danish registry has not had any issues concerning fragmentation of unit blocks and no technical solution has thus been implemented. In case of problems occurring in the upcoming year, we will advise our clients to split the transaction into several transactions with smaller amount of units. If the problem becomes frequent, we will look for a technical solution.

15 Information on the minimization of adverse impacts in accordance with Article 3, paragraph 14

No changes have occurred since the information reported in NIR 2011.

16 Methodology applied for the greenhouse gas inventory for Greenland

16.1 Introduction

The following sections contain a report of Greenland's part of the National Inventory Report (NIR) 2012. The structure of the report follows the UNFCCC guidelines on reporting and review (UNFCCC, 2002).

The report is to a far extent structured according to the recommended outline provided by the UNFCCC secretariat.

Previous to 2010 the greenhouse gas (GHG) inventory and this annex were completed exclusively by the then Danish National Environmental Research Institute, Aarhus University (Since 2011 NERI was changed to DCE – Danish Centre of Environment and Energy), with input from the Environmental and Nature Protection Agency (APA), Ministry of Domestic Affairs, Nature and Environment.

In 2008 an energy statistic was officially initiated at Statistics Greenland with the intention to "… create an important tool, which in regard to political and economical priorities, can contribute to the identification of efforts on energy matters…" and which "… in regard to environmental aspects will create a basis for assessing the development in regard to Greenland's meetings of the Kyoto protocol …". The first results on the new energy statistics, covering the period 2004-2007, were published in November 2008.

The GHG inventory submitted in April 2012 is completed by Statistics Greenland and the Ministry of Housing, Infrastructure and Transport, Greenland Government, with technical support from DCE. This report on methodology is written by Statistics Greenland with assistance from the Ministry of Housing, Infrastructure and Transport and documental support by DCE.

The annual emission inventories for Greenland for the years 1990-2010, are reported in the full CRF format.

The GHG's reported are:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

16.1.1 A description of the institutional arrangement for inventory preparation

The Greenland Ministry of Housing, Infrastructure and Transport is responsible for the annual preparation of the Greenlandic contribution to the National Inventory Report and the GHG inventories in the Common Reporting Format in accordance with the UNFCCC Guidelines. The Greenland Ministry of Housing, Infrastructure and Transport will provide the data to DCE. DCE is responsible for aggregating the Danish and Greenlandic CRF submissions and reporting the aggregated CRF and the National Inventory Report to the UNFCCC.

The inventory for LULUCF and KP-LULUCF is carried out by DCE and the documentation of the inventory (Sections 16.7 and 16.11) is completed by the Danish LULUCF experts.

Formerly, the provision of data was on a voluntary basis, but a formal contract between DCE (then NERI) and the Greenland Government came in place for the 2009 GHG inventory report.

The work concerning the annual GHG emission inventory is carried out in co-operation with other Greenlandic ministries, research institutes, organisations and companies:

Statistics Greenland (Ministry of Finance)
Annual energy statistics in a format suitable for the emission inventory work and fuel-use data for the large combustion plants. Since 2009 annual survey on emissions of F-gases.

Agricultural Advisory Service (Ministry of Fisheries, Hunting and Agriculture)
Background data on cropland and grassland, and statistics on livestock (sheep and reindeer).

Ministry of Domestic Affairs, Nature and Environment
Data on waste and emissions of F-gases. Annual Survey carried out by the Ministry of Domestic Affairs, Nature and Environment until 2008 and by Statistics Greenland from 2009 and onwards.

Ministry of Fisheries, Hunting and Agriculture and the Greenlandic Arboretum
Background data on forestry.

Greenland Airport Authority (Ministry of Housing, Infrastructure and Transport)
Statistics on domestic flights and foreign flights to and from Greenland.

16.1.2 Brief description of the process of inventory preparation - data collection, data processing, data storage

The background data (activity data and emission factors) for estimation of the Greenlandic emission inventories is collected and stored in central databases at Statistics Greenland. The databases are in SAS format and handled with software from the SAS Institute Inc. The SAS programs are designed by Statistics Greenland. The methodologies and data sources used for the different sectors are described briefly in Section 16.1.4 and more in depth in Sections 16.3 to 16.8 and Section 16.11.

The material is placed on servers at Statistics Greenland. The servers are subject to routine backup services. Material, which have been backed up is archived safely.

16.1.3 General description of methodologies and data sources used

The GHG inventory for Greenland includes the following sectors:

- Energy sector
- Industrial processes
- Solvent and other product use
- Agriculture
- Land Use, Land-use Change and Forestry
- Waste
- KP-LULUCF

The applied methodologies follow the IPCC Guidelines and IPCC Good Practice Guidance. In some cases the methodology is identical to the methodology applied in the Danish inventory, however, the availability of data – especially site specific data – do not allow the same methodology to be used for all the sectors. The brief methodological description is included below for the different sectors. More thorough descriptions are included in Sections 16.3-16.8 and 16.11.

Energy sector

Fuel combustion

The Greenlandic emission inventory for fuel combustion has been performed according to the IPCC tier 1 methodology. The inventory is based on activity data from the Greenlandic energy statistics and on emission factors for different fuels, plants and sectors.

Total fuel combustion is based on data from Polaroil, Statoil and Malik Supply A/S. Polaroil imports fuel and distributes fuel in all parts of Greenland. Statoil imports and distributes fuel in Kangerlussuaq. Malik Supply A/S, a Danish company, re-distributes fuel bought from Polaroil to Greenlandic trawlers, ships etc. By using detailed data from Polaroil, Statoil and Malik Supply A/S it is possible to determine total import, total export, total international bunkers and total domestic fuel combustion.

Total domestic fuel combustion is then divided into sectors and private households by using data from a survey on energy consumption, company specific sales data from Polaroil and local fuel distributors, company tax accountings, municipality and the Government of Greenland accountings, and by estimation.

Fuel combustion in private households is estimated using detailed information from a number of local fuel distributors. Fuel deliveries are registered by buildings. In Greenland each building has a unique number registered in the Greenlandic Area Register (NIN). By combining the NIN-register and the GER-register (see above) with statistics on housing and population each building is labelled *private household* or located to a sector describing the main activity in the building. This new building-sector register, completed annually, is used extensively to determine the buyer of fuel delivered by Polaroil or local fuel distributors.

Fuel combustion in road traffic is based on a model designed by Statistics Greenland. The model contains data on the vehicle stock obtained from the Greenland Police Department's register on engine data. The vehicles are divided into broad categories of type i.e. personal car, lorry, taxi, truck, ambulance, motorbike etc. Each category is assigned with ratios on fuel type and mileage. Input data on mileage is derived from a survey among businesses and private road traffic in 2008, 2009, 2010 and 2011. Each vehicle is divided in business categories or labelled *private vehicle* according to the owner. For each group the emissions are estimated by combining vehicle and annual mileage numbers with standard emission factors according to the type of fuel. The model does not take cold start or hot engines into account.

For air traffic annual emissions are based on activity data from Air Greenland A/S and sales data from the Greenland Airport Authority. For navigation, ferries and freight, annual emissions are based on activity data from Royal Arctic Line A/S (freight), Royal Arctic Tankers A/S (freight), Royal Arctic Bygdeservice A/S (freight/passengers), and Arctic Umiaq Line A/S (passengers) and the liquidated Assartuivik A/S (passengers).

For further information please refer to Section 16.3.

Fugitive emission

Greenland has no coal mines, no off-shore activities, no oil refineries, no natural gas transmission or distribution. For that reason there have been no fugitive emissions from such activities in 1990-2009. However in 2010 a scotish company initiated a search for oil along the westcoast of Greenland. Three wells were drilled and tested in 2010. The oil company reported a total fugitive emission of 44 tonnes CO_2 equivalents from all three wells. This information has been recognised as the total fugitive emission of CH_4 from fuels, whereas the calculation of fugitive emission of CO_2 and N_2O has been based on IPCC Guideline emission factors, see Section 16.3.

Furthermore, some fugitive emission occurs in the distribution of fuel e.g. when refuelling from ships to on-shore tanks, onshore loading of fuel to ships and offshore loading of ships. The emission would only be in the form of NMVOC. The fugitive emission from loading/unloading of ships is currently not estimated.

Industrial processes

Mineral products

CO_2 emissions occur from limestone and dolomite use, road paving with asphalt and asphalt roofing. Import statistics of asphalt and limestone are used as activity data for estimating the emissions.

Chemical industry

Greenland has no chemical industry.

Metal production

Greenland has no metal production.

Other production

There are several manufacturers of fish products and one tannery. Emissions of NMVOC are estimated, but there are no emissions of greenhouse gases occurring.

F-gases

Greenland has no production of halocarbons or SF_6. Data on consumption of F-gases (HFCs and SF_6) are obtained from an annual survey on consumption of halocarbons and SF_6 conducted by Statistics Greenland. Information on emission of industrial gases is available from 1995 onwards. Greenland has no consumption of PFCs.

For further information on the methodology for calculating emissions from industrial processes please refer to Section 16.4.

Solvent and other product use

The emission estimates for solvent and other product use are prepared by using import statistics of pure chemicals that fits the criteria for being considered a NMVOC compound. Additionally import statistics are used for products containing NMVOC's. The NMVOC emission is then calculated in to a CO_2 emission by using a standard value for carbon content in the NMVOC's. For further information see Section 16.5.

Agriculture

Enteric Fermentation Manure Management

Agriculture is sparse in Greenland due to climatic conditions. However sheep and reindeer are considered to contribute to emission of greenhouse gases. Enteric fermentation and manure management is assumed to contribute to emission of CH_4, and nitrogen excretion is assumed to contribute to emission of N_2O.

The emissions are given in CRF: Table 4 Sectoral Report for Agriculture and Table 4.A, 4.B(a), 4.B(b) and 4.D Sectoral Background Data for Agriculture. The calculation of emissions from the agricultural sector is based on methods described in the IPCC Guidelines (IPCC, 1996) and the Good Practice Guidance (IPCC, 2000). Activity data for livestock is on a one year average basis from the agriculture statistics published by Statistics Greenland. Data concerning the land use and crop yield is obtained from the Agricultural Advisory Service.

Data concerning the feed consumption and nitrogen excretion from sheep is based on information from the Agricultural Advisory Service supplemented by data on imported feed. Data concerning the feed consumption and nitrogen excretion from reindeer is based on information from the Agricultural Advisory Service and information from an article on reindeer management in Greenland.

Emission of N_2O is closely related to the nitrogen balance. Thus, quite a lot of the activity data is related to the calculation of ammonia emission. National standards are used to estimate the amount of ammonia emission. When estimating the N_2O emission the IPCC standard value is used for all emission sources. The emission of CO_2 from Agricultural Soils is included in the LULUCF sector.

For a more thorough description of the methodology for the agricultural sector please refer to Section 16.6.

Land use, land-use change and forestry

Greenland is the world's largest non-continental island on the northern American continent between the Arctic Ocean and the North Atlantic Ocean, northeast of Canada. The northernmost point of Greenland, Cape

Morris Jesup, is only 740 km from then North Pole. The southernmost point is Cape Farewell, which lies at about the same latitude as Oslo in Norway. Greenland is covering app. 2,166,086 km^2. It has been estimated that 81 % is covered permanently with ice leaving only 410,449 km^2 ice free. The climate is Arctic to sub arctic with cool winters and cold summers. The capitol Nuuk is having an average temperature of 1.4°C.

Due to its cold climate is the LULUCF sector of minor importance in relation to the emission of green house gases. Only a very minor area is covered by forest of which the major part has been planted within the last 40 years. Cropland was introduced in year 2000 and grassland management within the last 30 years. The cold climate slows down the biological processes making all growth rates very low.

In total has the emission from the LULUC sector in 2010 been estimated to a net source of 1.42 Gg CO_2 equivalent or 0.2 % of the total Greenlandic emission.

Forest land

Greenland has a few forests, which may qualify to the FAO criteria of forest definitions. The major forest areas are:

A natural forest in the Qinngua valley of 45 ha consisting mainly of *Betula Pubescens ssp. czerepanovii* which in the period 1990 to 2009 has had an average height of six meters and app. 100 trees pr ha. It is thus assumed that it has had the same biomass for the whole period.

187 ha other planted forest. The largest of this is an arboretum (a research area) where different species and origins of trees are investigated which are adaptable to the harsh climate.

Cropland

In 1990 no annual crops were grown in Greenland. In 2009 6.5 ha of cropland was used for annual crops. The primary production is potatoes. Potato fields are mainly managed by hand and primarily fens with a high content of organic matter which is used for this purpose. It is thus assumed that the IPCC standard emission factor for boreal/cold areas of five tonnes C pr ha can be used although it is probably an overestimation due to the cold climate and the current management practice.

Grassland

In total is 242.000 hectare reported as grassland. The grassland is located in mountainous areas used for grazing of sheep. Due to the global warming are there some smaller areas which have become improved fertilised grassland. The total area with improved grassland has increased from 490 ha in 1990 to 1089 ha in 2009. In 2010 the area decreased to 1066 ha.

Wetlands

Reported area with wetlands consists only of water-reservoirs. Due to lack of methodology for methane emissions under arctic conditions has no emission estimates has been made which is in accordance with the IPCC GPG 2003 guidelines.

Settlements

The few settlements are mainly built on cliffs with very sparse vegetation. Hence it is assumed that no changes in C stock occur.

Other land
No emission estimates has been made since no data is available which is in accordance with IPCC GPG 2003 guidelines.

For a more thorough description of the methodology applied for LULUCF and KP-LULUCF please refer to Section 16.7 and 16.11.

Waste

Solid waste management
The solid waste management in Greenland can be divided in the following processes:

- Managed waste disposal combined with open burning.
- Unmanaged waste disposal combined with open burning.
- Waste incineration with energy recovery.
- Waste incineration without energy recovery.

Waste incineration with energy recovery is according to IPCC Guidelines included under the energy sector.

Information on amount of waste produced pr year, amount of waste treated in the different processes, distribution between household and commercial waste, composition of the household waste and commercial waste, respectively, are provided by the Ministry of Domestic Affairs, Nature and Environment.

Wastewater handling
N_2O emission from human sewage is estimated. The calculation of the N_2O emission uses population data from Statistics Greenland and an estimate for average protein consumption combined with default values from the IPCC Guidelines. No emissions of CH_4 are assumed to occur.

For more information please refer to Section 16.8.

Memo Items

International Aviation Bunkers
Emissions from international aviation bunkers are considered to be of neglible importance. The Greenland Airport Authority has reported the annual amount of jet fuel loaded into foreign aircrafts including Danish aircrafts. However, it is not possible to distinguish between Danish aircrafts and other aircrafts. Since most foreign aircrafts by far are Danish the annual amount of jet fuel loaded into foreign aircrafts are therefore included as part of the IPCC category 1A3a Civil aviation.

International Marine Bunkers
Emissions from international marine bunkers are included from 2004 and onwards. Before 2004 international marine bunkers are considered to be of negligible importance.

KP-LULUCF

Regarding the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, Greenland as part of the Kingdom of Denmark has included emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol. All land converted from other activities into Cropland and Grassland is accounted for. No land has been allowed to leave elected areas under art. 3.4, see Section 16.11 for further details.

16.1.4 Brief description of key categories

A key category analysis (KCA) for year 1990 and 2010 has been carried out in accordance with the IPCC Good Practice Guidance. This is the third KCA done for the Greenlandic inventory. The first KCA was accomplished in the Greenlandic 2010 inventory submission.

The categorisation used results in a total of 35 categories. In the level KCA for the inventory for 1990, 5 key categories were identified. For the KCA for 2010, 6 categories were identified as key categories due to both level and trend. Four further categories were key categories due to the trend.

Of the six key sources due to level for the reporting year 2010 four are in the energy sector, of which CO_2 from liquid fuels excluding transport in the analysis contributes most with 78.0 % of the national total (this contribution and the percentage contributions in the following are results from the level KCA based on the absolute values of the emissions; this contribution as percentages may differ somewhat from the percentage used in the sectoral chapters). The remaining level key categories in the energy sector are all CO_2 from the transport sector. Civil aviation, road transportation and domestic navigation comprise respectively 6.5 %, 4.8 % and 3.8 % of the national total. The last key categories are N_2O from wastewater handling and consumption of HFC's.

The trend assessment shows that consumption of HFCs, N_2O from waste water handling, CH_4 from enteric fermentation, CO_2 removal from grassland remaining grassland and CH_4 emission from waste incineration are key categories due to the trend.

The categorisation used, results, etc. are included in Section 16.12 (Annex 1).

16.1.5 Information on QA/QC plan including verification

A number of measures are in place to ensure the quality of the Greenlandic greenhouse gas inventory.

The general QC activities include:

- Check that data are correctly moved between data processing steps, e.g. it is ensured that the data are imported correctly from the emission spreadsheets/databases to the CRF Reporter.
- The time series are analysed. Any large fluctuations are investigated and explained/corrected.
- The recalculations are analysed and the consistency of the emission estimates are verified.

- The completeness of the inventory is checked utilising the completeness checker incorporated in the CRF Reporter as well as expert knowledge from the inventory compilers.
- All references are checked and it is ensured that the citations are correct.

These types of QC checks are recommended as tier 1 QC checks in the IPCC Good Practice Guidance (IPCC, 2000).

The Greenlandic emission inventory is reviewed by Danish emission experts, who provide input to the Greenlandic inventory compilers on necessary improvements etc. This is done as a QA procedure. When the emission estimates are transferred to DCE, the quality control system of the Danish emission inventory is applied to the Greenlandic data.

All information related to the Greenlandic emission estimates are documented and archived securely annually. This is done in order to ensure that any part of the inventory can be reproduced at a later stage if necessary.

In addition source specific QA/QC activities are conducted; please see the associated paragraphs in the sectoral chapters.

16.1.6 General uncertainty evaluation

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the following sectors are included in the current year: fuel combustion, fugitive emissions, industrial processes, solid waste, wastewater treatment and waste incineration, solvents and other product use, agriculture and LULUCF.

The uncertainties for the activity rates and emission factors are shown in Table 16.1.4. The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 16.1.3. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total Greenlandic GHG emission is estimated with an uncertainty of ± 5.6 % and the trend in GHG emission since 1990 has been estimated to be 8.7 % ± 3.1 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CO_2 from liquid fuels in fuel combustion, N_2O emission from waste water treatment and CH_4 emission from enteric fermentation are the largest sources of uncertainty for the Greenlandic GHG inventory. The result is skewed by the fact that more than 90 % of the Greenlandic Greenhouse gas emission is from fuel combustion of liquid fuels.

Table 16.1.3 Uncertainties 1990-2010.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	± 5.6	8.7	± 3.1
CO_2	± 5.3	8.4	± 3.0
CH_4	± 56	-5.5	± 8.8
N_2O	± 86	-6.6	± 28
F-gases	± 51	+10 785	± 4 798

Table 16.1.4 Uncertainty rates for each emission source.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
		Gg CO_2 eqv	Gg CO_2 eqv	%	%
1A Liquid fuels	CO_2	621	667	2	5
1A Municipal waste	CO_2	2	7	2	25
1A Liquid fuels	CH_4	1	1	2	100
1A Municipal waste	CH_4	0	0	2	100
1A Biomass	CH_4	0	0	2	100
1A Liquid fuels	N_2O	2	2	2	500
1A Municipal waste	N_2O	0	0	2	500
1A Biomass	N_2O	0	0	2	200
1B2 Oil Exploration	CO_2	0	0	2	1 000
1B2 Oil Exploration	CH_4	0	0	2	200
1B2 Oil Exploration	N_2O	0	0	2	1 000
2A3 Limestone and dolomite use	CO_2	0	0	5	5
2A5 Asphalt roofing	CO_2	0	0	5	25
2A6 Road paving with asphalt	CO_2	0	0	5	25
2F Consumption of HFC	HFC	0	7	10	50
2F Consumption of SF_6	SF_6	0	0	10	50
3A Paint application	CO_2	0	0	10	15
3B Degreasing and dry cleaning	CO_2	0	0	10	15
3C Chemical products, manufacturing and processing	CO_2	0	0	10	15
3D5 Other	CO_2	0	0	10	20
4A Enteric Fermentation	CH_4	6	6	10	100
4B Manure Management	CH_4	0	0	10	100
4B Manure Management	N_2O	1	1	10	100
4D1 Direct N_2O emissions from agricultural soils	N_2O	0	1	20	50
4D2 Pasture range and paddock	N_2O	1	1	20	25
4D3 Indirect N_2O emissions from agricultural soils	N_2O	1	1	20	50
5A Forest	CO_2	0	0	5	50
5B Cropland	CO_2	0	0	5	50
5C Grassland	CO_2	0	1	5	50
6A Solid Waste Disposal on Land	CH_4	4	4	10	100
6B Wastewater Handling	N_2O	15	12	30	100
6C Waste incineration	CO_2	3	3	10	25
6C Waste incineration	CH_4	2	2	10	50
6C Waste incineration	N_2O	1	1	10	100

16.1.7 General assessment of completeness

The present Greenlandic greenhouse gas emission inventory includes all major sources identified by the Revised IPCC Guidelines.

16.1.8 References

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16.2 Trends in Greenhouse Gas Emissions

16.2.1 Description and interpretation of emission trends for aggregated greenhouse gas emission

The GHG emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors; Energy incl. Transport, Industrial Processes, Solvent and Other Product Use, Agriculture, LULUCF, and Waste. In Figure 16.2.3 and Figure 16.2.4 CO_2 emissions from fuel combustion in the Energy Sector is split into several sub-categories i.e. Energy Industries, Manufacturing Industries and Construction, Commercial and Institutional, Transport, Residential, Agriculture and Fishing.

The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. However, Greenland has no consumption of PFC. In 2010 total emission of greenhouse gases excluding LULUCF was 715.37 Gg CO_2 equivalent, and 716.79 Gg CO_2 equivalent including LULUCF.

Figure 16.2.1 shows total greenhouse gas emission in CO_2 equivalents from 1990 to 2010. The emissions are not corrected for temperature variations. CO_2 is the most important greenhouse gas. In 2010 CO_2 contributed to the total emission in CO_2 equivalent excluding LULUCF (Land Use and Land-Use Change and Forestry) with 94.7 %, followed by N_2O with 2.7 %, CH_4 1.7 % and F-gases (HFCs and SF_6) with 0.9 %. Since 1990 these percentages have been increasing for F-gases, almost constant for CO_2 and falling for N_2O and CH_4.

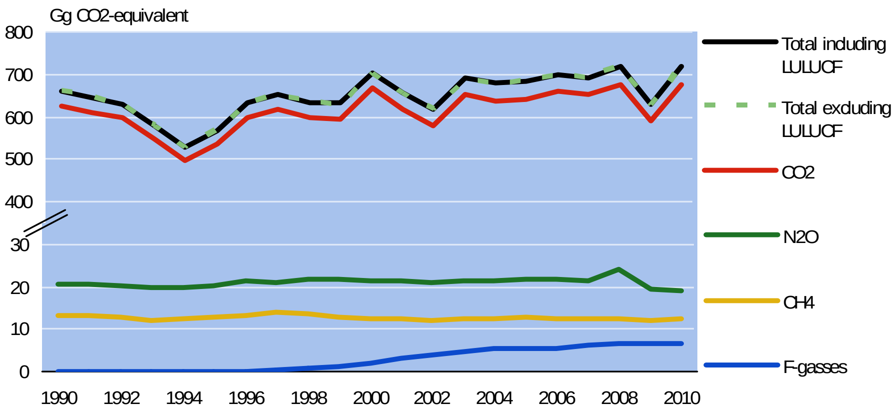


Figure 16.2.1 Greenhouse gas emission in CO_2 equivalents, time series 1990-2010.

Stationary combustion plants and transport represent the largest categories. Energy excluding transport contributed to the total emission in CO_2 equivalents excluding LULUCF with 79 % in 2010; see Figure 16.2.2. Transport contributed with 15 %. Industrial processes, solvent and other products use, agriculture and waste contributed to the total emission in CO_2 equivalents with 5 %.

The net CO_2 emission forestry etc. is 0.2 % of the total emission in CO_2 equivalents in 2010. The total GHG emission in CO_2 equivalents excluding LULUCF has increased by 8.5 % from 1990 to 2010 and increased 8.7% including LULUCF. Comments on the overall trends etc. seen in Figure 16.2.1 and Figure 16.2.2 are given in the sections below on the individual greenhouse gases.

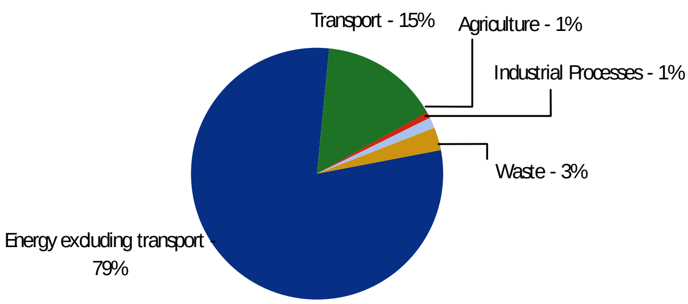


Figure 16.2.2 Greenhouse gas emission in CO_2 equivalents distributed on main sectors for 2010.

16.2.2 Description and interpretation of emission trends by gas

Carbon Dioxide

In Figure 16.2.3 and Figure 16.2.4 CO_2 emissions from fuel combustion in the Energy Sector is split into several sub-categories i.e. Energy Industries, Manufacturing Industries and Construction, Transport, Commercial and Institutional, Residential, Agriculture and Fishing.

The largest source to the emission of CO_2 is the energy sector. This sector includes combustion of fossil fuels like gas oil, gasoline, jet kerosene etc. From this sector Energy Industries (including oil exploration) contributes with 34 % making Energy Industries the largest contributor in 2010 followed by Agriculture and Fishing (AFF) and Residental each contributing with 17 % of the total CO_2 emission from fuel combustion in 2010. Emissions from Energy Industries have been reduced in later years due to massive investments in hydro power plants. However, in 2010 oil explorations were initiated along the west coast increasing fuel combustion and thus emissions in the Energy Industries to rise to the highest point ever.

Transport contributes with 16 % of the total CO_2 emission, Manufacturing Industries and Construction with 6 %, Commercial and Institutions with 9 %. And the category *Other* with 1 % of the emissions.

CO_2 emission - excluding LULUCF - increased by 13.6 % from 2009 to 2010. The main reason for this increase was a substantial increase in fuel combustion due to oil explorations in 2010. In 2010, the actual CO_2 emission was 8.5 % higher than the emission in 1990.

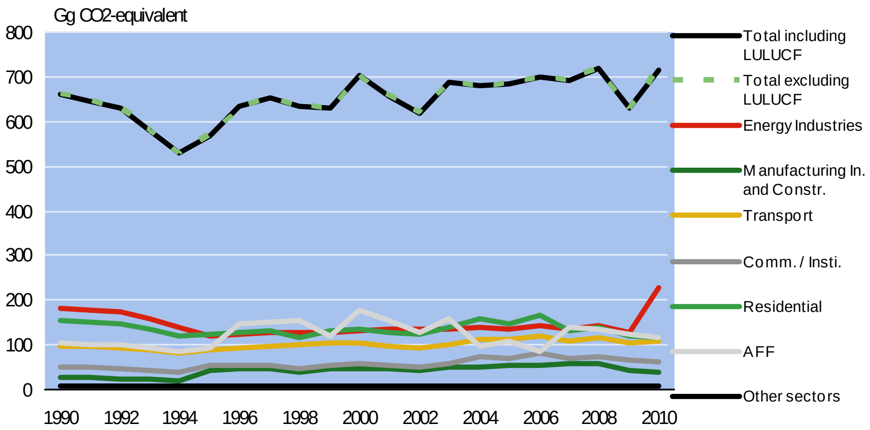


Figure 16.2.3 CO_2 emissions, time series for 1990-2010.

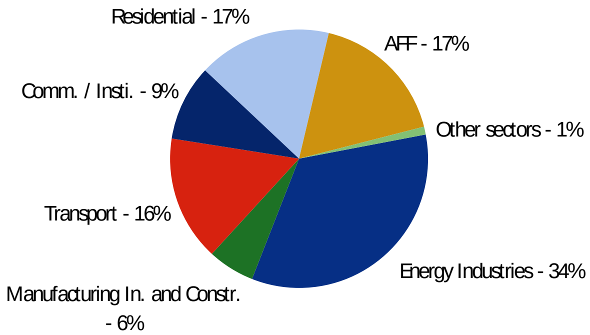


Figure 16.2.4 CO_2 emissions, distribution according to the main sectors for 2010.

Nitrous oxide

Waste, particularly waste water handling is the most important N_2O emission source in 2010 contributing 69 % to the total N_2O emissions, see Figure 16.2.6. Emission of N_2O from agricultural contributed 19 % to the total N_2O emissions in 2010. Fuel combustion including transport contributed 12 %. Since 1990 total emission of N_2O has decreased by 6.6 %.

The N_2O emission from agriculture decreased during the early nineties due to a decrease in reindeer livestock from 1990 to 1994. Since 1995 the emission of N_2O has increased and decreased for shorter periods depending on changes in the livestock and the use of fertiliser. In 2008, the actual N_2O emission was double the emission in 1990, see Figure 16.2.5. The cause of this was a significant increase in the use of fertilisers in 2008.

In 2009 and 2010 total N_2O emission was reduced by 18.4 % and 2.1 % due to a fall in the amount of waste water handling from industrial fishing plants and reduced use of synthetic fertilisers in agricultural activities, see Figure 16.2.5.

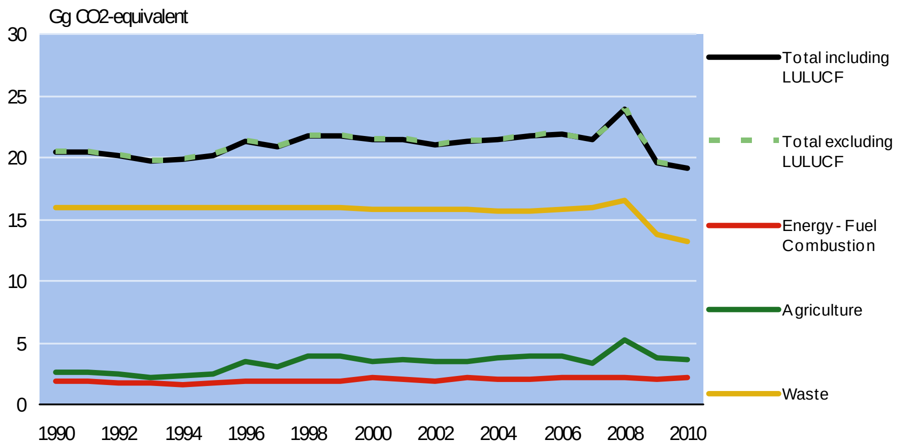


Figure 16.2.5 N_2O emissions, time series for 1990-2010.

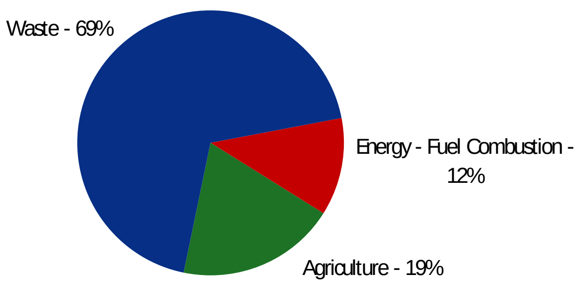


Figure 16.2.6 N_2O emissions, distribution according to the main sectors in 2010.

Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities contributing with 46 % of total CH_4 emission in 2010; see Figure 16.2.8. Waste handling contributes to 44 % of total emission and the energy sector to 10 % of total CH_4 emission in 2010. The emission from agriculture derives from enteric fermentation (98 %) and management of animal manure (2 %).

Since 1990 the overall number of sheep has increased, while the overall number of reindeer has decreased. From 1990 to 2010 the emission of CH_4 from agricultural activities has decreased by 8.1 %.

The emission of CH_4 from waste derives from solid waste disposal (71 %) and waste incineration (29 %). From 1990 to 2010 the emission of CH_4 from solid waste disposal has increased by 7.8 %, while emissions from waste incineration have decreased by 29.7 %. Overall emission of CH_4 from waste handling has decreased by 6.6 % from 1990 to 2010.

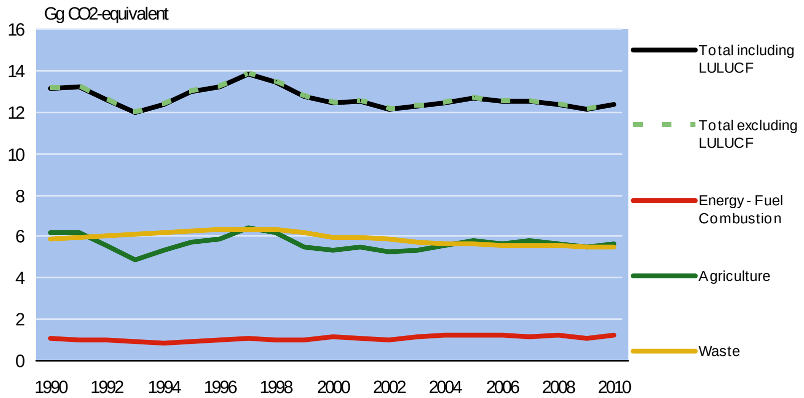


Figure 16.2.7 CH_4 emissions, time series for 1990-2010.

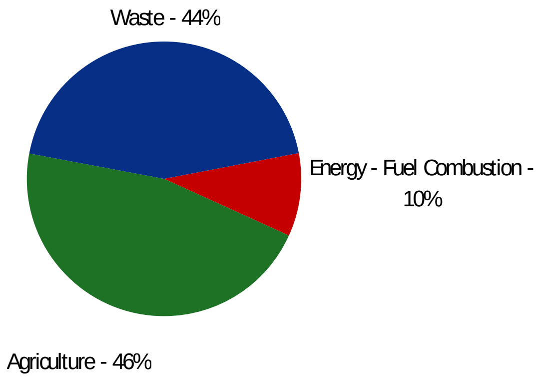


Figure 16.2.8 CH4 emissions, distribution according to the main sectors in 2010.

HFCs, PFCs and SF_6

This part of the Greenlandic inventory only comprises a full data set for HFCs and SF_6 from 1995. Greenland has no consumption that leads to emission of PFCs. From 1995 to 2010 there has been a continuous and substantial increase in the contribution from F-gases calculated as the sum of emissions in CO_2 equivalents, see Figure 16.2.9. This increase is caused by and simultaneous with an increase in the emission of HFCs. For the time series 2004-2010 the increase is lower than for the years 1995 to 2004. The increase from 1995 to 2004 is 8,892 %. From 2004 to 2010 total emission increased by 24.8 %. SF_6 contributed to the F-gas sum in 1995 with 59.4 %. Environmental awareness and regulation of this gas under Danish law has reduced its use considerably since 1995. In 2010 the contribution from SF_6 to the emission of F-gases was only 0.04 %.

The use of HFCs has increased to a great extent. Today HFCs are by far the dominant F-gas, comprising 40.6 % in 1995, but 99.96 % in 2010. HFCs are mainly used as a refrigerant.

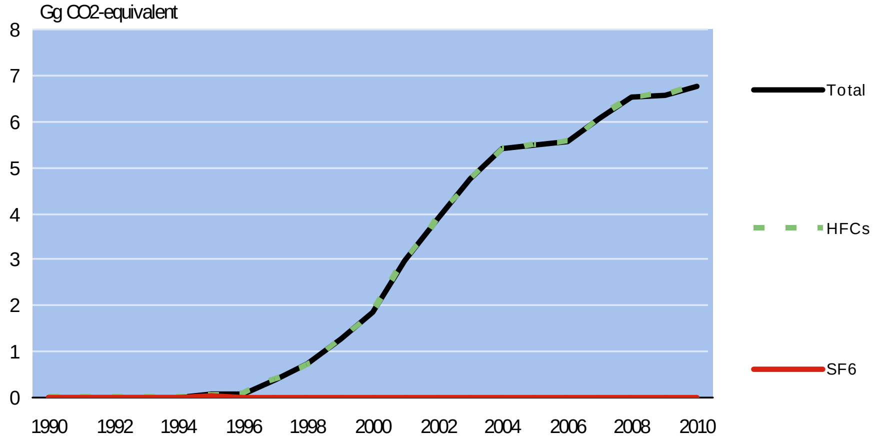


Figure 16.2.9 F-gas emissions, time series for 1990-2010.

16.2.3 Description and interpretation of emission trends by category

Energy

The emission of CO_2 from energy has increased by 8.2 % from 1990 to 2010. Emissions decreased from 1990 until 1994 due to the implementation of the first hydro power plant. However, since 1994 combustion of fuel increased continuously causing emissions to increase as well. The reason for this increase is primarily higher demand for transportation and heating. Combustion of fuel may decrease in certain years due to milder temperatures. In 2010 emissions increased significantly due to a significant increase in fuel conbustion due to the initation of oil exploration, which caused CO_2 emission from energy to rise by 14.6 % from 2009 to 2010. In 2012 four hydro power plants are currently operating and a fifth is under construction.

Emission of CH_4 has increased by 16.0 % from 1990 to 2010 primarily due to an increase in the use of fuel for transportation. The CH_4 emission from the transport sector has increased by 60.3 % from 1990 to 2010, mainly due to increasing domestic aviation.

Emission of N_2O has increased by 18.0 % from 1990 to 2010.

Industrial processes

Emissions from industrial processes (consumption of halocarbons and SF_6) other than fuel combustion amount to 0.9 % of the total emission in CO_2 equivalents excluding LULUCF in 2010. The main source is consumptions of HFCs. Emission of F-gases have increased considerable since 1990.

Agriculture

The agricultural sector contributes with 1.3 % of the total greenhouse gas emissions excluding LULUCF in 2010, 45.7 % of the total CH_4 emission and 19.3 % of the total N_2O emission. The total emission from the sector has increased by 6.5 % from 1990 to 2010. This increase is due to an increase in the use of fertilisers. The number of reindeer has decreased from 6,000 heads in 1990 to 3,000 heads in 2010. The number of sheep has increased from 19,929 heads in 1990 to 20,729 heads in 2010. The N_2O emission has increased by 40.9 % from 1990 to 2010 due to a significantly increase in the use of fertilisers, while the CH_4 emission decreased by 8.1 % during the same period.

LULUCF

Emissions from the LULUCF sector amount to just 0.2 % of the total emission in CO_2 equivalents in 2010. Forests are assumed to be a sink for the whole period increasing from approximately zero in 1990 to 37.1 tonnes CO_2 in 2010. The emission from cropland is estimated to zero in 1990 as there were no cropland in Greenland in 1990 and a net source in 2010 of 29.8 tonnes CO_2 pr year. The emission from grassland has been estimated to 179 tonnes CO_2 in 1990 increasing to 1,571 tonnes CO_2 in 2010.

Waste

The waste sector contributes with 3.0 % of the total greenhouse gas emissions in 2010, 44.5 % of the total CH_4 emission and 69.1 % of the total N_2O emission. The total emission from the sector has decreased by 10.6 % from 1990 to 2010. This decrease is caused by a decrease in the CH_4 emission from waste incineration by 29.7 %, and a decrease in N_2O emission from waste water handling by 16.6 %.

Total GHG emission from waste incineration without energy recovery has decreased by 6.7 % from 1990 to 2010 due to an increasing amount of waste incineration with energy recovery and a decrease in waste water handling from industrial fishing plants in 2010. Emission from incinerated waste used for heat production is included in the 1A1 IPCC category Energy Industries.

16.2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

NO_x

The largest sources to emission of NO_x are AFF (Agriculture, Forestry and Fisheries) followed by Transport and combustion in Energy Industries (public power and district heating plants). The AFF-sector is the most contributing sector to the emission of NO_x. In 2010, 46 % of the Greenlandic emission of NO_x came from AFF-related activities.

The emission of NO_x from AFF varies from year to year. In recent years emission of NO_x from AFF has been relatively stabile with a slightly decreasing tendency since 2000.

The emissions from transport obtain 27 % of total emissions in 2010. From 1990 to 2010 emission of NO_x from transport has decreased by 11.9 %. In the same period total emission of NO_x has increased by 10.3 %.

The emissions from energy industries obtain 15 % of total emission in 2010. The emission from energy industries have increased by 23.8 % from 1990 to 2010. The reduction is due to the increasing use of fossil fuel primarily in 2010 due to the initation of oil exploration.

Emission of NO_x from waste handling obtains 1 % of total emission, see Figure 16.2.10.

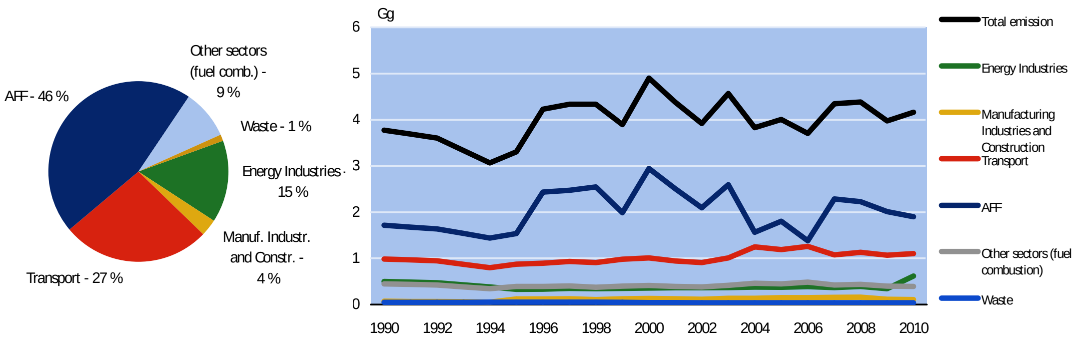


Figure 16.2.10 NO_x emissions. Distribution according to the main sectors (2010), and time series (1990-2010).

CO

Mobile sources like transport and AFF (agriculture, forestry and fisheries) contribute significantly to the total emission of this pollutant. Transport is the largest contributor to the total CO emission, see Figure 16.2.11.

Total CO emission has increased by 38.5 % from 1990 to 2010, largely due to increasing emissions from road transportation and civil aviation. Emissions from transport have more than doubled from 1990 to 2010.

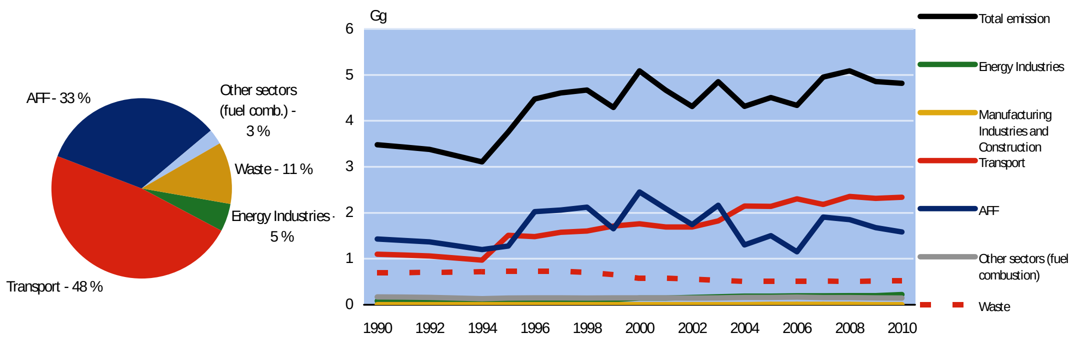


Figure 16.2.11 CO emissions. Distribution according to the main sectors (2010), and time series (1990-2010).

NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels fishing vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation and fishing vessels are the main contributors to this pollutant. Road transportation is included under transportation, which obtain 42 % of the total NMVOC emission in 2010. Fishing vessels are included under AFF (agriculture, forestry and fisheries), which obtain 28 % of total NMVOC emission in 2010, see Figure 16.2.12.

The evaporative emissions mainly originate from the use of solvents and the extraction, handling and storage of oil. Emissions from solvents and other product use have decreased by 21.8 % from 1990 to 2010.

The total anthropogenic emissions have increased by 20.2 % from 1990 to 2010, largely due to the increase in road transportation and AFF activities.

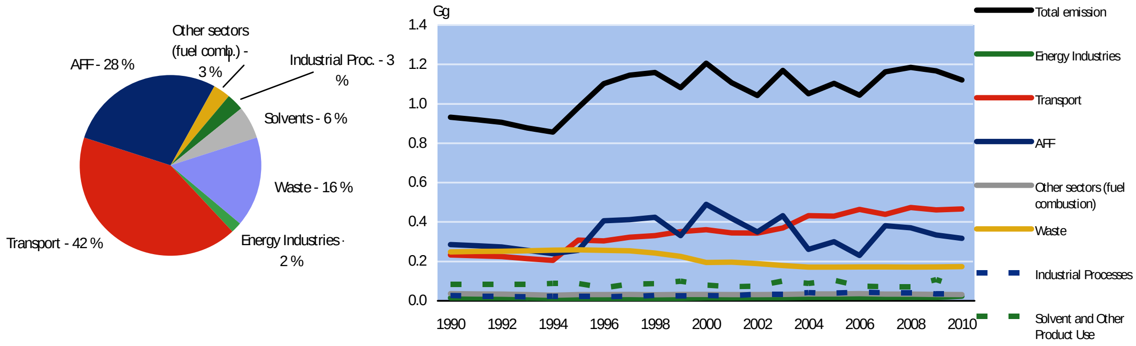


Figure 16.2.12 NMVOC emissions. Distribution according to the main sectors (2010), and time series (1990-2010).

SO_2

The main part of the SO_2 emission originates from the combustion of fossil fuels mainly gas oil in public power and district heating plants. From 1990 to 2010, total emission of SO_2 increased by 3.8 %.

Emissions from Energy Industries obtain 36 % of total SO_2 emission in 2010 followed by AFF (agriculture, forestry and fisheries) obtaining 17 % in 2010. Also emissions from other industrial combustion plants, non-industrial combustion plants and mobile sources are important. Transport contributed with 11 % of total SO_2 emission in 2010.

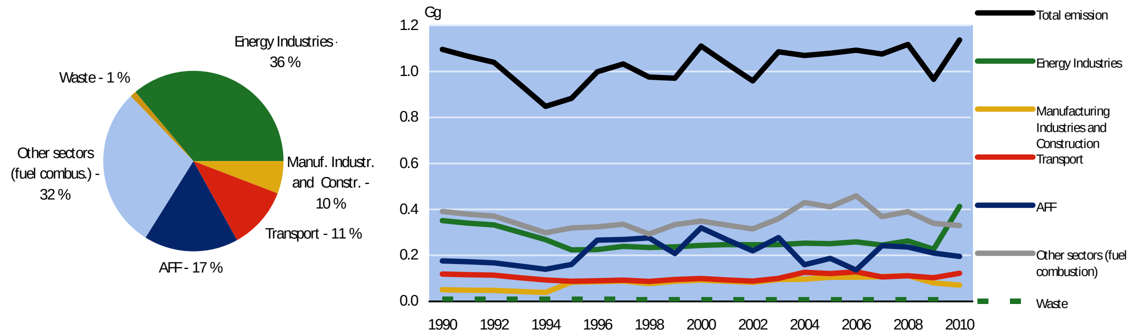


Figure 16.2.13 SO_2 emissions. Distribution according to the main sectors (2010), and time series (1990-2010).

16.3 Energy (CRF sector 1)

16.3.1 Overview of sector

The emission of greenhouse gases from energy activities includes CO_2, CH_4 and N_2O emission from fuel combustion. In 2010 fugitive emission of CO_2, CH_4 and N_2O occurred for the first time due to the initiation of well drilling and testing for oil and gas. The emissions are reported in CRF Tables 1.A(a), 1.A(b), 1.A(c), 1.A(d) and 1.B. Furthermore, the emission of non-methane volatile organic compounds (NMVOC), NO_X, CO and SO_2 from fuel combustion is given in CRF Table 1.

Summary tables for the energy sector are shown below.

Table 16.3.1 CO_2 emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
						Gg					
1 Energy	622.8	607.9	593.8	543.6	493.3	531.2	594.0	614.7	593.2	591.2	664.9
A Fuel Combustion (Sectoral Approach)	622.8	607.9	593.8	543.6	493.3	531.2	594.0	614.7	593.2	591.2	664.9
1 Energy Industries	183.1	177.8	173.6	157.1	140.6	121.2	122.1	129.0	127.0	129.1	132.6
2 Manufacturing Industries and Construction	26.4	25.6	25.0	22.5	20.1	43.8	44.5	46.2	40.0	45.9	48.2
3 Transport	95.9	95.4	93.4	87.0	80.6	88.4	92.3	96.3	100.6	104.0	105.4
4 Other Sectors	309.1	301.1	293.9	269.8	245.7	270.5	327.9	335.9	318.4	304.9	371.3
5 Other	8.2	8.0	7.8	7.0	6.3	7.3	7.3	7.3	7.3	7.3	7.3
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1 Energy	615.4	576.9	647.2	634.8	639.1	657.1	648.1	672.7	587.8	673.8	
A Fuel Combustion (Sectoral Approach)	615.4	576.9	647.2	634.8	639.1	657.1	648.1	672.7	587.8	673.8	
1 Energy Industries	133.8	134.4	135.0	138.5	137.1	142.3	135.1	143.9	126.0	226.4	
2 Manufacturing Industries and Construction	45.8	43.3	49.9	50.6	55.0	55.5	57.3	59.3	43.1	38.6	
3 Transport	95.7	92.0	100.9	113.0	111.6	120.3	109.6	116.4	105.2	107.8	
4 Other Sectors	332.9	299.9	354.1	325.5	328.1	331.7	338.9	345.8	306.3	293.7	
5 Other	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.02	

Table 16.3.2 CH_4 emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
						Gg					
1 Energy	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06
A Fuel Combustion (Sectoral Approach)	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06
1 Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Transport	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
4 Other Sectors	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.04
5 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1 Energy	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	
A Fuel Combustion (Sectoral Approach)	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	
1 Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3 Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
4 Other Sectors	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	
5 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.002	

Table 16.3.3 N_2O emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
						Gg					
1 Energy	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
A Fuel Combustion (Sectoral Approach)	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
1 Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1 Energy	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
A Fuel Combustion (Sectoral Approach)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
1 Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3 Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4 Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
B Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00	

16.3.2 Source category description

In this section emission source categories, fuel consumption data and emission data are presented.

Activity data on fuel consumption is based on annual statistics on energy published by Statistics Greenland, and information on waste incineration with energy recovery. The annual statistics on energy is divided into sectors according to the Greenlandic Business Register (GB2000). The register comprises 577 business categories. The official statistics on energy is published by aggregation into 34 categories.

In the Greenlandic emission database, all activity rates and emissions are based on the official statistics on energy. However, in order to fit the CRF format fuel consumption from the official statistics on energy is further aggregated into 15 sectors increased to 16 sectors in 2010 with the energy sebsector "Manufacture of Solid Fuels and Other Energy Industries" that contains emissions from oil exploration.

Fuel combustion

In 2010, total fuel combustion was 8,347 TJ of which 9.168 TJ was fossil fuels.

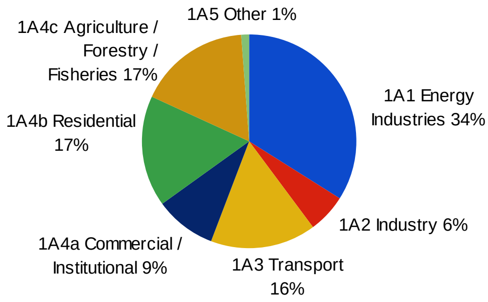
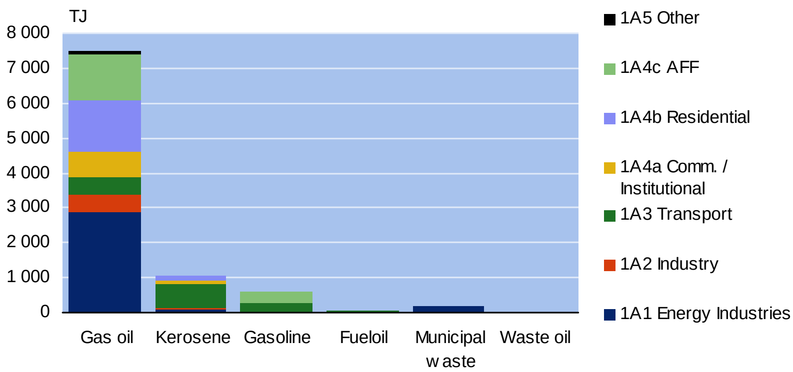


Figure 16.3.1 Fuel combustion rate, fossil fuels 2010 (Statistics Greenland).

In Greenland gas oil, kerosene and gasoline are used in fuel combustion. From 2010 fuel oil is also being imported and combusted in ships. Gas oil and kerosene are the most utilised fuels. Gas oil is used in power plants to produce electricity and heat, as well as in district heating, private households, industries and for transportation. In 2010 the combustion of gas oil increased significantly due to oil explorations.

Kerosene is primarily used in aviation, but also for heating in smaller settlements.



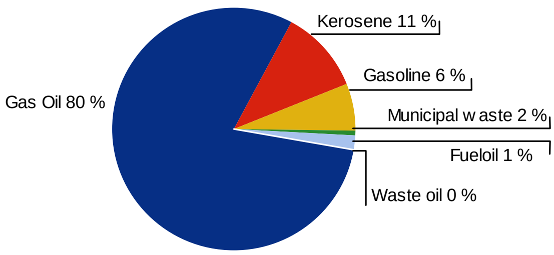


Figure 16.3.2 Fuel combustion, 2010 (Statistics Greenland).

Time series on fuel consumption are presented in Figure 16.3.3. Total fuel consumption has increased by 9.2 % from 1990 to 2010. Fossil fuel consumption has increased by 7.7 %. Consumption of renewable waste-energy has increased continuously with a total increase of almost 300 % from 1990 to 2010.

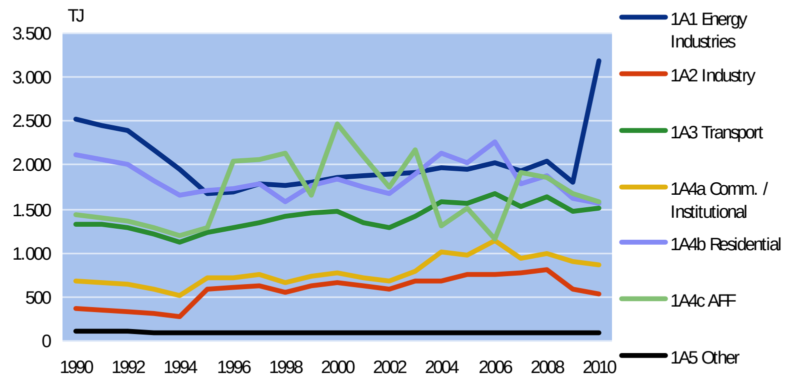
Fuel consumption is dominated by liquid fuels e.g. gas oil, kerosene and gasoline. In 2010 total fuel consumption consists of 98 % liquid fuels, 1 % solid fuels and 1 % biomass.

In 2010 Energy Industries accounted for 34 % of total fuel consumption. From 1990 to 1995 fuel consumption in Energy Industries decreased significantly due to the introduction of the first hydro power plant in 1993, and the introduction of burning waste to produce heat for district heating networks in 1989. Dependence on gas oil conversion decreased immediately. Nevertheless, from 1995 an onwards consumption of gas oil once again increased due to the general economic development. In 2007 fuel consumption in Energy Industries decreased due to a relatively warm winter. Contrary to this, the winter in 2008 was relatively colder, which increased fuel consumption to produce heat. In 2009 hydro power productions increased further when a fourth plant was opened. Together with a relatively warm 2009 winter fuel consumption in Energy Industries decreased additionally. In 2010 fuel consumption increased significantly due to oil explorations along the westcoast of Greenland.

Fuel consumption in Agriculture, Forestry and Fisheries accounted for 17 % of total fuel consumption in 2010. Fuel consumption in this sector has decreased since 2007. Before 2004, annual fuel combustion in this sector varied a great deal due to fluctuations in fishing activities from year to year. However, some uncertainty is expected in the 1990-2003 time series on fuel consumption in Agriculture, Forestry and Fisheries.

Residential fuel consumption accounted for 17 % of total fuel consumption in 2010. Fluctuations in fuel consumption are largely a result of variation in outdoor temperatures from year to year, which also causes fluctuations in fuel consumption in Energy Industries.

For 2004-2010 Statistics Greenland has conducted statistics on energy including detailed information on fuel consumption divided into 33 business categories and private households; see Section 16.3.3.1. Compared to the new statistics on energy the historic construction of time series on fuel consumption in 1990-2003 was based on a much simpler method. Some uncertainty is therefore to be expected in the 1990-2003 time series on sector-divided fuel consumption.



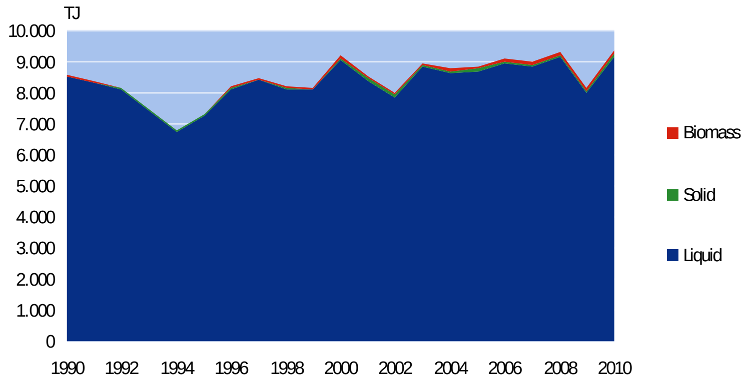


Figure 16.3.3 Fuel consumption time series 1990-2010 (Statistics Greenland).

Fugitive emissions from fuels

Greenland has no coal mines, no off-shore activities, no oil refineries, no natural gas transmission or distribution. For that reason there have been no fugitive emissions from such activities in 1990-2009. However in 2010 a scotish company initiated a search for oil along the westcoast of Greenland. Three wells were drilled and tested in 2010. The oil company reported a total fugitive emission of 44 tonnes CO_2 equivalents methan from all three wells. This information has been recognised as the total fugitive emission of CH_4 from fuels whereas the calculation of fugitive emission of CO_2 and N_2O has been based on IPCC Guideline emission factors (IPCC 2000 GPG, Table 2.16).

Furthermore, some fugitive emission occurs in the distribution of fuel e.g. when refuelling from ships to on-shore tanks, onshore loading of fuel to ships and offshore loading of ships. The emission would only be in the form of NMVOC. The fugitive emission from loading/unloading of ships is currently not estimated.

International bunker fuels

International Aviation Bunkers

Emissions from international aviation bunkers are considered to be of neglible importance. The Greenland Airport Authority has reported the annual amount of jet fuel loaded into foreign aircrafts including Danish aircrafts. However, it is not possible to distinguish between Danish aircrafts and other aircrafts. Since most foreign aircrafts by far are Danish the annual amount of jet fuel loaded into foreign aircrafts are therefore included as part of the IPCC category 1A3a Civil aviation.

International Marine Bunkers

Emission from international marine bunkers is included from 2004 and onwards. Before 2004 international marine bunkers are considered to be of neglible importance.

Feedstocks and non-energy use of fuels

At the moment Greenland has no production or use of feedstocks. Emissions from non-energy use of fuels (e.g. bitumen and solvents) are included in other sectors of the Greenlandic inventory (Industrial Processes (CRF sector 2) and Solvent and Other Product Use (CRF sector 3)).

16.3.3 Methodological issues

Activity data

The Greenlandic emission inventory for fuel combustion has been performed according to the IPCC tier 1 methodology. The inventory is based on activity data from the Greenlandic energy statistics and on emission factors for different fuels, plants and sectors.

Total fuel combustion is based on data from Polaroil, Statoil and Malik Supply A/S. Polaroil imports and distributes fuel in all parts of Greenland. Statoil imports and distributes fuel in Kangerlussuaq. Malik Supply A/S, a Danish company, re-distributes fuel bought from Polaroil to Greenlandic trawlers, ships etc. By using detailed data from Polaroil, Statoil and Malik Supply A/S it is possible to determine total import, total export, total international bunkers and total domestic fuel combustion.

Total domestic fuel combustion is then divided into sectors and private households by using data from a survey on energy consumption, company specific sales data from Polaroil and local fuel distributors, company tax accountings, municipal accountings and Greenland Government accountings, and by estimation.

In 2008, 2009, 2010 and 2011 Statistics Greenland conducted a survey among larger companies. By completing a questionnaire each company returned detailed information on the consumption of specific types of fuel in 2004-2010. The survey covered 62.9 % of total GHG emission from energy combustion in 2010, see Table 16.3.4.

By using detailed information on sales from Polaroil and local fuel distributors it is possible to determine fuel combustion in private companies and public offices with an automatic deal on supply. The sales data covers 9.5 % of total GHG emission from energy combustion in 2010, see Table 16.3.4.

Tax accountings in DKK are used to determine annual consumption of fuel in private companies, in municipalities, and within the Greenland Government. At the moment tax accountings are primarily used for determining fuel combustion in municipalities and public offices in settlements. Accountings cover 11.0 % of total GHG emission from energy combustion in 2010, see Table 16.3.4.

The remaining amount of total inland fuel combustion is divided into sectors and private households by estimation. This work is carried out by involving statistical material on population, housing, public finances, fisheries and hunting, and national accountings. The Greenlandic Business Register (GER) is used to divide remaining companies into sectors. Information on employees, operating units, vehicles etc. is used to determine the activity in each company.

Fuel combustion in private households is estimated using detailed information from a number of local fuel distributors. Fuel deliveries are registered by buildings. In Greenland each building has a unique number registered in the Greenlandic Area Register (NIN). By combining the NIN-register and the GER-register (see above) with statistics on housing and population each building is labelled *private household* or located to a sector describing the main activity in the building. This new building-sector register, completed annually, is used extensively to determine the buyer of fuel delivered by Polaroil or local fuel distributors.

Fuel combustion in road traffic is based on a model designed by Statistics Greenland. The model contains data on the vehicle stock obtained from the Greenland Police Department's register on engine data. The vehicles are divided into broad categories of type i.e. personal car, lorry, taxi, truck, ambulance, motorbike etc. Each category is assigned with ratios on fuel type and mileage. Input data on mileage is derived from a survey among businesses and private road traffic in 2008, 2009, 2010 and 2011. Each vehicle is divided in business categories or labelled *private vehicle* according to the owner. For each group the emissions are estimated by combining vehicle and annual mileage numbers with standard emission factors according to the type of fuel. The model does not take cold start or hot engines into account.

For air traffic annual emissions are based on activity data from Air Greenland A/S and sales data from the Greenland Airport Authority. For navigation, ferries and freight, annual emissions are based on activity data from Royal Arctic Line A/S (freight), Royal Arctic Tankers A/S (freight), Royal Arctic Bygdeservice A/S (freight/passengers), and Arctic Umiaq Line A/S (passengers) and the liquidated Assartuivik A/S (passengers).

Table 16.3.4 shows the part of total CO_2 emission divided into sources - survey, specific sales data, tax accountings, and estimation.

Table 16.3.4 CO_2 emission from fuel combustion by sources to sectoral division (2004-2010).

	2004	2005	2006	2007	2008	2009	2010
				pct.			
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Survey	49.7	49.4	49.1	50.4	50.5	53.5	62.9
Sales data from Polaroil	2.8	3.5	3.8	3.6	3.4	3.1	4.3
Sales data from local fuel distributors	0.0	0.0	3.3	5.2	6.6	6.6	5.2
Accountings	12.9	12.4	13.1	13.0	12.2	12.8	11.0
Estimation	34.6	34.8	30.8	27.8	27.2	24.1	16.7

The procedure described above is used to divide total fuel combustion into sectors and private households during the period 2004-2010. Formerly, the period 1990-2003, activity data on sectors and private households were estimated using aggregated statistics on population, housing, companies, data on sales from Polaroil, and data on energy consumption in larger companies.

An increasing part of municipal waste incineration is utilised for heat and power production. Thus, incineration with energy-recovery is included in the Energy sector.

Table 16.3.5 shows the activity data on fuel combustion for the period 1990-2010.

Table 16.3.5 Activity data on fuel combustion (SINK categories).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
						TJ					
Total	8 559	8 358	8 166	7 484	6 801	7 331	8 190	8 475	8 189	8 172	9 192
Energy industries	2 519	2 447	2 393	2 169	1 944	1 685	1 698	1 794	1 766	1 805	1 868
Manufacturing and construction	360	349	340	307	274	598	607	630	546	626	658
Domestic aviation	541	556	547	524	500	581	636	660	775	748	738
Road transport	501	488	476	437	397	370	369	387	361	401	417
National navigation	288	280	273	249	224	285	285	299	276	308	321
Commercial/Institutional	682	662	645	583	520	715	724	748	658	744	774
Residential	2 120	2 062	2 014	1 832	1 651	1 710	1 731	1 787	1 576	1 777	1 851
AFF	1 436	1 405	1 372	1 288	1 205	1 287	2 039	2 070	2 134	1 663	2 465
Other	112	109	106	96	86	99	99	99	99	99	99
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Total	8 514	7 995	8 964	8 799	8 858	9 112	8 991	9 330	8 171	9 347	
Energy industries	1 885	1 900	1 915	1 969	1 951	2 024	1 927	2 049	1 806	3 179	
Manufacturing and construction	624	590	680	691	750	758	782	809	588	528	
Domestic aviation	632	603	646	608	633	691	701	753	635	654	
Road transport	399	388	433	507	507	570	501	534	490	477	
National navigation	308	298	334	462	419	420	334	347	350	378	
Commercial/Institutional	716	690	787	1 009	968	1 135	940	999	899	869	
Residential	1 748	1 670	1 895	2 142	2 020	2 258	1 793	1 878	1 619	1 568	
AFF	2 101	1 755	2 174	1 311	1 510	1 156	1 913	1 863	1 684	1 593	
Other	99	99	99	99	99	99	99	99	99	99	

Sources: Statistics Greenland. Notes: Data on fuel combustion in 1993 are interpolated from 1992 and 1994, since no data is available for 1993.

Emission factors

For each fuel and source category a set of general area source emission factors has been determined. The emission factors are either nationally referenced or based on the IPCC Reference Manual (IPCC, 1997).

CO_2

The CO_2 emission factors applied are presented in Table 16.3.6. For municipal waste and all other fuels the same emission factor is applied for 1990-2010.

In reporting to the Climate Convention, the CO_2 emission is aggregated to three fuel types: Liquid fuel, Biomass and Other fuel.

The CO_2 emission from incineration of municipal waste with energy-recovery (75.1 + 37.0 kg pr GJ) is divided into two parts: the emission from combustion of the plastic content of waste (which is included in the Greenlandic total) and the emission from combustion of the rest of the waste – the biomass part (which is reported as a memo item). In the IPCC reporting, the fossil part of the waste and the associated emissions from fuel combustion of the plastic content of the waste is reported in the fuel category, *Other fuels*. The emission factors on municipal waste have been revised in this 2011 inventory submission. Greenland uses the Danish emission factors on municipal waste, which have been revised recently due to new information.

Table 16.3.6 CO_2 emission factors 1990-2010.

Fuel	Emission factor	Unit	Reference type	IPCC fuel Category
Gas oil	73.326	kg pr GJ	IPCC reference manual	Liquid
Kerosene	71.148	kg pr GJ	IPCC reference manual	Liquid
Jet-Kerosene	70.785	kg pr GJ	IPCC reference manual	Liquid
Gasoline	68.607	kg pr GJ	IPCC reference manual	Liquid
Fueloil	76.593	kg pr GJ	IPCC reference manual	Liquid
Waste oil	76.593	kg pr GJ	IPCC reference manual	Liquid
Municipal waste – biomass	75.100	kg pr GJ	Country specific	Biomass
Municipal waste – fossil fuel	37.000	kg pr GJ	Country specific	Other fuels

The CO_2 emission has been calculated by using the same methodology as described in the IPCC Guidelines (IPCC, 1997). This methodology implies use of C content pr fuel type (default) and fraction of carbon oxidised (default); see the equation below.

$$E_{CO_2} = \sum Act_a \times EF_{C,a} \times Ox \times 44/12$$

where:

Act_a = activity; consumption of fuel a

$EF_{C,a}$ = C emission factor for fuel a

Ox = oxidation factor

The emissions of CH_4, N_2O, NO_X, CO and NMVOC have been calculated at sector/fuel level by using IPCC default emission factors combined with measured/Danish EF waste incineration (with energy recovery), se Table 16.3.7 – Table 16.3.9 below.

The equation applied for each pollutant is:

$$E = \sum (EF_{ab} \times Act_{ab})$$

where:

EF = emission factor

Act = activity; fuel input

a = fuel type

b = sector activity

CH_4

The CH_4 emission factors applied for 1990-2010 are presented in Table 16.3.7. Emission factors for municipal waste refer to emission measurements carried out in Danish plants (Nielsen et al., 2010). Other emission factors refer to the IPCC Guidelines (IPCC, 1997).

Table 16.3.7 CH_4 emission factors 1990-2010.

Fuel group	Fuel	CRF sector		Emission factor g pr GJ	Reference
Liquid	Gas oil	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	5	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Kerosene	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	20	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Gasoline	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	20	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Fueloil	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	5	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Waste oil	1A1	Energy Industries	3	IPCC, 1997
Biomass	Municipal waste	1A1	Energy Industries	30	Nielsen et al., 2010
Other fuel	Municipal waste	1A1	Energy Industries	30	Nielsen et al., 2010

N_2O

The N_2O emission factors applied for 1990-2010 are presented in Table 16.3.8. Emission factors for municipal waste refer to emission measurements carried out in Danish plants (Nielsen et al., 2010). Other emission factors refer to the IPCC Guidelines (IPCC, 1997).

Table 16.3.8 N_2O emission factors 1990-2010.

Fuel group	Fuel	CRF sector		Emission factor g pr GJ	Reference
Liquid	Gas oil	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Kerosene	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Gasoline	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Fueloil	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Waste oil	1A1	Energy Industries	0.6	IPCC, 1997
Biomass	Municipal waste	1A1	Energy Industries	4	Nielsen et al., 2010
Other fuel	Municipal waste	1A1	Energy Industries	4	Nielsen et al., 2010

SO_2, NO_X, NMVOC and CO

Emission factors for SO_2, NO_X, NMVOC and CO are listed in Table 16.3.9. The same emission factors have been applied in the period 1990-2010.

Table 16.3.9 SO_2, NO_X, NMVOC and CO emission factors 1990-2010 (g pr GJ).

Fuel group	Fuel	CRF sector		NO_X	CO	NMVOC	SO_2	Reference
Liquid	Gas oil	1A1	Energy Industries	200	15	5	141	1
		1A2	Manufacturing Industries and Constructions	200	10	5	141	1
		1A3a	Transport – Civil aviation	300	100	50	141	1
		1A3b	Transport – Road transportation	800	1 000	200	141	1
		1A3d	Transport – Navigation	1 500	1 000	200	141	1
		1A4a,b	Other sectors	100	20	5	141	1
		1A4c	Other sectors – AFF stationary	100	20	5	141	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	141	1
		1A5b	Other – Military mobile	1 500	1 000	200	141	1
	Kerosene	1A1	Energy Industries	200	15	5	23	1
		1A2	Manufacturing Industries and Constructions	200	10	5	23	1
		1A3a	Transport – Civil aviation	300	100	50	23	1
		1A3b	Transport – Road transportation	600	8 000	1 500	23	1
		1A3d	Transport – Navigation	1 500	1 000	200	23	1
		1A4a,b	Other sectors	100	20	5	23	1
		1A4c	Other sectors – AFF stationary	100	20	5	23	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	23	1
		1A5b	Other – Military mobile	1 500	1 000	200	23	1
	Gasoline	1A1	Energy Industries	200	15	5	46	1
		1A2	Manufacturing Industries and Constructions	200	10	5	46	1
		1A3a	Transport – Civil aviation	300	100	50	46	1
		1A3b	Transport – Road transportation	600	8 000	1 500	46	1
		1A3d	Transport – Navigation	1 500	1 000	200	46	1
		1A4a,b	Other sectors	100	20	5	46	1
		1A4c	Other sectors – AFF stationary	100	20	5	46	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	46	1
		1A5b	Other – Military mobile	1 500	1 000	200	46	1
	Fueloil	1A1	Energy Industries	200	15	5	492	1
		1A2	Manufacturing Industries and Constructions	200	10	5	492	1
		1A3a	Transport – Civil aviation	300	100	50	492	1
		1A3b	Transport – Road transportation	600	8 000	1 500	492	1
		1A3d	Transport – Navigation	1 500	1 000	200	492	1
		1A4a,b	Other sectors	100	20	5	492	1
		1A4c	Other sectors – AFF stationary	100	20	5	492	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	492	1
		1A5b	Other – Military mobile	1 500	1 000	200	492	1
	Waste oil	1A1	Energy Industries	200	15	5	477	1
Biomass	Municipal waste	1A1	Energy Industries	100	1 000	50	6	2
Other fuel	Municipal waste	1A1	Energy Industries	100	1 000	50	6	2

Sources: 1) IPCC Guidelines (IPCC, 1997). 2) Nielsen et al., 2010.

16.3.4 Emissions

The greenhouse gas (GHG) emissions are listed in Table 16.3.10. The total emission of greenhouse gases from energy (fuel combustion and fugitive emissions) accounts for 94.5 % of total Greenlandic GHG emission in 2010.

The CO_2 emission from energy accounts for 99.5 % of the Greenlandic CO_2 emission (excluding net CO_2 emission from Land Use, Land Use Change and Forestry (LULUCF). The CH_4 emission from fuel combustion (Sectoral Approach) accounts for 9.8 % of the Greenlandic emission and the N_2O emission from fuel combustion accounts for 11.6 % of the Greenlandic N_2O emission.

Table 16.3.10 Greenhouse gas emission for the year 2010.

		CO_2	CH_4	N_2O
		Gg CO_2 equivalent		
1A1	Fuel consumption, Energy Industries	226.4	0.3	0.8
1A2	Fuel consumption, Manufacturing Industries and Construction	38.6	0.0	0.1
1A3	Fuel consumption, Transport	107.8	0.2	0.6
1A4	Fuel consumption, Other sectors	300.9	0.7	0.8
1B2	Fugitive emissions from fuel, Oil and natural gas	0.0	0.0	0.0
Total emission from energy		673.8	1.2	2.2
Greenlandic emission (excluding net emission from LULUCF)		677.1	12.4	19.1
			%	
Emission share for energy		99.5	9.8	11.6

CO_2 is the most important GHG pollutant and accounts for 99.5 % of the GHG emission in CO_2 equivalents from energy, see Figure 16.3.4.

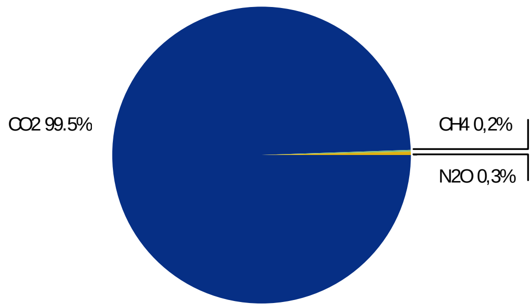


Figure 16.3.4 GHG emissions (CO_2 equivalent) from stationary combustion plants.

Figure 16.3.5 depicts the time series of GHG emission in CO_2 equivalents from energy. As shown by the blue curve the development in total GHG emission follows the CO_2 emission development very closely. Both CO_2 and total GHG emission are 8 % higher in 2010 compared to 1990.

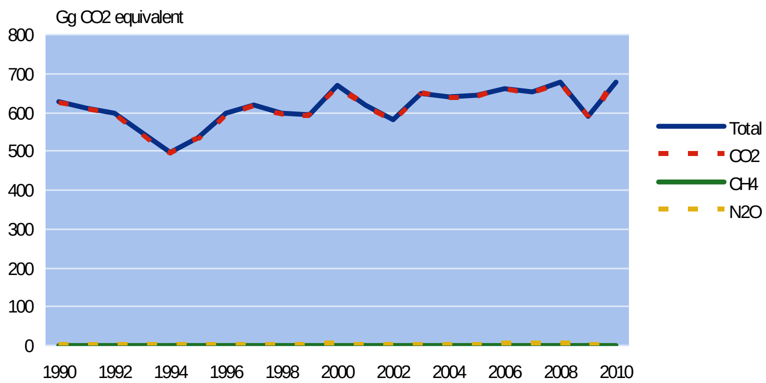


Figure 16.3.5 GHG emission time series for energy.

From 1990 to 1994 total GHG emission was reduced by 21 %. This was primarily due to the introduction of the first hydropower plant in 1993 but also to the introduction of burning waste to produce heat for district heating network in 1989. Dependence on gas oil conversion decreased immediately. Nevertheless, from 1995 an onwards consumption of gas oil once again increased due to the general economic development

In 2001-2002 total GHG emission decreased due to a minor recession in the economy. However since 1994 GHG emissions have increased in general with some fluctuations from year to year. The fluctuations are largely a result of outdoor temperature variations from year to year i.e. in 2008 the winter was relatively colder than in 2007. As a result fuel consumption increased in 2008 increasing GHG emission from fuel combustion. In 2009 GHG emission decreased by 13 % due to a significantly substitution in Energy Industries from fuel consumption to hydro power production together with a relatively warmer winter. However, in 2010 GHG emission increased by 15 % due to the initiation of oil exploration.

CO_2

Stationary combustion plants are amnong the most important GHG emission sources to CO_2 emission from energy. In 2010 CO_2 emissions from stationary combustion plants accounted for 15.8 % of the total CO_2 emissions. Energy Industries which also covers manufacture of solid fuels and other energy industries i.e. oil exploration acounted for 33.6 % of the total Greenlandic CO_2 emission from energy in 2010, see Table 16.3.11.

Table 16.3.11 lists CO_2 emission for energy in 2010 as well as the relative percentage for each category under the sectoral approach. The table reveals that Energy Industries accounts for 33.6 % of the CO_2 emission. Other large CO_2 emission sources are Transportation, Residential plants and activities regarding Agriculture, Forestry and Fisheries (AFF). These are sectors, which also account for a considerable share of fuel consumption.

Table 16.3.11 CO_2 emission from energy 2010.

		2010	
		Gg	%
1A1	Energy Industries	226.4	33.6
1A2	Manufacturing Industries	38.6	5.7
1A3	Transport	107.8	16.0
1A4a	Commercial / Institutional	63.5	9.4
1A4b	Residential	114.8	17.0
1A4c	Agriculture / Forestry / Fisheries	115.4	17.1
1A5	Other	7.3	1.1
1B2	Fugitive emissions from fuel, oil and natural gas	0.0	0.0
Total		673.8	100.0

The CO_2 emission from combustion of biomass fuels is not included in the total CO_2 emission data, since biomass fuels are considered CO_2 neutral. The CO_2 emission from biomass combustion is reported as a memo item in the Climate Convention reporting. In 2010, the CO_2 emission from biomass combustion was 13.5 Gg.

Time series for CO_2 emissions are provided in Figure 16.3.6. Fluctuations in CO_2 emission from AFF primarily regard fluctuations in fishing activities from year to year. Fluctuations in CO_2 emission from residential plants are largely a result of outdoor temperature variations from year to year. This also causes fluctuations in CO_2 emission from Energy Industries which cover electricity and heat production. However, the significant increase in emission from Energy Industries in 2010 is caused by the initiation of oil exploration in 2010, which is reported in the subsector "Manufacture of Solid Fuels and Other Energy Industries.

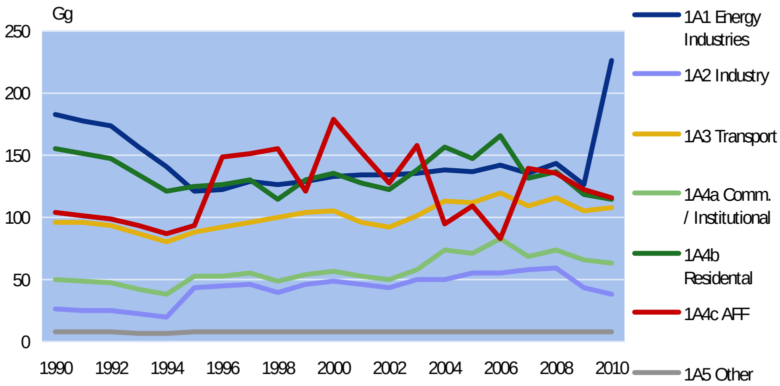


Figure 16.3.6 CO_2 emission time series for fuel combustion (Sectoral Approach).

Detailed trend discussion on CRF category level is available in Section 16.2.

CH_4

CH_4 emission from energy accounts for 9.8 % of the Greenlandic CH_4 emission. Table 16.3.12 lists the CH_4 emission inventory for energy in 2010. The table reveals that Energy Industries accounted for 24.8 % of the CH_4 emission from energy in 2010. Residential plants accounted for 27 % of the emission in 2010.

Table 16.3.12 CH_4 emission from fuel combustion 2010.

		2010	
		Mg	%
1A1	Energy Industries	14.4	24.8
1A2	Industry	1.1	1.8
1A3	Transport	7.6	13.2
1A4a	Commercial / Institutional	8.7	15.0
1A4b	Residential	15.7	27.0
1A4c	Agriculture / Forestry / Fisheries	8.0	13.8
1A5	Other	0.5	0.9
1B2	Fugitive emissions from fuel, Oil and natural gas	2.1	3.6
Total		58.0	100.0

The CH_4 emission from energy has increased by 16 % since 1990. Time series for CH_4 emissions are provided in Figure 16.3.7. Fluctuations in CH_4 emission from AFF primarily regard fluctuations in fishing activities from year to year. Fluctuations in CH_4 emission from residential plants are largely a result of outdoor temperature variations from year to year. This also causes fluctuations in CH_4 emission from Energy Industries, which cover electricity and heat production and manufacture of solid fuels and other Energy Industries. The increase of CH_4 emission in 2010 was caused by the initation of activities concerning oil exploration.

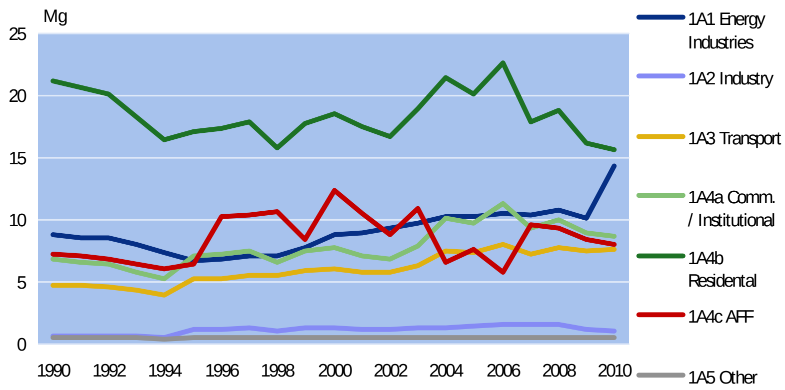


Figure 16.3.7 CH_4 emission time series for energy.

Detailed trend discussion on CRF category level is available in Section 16.2.

N_2O

The N_2O emission from energy accounts for 11.6 % of the Greenlandic N_2O emission. Table 16.3.13 lists the N_2O emission inventory for energy in 2010. The table reveals that Energy Industries accounted for 35.3 % of the N_2O emission from energy. Transport accounted for 25.5 % of the emissions in 2010.

Table 16.3.13 N_2O emission from energy 2010.

		2010	
		Mg	%
1A1	Energy Industries	2.5	35.3
1A2	Industry	0.3	4.4
1A3	Transport	1.8	25.5
1A4a	Commercial / Institutional	0.5	7.3
1A4b	Residential	0.9	13.2
1A4c	Agriculture / Forestry / Fisheries	1.0	13.4
1A5	Other	0.1	0.8
1B2	Fugitive emissions from fuel, Oil and natural gas	0.0	0.0
Total		7.1	100.0

Figure 16.3.8 shows the time series for the N_2O emission from energy. The N_2O emission has increased by 18 % from 1990 to 2010. Once again, the 2010 increase in N_2O emission from Energy Industries is predominantly caused by the startup of oil explorative activities.

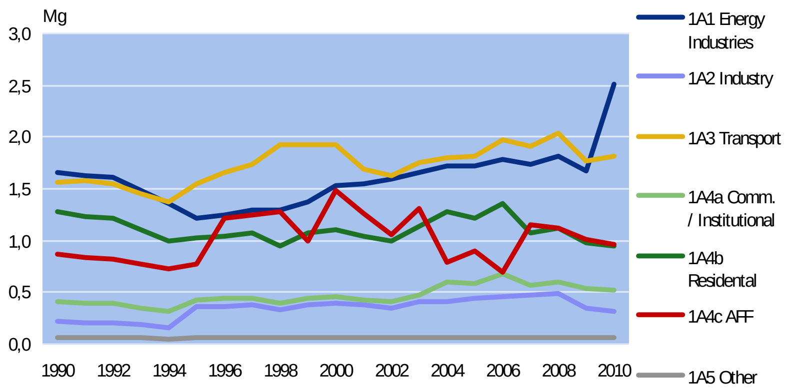


Figure 16.3.8 N_2O emission time series for energy.

Detailed trend discussion on CRF category level is available in Section 16.2.

SO_2, NO_X, NMVOC and CO

The emissions of SO_2, NO_X, NMVOC and CO from energy in 2010 are presented in Table 16.3.14. SO_2 from energy accounts for 99.5 % of the Greenlandic SO_2 emission. NO_X, CO and NMVOC account for 99.1, 89.2 % and 75.2 % respectively, of the Greenlandic emissions for these substances.

Table 16.3.14 SO_2, NO_X, NMVOC and CO emission from energy 2010.

	NO_X	CO	NMVOC	SO_2
	Gg	Gg	Gg	Gg
1A1 Fuel consumption, Energy Industries	0.6	0.2	0.0	0.4
1A2 Fuel consumption, Manuf. Industries and Constr.	0.1	0.0	0.0	0.1
1A3 Fuel consumption, Transport	1.1	2.3	0.5	0.1
1A4 Fuel consumption, Other sectors	2.3	1.7	0.3	0.5
1B2 Fugitive emissions from fuel, Oil and natura gas	NO	NO	NE	NO
Total emission from fuel consumption and fugitive emissions from fuel	4.1	4.3	0.8	1.1
Greenlandic emission	4.2	4.8	1.1	1.1
		%		
Emission share for fuel consumption	99.1	89.2	75.2	99.5

16.3.5 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for the energy sector. The uncertainties for the activity data and emission factors are shown in Table 16.3.15.

Table 16.3.15 Uncertainties for activity data and emission factors for the energy sector.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
1A Liquid fuels	CO_2	2	5
1A Municipal waste	CO_2	2	25
1B2 Oil exploration	CO_2	2	1 000
1A Liquid fuels	CH_4	2	100
1A Municipal waste	CH_4	2	100
1A Biomass	CH_4	2	100
1B2 Oil exploration	CH_4	2	200
1A Liquid fuels	N_2O	2	500
1A Municipal waste	N_2O	2	500
1A Biomass	N_2O	2	200
1B2 Oil exploration	N_2O	2	1 000

The activity data comes from the official Greenlandic energy statistics, which is considered to be of high quality, therefore the uncertainty of the activity data have been set to 2 %.

Regarding the emission factor uncertainty, the CO_2 emission factors are considered the most certain, and for liquid fuels an emission factor uncertainty of 5 % has been assumed. To account for the more inhomogeneous nature of municipal waste the emission factor uncertainty has been set to 25 %. For CH_4 the emission factor uncertainty has been set to 100 % in accordance with the IPCC GPG (IPCC, 2000). For N_2O the emission factor uncertainties have been estimated to between 200 % and 500 %. This is based on a first estimate and can be improved upon in the future.

Regarding fugitive emissions from oil exploration emission factor uncertainty has been set to 1,000 % for CO_2 and N_2O. Fugitive emission of CO_2 and N_2O is calculated based on standard IPCC emission factors for drilling and testing. The emission factor uncertainty for CH_4 has been set to 200 %. The amount of fugitive emission of CH_4 is obtained directly from the scotish oil company and the uncertainty concerning CH_4 is therefore considered to be mush lower than for CO_2 and N_2O.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 16.3.16.

Table 16.3.16 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2010 %	Trend uncertainty %
GHG	5.5	8.2	±3.0
CO_2	5.3	8.2	±3.0
CH_4	88	16.0	±15.6
N_2O	450	18.0	±46

16.3.6 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, the official Greenland energy statistics has gone through a great deal of quality work with regard to accuracy, comparability and completeness. Statistics Greenland is responsible for the official Greenlandic energy statistics, and as such responsible for the completeness of data. The uncertainties connected with estimating fuel consumption do not influence the coherence between the energy statistics and the datasets used in the emission inventory submission. For the remainder of the datasets, it is assumed that the level of uncertainty is relatively small. See chapter regarding uncertainties for further comments.

Statistics on fuel consumption is reported by Statistics Greenland in form of a spreadsheet. Annual consumption of gas oil, kerosene and gasoline are divided into business categories and private households. To ensure consistency data are compared with those from previous years and large discrepancies are checked.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this is to be elaborated.

Time series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked of the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time series imported to the CRF Reporter is checked for fuel rate, units for fuel rate, emission factor and plant-specific emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

Reference approach

In addition to the sector-specific CO_2 emission inventories (the Greenlandic approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the Greenlandic approach.

Data for import, export and stock change used in the reference approach originate from the annual "basic data" table prepared by Statistics

Greenland. The fraction of carbon oxidised has been assumed to be 1.00. The carbon emission factors are default factors originating from the IPCC Reference Manual (IPCC, 1997). The country-specific emission factors are not used in the reference approach, the approach being for the purposes of verification.

The Climate Convention reporting tables include a comparison of the Greenlandic approach and the reference approach estimates. To make results comparable, the CO_2 emission from incineration of the plastic content of municipal waste is added in the reference approach while the fuel consumption is subtracted.

In 2010 the fuel consumption rates in the two approaches differ by 0.0 % and the CO_2 emission differs by 1 %. In the period 1990-2009 both the fuel consumption and the CO_2 emission differ by 1 % or less at all times. The differences in energy consumption are below 1 % for all years. The difference in CO_2 emission is 1 % from 1990 to 1999, and below 1 % since 2000. According to IPCC Good Practice Guidance (IPCC, 2000) the difference should be within 2 %. A comparison of the Greenlandic approach and the reference approach is illustrated in Figure 16.3.9.

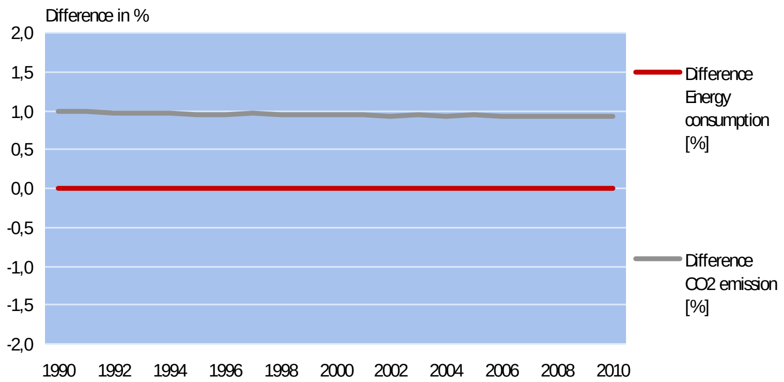


Figure 16.3.9 Comparison of the reference approach and the national approach.

16.3.7 Source specific recalculations and improvements

Improvements and recalculations since the 2011 emission inventory submission include:

- Update of fuel rates according to the latest energy statistics. The update includes the years 2004-2009.
- Adjustment of bulk density on fossil fuels aconding to specifications from Polaroil on annualy imports. The adjustments include the years 1990-2009.
- Adjustment of municipal waste with energy recovery according to improvements in population statistics, which is used in the estimation of municipal waste.

Table 6.3.17 shows recalculations in the energy sector compared with the 2011 submission.

Table 16.3.17 Changes in GHG emission in the energy sector compared with the 2011 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Previous inventory, Gg CO_2 eqv.	625.2	610.3	596.1	545.8	495.3	533.5	596.6	617.4	595.9	593.8	667.6
Recalculated, Gg CO_2 eqv.	625.7	610.8	596.6	546.2	495.7	533.9	596.9	617.7	596.2	594.2	668.2
Change in Gg CO_2 eqv.	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.5
Change in pct.	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Previous inventory, Gg CO_2 eqv.	617.9	579.2	649.8	631.0	635.5	657.4	652.2	685.9	594.5	-	
Recalculated, Gg CO_2 eqv.	618.5	579.8	650.4	638.1	642.3	660.5	651.4	676.1	590.9	677.2	
Change in Gg CO_2 eqv.	0.5	0.6	0.7	7.1	6.9	3.2	-0.8	-9.8	-3.6	-	
Change in pct.	0.1	0.1	0.1	1.1	1.1	0.5	-0.1	-1.4	-0.6	-	

16.3.8 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Improved documentation for emission factors

The reporting of, and references for, the applied emission factors have been improved in the current year and will be further developed in future inventories. This will happen on the advice from the Danish National Environmental Research Institute.

2) Improvements in plant specific fuel combustion

Plant specific fuel combustion will be further improved according to the developments made by Statistics Greenland in the energy statistics.

3) Uncertainty estimates

Uncertainty estimates are largely based on the default uncertainty levels for activity rates and emission factors. More country-specific uncertainty estimates will be incorporated in future inventories.

4) Uncertainty estimates

Statistics Greenland is in contact with the Swedish oil company from which oil is imported to Greenland. The plan is to obtain country specific emission factors on fossil fuels, and implement the new country specific emission factors in the 2013 submission.

16.3.9 References

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16.4 Industrial processes (CRF sector 2)

16.4.1 Overview of sector

In this chapter industrial emissions of greenhouse gases, not related to generation of energy, are presented.

The emission of greenhouse gases from industrial processes includes CO_2, HFCs and SF_6. The emissions are reported in CRF Tables 2(I), 2(I).A, 2(II), 2(II).C, 2(II).E and 2(II).F. Furthermore, the emission of non-methane volatile organic compounds (NMVOC) and CO from industrial processes related to asphalt roofing, road paving with asphalt and production of food and drink are given in CRF Table 2(I).

An overview of sources identified is presented in Table 16.4.1 with an indication of the contribution to the industrial part of the emission of greenhouse gases in 2010. Emissions are extracted from the CRF tables.

Table 16.4.1 Overview of greenhouse gas sources 2010.

Process	IPCC Code	Substance	Emission tonnes CO_2 eqv.	%
Mineral Products				
Limestone and Dolomite Use	2A	CO_2	4.94	0.073
Asphalt Roofing	2A	CO_2	0.06	0.001
Road Paving with Asphalt	2A	CO_2	0.07	0.001
Consumption of Halocarbons and SF_6				
Refrigeration and Air Conditioning Equipment	2F	HFCs	6 771	99.881
Electrical Equipment	2F	SF_6	2.96	0.044
Total emission			6 779	100

The subsectors *Mineral Products* (2A) constitutes 0.075 % and *Consumption of Halocarbons and SF_6* (2F) constitutes 99.925 % of the industrial emission of greenhouse gases. The total emission of greenhouse gases (excl. LULUCF) in Greenland is estimated to 715.4 Gg CO_2 equivalent, of which industrial processes contribute with 6.779 Gg CO_2 equivalent (0.95 %). The emission of greenhouse gases from industrial processes from 1990-2010 are presented in Figure 16.4.1.

Greenland has no chemical industry, metal production or production of halocarbons or SF_6. Greenland has no consumption of PFCs.

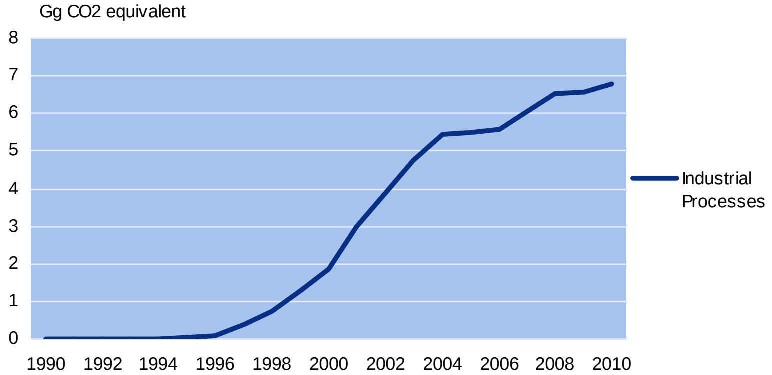

Figure 16.4.1 Emission of greenhouse gases from industrial processes 1990-2010.

The key categories in the industrial sector *Mineral Products* and *Consumption of Halocarbons and SF_6* constitute 0.00003 % and 1.0 % of the total emission of greenhouse gases. The trends in greenhouse gases from the industrial sector/subsectors are presented in Table 16.4.2. The emissions are extracted from the CRF tables.

Table 16.4.2 Emission of greenhouse gases from industrial processes in different subsectors from 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (tonnes CO_2)											
A. Mineral Products	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.13	0.12	0.13	4.09
CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFCs (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	NE	NE	NE	NE	16	25	77	390	713	1 279	1 871
PFCs (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6 (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	NE	NE	NE	NE	NE	35.9	3.4	3.4	3.3	3.3	3.3
Continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
CO_2 (tonnes CO_2)											
A. Mineral Products	2.94	1.46	3.05	2.06	0.52	0.20	1.71	3.24	0.20	5.08	
CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
HFCs (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	2 964	3 898	4 750	5 425	5 499	5 558	6 065	6 527	6 568	6 771	
PFCs (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
SF_6 (tonnes CO_2 eqv.)											
F. Consumption of Halocarbons and SF_6	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	

Greenland has no production of halocarbons or SF_6. Data on consumption of F-gases (HFCs and SF_6) are obtained from the Statistics Greenland (imports) and by an annual survey on consumption halocarbons and SF_6. Information on consumption of F-gases is available from 1995 onwards. Greenland has no consumption of PFCs.

One single plant in Greenland has reported use of SF_6 in 1995. The emission of SF_6 was 35.9 tonnes CO_2 equivalents in 1995. The annual emission from 1996 and onwards is assumed to be 0.5 % of the amount filled into the plant in 1995. This causes a relative high emission of SF_6 in 1995 and a much lower emission in the period 1996-2010.

Energy consumption associated with industrial processes and emissions thereof are included in the Energy sector of the inventory.

16.4.2 Source category description

Mineral products

The subsector *Mineral products* (2A) cover the following processes:

- Limestone and dolomite use.
- Roof covering with asphalt materials.
- Road paving with asphalt.

The time series for the emission of CO_2 from Mineral products (2A) are presented in Table 16.4.3. The emissions are extracted from the CRF tables and the values are rounded.

Table 16.4.3 Time series for emission of CO_2 (tonnes) from Mineral products (2A).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3. Limestone and dolomite use	-	-	-	-	-	-	-	-	-	-	3.96
5. Asphalt roofing	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01
6. Road paving	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.11	0.11	0.13	0.12
Total	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.13	0.12	0.13	4.09
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
3. Limestone and dolomite use	2.77	1.32	2.64	1.80	0.11	0.03	1.51	2.96	0.03	4.94	
5. Asphalt roofing	0.00	0.02	0.04	0.07	0.03	0.05	0.05	0.08	0.06	0.06	
6. Road paving	0.17	0.12	0.37	0.19	0.38	0.12	0.15	0.20	0.11	0.07	
Total	2.94	1.46	3.05	2.06	0.52	0.20	1.71	3.24	0.20	5.08	

The use of limestone and dolomite started in 2000. Hence there is no emission from limestone and dolomite use before 2000. The use of limestone and dolomite has been estimated from the annual import of these products to Greenland. Imports seem to vary a great deal from year to year, which causes the estimated use to vary as well. In 2010 the estimated use of limestone and dolomite increase significantly, which leads to an additionally increase in emission of CO_2.

The increase in CO_2 emission is most significant for the use of asphalt roofing. From 1990 to 2010, the CO_2 emission increased from 0.01 to 0.06 tonnes CO_2; an increase of 599 %. The increase in CO_2 from asphalt roofing has primarily taken place from 2002 and onwards. Since 2002 annual building activities have increased by an average of 5.5 % for dwellings alone compared to 1990.

The most significant CO_2 emission comes from the use of limestone and dolomite, which constitutes 97.3 % of the total CO_2 emission from mineral products in 2010. The CO_2 emission in 2010 from the use of limestone and dolomite is the highest emission from mineral products to this point.

The CO_2 emission from subsectors under mineral products fluctuates a great deal from year to year. This is caused by fluctuations in building activities and road paving. However fluctuations in CO_2 are also caused by the fact that activity data for mineral products are based on import data, which do not allow distinction of imported amount into consumption and stockpiling.

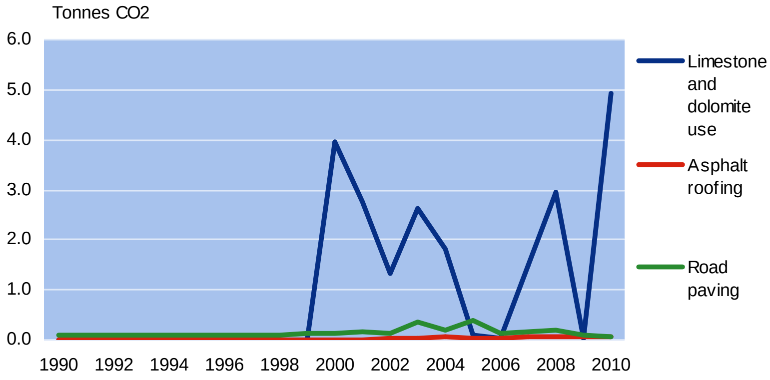

Figure 16.4.2 Emission of CO_2 from mineral products.

Consumption of Halocarbons and SF_6

The subsector *Consumption of Halocarbons and SF_6* (2F) includes the following source categories and the following F-gases of relevance for Greenlandic emissions:

- 2F1: Refrigeration: HFC32, 125, 134a, 143a, unspecified HFCs.
- 2F8: Electrical equipment: SF_6.

A quantitative overview is given below for each of these source categories and each F-gas, showing their emissions in tonnes through the time series. The data is extracted from the CRF tables that form part of this submission and the data presented is rounded values. It must be noticed that the inventories for the years 1990-1993 (1994) might not cover emissions of these gases in full. The chosen base-year for these gases is 1995 for Greenland.

Table 16.4.4 Emission of HFCs from refrigeration (t).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HFC32	NE	NE	NE	NE	NE	NA	0.00	0.00	0.00	0.00	0.00
HFC125	NE	NE	NE	NE	NE	NA	0.01	0.04	0.08	0.15	0.22
HFC134a	NE	NE	NE	NE	0.01	0.02	0.03	0.06	0.10	0.17	0.24
HFC143a	NE	NE	NE	NE	NE	NA	0.01	0.05	0.09	0.16	0.24
Unspecified HFCs	NE	NE	NE	NE	NE	NA	0.00	0.00	0.00	0.00	0.00
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
HFC32	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
HFC125	0.35	0.46	0.56	0.64	0.64	0.65	0.71	0.76	0.77	0.80	
HFC134a	0.35	0.45	0.55	0.63	0.65	0.65	0.68	0.67	0.64	0.62	
HFC143a	0.39	0.51	0.63	0.71	0.72	0.72	0.79	0.86	0.88	0.91	
Unspecified HFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 16.4.5 Emission of SF_6 from electrical equipment (kg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SF_6	NE	NE	NE	NE	NE	1.50	0.14	0.14	0.14	0.14	0.14
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
SF_6	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	

The emission of SF_6 was highest in 1995, when one single plant in Greenland reported use of SF_6. The emission of SF_6 was 1.5 kg in 1995. Since 1995 the annual emission is assumed to be 0.5 % of the amount filled into the plant in 1995. This causes a relative high emission of SF_6 in 1995 and a much lower emission in the following years. In 2010 the emission of SF_6 was 0.12 kg.

HFCs are used in various types of refrigeration in industry, retail, buildings and onboard ships. In 1994 and 1995 consumption of HFC134a was the only reported HFC used for refrigeration. Since 1996 consumption of HFC32, 125, 134A, 143A has been reported continuously. The emission of HFCs has increased rapidly since 1995.

Table 16.4.6 and Figure 16.4.3 and Figure 16.4.4 quantify an overview of the emissions of the gases in CO_2 equivalents. The reference is the trend table as included in the CRF table for year 2010.

Table 16.4.6 Time series for emission of HFCs and SF_6 (tonnes CO_2 eqv.).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HFCs	NE	NE	NE	NE	16	25	77	390	713	1 279	1 871
SF_6	NE	NE	NE	NE	NE	35.9	3.4	3.4	3.3	3.3	3.3
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
HFCs	2 964	3 898	4 750	5 425	5 499	5 558	6 065	6 527	6 568	6 771	
SF_6	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	

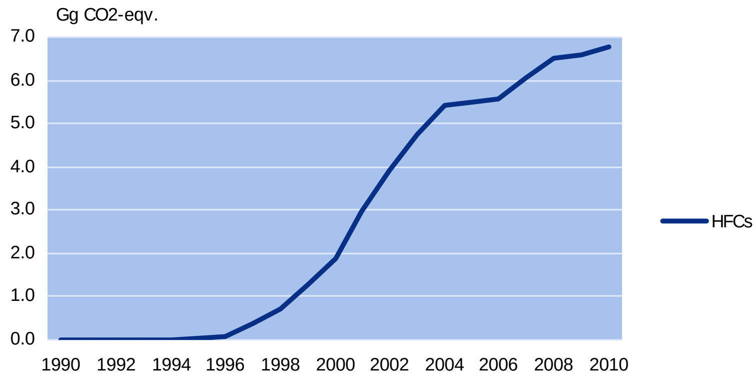

Figure 16.4.3 Emission of HFCs (from refrigeration).

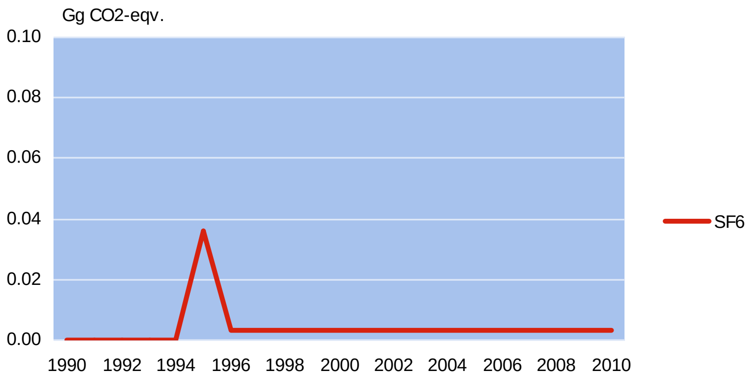

Figure 16.4.4 Emission of SF_6 (from electrical equipment).

HFCs is by far the most dominant group. HFCs constitute a key category both with regard to the key category level and the trend analysis.

16.4.3 Methodological issues

General

The CO_2 emission from the use of limestone and dolomite, asphalt materials used for roof covering and road paving has been estimated from the annual import of these products to Greenland.

The emissions of HFCs and SF_6 have been estimated from data on consumption of F-gases. Activity data includes annual imports and data on consumption of halocarbons and SF_6 obtained from an annual survey among importers and consumers of F-gases.

The following sections contain a description of activity data and emission factors used for the subsectors under industrial processes. The section is concluded by a description of the emissions of greenhouse gases from industrial processes.

Activity data

Activity data for subsectors *Mineral Products* (2A) and *Other Production* (2D) are presented in Table 16.4.7. Activity data under subsector *Other Production* (2D) are used for calculation of emission of non-methane volatile organic compounds (NMVOC).

The activity data are rounded. Notice that production of beer is given in hectolitre (hl). All other activity data are given in tonnes (t).

Statistics on imports are used to estimate annual consumption of mineral products. Statistics on imports of whole coffee beans and yeast for baking are used to estimate annual production of coffee and bread. Statistics on landings of fish and seafood to domestic plants are used to determine domestic processing of fish and seafood. Statistics on imports are produced by Statistics Greenland (2011b).

Production of beer including a fermentation process has taken place at the brewery "Godthåb Bryghus" since 2005 (Godthåb Bryghus, 2011). The brewery has reported annual production in rounded hectolitre. The much larger company "Nuuk Imeq" has no production of beer including a fermentation process. As a bottling company the activity at "Nuuk Imeq" only includes diluting of the concentrated quantities imported to Greenland and afterwards bottling of the beer.

Table 16.4.7 Time series for activity data for Mineral Products and Other Production (Godthåb Bryghus, 2011, Statistics Greenland, 2011b).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Mineral Products											
2A3 Limestone and dolomite use (t)	-	-	-	-	-	-	-	-	-	-	9
2A5 Asphalt materials used for roofing (t)	37	35	39	39	13	56	29	59	39	7	26
2A6 Asphalt used for road paving (t)	591	581	595	604	597	577	532	664	649	752	694
Other Production											
2D2 Food and Drink - Beans roasted to produce coffee (t)	0	0	0	0	-	0	-	-	0	0	0
2D2 Food and Drink - Production of bread (t)	356	346	339	358	501	244	415	500	847	689	687
2D2 Food and Drink - Landings of fish and seafood (t)	81 768	72 395	65 553	59 423	64 479	67 786	60 662	62 244	67 247	63 750	74 105
2D2 Food and Drink - Production of beer (hl)	-	-	-	-	-	-	-	-	-	-	-

continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Source
Mineral Products											
2A3 Limestone and dolomite use (t)	6	3	6	4	0	0	3	7	0	11	1
2A5 Asphalt materials used for roofing (t)	11	81	149	263	114	193	209	321	241	256	1
2A6 Asphalt used for road paving (t)	988	705	2 218	1 127	2 258	698	912	1 206	629	443	1
Other Production											
2D2 Food and Drink - Beans roasted to produce coffee (t)	1	-	0	0	0	0	1	0	0	0	2
2D2 Food and Drink - Production of bread (t)	566	1 020	1 048	1 338	1 014	1 134	859	931	587	790	2
2D2 Food and Drink - Landings of fish and seafood (t)	66 929	85 970	80 667	102 570	103 642	111 351	118 260	109 420	102 393	99 829	2
2D2 Food and Drink - Production of beer (hl)	-	-	-	-	1 000	2 000	2 000	1 850	1 650	2 010	2

Sources:

1) Statistics on imports are used to estimate annual consumption of mineral products.

2) Statistics on imports of whole coffee beans and yeast for baking are used to estimate annual production of coffee and bread.

3) Statistics on landings of fish and seafood to domestic plants are used to determine domestic processing of fish and seafood.

4) Data from the brewery "Godthåb Bryghus" are used to determine annual production of beer.

The data for emission of HFCs and SF_6 has been obtained in continuation on the work on inventories for previous years. The determination includes the quantification and determination of any import and export of HFCs and SF_6 contained products and substances in stock form. This is in accordance with IPCC guidelines (IPCC (1997), vol. 3, p. 2.43ff), as well as the /relevant decision trees from the IPCC Good Practice Guidance (IPCC (2000) p. 3.53ff).

The following sources of information have been used (Statistics Greenland, 2011a):

- Importers, wholesaler and suppliers.
- Statistics Greenland.
- Consuming enterprises.

Importers and suppliers provide consumption data of F-gases. Emission factors are defaults from the GPG. Import/export data for sub-source categories where import/export is relevant are quantified on estimates from import/export statistics of products + default values of the amount of gas in the product.

The determination of emissions of F-gases is based on a calculation of the actual emission. The actual emission is the emission in the evaluation year, accounting for the time lapse between consumption and emission. The actual emission includes Greenlandic emissions from production and from products during their lifetimes. Consumption and emissions of F-gases are, whenever possible for individual substances, even though the consumption of certain HFCs has been limited. This has been varied out to ensure transparency of evaluation in the determination of GWP values. However, the continued use for Other HFCs has been necessary since not all importers and suppliers have specified records of sales for individual substances.

Only the actual emission has been calculated. Thus, the potential emission is assumed to be the same as the actual emission in the CRF tables.

Table 16.4.8 Content (w/w%) of "pure" HFC in HFC-mixtures, used as trade names.

HFC mixtures	HFC32	HFC125	HFC134a	HFC143a	Unspecified HFCs
	%	%	%	%	%
HFC-134, total			100		
HFC-404, total		44	4	52	
HFC-407c, total	23	25	52		
HFC-507a, total		50		50	
Unspecified HFCs					100

The substances have been accounted for in the survey according to their trade names, which are mixtures of HFCs used in the CRF. In the transfer to the "pure" substances used in the CRF reporting schemes, the ratios shown in Table 16.4.8 have been used.

Activity data for the consumption of F-gases is shown in Table 16.4.9. The activity data are rounded and given in kg.

Table 16.4.9 Time series for activity data for the consumption of F-gases by trade-names (Statistics Greenland, 2011a).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
						Kg					
HFC-134											
Domestic	NE	NE	NE	264	139	91	187	134	453	319	289
Commercial and Industry	NE	NE	NE	-	-	-	123	123	247	247	493
Transport	NE	NE	NE	-	-	-	64	64	128	128	256
HFC-404a											
Commercial and Industry	NE	NE	NE	-	-	-	488	488	976	976	1 952
Transport	NE	NE	NE	-	-	-	82	82	164	164	328
HFC-407c											
Commercial and Industry	NE	NE	NE	-	-	-	34	34	68	68	135
HFC-507a											
Transport	NE	NE	NE	-	-	-	113	113	225	225	450
Unspecified HFCs											
Commercial and Industry	NE	NE	NE	-	-	-	45	45	90	90	180
SF_6											
Electrical Equipment	NE	NE	NE	-	-	30	-	-	-	-	-
Continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
HFC-134											
Domestic	492	774	635	635	-	-	-	-	-	-	
Commercial and Industry	493	493	493	260	208	680	329	312	195	484	
Transport	256	256	256	120	120	30	30	-	-	-	
HFC-404a											
Commercial and Industry	1 952	1 952	1 952	1 324	1 041	2 033	2 069	1 950	2 089	2 993	
Transport	328	328	328	154	222	369	413	384	241	205	
HFC-407c											
Commercial and Industry	135	135	135	68	83	31	4	112	90	-	
HFC-507a											
Transport	450	450	450	-	-	120	180	-	120	-	
Unspecified HFCs											
Commercial and Industry	180	180	180	326	314	556	698	309	400	576	
SF_6											
Electrical Equipment	-	-	-	-	-	-	-	-	-	-	

Emission factors

The CO_2 emission factors applied for mineral products in 2010 are presented in Table 16.4.10. The same emission factor has been applied for 1990-2010.

Table 16.4.10 CO_2 emission factors 2010.

Product	Emission factor	Unit	Reference	IPCC Category
Limestone and dolomite use	440	kg pr tonne	IPCC, 1997	2A3
Asphalt materials used for roofing	0.25	kg pr tonne	Nielsen et al., 2011	2A5
Asphalt used for road paving	0.168	kg pr tonne	Nielsen et al., 2011	2A6

The CO emission factors applied for the consumption of asphalt products under mineral products in 2010 are presented in Table 16.4.11. The same emission factor has been applied for 1990-2010.

Table 16.4.11 CO emission factors 2010.

Product	Emission factor	Unit	Reference	IPCC Category
Asphalt materials used for roofing	0.01	kg pr tonnes	Nielsen et al., 2011	2A5
Asphalt used for road paving	0.075	kg pr tonnes	Nielsen et al., 2011	2A6

The NMVOC emission factors applied for the consumption of asphalt products under mineral products and products used in the production of food and drink in 2010 are presented in Table 16.4.12. The same emission factor has been applied for 1990-2010.

Table 16.4.12 NMVOC emission factors 2010.

Product	Emission factor	Unit	Reference	IPCC Category
Asphalt materials used for roofing	0.08	kg pr tonnes	Nielsen et al., 2011	2A5
Asphalt used for road paving	0.015	kg pr tonnes	Nielsen et al., 2011	2A6
Food and Drink - Beans roasted to produce coffee	0.55	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Production of bread	8	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Landings of fish and seafood	0.3	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Production of beer	0.0625	kg pr hl	Nielsen et al., 2011	2D2

16.4.4 Emissions

The greenhouse gas (GHG) emissions are listed in Table 16.4.13. The emission from industrial processes accounts for 1.0 % of the Greenlandic GHG emission.

The CO_2 emission from industrial processes accounts for just 0.00075 % of the Greenlandic CO_2 emission (excluding net CO_2 emission from Land Use, Land Use Change and Forestry (LULUCF). The HFC emission from industrial processes accounts for 100 % of the Greenlandic emission and the SF_6 emission accounts for 100 % of the Greenlandic SF_6 emission.

Table 16.4.13 Greenhouse gas emission for the year 2010.

		CO_2	HFC	SF_6
		Tonne CO_2 equivalent		
2A3	Limestone and Dolomite Use	4.94	NA	NA
2A5	Asphalt Roofing	0.06	NA	NA
2A6	Road Paving with Asphalt	0.07	NA	NA
2F1	Refrigeration	NA	6 771	NA
2F8	Electrical Equipment	NA	NA	3.0
Total emission from industrial processes		5.08	6 771	3.0
		Gg CO_2 equivelent		
Greenlandic emission (excluding net emission from LULUCF)		677.1	6.771	0.003
			%	
Emission share for industrial processes		0.00075	100	100

HFC is the most important GHG pollutant and accounts for 99.88 % of the GHG emission in CO_2 equivalents from industrial processes. Illustration of the percentage of share in a figure is omitted due to the large share of HFC, which completely dominates as the most significant GHG pollutant from industrial processes.

CO_2

Figure 16.4.5 depicts the time series of CO_2 emission from industrial processes. As shown by the blue curve total CO_2 emission follows the CO_2 emission from use of limestone and dolomite closely. Limestone and dolomite was not imported to Greenland before 2000. Thus emission of CO_2 from the use of mineral products increased significantly in 2000. The emission of CO_2 has increased by a factor 47 from 1990 to 2010 primarily due to the introduction of limestone and dolomite import in 2000. In 2010 limestone and dolomite imports increased significantly causing emissions from mineral products to increase as well. Data on imports are used to estimate the annual use of limestone and dolomite. This causes a great deal of fluctuations from year to year.

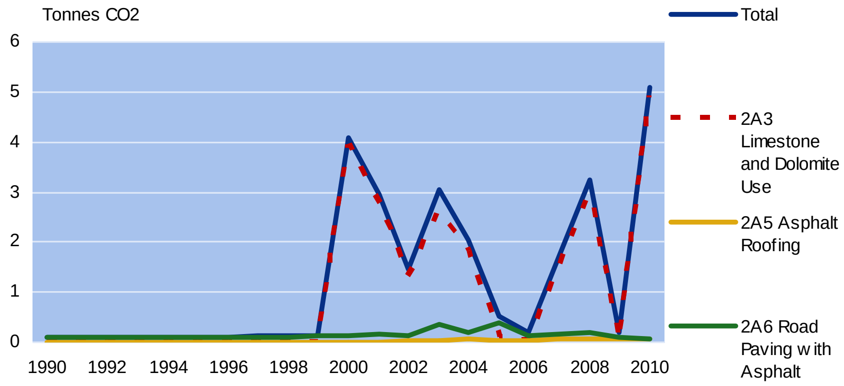

Figure 16.4.5 Emission of CO_2 from industrial processes.

Emission of HFCs and SF_6 are illustrated in Figure 16.4.3 and Figure 16.4.4.

NMVOC and CO

The emissions of NMVOC and CO from industrial processes in 2010 are presented in Table 16.4.14. NMVOC and CO account for 3.25 % and 0.001 % respectively, of the Greenlandic emissions for these substances.

Table 16.4.14 NMVOC and CO emission from industrial processes 2010.

		NMVOC	CO
		Tonnes	
2A5	Asphalt Roofing	0.02	0.00
2A6	Road Paving with Asphalt	0.01	0.03
2D2	Food and Drink	36.39	NA
Total emission from industrial processes		36.42	0.04
Greenlandic emission		1 121.1	4 818.1
		%	
Emission share for industrial processes		3.25	0.001

16.4.5 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for industrial processes. The uncertainties for the activity data and emission factors are shown in Table 16.4.15.

Table 16.4.15 Uncertainties for activity data and emission factors for industrial processes.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
2A3 Limestone and dolomite use	CO_2	5	5
2A5 Asphalt roofing	CO_2	5	25
2A6 Road paving with asphalt	CO_2	10	50
2F Consumption of HFC	HFC	10	50
2F Consumption of SF6	SF_6	10	50

The activity data comes from the import statistics, which is considered to be of high quality, therefore the uncertainty of the activity data has been set to 5 % for limestone and dolomite use and asphalt roofing, while it is assumed to be 10 % for road paving and consumption of HFCs and SF_6.

Regarding the emission factor uncertainty, the CO_2 emission factor for limestone and dolomite use is considered very certain. It is derived from stoichiometric calculations. Thus an emission factor of 5 % has been assumed. The uncertainty levels for asphalt roofing and road paving are expert judgements. The emission of F-gases is dominated by emissions from refrigeration equipment and, therefore, the uncertainties assumed for this sector will be used for all the F-gases. The IPCC propose an uncertainty at 30-40 % for regional estimates. However, Greenlandic statistics have been developed over a number of years and, therefore the uncertainty on activity data is assumed to be 10 %. The uncertainty on the emission factor is, on the other hand, assumed to be 50 %. The base year for F-gases for Greenland is 1995.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 16.4.16.

Table 16.4.16 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2010[1] %	Trend uncertainty %
GHG	36	15 384	± 4 276
CO_2	6.9	4 587	± 1 121
HFC	51	26 692	± 3 789
SF_6	51	-92	± 1.2

[1] For f-gases the base year of 1995 is used.

16.4.6 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, the official Greenland import statistics has gone through a great deal of quality work with regard to accuracy, comparability and completeness. Statistics Greenland is responsible for the official Greenlandic import statistics, and as such responsible for the completeness of data.

Statistics on imports is reported by Statistics Greenland in form of a spreadsheet. Annual import of limestone and dolomite, asphalt materials used for roof covering and road paving, whole coffee beans and yeast for baking are compared with imports in previous years and large discrepancies are checked. The same procedure is used to ensure accuracy in annual use of F-gases and statistics on landings of fish and seafood to domestic plants.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this needs to be elaborated.

Time series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked in the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

16.4.7 Source specific recalculations and improvements

The sectors *Mineral Products* (2A) and *Other Production* (2D) were included in the inventory for the first time in the 2010 submission. During implementation the following improvements were made:

Introduction of new activity data on non-energy use of limestone and dolomite, products containing bitumen used for asphalt roofing, and road paving with asphalt.

Introduction of new activity data on consumption of products used in the production of food and drink i.e. raw coffee beans, yeast used for baking, landings of fish, shellfish, seals and whales, and production of beer. Use of these products caused no CO_2 emission only non-methane volatile organic compounds (NMVOC).

Improved data on use of F-gases. Activity data on F-gases are now divided into domestic, commercial and industry, transport, and electrical equipment. Further more the substances, which are accounted according to their trade names, are now transferred into “pure” substances.

In the 2012 emission inventory submission there have been no further improvements or recalculations compared to the 2011 submission. However, some minor revisions have been made concerning the use of mineral products. Therefore Table 16.4.17 shows some minor changes in recalculations relating to industrial processes compared with the 2011 submission.

Table 16.4.17 Changes in GHG emission in the industrial processes sector compared with the 2011 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Previous inventory, Gg CO_2 eqv.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.7	1.3	1.9
Recalculated, Gg CO_2 eqv.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.7	1.3	1.9
Change in Gg CO_2 eqv.	-	-	-	-	-	-	-	-	-	-	-
Change in pct.	-	-	-	-	-	-	-	-	-	-	-
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Previous inventory, Gg CO_2 eqv.	3.0	3.9	4.8	5.4	5.5	5.6	6.1	6.5	6.6	-	
Recalculated, Gg CO_2 eqv.	3.0	3.9	4.8	5.4	5.5	5.6	6.1	6.5	6.6	6.8	
Change in Gg CO_2 eqv.	-	-	-	-	-	-	0.0	0.0	0.0	-	
Change in pct.	-	-	-	-	-	-	0.0	0.0	0.0	-	

16.4.8 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Distribution of unspecified mix of HFCs into single HFCs

An unspecified mix of HFCs is used in commercials and industries. In future inventories attempts will be made in order to distribute the unspecified mix of HFCs into single substances.

16.4.9 References

Godthåb Bryghus (Brewery in Nuuk), 2011: Data on production of beer 2006-2010. Not published.

IPCC, 1997: Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories. Available at: http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.htm (15-04-2007).

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Nielsen, O.-K., Mikkelsen, M.H., Hoffmann, L., Gyldenkærne, S., Winther, M., Nielsen, M., Fauser, P., Thomsen, M., Plejdrup, M.S., Albrektsen, R., Hjelgaard, K., Bruun, H.G., Johannsen, V.K., Nord-Larsen, T., Bastrup-Birk, A., Vesterdal, L., Møller, I.S., Rasmussen, E., Arfaoui, K., Baunbæk, L., Hansen, M.G., 2011: Denmark's National Inventory Report 2011 – Emission Inventories 1990-2009 - Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. National Environmental Research Institute, University of Aarhus. 1205 pp. – NERI Technical Report no. 827. Available at: http://www.dmu.dk/Pub/FR827.pdf

Statistics Greenland, 2011a: Annual survey among importers, suppliers and consumers of F-gases in Greenland in 2010. Not published.

Statistics Greenland, 2011b: Foreign Trade, Import and Export. Available at:
http://www.stat.gl/dialog/main.asp?lang=da&version=201001&link=IE&subthemecode=p2&colcode=p as "Grønlands udenrigshandel 2010 (foreløbige tal)" (04-05-2011). Data more detailed than the published version of the foreign trade statistics are used in order to access imports at the most detailed level.

16.5 Solvent and other product use (CRF sector 3)

16.5.1 Overview of sector

This section presents the methodology used for calculating CO_2 and NMVOC emissions from use of solvents in industrial processes and households that are related to the source categories Paint application (CRF sector 3A), Degreasing and dry cleaning (CRF sector 3B), Chemical products, manufacture and processing (CRF sector 3C) and Other (CRF sector 3D).

Solvents are chemical compounds that are used on a global scale in industrial processes and as constituents in final products to dissolve e.g. paint, cosmetics, adhesives, ink, rubber, plastic, pesticides, aerosols or are used for cleaning purposes, i.e. degreasing. NMVOCs are main components in solvents - and solvent use in industries and households is typically the dominant source of anthropogenic NMVOC emissions. In industrial processes where solvents are produced or used NMVOC emissions to air and as liquid can be recaptured and either used or destroyed. Solvent containing products are used indoor and outdoor and the majority of solvent sooner or later evaporate. A small fraction of the solvent ends up in waste or as emissions to water and may finally also contribute to air pollution by evaporation from these compartments.

In this section the methodology for the Greenland NMVOC emission inventory for solvent use is presented and the results for the period 1990 – 2010 are summarised. The method is based on the detailed approach described in EMEP/CORINAIR (2004) and emissions are calculated for the CRF sectors mentioned above.

16.5.2 Source category description

Table 16.5.1 and Figure 16.5.1 show the emissions of chemicals from 1990 to 2010, where the used amounts of single chemicals have been assigned to specific products and CRF categories.

Table 16.5.2 shows the used amounts of chemicals for the same period. Table 16.5.1 is derived from Table 16.5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 16.5.3 shows the used amounts of products from 1990 to 2010.

The default NMVOC-CO_2 conversion factor of 0.85 * 3.667 = 3.11 is used.

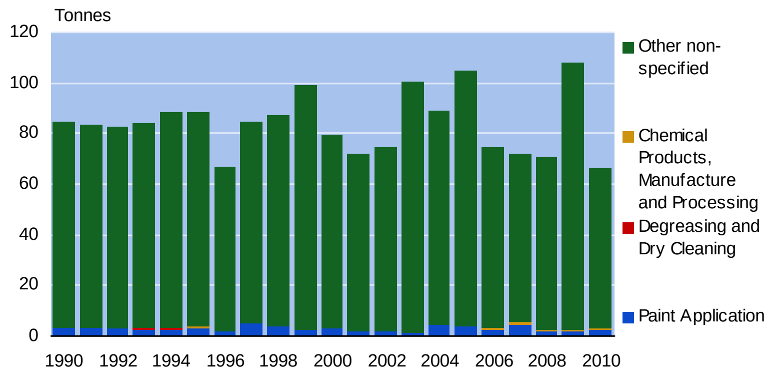

Figure 16.5.1 Emission of NMVOC from solvent and other product use. The methodological approach for finding emissions is described in the text. Figures can be seen in Table 16.5.1.

Table 16.5.1 Emission of chemicals in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Paint application (3A)	3.1	3.0	2.9	2.8	2.5	3.4	2.1	5.2	3.8	2.5	3.1
Degreasing and dry cleaning (3B)	0.1	0.1	0.1	0.1	0.4	NO	NO	0.1	0.2	NO	NO
Chemical products, manufacturing and processing (3C)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Other (3D)	81.2	80.1	79.4	81.2	85.4	85.2	64.9	79.2	82.8	96.8	76.4
Total NMVOC	84.4	83.3	82.5	84.1	88.3	88.7	67.1	84.4	86.9	99.4	79.5
Total CO_2	263.4	259.7	257.4	262.5	275.6	276.7	209.3	263.4	271.0	310.1	247.9
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Paint application (3A)	1.9	2.1	1.3	4.4	3.9	2.2	4.7	1.8	2.0	2.5	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	0.0	0.0	NO	
Chemical products, manufacturing and processing (3C)	0.0	0.1	0.0	0.2	0.1	1.2	1.3	0.4	0.6	0.7	
Other (3D)	69.8	72.7	99.3	84.3	100.5	71.1	65.8	68.3	105.5	62.8	
Total NMVOC	71.7	74.8	100.7	88.9	104.5	74.5	71.8	70.5	108.2	66.0	
Total CO_2	223.6	233.5	314.0	277.5	326.1	232.5	224.0	219.9	337.5	205.9	

Table 16.5.2 Used amounts of chemicals in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Paint application (3A)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Chemical products, manufacturing and processing (3C)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (3D)	37.0	36.6	35.1	34.8	59.6	43.5	45.4	32.8	27.1	36.5	18.6
Total NMVOC	37.0	36.6	35.1	34.8	59.6	43.5	45.4	32.8	27.1	36.5	18.6
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Paint application (3A)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Chemical products, manufacturing and processing (3C)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Other (3D)	33.0	20.0	31.9	27.5	27.4	30.4	24.2	26.2	68.2	36.7	
Total NMVOC	33.0	20.0	31.9	27.5	27.4	30.4	24.2	26.2	68.2	36.7	

Table 16.5.3 Used amounts of products in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Paint application (3A)	3.9	3.8	3.7	3.5	3.1	4.3	2.7	6.5	4.8	3.1	3.8
Degreasing and dry cleaning (3B)	0.2	0.2	0.1	0.1	0.8	NO	NO	0.1	0.4	NO	NO
Chemical products, manufacturing and processing (3C)	0.3	0.2	0.2	0.2	0.5	0.1	0.1	0.1	0.1	0.8	0.0
Other (3D)	84.6	83.5	83.5	85.8	84.9	84.5	61.8	81.8	90.9	105.7	83.8
Total products	89.0	87.7	87.5	89.7	89.4	89.0	64.6	88.6	96.1	109.5	87.6
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Paint application (3A)	2.4	2.6	1.6	5.5	4.8	2.8	5.8	2.3	2.6	3.1	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	0.0	0.0	NO	
Chemical products, manufacturing and processing (3C)	0.1	0.4	0.2	0.5	0.3	11.5	13.9	4.4	6.1	5.7	
Other (3D)	72.2	83.3	109.5	96.2	107.2	77.8	69.8	71.6	97.5	62.3	
Total products	74.6	86.2	111.4	102.2	112.3	92.1	89.5	78.2	106.2	71.1	

16.5.3 Methodological issues

Emission modelling of solvents can basically be done in two ways: 1) By estimating the amount of (pure) solvents consumed, or 2) By estimating the amount of solvent containing products consumed, taking account of their solvent content (EMEP/CORINAIR, 2004).

In 1) all relevant solvents must be estimated, or at least those together representing more than 90 % of the total NMVOC emission, and in 2) all relevant source categories must be inventoried or at least those together contributing more than 90 % of the total NMVOC emission. A simple approach is to use a pr capita emission for each category, whereas a detailed approach is to get all relevant consumption data (EMEP/CORINAIR, 2004).

The detailed method 1) is used in the emission inventory for solvent use, thus representing a chemicals approach, where each chemical (NMVOC) and chemical containing product (group) is estimated separately. The sum of emissions of all estimated NMVOCs used as solvents equals the NMVOC emission from solvent use.

Activity data

The definitions of solvents and VOC that are used are as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Organic solvent shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative". VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular condition of use".

Import figures of chemicals and chemical containing products are obtained from Statistics Greenland. There is no production or export of chemicals and chemical containing products, therefore the import amount is assumed to be equivalent to the used amount.

Emission factors

For some chemicals the emission factors are precise but for others they are rough estimates. In the Danish inventory emission factors are divided into four categories: 1) chemical industry (lowest EF), 2) other industry, 3) non-industrial activities, 4) domestic and other diffuse use (highest EF). This implies that high emission factors are applicable for use of solvent containing products and lower emission factors are applicable for use in industrial processes

The emission factors used in the Greenlandic inventory are the same as developed for the Danish inventory (please refer to Chapter 5). For the chemicals assumed to be used for industrial purposes the mean value of category 1 and 2 above is used.

16.5.4 Emissions

Table 16.5.1 and Figure 16.5.1 show the emissions of chemicals from 1994 to 2010, where the used amounts of single chemicals have been assigned to specific products and CRF categories. Table 16.5.2 shows the used amounts of chemicals for the same period. Table 16.5.1 is derived from Table 16.5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 16.5.3 showing the used amount of products is derived from Table 16.5.2, by assessing the amount of chemicals that is comprised within products belonging to each of the four source categories. The default NMVOC-CO_2 conversion factor of 0.85 * 3.667 = 3.11 is used.

16.5.5 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for solvent and other product use. The uncertainties for the activity data and emission factors are shown in Table 16.5.4.

Table 16.5.4 Uncertainties for activity data and emission factors for solvents.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
3A Paint application	CO_2	10	15
3B Degreasing and dry cleaning	CO_2	10	15
3C Chemical products, manufacturing and processing	CO_2	10	15
3D5 Other	CO_2	10	20

The activity data comes from the import statistics, which is considered to be of high quality, therefore the uncertainty of the activity data has been set to 10 %.

Regarding the emission factor uncertainties, the uncertainty comprises of both the uncertainty of the NMVOC emission factor, and the uncertainty of the conversion factor of NMVOC to CO_2.

The resulting uncertainty for CO_2 is shown in Table 16.5.5.

Table 16.5.5 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2010 %	Trend uncertainty %
CO_2	21.3	-21.8	± 10.5

16.5.6 Source specific QA/QC

Time series of activity data and emissions are analysed. Large inter annual variations is investigated further to ensure the accuracy of the estimates.

16.5.7 Source specific recalculations and improvements

Emissions from solvent and other product use were included in the Greenlandic emission inventory for the first time in the 2010 submission.

There have been a few improvements in the 2012 emission inventory submission due to revised figures on import of certain products.

Table 16.5.6 Changes in GHG emission in the industrial processes sector compared with the 2011 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Previous inventory, Gg CO_2 eqv.	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2
Recalculated, Gg CO_2 eqv.	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2
Change in Gg CO_2 eqv.	-	-	-	-	-	-	-	-	-	-	-
Change in pct.	-	-	-	-	-	-	-	-	-	-	-
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Previous inventory, Gg CO_2 eqv.	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.3	-	
Recalculated, Gg CO_2 eqv.	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	
Change in Gg CO_2 eqv.	-	-	-	-	-	0.0	0.0	0.0	0.0	-	
Change in pct.	-	-	-	-	-	4.3	4.5	0.7	11.3	-	

16.5.8 Source specific planned improvements

It will be investigated whether use of N_2O is occurring in Greenland.

16.5.9 References

Nielsen, O.-K., Mikkelsen, M.H., Hoffmann, L., Gyldenkærne, S., Winther, M., Nielsen, M., Fauser, P., Thomsen, M., Plejdrup, M.S., Albrektsen, R., Hjelgaard, K., Bruun, H.G., Johannsen, V.K., Nord-Larsen, T., Bastrup-Birk, A., Vesterdal, L., Møller, I.S., Rasmussen, E., Arfaoui, K., Baunbæk, L., Hansen, M.G., 2011: Denmark's National Inventory Report 2011 – Emission Inventories 1990-2009 - Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. National Environmental Research Institute, University of Aarhus. 1205 pp. – NERI Technical Report no. 827. Available at: http://www.dmu.dk/Pub/FR827.pdf

Emission Inventory Guidebook 3rd edition, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections, 2002update. Available at: http://reports.eea.eu.int/EMEP-CORINAIR3/en (07-11-2003).

Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, Brüssel, 1999.

Statistics Greenland, 2011: Foreign Trade, Import and Export. Available at:
http://www.stat.gl/dialog/main.asp?lang=da&version=201001&link=IE&subthemecode=p2&colcode=p as "Grønlands udenrigshandel 2010 (foreløbige tal)" (04-05-2011). Data more detailed than the published version of the foreign trade statistics are used in order to access imports at the most detailed level.

16.6 Agriculture (CRF sector 4)

The emission of greenhouse gases from agricultural activities includes CH_4 emission from enteric fermentation, CH_4 and N_2O emission from manure management and N_2O emission from agricultural soils. The emissions are reported in CRF Tables 4.A, 4.B and 4.D.

Emission from rice production, burning of agricultural crop residue and burning of savannas does not occur in Greenland and the CRF Tables 4.F, 4.C and 4.E have, consequently, not been completed.

Emission of non-methane volatile organic compounds (NMVOC) from agricultural activities has not been estimated.

16.6.1 Overview of sector

In CO_2 equivalents, the agricultural sector (without LULUCF) contributes with 1.3 % of the overall greenhouse gas emission (GHG) in 2010. From 1990 to 2010 emissions increased from 8.78 Gg CO_2 equivalents to 9.35 Gg CO_2 equivalents, which correspond to an increase of 6.5 %, see Table 16.6.1. This emission increase is primarily caused by a significant rise in the use of synthetic fertiliser.

Table 16.6.1 Emission of GHG in the agricultural sector 1990-2010 in Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CH_4	6.16	6.21	5.58	4.89	5.33	5.72	5.89	6.42	6.16	5.52	5.36
N_2O	2.62	2.64	2.40	2.15	2.33	2.47	3.48	2.99	3.89	3.94	3.48
Total	8.78	8.85	7.98	7.03	7.66	8.19	9.37	9.41	10.05	9.46	8.84
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
CH_4	5.46	5.26	5.33	5.60	5.82	5.64	5.77	5.63	5.52	5.66	
N_2O	3.60	3.41	3.47	3.70	3.87	3.90	3.39	5.16	3.77	3.69	
Total	9.06	8.67	8.80	9.30	9.70	9.54	9.16	10.79	9.29	9.35	

As showed in Figure 16.6.1, CH_4 emission contributed with 60.5 % of the total GHG emission from the agricultural sector in 2010 and N_2O contributed with the remaining 39.5 % given in CO_2 equivalents. The major part of the emission is related to livestock production, which in Greenland particularly means the production of sheep. A smaller part is related to the reindeer production. Concerning the emission from agricultural soils, the main sources are use of synthetic fertiliser, nitrogen leaching from leaching and run-off and emission from grassing animals.

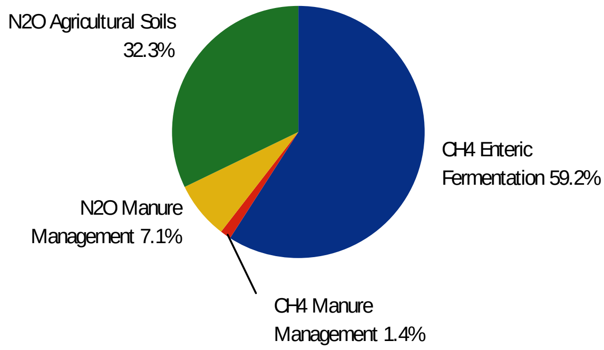

Figure 16.6.1 Emission of greenhouse gases from agriculture in 2010.

16.6.2 Source category description

The calculations of the emissions are based on methods described in the IPCC Reference Manual (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).

Statistics Greenland is responsible for collecting of data, preparation of emission inventory and reporting. Inputs of data are basically obtained from Statistics Greenland and the Greenland Agricultural Consulting Services (ACS). Data on climate are supplied by the Danish Meteorological Institute (DMI) and Greenland Survey (ASIAQ), and published by Statistics Greenland.

Table 16.6.2 List of institutes involved in the emission inventory for the agricultural sector.

References	Link	Abbrevia-tion	Data/information
Statistics Greenland	*www.stat.gl*	GST	- reporting - data collecting - no. of animal - feed import - use of synthetic fertiliser - spring temperature
The Agricultural Consulting Services	*http://nunalerineq.org/*	ACS	- N-excretion - milk yield - feed consumption and composition - stable- and grassing situation - animal growth and weight - land use - crop production
The Danish Plant Directorate	*www.pdir.dk*	PD	- N content in different fertiliser types
The Danish Agricultural Advisory Centre, Aarhus University	*www.lr.dk*	DAAC	- N content in crop residue

16.6.3 CH_4 emission from Enteric Fermentation (CRF sector 4A)

Description

The major part of the agricultural CH_4 emission originates from digestive processes. In 2010, this source accounts for 59.2 % of the total GHG emission from agricultural activities. The emission is primarily related to ruminants, which in Greenland is sheep. In 2010 sheep contributed with 88 % and the remaining 12 % from reindeer.

Methodological issues

The implied emission factors for all animal categories are based on the Tier 2/Country Specific (CS) approach. Feed consumption and composition for sheep and reindeer is based on data from Statistics Greenland and the Agricultural Consulting Services (ACS), which has information concerning the agricultural conditions in practice. Default values for the methane conversion rate (Y_m) for sheep given by the IPCC are used, as an average of mature sheep and lambs, which mean an Y_m value of 6 %.

Gross energy intake (GE)

The gross energy intake for sheep and reindeer is based on feeding plans for sheep from the Greenland Agricultural Consulting Services supplemented by data on imported feed. For reindeer information on gross energy intake is based on an article on reindeer management in Greenland.

Table 16.6.3 Parameters for calculation of emission from enteric fermentation.

Animal Category	Gross Energy (GE)	Methane conversion factor (Y_m)	Emission factor
	MJ pr head pr day		Kg CH_4 pr head pr yr
Sheep	28.4	0.06	11.2
Reindeer	27.5	0.06	10.7

The default CH_4 emission factor for sheep Tier 1 methodology is estimated to 8 kg CH_4 per animal per year. The default GE is given as 20 MJ/head/yr, which is lower than the calculated GE for Greenland, and can explain the lower emission factor. Another reason could be the fact that the national value for feed intake includes lambs. After lambing, ewes and lambs are put out to pasture. Thus lambs only feed through their mother and grass. Lambs are not fed separately before slaughter.

There is no default GE for reindeer. However, Norway, Sweden and Finland have estimated gross energy intake for reindeer to 29.6 – 31.6 MJ/head/day. Based on an article on reindeer management in southern Greenland by H.E. Rasmussen in 1992, the Greenlandic gross energy intake for reindeer has been estimated to 27.5 MJ pr head pr day, which is lower than Norway, Sweden and Finland. However, holding in mind that food conditions for reindeer is more scarcely in Greenland compared to conditions in Norway, Sweden and Finland, which have more forest, and that reindeer in Greenland are not fed separately, the estimated of gross energy intake for reindeer in Greenland seems acceptable.

Activity data

Table 16.6.4 shows the development in livestock. The number of sheep is varying slightly. The number of reindeer has decreased considerably since 1990. The reindeer livestock decreased significantly in 1999, when one of two reindeer stations closed. Since 1999 there has been only one reindeer station in Greenland.

Table 16.6.4 Number of animals from 1990-2010 (CRF Table 4.A. 4.B (a) and 4.B (b).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Sheep	19 929	20 134	17 900	16 256	17 818	19 464	20 163	23 134	19 929	21 007	20 444
Reindeer	6 000	6 000	5 600	4 300	4 600	4 600	4 600	3 800	6 000	2 106	2 000
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Sheep	20 394	18 967	19 259	20 383	21 317	21 289	21 704	21 080	20 139	20 729	
Reindeer	2 480	3 100	3 100	3 100	3 100	2 318	2 441	2 500	3 000	3 000	

Implied emission factor

The implied emission factor (IEF) could vary across years for sheep and reindeer due to changes in feed consumption. However, no existing data can document a change in feed intake. Therefore the same IEF is used for all years.

Time series consistency

The emission from enteric fermentation is given in Table 16.6.5. From 1990 to 2010, the emission has decreased by 8 % due to a fall in number of reindeer.

Table 16.6.5 Emission of CH_4 from Enteric Fermentation 1990–2010, tonnes CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Sheep	222	225	200	181	199	217	225	258	222	234	228
Reindeer	64	64	60	46	49	49	49	41	64	23	21
Total, tonnes CH_4	287	289	260	227	248	266	274	299	287	257	250
Total, tonnes CO_2 eqv.	6 018	6 066	5 452	4 775	5 208	5 594	5 758	6 275	6 018	5 396	5 240
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Sheep	228	212	215	227	238	238	242	235	225	231	
Reindeer	27	33	33	33	33	25	26	27	32	32	
Total, tonnes CH_4	254	245	248	261	271	262	268	262	257	263	
Total, tonnes CO_2 eqv.	5 336	5 141	5 209	5 473	5 692	5 510	5 635	5 502	5 393	5 532	

16.6.4 CH_4 and N_2O emission from Manure Management (CRF sector 4B)

Description

The emissions of CH_4 and N_2O from manure management are given in CRF Table 4.B (a) and 4.B (b). This source contributes with 8 % of the total emission from the agricultural sector in 2010. The major part of the emission originates from the production of sheep.

Methodological issues

CH_4 emission

The IPCC Tier 2/CS methodology has been used for the estimation of the CH_4 emission from manure management. Calculation of volatile solids, VS is based on national value of gross energy intake (GE). Default values is used for the maximum methane producing capacity (B_0), digestibility (DE), the ash content and the methane conversion factor (MCF).

For reindeer no default values exists. Thus DE, ASH and B_o estimates for sheep are used. Sheep and reindeer are similar creatures, both ruminants. Greenlandic reindeer weigh an average of 70 kg. Greenlandic sheep weight approximately 50 kg. However, while sheep are fed relative more intensively, reindeer only feed on what they find in nature all year around. On these arguments the best estimate is to use DE, ASH and B_0 estimates for sheep on reindeer as well.

Table 16.6.6 CH_4 – Manure management – use of national parameters and IPCC default values.

Parameter	Unit	Sheep	Reindeer	Default or national value
Gross energy intake (GE)	MJ pr head pr day	28.4	27.2	National
Digestibility (DE)	Percent	60	60	IPCC default
Ash content (ASH)	Percent	8	8	IPCC default
Volatile solids (VS)	Kg VS pr head pr day	0.57	0.54	National
Max. methane producing capacity (B_0)	M^3 pr kg VS	0.19	0.19	IPCC default
CH_4 conversion factor (MCF), solid storage and pasture	Percent	1	1	IPCC default
Emission factor	Kg CH_4 pr head pr yr	0.26	0.25	Tier 2

There are no changes in stable conditions or feed intake during the years 1990 to 2010. The implied emission factor is therefore the same for all years.

The default emission factor for sheep is 0.19 kg CH_4 per head per year. The higher national value is due to a higher estimate for gross energy intake.

Table 16.6.7 shows a decrease in the CH_4 emission from manure management from 1990 to 2010 by 8 %, which primarily is related to the fall in the production of reindeer.

Table 16.6.7 Emission of CH_4 from Manure Management 1990-2010, tonnes CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Sheep	5.2	5.2	4.7	4.2	4.6	5.1	5.2	6.0	5.2	5.5	5.3
Reindeer	1.5	1.5	1.4	1.1	1.2	1.2	1.2	1.0	1.5	0.5	0.5
Total, tonnes CH_4	6.7	6.7	6.1	5.3	5.8	6.2	6.4	7.0	6.7	6.0	5.8
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Sheep	5.3	4.9	5.0	5.3	5.5	5.5	5.6	5.5	5.2	5.4	
Reindeer	0.6	0.8	0.8	0.8	0.8	0.6	0.6	0.6	0.8	0.8	
Total, tonnes CH_4	5.9	5.7	5.8	6.1	6.3	6.1	6.3	6.1	6.0	6.1	

N_2O emission

Based on information from the Greenland Agricultural Consulting Services it is estimated that for sheep 55 % of the N-excretion is taken place in stable and all manure is handled as solid manure. The IPCC default emission value is applied, which means 2.0 % of the N-excretion for solid manure.

Reindeer is grassing all year. The emission from manure deposits on grass is included in “Pasture, Range and Paddock”.

The total nitrogen excretion for sheep has increased by 4 % from 1990 to 2010 (Table 16.6.8) due to an increase in the number of sheep.

Table 16.6.8 Total nitrogen excretion for sheep, 1990-2010, tonnes N.

CRF table 4.B(b)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Livestock category											
N-excreted, tonnes in total	120	121	107	98	107	117	121	139	120	126	123
N-excretion, tonnes in stable	66	66	59	54	59	64	67	76	66	69	67
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Livestock category											
N-excreted, tonnes in total	122	114	116	122	128	128	130	126	121	124	
N-excretion, tonnes in stable	67	63	64	67	70	70	72	70	66	68	

Time series consistency

As shown in Table 16.6.9, total emission from manure management from 1990 to 2010 in CO_2 equivalents has increased by 2 % due to an increase in the number of sheep.

Table 16.6.9 Emissions of N_2O and CH_4 from Manure Management 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
N_2O emission, tonnes CO_2 eqv.	641	647	576	523	573	626	648	744	641	675	657
CH_4 emission, tonnes CO_2 eqv.	140	141	127	111	121	130	134	146	140	126	122
Total, tonnes CO_2 eqv.	781	789	703	634	694	756	783	890	781	801	779
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
N_2O emission, tonnes CO_2 eqv.	656	610	619	655	685	684	698	678	647	666	
CH_4 emission, tonnes CO_2 eqv.	124	120	121	128	133	128	131	128	126	129	
Total, tonnes CO_2 eqv.	780	730	741	783	818	813	829	806	773	795	

16.6.5 N_2O emission from Agricultural Soils (CRF sector 4D)

Description

The N_2O emissions from agricultural soils CRF Table 4.D contributed in 2010 with 32.3 % of the total emission from the agricultural sector. Figure 16.6.2 shows the overall development from 1990 to 2010 and the distribution on different sources. Since 1990 N_2O emissions increased suddenly in 1996, when farmers increased their use of synthetic fertiliser significantly. From 1997 to 2007 the emission of N_2O varied with an increasing trend. In 2008 the emission of N_2O increased considerably due to a considerable increase in the use of synthetic fertiliser caused by a periodical drought in the agricultural part of Greenland. In 2009 and 2010 the use of synthetic fertiliser has returned to a more normal level thus the emission of N_2O has dropped as well.

Emission from synthetic fertiliser and nitrogen leaching is an essential part of the total emission from agricultural soils and contributes totally with 55.6 %. Of the remaining sources the greatest part of the emission, by 22 %, origins from pasture, range and paddocks. Emissions from all sources have increased from 1990 to 2010 except from atmospheric depositions and grassing animal where a fall in number of reindeer has taken place.

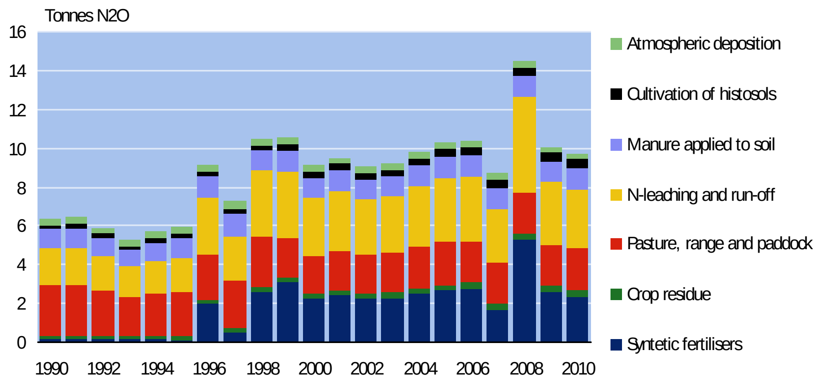

Figure 16.6.2 N_2O emissions from agricultural soils 1990-2010.

Methodological issues

To calculate the N_2O emission a combination of IPCC Tier 1a and Tier 1b is used. Tier 1b is used in calculation of emission from crops residue. Emissions of N_2O are closely related to the nitrogen balance. Data concerning the N-excretion, evaporation of ammonia from synthetic fertiliser and grassing animal are based on national values.

The NH_3 and N_2O emission factor survey is presented in Table 16.6.10 and shows that except from histosols all N_2O emission factor is based on IPCC default values. The estimated emissions from the different subsources are described in the text which follows.

Table 16.6.10 Emissions factor - N_2O emission from the Agricultural Soils 1990-2010.

Agricultural soils – emission sources CRF Table 4.D	Ammonia emission factor	N_2O emission factor (country specific value)	N_2O emission factor (IPCC default value)
	Kg NH_3-N pr kg N	kg N_2O-N pr ha	kg N_2O -N pr kg N
1. Direct Soil Emissions			
Synthetic Fertiliser Applied to Soils	0.01 (CS)		0.0125
Animal Wastes Applied to Soils	0.20 (IPCC default)		0.0125
N-fixing Crops			0.0125
Crop Residue			0.0125
Cultivation of Histosols		1.06*	
2. Animal Production	0.07 (CS)		0.02
3. Indirect Soil Emissions			
Atmospheric Deposition			0.01
Nitrogen Leaching and Runoff			0.025

CS = country specific value

* Include both emission from cropland and improved grassland. For further details see Section 16.7.

Direct emissions

Synthetic fertiliser

The calculation of nitrogen (N) applied to soil from use of synthetic fertiliser is based on data on imports from the Statistics Greenland. No data is available before 1994. The consumption for 1990 to 1993 is assumed to be on the same level as 1994. The nitrogen content for each fertiliser type is estimated based on expert judgement from the Danish Plant Directorate (Troels Knudsen, pers. comm.).

Table 16.6.11 shows the consumption of each type of fertiliser. Furthermore, the ammonia emission factor for each fertiliser is given, based on the values given in EMEP/EEA emission inventory guide book 2009 (Table 3-2). The emission factors are depending on the mean spring temperature estimated to 7 degrees in Greenland. The spring temperature has to reflect the time where the fertilisers are applied, which in Greenland normally is June.

Table 16.6.11 Synthetic fertiliser consumption 2010 and the NH_3 emission factors.

Synthetic fertiliser	Calculation of ammonia emission factor[1]	NH_3 emission factor[1] kg NH_3-N pr kg N	Consumption[2] t N
Fertiliser type			
Ammonium sulphate	=0.0107+0.0006*ts	1.49	NO
Ammonium nitrate	=0.008+0.0001*ts	0.87	1
Calcium ammonium nitrate	=0.008+0.0001*ts	0.87	0
Anhydrous ammonia	=0.0127+0.0012*ts	2.11	NO
Urea	=0.1067+0.0035*ts	13.12	0
Nitrogen solutions	=0.0481+0.0025*ts	6.56	NO
Ammonium phosphates	=0.0107+0.0006*ts	1.49	NO
Other NK and NPK	=0.008+0.0001*ts	0.87	119
Total consumption of N in synthetic fertiliser			120
National emission of NH_3-N, tonnes	1.2		
Average NH_3-N emission (FracGASF)	0.01		

*ts= means spring temperature=7 degree.

[1]) EMEP/EEA (2009).

[2]) Statistics Greenland and the Danish Plant Directorate.

The Greenlandic value for the FracGASF is estimated to less than 0.01 in 2010, which is considerably lower than the recommended default value in IPCC, i.e. 0.10. The major part of the fertiliser types used in Greenland is related to ammonia nitrate and NPK fertiliser where the emission factor is quite low, i.e. 0.0087 kg NH_3-N pr kg N. Before 1995 urea accounted for a higher fraction. The value of FracGASF for these years is estimated to 0.10-0.13.

Table 16.6.12 FracGASF, 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
FracGASM	0.13	0.13	0.13	0.13	0.13	0.10	0.02	0.03	0.01	0.01	0.01
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
FracGASM	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	

Table 16.6.13 shows an increase in use of fertiliser and a particularly high increase in 2008. Due to a relatively small number of farms the individual handling of one farmer has a high effect on the total consumptions. With consumption of fertilisers being based on imports of fertilisers it is not possible to account for fertilisers bought for stockpiling. Thus it is possible that the relative high increase in use of fertilisers in 2008 is due to stockpiling. Another explanation could be that both 2007 and 2008 were relative dry years leading to a considerable decrease in amount of hey harvested. Hence, it is possible that farmers have tended to increase the use of fertilisers in 2008 to produce more feed. The use of fertiliser returned to a more normal level in 2009 and 2010.

Table 16.6.13 Nitrogen applied as fertiliser to agricultural soils 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
N content in synthetic fertiliser, tonnes N	9	9	9	9	9	6	102	28	135	158	117
NH_3-N emission, tonnes	1	1	1	1	1	1	2	1	1	1	1
N in fertiliser applied on soil, tonnes N	8	8	8	8	8	6	100	27	134	157	116
N_2O emission, tonnes	0.16	0.16	0.16	0.16	0.16	0.11	1.97	0.53	2.63	3.08	2.28
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
N content in synthetic fertiliser, tonnes N	126	114	117	128	136	144	86	273	134	120	
NH_3-N emission, tonnes	1	1	1	1	1	1	1	2	1	1	
N in fertiliser applied on soil, tonnes N	125	113	116	127	135	142	85	271	133	119	
N_2O emission, tonnes	2.45	2.22	2.27	2.49	2.65	2.80	1.67	5.32	2.61	2.34	

Manure applied to soil

The amount of nitrogen applied to soil from sheep on stables is estimated as the N-excretion in stables minus the ammonia emission, which occur in stables, under storage and in relation to the application of manure. There are no measurements of ammonia emission from stables in Greenland. Thus IPCC default is used. However, the FracGASM default at 0.20 (IPCC 1997. Table 4-19) match the Danish emission ammonia from sheep, which are estimated to 24 % in 1990 reduced to 19 % in 2008. A lower ammonia emission in Greenland is expected due to the cold climate, but on the other hand no ammonia reducing measures are implemented as in Denmark. The FracGASM at 0.20 are therefore considered as reliable.

Table 16.6.14 shows the development in nitrogen excretion in stables, the estimated amount of N applied on soil and the N_2O emission.

Table 16.6.14 Nitrogen applied as manure to agricultural soils 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
N-excretion in stable, tonnes N	66	66	59	54	59	64	67	76	66	69	67
NH_3-N emission, tonnes N	13	13	12	11	12	13	13	15	13	14	13
N in manure applied on soil, tonnes N	53	53	47	43	47	51	53	61	53	55	54
N_2O emission, tonnes N_2O	1.03	1.04	0.93	0.84	0.92	1.01	1.05	1.20	1.03	1.09	1.06
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
N-excretion in stable, tonnes N	67	63	64	67	70	70	72	70	66	68	
NH_3-N emission, tonnes N	13	13	13	13	14	14	14	14	13	14	
N in manure applied on soil, tonnes N	54	50	51	54	56	56	57	56	53	55	
N_2O emission, tonnes N_2O	1.06	0.98	1.00	1.06	1.11	1.10	1.13	1.09	1.04	1.07	

Crop residue

The cultivated area is approximately 1,073 ha with the main part as grass fields, only 6,5 ha are used for potato production. The cultivated area decreased by 23 ha in 2010 due the shutdown of a farm. To estimate the emission from crop residue, IPCC Tier 1b has been applied. N_2O emissions from crop residues are calculated based on the total aboveground N-content in crop residue returned to soil, which in Greenland includes residue of leafs from grass fields and the top from potatoes.

National values for nitrogen content used are provided by the Faculty of Agricultural Sciences, Aarhus University (Djurhuus and Hansen 2003). Values are calculated based on relatively few observations related to Danish conditions, but are at present the best available data.

Table 16.6.15 N-content in crops residue 2010.

	Stubble	Husks	Top	Leafs	Frequency of ploughing	Nitrogen content in crop residue	
Crop type	kg N pr ha	kg N pr ha	kg N pr ha	kg N pr ha	No. of year before ploughing	kg N pr ha pr yr	kg N pr yr
Potatoes (top), non-harvest	-	-	48.7	-	1	48.7	17 546
Grass- and clover field in rotation	32.3		-	10.0	5	16.5	317
Total N from crop residue – 2010, kg							17 863

Reference: Djurhuus and Hansen 2003

To calculate the N_2O emission the IPCC standard emission factor 1.25 % is used. The national emission from crop residues has more than doubled from 1990 to 2010 (Table 16.6.16) as a result of increasing agricultural area.

Table 16.6.16 Emissions from crop residue 1990-2010.

Crop residue	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Grass stub/leaves, kg N	8 071	8 498	8 925	9 352	9 778	10 205	10 632	11 059	11 486	11 912	12 339
Potato tops, kg N	0	0	0	0	0	0	0	0	0	0	0
Crop residue total, kg N	8 071	8 498	8 925	9 352	9 778	10 205	10 632	11 059	11 486	11 912	12 339
N_2O emission, kg	159	167	175	184	192	200	209	217	226	234	242
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Grass stub/leaves, kg N	12 766	14 005	14 384	14 614	15 176	15 823	16 018	16 378	17 925	17 546	
Potato tops, kg N	244	244	244	244	244	244	244	244	317	317	
Crop residue total, kg N	13 010	14 249	14 628	14 857	15 420	16 066	16 262	16 621	18 241	17 863	
N_2O emission, kg	256	280	287	292	303	316	319	326	358	351	

Frac vaules

There is no cultivation of nitrogen fixing crops, why the Fraction value $Frac_{NCRBF}$ is not relevant. Until national data is available, the default value of $Frac_{NCRO}$ by 0.015 is used. The default value of $Frac_R$ is not current for the Greenlandic conditions, where the main part of the aboveground biomass is harvest and used for ensilage. Until national data is available, the $Frac_R$ is registered as "Not Estimated".

Cultivation of histosols

N_2O emissions from histosols are based on the area with organic soils multiplied by the emission factor of 1.06 kg N_2O-N pr. kg N in 2010. See Section 16.7 on LULUCF for further description on cultivation of histosols.

Table 16.6.17 shows an increase in the N_2O emission from 1990 to 2010 due to extend of the agricultural area.

Table 16.6.17 Activity data and emission from cultivation of histosols 1990-2010.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cultivated histosols, ha	123	129	136	142	149	155	161	168	174	181	187
N_2O emission, kg	201	211	222	232	243	254	264	275	285	296	307
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Cultivated histosols, ha	195	214	220	223	232	242	245	250	274	268	
N_2O emission, kg	325	356	366	371	385	401	406	415	456	447	

Pasture, Range and Paddock

The amount of nitrogen deposited on grass includes grassing from reindeer 365 days a year and from sheep 164 days a year. An ammonia emission factor of 7 % is used for all animal categories based on investigations from the Netherlands and the United Kingdom (Jarvis et al., 1989a. Jarvis et al., 1989b and Bussink, 1994). EMEP/EEA emission inventory guidebook 2009 use a similar emission factor at 6 % for grassing dairy cattle (calculated from 4B, Appendix B).

Table 16.6.18 shows the estimated values of N-excretion from grassing animals, ammonia emission, the N_2O emission and the FracGRAZ value. As a consequence of all in number of reindeer, both the N_2O emission and the FracGRAZ value have decreased from 1990 to 2010.

Table 16.6.18 Emission from grassing animals 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
N-excretion on grass, tonnes N	88	89	81	69	75	79	81	84	88	69	67
NH_3-N emission, tonnes	6	6	6	5	5	6	6	6	6	5	5
N deposited on grass, tonnes N	82	83	75	64	69	73	75	78	82	64	62
N_2O emission, tonnes	2.58	2.60	2.35	2.01	2.18	2.31	2.36	2.46	2.58	2.01	1.95
FracGRAZ	0.57	0.57	0.58	0.56	0.56	0.55	0.55	0.52	0.57	0.50	0.50
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
N-excretion on grass, tonnes N	69	69	70	73	75	71	73	71	72	73	
NH_3-N emission, tonnes	5	5	5	5	5	5	5	5	5	5	
N deposited on grass, tonnes N	64	64	65	68	70	66	68	66	67	68	
N_2O emission, tonnes	2.03	2.02	2.04	2.13	2.20	2.07	2.12	2.08	2.09	2.14	
FracGRAZ	0.51	0.52	0.52	0.52	0.52	0.50	0.50	0.51	0.52	0.52	

Indirect emissions

Atmospheric deposition

Atmospheric deposition includes ammonia emission from manure management, use of synthetic fertiliser and from grassing animals

The N_2O emission from atmospheric deposition is nearly unaltered from 1990 to 2010. The fall in the reindeer production compensate for an increase in the number of sheep and a rise in use of synthetic fertiliser.

Table 16.6.19 Emission from atmospheric deposition 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NH_3-N manure management, tonnes	13	13	12	11	12	13	13	15	13	14	13
NH_3-N synthetic fertliser, tonnes	1	1	1	1	1	1	2	1	1	1	1
NH_3-N pasture, tonnes	6	6	6	5	5	6	6	6	6	5	5
NH_3-N total, tonnes	21	21	19	17	18	19	21	22	21	20	19
N_2O emission, tonnes	0.32	0.33	0.29	0.26	0.29	0.30	0.33	0.34	0.32	0.32	0.30
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
NH_3-N manure management, tonnes	13	13	13	13	14	14	14	14	13	14	
NH_3-N synthetic fertliser, tonnes	1	1	1	1	1	1	1	2	1	1	
NH_3-N pasture, tonnes	5	5	5	5	5	5	5	5	5	5	
NH_3-N total, tonnes	19	18	19	20	21	20	21	21	19	20	
N_2O emission, tonnes	0.30	0.29	0.29	0.31	0.32	0.32	0.33	0.33	0.31	0.31	

Nitrogen leaching and Run-off

The amount of nitrogen lost by leaching and run-off is calculated by using the IPCC default FracLEACH at 0.3 (IPCC 1997, Table 4-24).

The emission has more than doubled from 1990 to 2008. The total nitrogen content in manure has decreased due to a fall in the reindeer production. The increasing is due to a significant rise in use of synthetic fertiliser. In 2009 and the amount of nitrogen lost by leaching and run-off decreased primarily due to a decrease in the use of synthetic fertiliser.

Table 16.6.20 Emission from N-leaching and runoff 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
N-excretion total, tonnes N	154	155	140	122	133	143	147	161	154	138	134
N in synthetic fertiliser, tonnes	9	9	9	9	9	6	102	28	135	158	117
N_2O emission, tonnes	1.92	1.94	1.75	1.55	1.68	1.76	2.94	2.22	3.41	3.50	2.96
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
N-excretion total, tonnes N	137	132	133	140	146	141	144	141	138	142	
N in synthetic fertiliser, tonnes	126	114	117	128	136	144	86	273	134	120	
N_2O emission, tonnes	3.09	2.89	2.95	3.16	3.32	3.36	2.72	4.88	3.20	3.09	

Activity data

Table 16.6.21 provides an overview on activity data from 1990 to 2010 used to the estimation of N_2O emission from agricultural soils. For all emission sources the unit tonnes of nitrogen are used except from cultivation of histosols, where the unit is given as hectare.

Table 16.6.21 Activity data - agricultural soils 1990-2010, tonnes N (cultivation of histosols = ha).

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Direct Emissions											
Synthetic Fertiliser	8	8	8	8	8	6	100	27	134	157	116
Animal Manure Applied to Soils	53	53	47	43	47	51	53	61	53	55	54
Crop Residue	8	8	9	9	10	10	11	11	11	12	12
Cultivation of histosols	123	129	136	142	149	155	161	168	174	181	187
2. Pasture, Range and Paddock Manure	82	83	75	64	69	73	75	78	82	64	62
3. Indirect Emissions											
Atmospheric Deposition	21	21	19	17	18	19	21	22	21	20	19
Nitrogen Leaching and Run-off	49	49	45	39	43	45	75	56	87	89	75
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1. Direct Emissions											
Synthetic Fertiliser	125	113	116	127	135	142	85	271	133	119	
Animal Manure Applied to Soils	54	50	51	54	56	56	57	56	53	55	
Crop Residue	13	14	15	15	15	16	16	17	18	18	
Cultivation of histosols	195	214	220	223	232	242	245	250	274	268	
2. Pasture, Range and Paddock Manure	64	64	65	68	70	66	68	66	67	68	
3. Indirect Emissions											
Atmospheric Deposition	19	18	19	20	21	20	21	21	19	20	
Nitrogen Leaching and Run-off	79	74	75	80	85	85	69	124	82	79	

Time series consistency

The N_2O emissions from agricultural soils have increased from 6.4 tonnes N_2O in 1990 to 14.5 tonnes N_2O in 2008. The more than doubled emission is a consequence of a significant increase in use of nitrogen in synthetic fertiliser. In 2009 and 2010 N_2O emissions from agricultural soils decreased primarily due to a fall in the use of synthetic fertiliser.

Table 16.6.22 Emissions of N_2O from Agricultural Soils 1990–2010, tonnes N_2O.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total N_2O emission	6.4	6.4	5.9	5.2	5.7	5.9	9.1	7.2	10.5	10.5	9.1
1. Direct Emissions											
Synthetic Fertiliser	0.2	0.2	0.2	0.2	0.2	0.1	2.0	0.5	2.6	3.1	2.3
Animal Manure Applied on Soil	1.0	1.0	0.9	0.8	0.9	1.0	1.0	1.2	1.0	1.1	1.1
Crop Residue	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cultivation of Histosols	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
2. Pasture, Range and Paddock Manure	2.6	2.6	2.4	2.0	2.2	2.3	2.4	2.5	2.6	2.0	1.9
3. Indirect Emissions											
Atmospheric Deposition	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Nitrogen Leaching and Run-off	1.9	1.9	1.8	1.5	1.7	1.8	2.9	2.2	3.4	3.5	3.0
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Total N_2O emission	9.5	9.0	9.2	9.8	10.3	10.4	8.7	14.5	10.1	9.7	
1. Direct Emissions											
Synthetic Fertiliser	2.4	2.2	2.3	2.5	2.6	2.8	1.7	5.3	2.6	2.3	
Animal Manure Applied on Soil	1.1	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.0	1.1	
Crop Residue	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	
Cultivation of Histosols	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	
2. Pasture, Range and Paddock Manure	2.0	2.0	2.0	2.1	2.2	2.1	2.1	2.1	2.1	2.1	
3. Indirect Emissions											
Atmospheric Deposition	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
Nitrogen Leaching and Run-off	3.1	2.9	2.9	3.2	3.3	3.4	2.7	4.9	3.2	3.1	

16.6.6 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for agricultural sector. The uncertainties for the activity data and emission factors are shown in Table 16.6.23.

Table 16.6.23 Uncertainties for activity data and emission factors for agriculture.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
4A Enteric Fermentation	CH_4	10	100
4B Manure Management	CH_4	10	100
4B Manure Management	N_2O	10	100
4D1 Direct N_2O emissions from agricultural soils	N_2O	20	50
4D2 Pasture range and paddock	N_2O	20	25
4D3 Indirect N_2O emissions from agricultural soils	N_2O	20	50

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 16.6.24.

Table 16.6.24 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2010 %	Trend uncertainty %
GHG	61	6.5	± 15
CH_4	98	-8.1	± 13
N_2O	31	40.9	± 25

16.6.7 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, data on livestock, land-use categories, synthetic fertilisers and cultivation of histosols has gone through a great deal of quality work with regard to accuracy, comparability and completeness.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Annual data on livestock, land-use categories, synthetic fertilisers and cultivation of histosols are compared with previous years and large discrepancies are checked.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this needs to be elaborated.

Time series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked of the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

16.6.8 Source specific recalculations and improvements

Table 16.6.25 shows recalculations in the agricultural sector compared with the 2011 submission. Some improvements have been made primarily regarding emission from agricultural soils, where the emission factor on cultivation of histosols have been revised, see Section 16.7 for further details.

Table 16.6.25 Changes in GHG emission in the agricultural sector compared with the 2011 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Previous inventory, Gg CO_2 eqv.	9.2	9.3	8.4	7.5	8.2	8.7	9.9	10.0	10.6	10.1	9.5
Recalculated, Gg CO_2 eqv.	8.8	8.9	8.0	7.0	7.7	8.2	9.4	9.4	10.1	9.5	8.8
Change in Gg CO_2 eqv.	-0.4	-0.4	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6	-0.6	-0.6	-0.6
Change in pct.	-4.5	-4.7	-5.4	-6.4	-6.2	-6.0	-5.5	-5.7	-5.6	-6.1	-6.7
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Previous inventory, Gg CO_2 eqv.	9.7	9.4	9.5	10.1	10.5	10.4	10.0	11.6	10.2	-	
Recalculated, Gg CO_2 eqv.	9.1	8.7	8.8	9.3	9.7	9.5	9.2	10.8	9.3	9.3	
Change in Gg CO_2 eqv.	-0.7	-0.7	-0.7	-0.8	-0.8	-0.8	-0.8	-0.8	-0.9	-	
Change in pct.	-6.8	-7.7	-7.8	-7.5	-7.5	-7.9	-8.3	-7.3	-9.1	-	

16.6.9 Source specific planned improvements

The Greenlandic emission inventory for the agricultural sector largely meets the request as set down in the IPCC Good Practice Guidance. Thus for the moment improvements especially concern the QA/QC practice.

16.6.10 References

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16.7 LULUCF (CRF sector 5)

16.7.1 Overview of LULUCF

This LULUCF chapter covers only the territory of Greenland. Greenland is part of the Danish Kingdom.

Figure 16.7.1 Municipalities and major cities in Greenland.

Greenland is the world's largest non-continental island on the northern American continent between the Arctic Ocean and the North Atlantic Ocean, northeast of Canada. The northernmost point of Greenland, Cape Morris Jesup, is only 740 km from then North Pole. The southernmost point is Cape Farewell, which lies at about the same latitude as Oslo in Norway. Geographical coordinates are 72 00 N, 40 00 W.

Greenland is covering approx. 2,166,086 km^2. It has been estimated that 81 % is covered permanently with ice leaving only 410,449 km^2 ice free. The distance from the South to the North is 2,670 km, and from East to West 1,050 km.

The Terrain is flat to gradually sloping ice cap, which covers all but a narrow, mountainous, barren, rocky coast. The ice cap is up to 3 km thick, and contains 10 per cent of the world's resources of freshwater.

The climate is Arctic to sub-arctic with cool winters and cold summers in which the mean temperature does not exceed 10° C.

The mean temperature in January is for Nuuk, -8.6°, Kangerlussuaq, -17.0° and Ilulissat -9.6° (2007) and for July: Nuuk 7.7°, Kangerlussuaq 11.5° and Ilulissat 9.6° (2007).

Greenland is normally defined as having three different climatic zones. For the purpose of reporting is used the definition "Polar and Moist" according to IPCC GPG 2006 although some areas may qualify as Arctic deserts.

The sparse population is confined to small settlements along the coast, but close to one-quarter of the population lives in the capital, Nuuk. The total population in January 2010 was 56,452 inhabitants.

Due to the cold climate and the small constant population there is almost no land use change occurring. The total area with Forests has been estimated to 232.5 hectares and 6.5 hectares with Cropland. Grassland is divided into improved Grassland covering 1066 hectares and unimproved Grassland covering 241,000 hectares. Wetlands consist of man made water reservoirs – in total 1,076 hectares. Settlements cover 5,180 hectares. Land classified as "Other Land" is then 99.9 % of the total area.

In the following text the abbreviations are used in accordance with definitions in the IPCC guidelines:

A:	Afforestation, areas with forest established after 1990 under Article 3.3.
R:	Reforestation, areas which have temporarily been unstocked for less than 10 years - included under Article 3.4.
D:	Deforestation, areas where forests are permanently removed to allow for other land use, included under Article 3.3.
FF:	Forest remaining Forest, areas remaining forest after 1990.
FL:	Forest Land meeting the definition of forests.
CL:	Cropland.
GL:	Grassland.
SE:	Settlements.
OL:	Other land, unclassified land.
FM:	Forest Management, areas managed under Article 3.4.
CM:	Cropland Management, areas managed under Article 3.4.
GM:	Grazing land Management, areas managed under Article 3.4.

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of carbon dioxide. LULUCF are reported in the new CRF format. Removals are given as negative figures and emissions are reported as positive figures according to the guidelines.

In total the LULUCF sector has been estimated as a net source of 1.42 Gg CO_2 equivalents in 2010 equivalent to 0.2 % of the total Greenlandic emission.

The overall land use change from 1990 to 2010 is very small. Afforestation has been made on 14 hectares. No deforestation has occurred and the Cropland area has increased from none to 6.5 hectares.

The emission data are reported in the new CRF format under IPCC categories 5A (Forestry), 5B (Cropland), 5C (Grassland), 5D (Wetlands) and 5E (Settlements) and 5F (Other Land).

Fertilisation of forests and other land is not occurring and all fertiliser consumption is therefore reported in the agricultural sector. No drainage of forest soils is made. All liming is reported under Grassland because liming is not occurring in the forests and the very small area with Cropland. Field burning of wooden biomass is not occurring. Wildfires may occur sporadic in the mountains and these are reported as "Other land". Hence wildfires are reported as NO.

Table 16.7.1 gives an overview of the emission from the LULUCF sector in Greenland. The Forests are a net sink. Cropland is ranging from being zero in 1990 (no Cropland was occurring in 1990) to being a net source in 2010. GL has been estimated to be a small net source in 2010 due a decrease in the improved area with grassland compared to 2009, which has decreased the amount of living biomass in GL.

Table 16.7.1 Overall emission (Gg CO_2) from the LULUCF sector in Greenland, 1990-2010.

Greenhouse gas source and sink categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
5. Land Use, Land-Use Change and Forestry, CO_2	0,21	0,39	0,53	0,64	0,62	0,96	0,86	0,15	1,42
A. Forest Land	NA	-0,02	-0,03	-0,05	-0,05	-0,05	-0,06	-0,03	-0,04
B. Cropland	IE,NA,NO	IE,NA,NO	IE,NA,NO	0,02	0,02	0,02	0,02	0,03	0,03
C. Grassland	0,21	0,41	0,56	0,66	0,65	0,98	0,89	0,16	1,43
D. Wetlands	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA

16.7.2 Forest remaining forest (5.A.1)

Forests and forest management

Greenland has virtually no forests and therefore there exist no official forest statistics. All forests are situated in the most southern part of Greenland. In an attempt to introduce trees to Greenland research were carried out to find species adaptable for the Greenlandic climate. This resulted in establishment of the Greenlandic Arboretum, which covers 150 hectares out of the total area of 218.5 hectares, Figure 16.7.2 and Table 16.7.2. Information about the Greenlandic Arboret can be found at:

http://sl.life.ku.dk/om_skov_landskab/arboreter_terapihaver/arboret_groenland/Groenland_arboret_historie.aspx

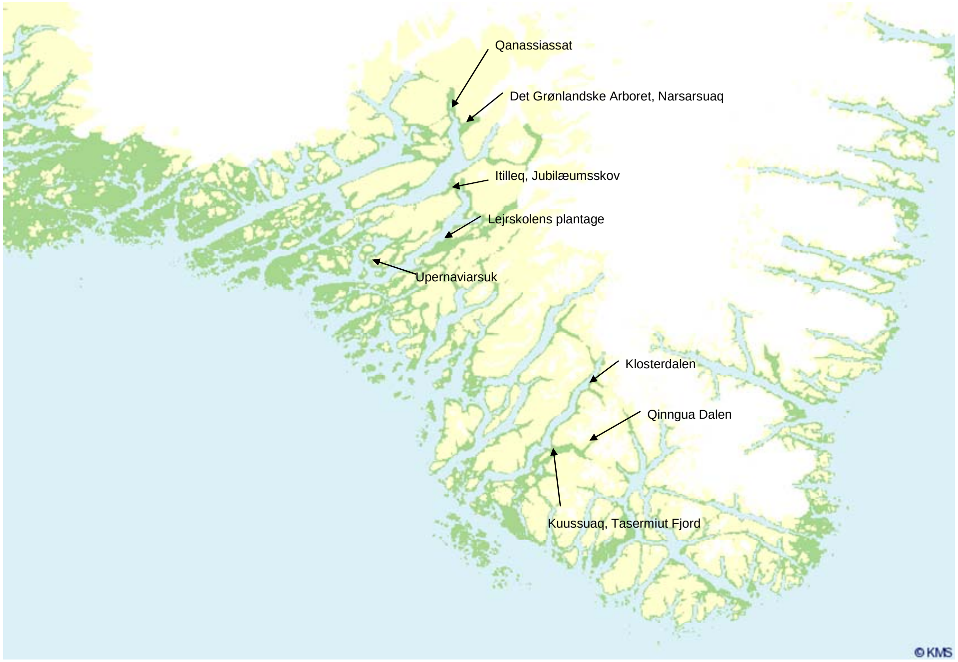

Figure 16.7.2 The position of the Greenlandic forests (Courtesy to Rasmus Enoksen Christensen).

Table 16.7.2 Forests in Greenland 1990 and 2010.

Location	Established	Dominant tree	Area,ha	1990 average tree height (m)	2010 average tree height	Density 1990 (trees pr ha)	Density 2009
Qinngua Valley	Natural	Birch and mountain ash	45	n.a	6	100	100
Qanassiassat Forest	1953-63	Conifer	1	5	10.9	1500	1000
	1962-64	Conifer	5	3	10.1	1300	900
Kuussuaq Forest	-1982						
	2008	Conifer	3	***	< 1	***	
Kuussuaq Forest							3500
Greenland Arboretum	(1976-1980)	Conifer	3	4	7	300	300
Greenland Arboretum	1980 -	Conifer	150	2	3	1500	1700
Itilleq	2004-2005	Conifer	6	***	< 1	***	3500
Upernaviarsuk	1954	Conifer	0,5	1,5	3	200	200
Lejrskolen	1999-2005	Conifer	4	***	1	***	2500
Klosterdalen	2000	Conifer	1	***	1	***	2000
Total			232.5				

Forest definition

The forest definition adopted in Greenland is almost identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10 %. The minimum width is 20 m." Temporarily non wooded areas, fire breaks, and other small open areas, that are an integrated part of the forest, are also included. However, due to extreme slow growing rates many of the forests are currently below 5 meters height.

Figure 16.7.3 shows a picture of the best developed forest in Greenland.

Figure 16.7.3 The forest in Kuusuaq. Photo: Rasmus E. Christensen, 2005.

Of special interest is the forest in Qinngua Valley. The Qinngua Valley is situated in a remote area. It consists of natural birch (*Betula pubescens spp. czerepanovii* and *B. glandulosa.)* which develops to forest like trees (Figure 7.3) probably due to an introgressiv hybridisation (Rasmus Enoksen Christensen). This forest will probably not follow the FAO forest definition but are included in the inventory as a sub-division under forests. The Qinngua-valley is not included in the FAO forest statistics.

Figure 16.7.4 Kuussuaq, Tasermiut fjor. Photo: Rasmus Christensen, Juni 2004.

Methodological issues for forests

Estimation of volume, biomass and carbon pools

Due to lack of precise data and slow growth rates, simple functions are used that only include the height of the trees and the number per hectare.

The height of the trees has been estimated by Rasmus Enoksen Christensen based on data from the Aboretum. It is assumed that the trees are conical and the stem diameter at ground level is based on the general formula for even-aged forests (Vanclay, 2009).

$$D = \beta(H - 1.3)/\ln(N) \quad \text{(eq.1)}$$

Where:

D = diameter at breast height, cm

ß = slope, species dependent

H = Height of the trees (meters)

N = Number of trees per hectare

Eq. 1 has been simplified by omitting the breast height (1.3 meters) to

$$D = \beta(H)/\ln(N) \quad \text{(eq.2)}$$

so that D is representing the diameter at ground level. The ß-value used is given in Table 16.7.2.

Table 16.7.2 ß-values for estimating the diameter of trees (from Vanclay, 2009).

	Betula, spp	Conifers
ß-values	6.54	7.51

In order to estimate the C stock and C stock change is used the average default values from the IPCC 2006 guidelines for BCEF, density, C-content and Root-Shoot ratio for Boreal stands with a growing stock level of 21-50 m^3, IPCC table 4.5, pp 4.50. The values are given in Table 16.7.3.

Table 16.7.3 Biomass expansion factors used for Greenland.

		Qinngua Walley (Betula, spp.) Birch	Conifers	Orpiuteqarfia (Larix sibirica) Sibirian Larch)
BCEF	Dimensionless	0.7	0.66	0.78
Density	kg dry matter per litre	0.51	0.4	0.46
C-content	kg C per kg dry matter	0.48	0.51	0.51
Root-shoot-ratio	Dimensionless	0.39	0.39	0.39
Dead Organic Matter	kg per kg aboveground biomass	0.1	0.2	0.1

Source: IPCC 2006 guidelines.

Dead wood volume, biomass and carbon

The volume of dead organic matter (DOM) is estimated as a fraction of the aboveground biomass (Table 16.7.3). It is assumed that litter is included in DOM.

Forest soils: forest floors and mineral soil

Following the cold climate and the slow growing rate it is assumed that no changes takes place in C-stock in the soil and hereby following the IPCC 2006 guidelines at Tier 1 level.

Uncertainties and time series consistency

The uncertainty in estimation of the C stock changes in the Greenlandic forests is very high. As there are very limited resources to visit and monitor in the remote areas there are very few data available. The current inventory is therefore based on the best knowledge available. It should also be taken into consideration that the importance of the forest sector in Greenland is marginal as only very little thinning is taking place as well as no deforestation and that the effect on the inventory is almost not measurable.

In the overall uncertainty section for the LULUCF is made a Tier 1 uncertainty analysis.

QA/QC and verification

Focus on the measurements of carbon pools in forest in Greenland will contribute to QA/QC and verification, but at the moment there are no plans to a further monitoring of the Greenlandic forests.

Recalculations and changes made in response to the review process

No recalculations have been made.

Planned improvements

No improvements are planned.

16.7.3 Land converted to forests

Forest area

See Section 16.2.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation.

Forest definition

See Section 16.2.1 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix).

Methodological issues for land converted to forest

See also Section 16.2.1.

Since 1990 there has been a slight increase in the forest area of 14 hectares. This has taken place on land converted from "OL".

Uncertainties and time series consistency

See Section 16.2.1. For uncertainties, please se Chapter 16.7.13.

QA/QC and verification

No QA/QC plan has been made yet. The afforestated area is known.

Recalculations, including changes made in response to the review process

None

Planned improvements

No improvements are planned.

16.7.4 Cropland – 5B

Cropland and cropland management – 5B1

In 1990 there were no cropland occurring in Greenland. Due to the global warming it is now possible to have a few crops which may mature. In 2001 the first five hectares with annual crops were established. These are reported under 5.B.2. A more intensive description of the agriculture in

Greenland can be found at
http://nunalerineq.gl/english/landbrug/jord/index-jord.htm

Land converted to cropland – 5B2

In 2001 the first annual crops were grown in Greenland. Approximately five hectares with garden crops were grown. Of this is it assumed that 25 % of the area is on organic soils (pers. comm. with Kenneth Høeg, former chief agricultural advisor in Greenland). The area converted to cropland was improved grassland.

Figure 16.7.5 Cropland and Grassland in Greenland.
(Photos from: http://nunalerineq.gl/english/landbrug/landbrug/index-landbrug.htm).

The region is generally characterized by a slightly podsol type of soil with a low pH value and small amounts of accessible plant nutrients. Larger concentrations of clay rarely occur, but considerable quantities of silt are often observable on the surface. Also, a certain amount of brown earth occurs in inland areas.

Methodological issues

Change in carbon stock in living biomass

For land converted to cropland is used a standard default value of 5,000 kg DM (dry matter) per hectare in above- and below-ground (IPCC 2006).

Change in carbon stock in dead organic matter

No organic matter is reported under CL.

Change in carbon stock in soils

No C stock changes in mineral soils are assumed. The emission in the 25 % organic soils is estimated by using the IPCC 2006 default value for cropland, Table 5.6 pp 5.19 of 5,000 kg C per ha per year.

Uncertainties and time series consistency
The time series are complete. For uncertainties, please see Chapter 16.7.13.

Category-specific QA/QC and verification
The number of hectares is provided by the Greenlandic Agricultural Consulting Services. As agricultural activities are economically subsidised in Greenland the figures are very accurate.

Category-specific recalculation
No recalculation has been made.

Category-specific planned improvements
No improvements are planned.

16.7.5 Grassland – 5C

Grassland remaining grassland – 5C1
Grassland in Greenland is dominated by unimproved grassland where the sheep is grazing. The total area with GL has been estimated to 242,000 hectares. Of these only approximately 1,000 hectare is improved where stones have been removed combined with sowing of more high yielding species, see Figure 16.7.5.

Since 1990 the area with improved grassland has been extended from 460 hectares to 1066 hectares.

Methodological issues for grassland
Grassland is divided into improved and unmanaged Grassland.

Change in carbon stock in living biomass
As more GL becomes improved the amount of living biomass at peak is increased. To estimate the amount of living biomass in improved GL is using the same default value as for Cropland, e.g. 5000 kg DM per hectare, IPCC 2006 default value for cropland, Table 5.9 pp 5.28. For unmanaged Grassland is used a default value of 1700 kg DM per hectare according to IPCC 2006 default, Table 6.4 pp 6.27. No estimates for below-ground biomass are given. For conversion from DM to C is used a default value of 0.5 kg C per kg DM.

Change in carbon stock in dead organic matter
No changes in dead organic matter are estimated as this is not occurring for this category.

Change in carbon stock in soils
No changes in the carbon stock in mineral soils are assumed. For organic soils on improved grassland is used a default EF of 1,250 kg C per ha per year (IPCC, 2006) default value for grassland, Table 6.3 pp 6.17. For unmanaged grassland no carbon stock change is expected.

Uncertainties and time series consistency
The time series is complete. For uncertainties, please se Chapter 16.7.13.

Category-specific QA/QC and verification
The number of hectares is provided by the Greenlandic Agricultural Consulting Services. As the agriculture is subsidised in Greenland the figures are very accurate.

Recalculations
No recalculation has been made.

Planned improvements
No improvements are planned.

16.7.6 Wetlands – 5D

Wetland in Greenland includes only human made water reservoirs and not naturally occurring wetlands. In total 1,076 hectares with ponds and water reservoirs distributed on 48 locations are reported.

No emission estimates from these reservoirs has been made yet.

Uncertainties and time series consistency
Not estimated.

QA/QC and verification
QA and QC have been made by DCE and Statistics Greenland.

Recalculations
No recalculations have been made.

Category-specific planned improvements
No improvements are planned.

16.7.7 Settlements – 5E

In total there are approximately 56,000 inhabitants in Greenland with about one quarter of the population in the capital, Nuuk.

Table 7.4 Inhabitants and the area occupied with houses, hectares.

	1990	2000	2010
Cities, inhabitants	44,427	45,734	47.857
Small villages, inhabitants	11,131	10,373	8.758
City area, ha	2,964	3,051	3,355
Villages, ha	1,825	1,825	1,825
Settlements, total, ha	4,789	4,876	5,180

The cities are build on the rocky coastline where almost none vegetation occurs. As a consequence estimates for C stock in living biomass and in soil have been made.

The small increase in the area with Settlements since 1990 has taken place on “Other land”.

Currently, no official data or measurements of the area of villages and settlements is available. Alternatively, land utilized for villages and settlements have been measured by the use of NunaGIS, which is a digital internet atlas displaying maps over villages and settlements in Greenland. NunaGIS is available at www.nunagis.gl.

16.7.8 Other land

The far major part of Greenland is covered with snow or rocks. Thus Other Land consists of 99.9 % of the total area.

No emission estimates have been made for this area.

The global warming can be seen in Greenland with longer and warmer summers, which again increase the amount of living biomass. Especially since the early 1990's there has been changes observed in the environment, e.g. as given in the area with Cropland and Grassland has increased. However, no methodology exists currently to estimate a proper estimate of the amount of living biomass in the large area classified as "Other land".

16.7.9 Direct N_2O emissions from N fertilization of Forest Land and Other land use – 5(I)

Not occurring.

16.7.10 Non-CO_2 emissions from drainage of forest soils and wetlands – 5(II)

Not occurring.

16.7.11 N_2O emissions from disturbance associated with land-use conversion to cropland – 5(III)

Not occurring.

16.7.12 CO_2 emissions from agricultural lime application – 5(IV)

As part of the agricultural practice liming is taking place on acidic agricultural soils (Kenneth Høeg, personal communation). The total amount of lime consumed in 2009, based on import statistics, is 5 tonnes lime and 5 tonnes dolomite.

The amount of C is calculated according to the guidelines with a 90 % purity of lime and 95 % purity for dolomite. It is assumed that all C disappear as CO_2 the same year as the lime is applied.

Planned Improvements

None.

16.7.13 Biomass burning – 5(V)

No biomass burning takes place in Greenland, and wildfires rarely occur due to the moist climate.

16.7.14 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for LULUCF. The uncertainties for the activity data and emission factors are shown in Table 16.7.4.

Table 16.7.4 Uncertainties for activity data and emission factors for LULUCF.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
5A Forest	CO_2	5	50
5B Cropland	CO_2	5	50
5C Grassland	CO_2	5	50

The assumed uncertainties represent expert judgement.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 16.7.5.

Table 16.7.5 Uncertainties for the emission estimates.

		1990 Emission/sink, Gg CO_2 eqv.	2010 Emission/sink, Gg CO_2 eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2 eqv.
5. LULUCF		-0,7	-5,4				48,9	2,6
5.A Forests		0,0	-0,04				50,2	0,0
Forests	CO_2	NA	-0,04	5	50	50,2	50,2	0,0
5.B Cropland		0,0	-0,1				50,2	0,1
Cropland	CO_2	NA	-0,1	5	50	50,2	50,2	0,1
5.C.Grassland		-0,8	-5,2				50,2	2,6
Grassland	CO_2	-0,8	-5,2	5	50	50,2	50,2	2,6
5(IV) Liming	CO_2	0,0	0,0				50,2	0,0
	CO_2	0,0	0,0	5	50	50,2	50,2	0,0

16.7.15References

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16.8 Waste (CRF sector 6)

16.8.1 Overview of sector

The waste sector consists of the CRF source category 6.A. Solid Waste Disposal on Land, 6.B. Wastewater Handling, 6.C. Waste Incineration and 6.D. Other.

In CO_2 equivalents, the waste sector (without LULUCF) contributes with 3.0 % of the overall greenhouse gas emission (GHG) in 2010. This corresponds to an emission of 21.8 Gg CO_2 equivalents.

The Greenlandic inventory includes CH_4 emissions from solid waste disposal on land, CH_4 and N_2O from wastewater handling and CO_2, CH_4, N_2O, NO_x, CO, NMVOC and SO_2 from waste incineration. Only emissions from waste incineration without energy recovery are included in the waste sector. Emissions from waste incineration with energy recovery are included in the energy sector.

Table 16.8.1 shows the greenhouse gas emissions from the waste sector. The emissions are taken from the CRF tables and are presented as rounded figures.

Table 16.8.1 Emissions for the waste sector, Gg CO_2 equivalents.

		1990	1991	1992	1993	1994	1995	1996
6 A. Solid Waste Disposal on Land	CH_4	3.6	3.7	3.8	3.8	3.9	3.9	4.0
6 B. Wastewater Handling	N_2O	14.9	14.8	14.8	14.8	14.9	14.9	14.9
6 C. Waste incineration	CO_2	2.6	2.6	2.6	2.6	2.7	2.7	2.9
6 C. Waste incineration	CH_4	2.3	2.3	2.3	2.3	2.3	2.4	2.3
6 C. Waste incineration	N_2O	1.1	1.1	1.1	1.1	1.1	1.1	1.1
6. Waste	To-	24.4	24.5	24.6	24.7	24.9	25.0	25.3
continued		1997	1998	1999	2000	2001	2002	2003
6 A. Solid Waste Disposal on Land	CH_4	4.1	4.1	4.1	4.2	4.1	4.1	4.1
6 B. Wastewater Handling	N_2O	14.9	14.9	14.9	14.9	14.9	14.9	14.9
6 C. Waste incineration	CO_2	3.1	3.5	3.4	3.2	3.3	3.2	3.1
6 C. Waste incineration	CH_4	2.3	2.2	2.1	1.8	1.8	1.7	1.6
6 C. Waste incineration	N_2O	1.1	1.1	1.0	0.9	0.9	0.9	0.8
6. Waste	To-	25.5	25.8	25.5	24.9	25.0	24.9	24.6
continued		2004	2005	2006	2007	2008	2009	2010
6 A. Solid Waste Disposal on Land	CH_4	4.1	4.1	4.0	4.0	4.0	3.9	3.9
6 B. Wastewater Handling	N_2O	14.9	14.9	15.0	15.1	15.7	13.0	12.4
6 C. Waste incineration	CO_2	3.1	3.1	3.1	3.1	3.1	3.1	3.1
6 C. Waste incineration	CH_4	1.6	1.6	1.6	1.6	1.6	1.6	1.6
6 C. Waste incineration	N_2O	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6. Waste	To-	24.4	24.4	24.5	24.5	25.1	22.4	21.8

The largest source of greenhouse gas emission in 2010 from the waste sector is N_2O emission from wastewater handling (57 %), more specifically from industrial effluents. Other large sources are CH_4 from solid waste disposal on land (18 %) and CO_2 from waste incineration (14 %).

The total greenhouse gas emission from the waste sector has decreased by 10.6 % from 1990 to 2010. Emission of N_2O from wastewater handling and CH_4 from solid waste disposal on land continued decreasing in 2010, while emissions of CH_4, N_2O and CO_2 from waste incineration increased slightly in 2010.

16.8.2 Solid waste management

Activity data for waste amounts for solid waste management are shown in Table 16.8.2.

Table 16.8.2 Waste amounts for solid waste management, tonnes.

	1990	1991	1992	1993	1994	1995	1996
6 A1. Managed Waste Disposal	6 056	6 124	6 168	6 232	6 334	6 428	6 410
6 A2. Unmanaged Waste Disposal	1 362	1 359	1 358	1 360	1 341	1 289	1 217
6 C. Waste incin., energy recovery	5 519	5 578	5 618	5 733	5 918	6 072	6 178
6 C. Waste incin., without energy rec.	16 566	16 713	16 808	16 955	17 195	17 460	17 828
6. Waste total	29 503	29 775	29 952	30 280	30 788	31 249	31 633
continued	1997	1998	1999	2000	2001	2002	2003
6 A1. Managed Waste Disposal	6 416	6 145	5 697	4 876	4 943	4 746	4 451
6 A2. Unmanaged Waste Disposal	1 160	1 060	988	910	868	843	835
6 C. Waste incin., energy recovery	6 275	6 398	8 200	11 279	11 526	12 658	14 084
6 C. Waste incin., without energy rec.	18 162	18 756	17 827	16 068	16 285	15 874	15 220
6. Waste total	32 014	32 360	32 712	33 132	33 623	34 121	34 589
continued	2004	2005	2006	2007	2008	2009	2010
6 A1. Managed Waste Disposal	4 215	4 246	4 264	4 293	4 312	4 346	4 413
6 A2. Unmanaged Waste Disposal	828	826	818	791	763	746	722
6 C. Waste incin., energy recovery	15 312	15 572	15 788	16 056	16 366	16 686	17 077
6 C. Waste incin., without energy rec.	14 700	14 790	14 836	14 823	14 778	14 837	14 955
6. Waste total	35 055	35 435	35 705	35 964	36 220	36 614	37 168

The waste amounts are based on municipal data on waste and waste incineration with energy recovery on local incinerator plants in 2004, and a survey by Consulting Company Carl Bro in 1996 and 2001, where waste amounts per person per year was identified as 650 kg and 455 kg for Greenlandic towns and villages, respectively. For the time series these amounts were regulated by 1 % per year upwards for years after 2004 and by 1 % per year downwards for years before 2004. Further, to construct the time series statistical data from Statistics Greenland on population in towns and villages were used. Other results of the survey used for the time series are that it was estimated that (1) 70 % of waste amounts is incinerated and 30 % deposited and (2) 80 % of combustible waste amounts deposited is burned in open burning.

Solid waste disposal

Source Category Description

The category consists of managed and unmanaged disposal of waste on land.

Methodological issues, activity data, emission factors and emissions

In Table 16.8.3 the composition of the waste according to the survey mentioned is shown.

Table 16.8.3 Composition of household and commercial waste before and after open burning.

Fraction	Household waste[2]	Commercial waste[2]	Household / Commercial Weighted	After open burning	Weighted (after open burning)
			%		
Paper/cardboard, dry	8.00[1]	20.00	11.84	2.37	7.66
Paper/cardboard, wet	10.00[1]	7.00	9.04	1.81	5.85
Plastics	7.00[1]	9.00	7.64	1.53	4.94
Organic waste	44.00[1]	34.00	40.80	8.16	26.40
Other combustible	17.50[1]	16.00	17.02	3.40	11.00
Glass	7.50[1]	3.00[1]	6.06	6.06	19.60
Metal	3.50[1]	3.00[1]	3.34	3.34	10.80
Other, non combustible	1.00[1]	5.00	2.28	2.28	7.37
Hazardous waste	1.50[1]	3.00[1]	1.98	1.98	6.40
Total	100.00	100.00	100.00	30.93	100.00
Pct (%)	68[3]	32[3]		80[4]	

Notes:

[1] Measured values.

[2] Source: Former Environmental and Nature Agency, Ministry of Infrastructure and Environment. Survey from 2004.

[3] Distribution of household and commercial waste.

[4] Share of combustible waste burned at waste disposal sites.

A Tier 2 approach with a first order decay model is introduced for estimation of emissions of CH_4 from the solid waste disposals. For this purpose the activity data in Table 16.8.2 are estimated back to 1960 (not shown) based on the methodology described in connection to Table 16.8.2. Combining these activity data and the composition data in Table 16.8.3 time series for 1960-2010 with amounts of waste in waste fractions are calculated.

For these time series the waste fractions are associated to (1) Dissolved Organic Carbon (DOC) values according to Section 16.8.2 of this NIR and (2) emission factors based on DOC values and values of methane correction factors, fraction of DOC dissimilated and fraction of CH_4 in gas emitted according to the IPCC GL and GPG for managed disposals, Table 16.8.4 and unmanaged disposal, Table 16.8.5.

Table 16.8.4 DOC values and emission factors for CH_4 for managed disposals.

	Paper / cardboard, dry	Paper / cardboard, wet	Plastics	Organic waste	Other combustible	Glass	Metal	Other, non combustible	Hazardous waste
DOC weighted (after open burning) fraction	0.40	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.00
Emission factor kg CH_4/tonnes[1]	133.3	66.7	0.0	66.7	66.7	0.0	0.0	0.0	0.0
[1]) based on:									
Methane correction factor				1					
Fraction of DOC dissimilated and emitted				0.5					
Fraction of CH_4 in gas emitted				0.5					

Table 16.8.5 DOC values and emission factors for CH_4 for unmanaged disposals.

	Paper/ cardboard dry	Paper/ cardboard wet	Plastics	Organic waste	Other com-bustible	Glass	Metal	Other, non-combustible	Hazardous waste
DOC weighted (after open burn-ing) fraction	0.40	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.00
Emission factor kg CH_4/tonnes[1]	53.3	26.7	0.0	26.7	26.7	0.0	0.0	0.0	0.0

[1]) based on:

Methane correction factor	0.4
Fraction of DOC dissimilated and emitted	0.5
Fraction of CH_4 in gas emitted	0.5

For managed and unmanaged disposals the default half life time of 14 years and a time lag of 0.5 years are used. For the oxidation factor and according to the GPG for managed disposal 0.1 and for unmanaged 0.0 are used.

In Tables 16.8.6 and 16.8.7 selected data and results are shown for 1990-2009 for managed and unmanaged disposal, respectively. The data in the tables are as follows. The AD for the FOD model as amounts of waste in fractions, the potential emission of CH_4 calculated with emission factors on waste amounts in fractions, the annual generated emission of CH_4 calculated with the FOD model using the potential emissions, the oxi-dized CH_4 and the actual annual CH_4 emission calculated as the annual generated emission minus the CH_4 oxidized. Calculations are performed since 1960 and are not shown.

Table 16.8.6 Managed disposal. AD for the FOD model (amounts of waste in fractions), the potential emission of CH_4, the oxidized CH_4 and the annual CH_4 emission for 1990-2009.

	Paper /cardboard dry	Paper /cardboard wet	Plastics	Organic waste	Other combustible	Glass	Metal	Other, non combustible	Hazardous waste	Waste total	Potential emission	Annual generated emission	Annual oxidized emission	Annual emission
Unit	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4
1990	464	354	299	1 598	667	1 187	654	446	388	6 056	232.7	174.8	17.5	157.3
1991	469	358	303	1 616	674	1 200	661	451	392	6 124	236.4	177.8	17.8	160.0
1992	472	361	305	1 627	679	1 209	666	455	395	6 168	239.0	180.7	18.1	162.6
1993	477	364	308	1 644	686	1 221	673	459	399	6 232	240.8	183.6	18.4	165.3
1994	485	370	313	1 671	697	1 241	684	467	405	6 334	243.3	186.5	18.6	167.8
1995	492	376	318	1 696	708	1 260	694	474	412	6 428	247.2	189.4	18.9	170.5
1996	491	375	317	1 691	705	1 256	692	473	410	6 410	250.9	192.4	19.2	173.2
1997	491	375	317	1 693	706	1 257	693	473	411	6 416	250.2	195.2	19.5	175.7
1998	471	359	304	1 621	676	1 204	664	453	393	6 145	250.5	197.9	19.8	178.1
1999	436	333	281	1 503	627	1 116	615	420	365	5 697	239.9	199.9	20.0	179.9
2000	373	285	241	1 286	537	955	527	359	312	4 876	222.4	201.0	20.1	180.9
2001	378	289	244	1 304	544	969	534	364	316	4 943	190.3	200.5	20.0	180.4
2002	363	277	234	1 252	522	930	513	350	304	4 746	193.0	200.1	20.0	180.1
2003	341	260	220	1 174	490	872	481	328	285	4 451	185.3	199.4	19.9	179.4
2004	323	246	208	1 112	464	826	455	311	270	4 215	173.7	198.1	19.8	178.3
2005	325	248	210	1 120	467	832	459	313	272	4 246	164.5	196.5	19.7	176.9
2006	326	249	211	1 125	469	836	460	314	273	4 264	165.7	195.0	19.5	175.5
2007	329	251	212	1 133	473	841	464	316	275	4 293	166.4	193.6	19.4	174.3
2008	330	252	213	1 138	475	845	466	318	276	4 312	167.6	192.4	19.2	173.2
2009	333	254	215	1 147	478	852	469	320	278	4 346	168.3	191.2	19.1	172.1
2010	338	258	218	1 164	486	865	477	325	283	4 413	169.6	190.2	19.0	171.2

Table 16.8.7 Unmanaged disposal. AD for the FOD model (amounts of waste in fractions), the potential emission of CH_4, the oxidized CH_4 and the annual CH_4 emission for 1990-2009.

	Paper /cardboard dry	Paper /cardboard wet	Plastics	Organic waste	Other com-bustible	Glass	Metal	Other, non combustible	Hazardous waste	Waste total	Potential emission	Annual generated emission	Annual oxidized emission	Annual emission
Unit	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4
1990	104	80	67	359	150	267	147	100	87	1 362	21	15.8	0.0	15.8
1991	104	79	67	359	150	266	147	100	87	1 359	21	16.1	0.0	16.1
1992	104	79	67	358	149	266	147	100	87	1 358	21	16.3	0.0	16.3
1993	104	79	67	359	150	266	147	100	87	1 360	21	16.6	0.0	16.6
1994	103	78	66	354	148	263	145	99	86	1 341	21	16.8	0.0	16.8
1995	99	75	64	340	142	253	139	95	83	1 289	21	17.0	0.0	17.0
1996	93	71	60	321	134	238	131	90	78	1 217	20	17.1	0.0	17.1
1997	89	68	57	306	128	227	125	86	74	1 160	19	17.2	0.0	17.2
1998	81	62	52	280	117	208	115	78	68	1 060	18	17.3	0.0	17.3
1999	76	58	49	261	109	194	107	73	63	988	17	17.2	0.0	17.2
2000	70	53	45	240	100	178	98	67	58	910	15	17.2	0.0	17.2
2001	66	51	43	229	96	170	94	64	56	868	14	17.0	0.0	17.0
2002	65	49	42	222	93	165	91	62	54	843	14	16.8	0.0	16.8
2003	64	49	41	220	92	164	90	62	53	835	13	16.7	0.0	16.7
2004	63	48	41	218	91	162	89	61	53	828	13	16.5	0.0	16.5
2005	63	48	41	218	91	162	89	61	53	826	13	16.3	0.0	16.3
2006	63	48	40	216	90	160	88	60	52	818	13	16.2	0.0	16.2
2007	61	46	39	209	87	155	85	58	51	791	13	16.0	0.0	16.0
2008	58	45	38	201	84	150	82	56	49	763	12	15.8	0.0	15.8
2009	57	44	37	197	82	146	81	55	48	746	12	15.6	0.0	15.6
2010	55	42	36	191	80	142	78	53	46	722	12	15.4	0.0	15.4

16.8.3 Wastewater handling

Source category description

In Greenland no wastewater treatment occurs; although it should be mentioned some filtering of solid residues from industry may occur and likewise there are ongoing projects focussing on septic tanks at household levels. N_2O emission from human sewage is estimated. It is assumed that no methane emission occurs.

Methodological issues

According to the IPCC Guidelines (IPCC, 1997) the important factors for CH_4 production from handling of wastewater are: wastewater characteristics, handling systems, temperature and BOD vs. COD.

The Guidelines state that production of CH_4 generally requires temperatures above 15˚C, and at temperatures below this the lagoon is principally a sedimentation tank (IPCC, 1997). Temperatures in Greenland rarely exceed 15˚C, and the monthly average temperature has not exceeded 12˚C during the period 1993-2010. Therefore CH_4 is reported as Not Applicable in the CRF.

N_2O emission from wastewater handling

The IPCC default methodology only includes N_2O emissions from human sewage based on annual per capita protein intake. The methodology account for nitrogen intake ("outcome"), i.e. faeces and urine, only and neither the industrial nitrogen input nor non-consumption protein from kitchen, bath and laundry discharges are included.

The formula used for calculation of the emission from effluent WWTP discharges is:

$$E_{effluents} = P \cdot F_N \cdot N_{pop} \cdot F_{nc} \cdot F \cdot EF \cdot effluent \cdot \frac{M_{N_2O}}{M_{N_2}}$$

where P is the annual protein per capita consumption per person per year set constant to 171.5 g/day (see below text).

F_N is the fraction of nitrogen in protein, i.e. 0.16 (IPCC, 1997).

N_{pop} is the Greenlandic population (source: Statistics Greenland).

F_{nc} is the fraction of the population not connected to the municipal sewer system, i.e. set to 1 as no wastewater treatment plants exists in Greenland at this point.

F is the fraction of non-consumption protein in domestic wastewater. i.e. 1.1 (IPCC, 2006).

$EFN_2O.WWTP.effluent$ is the IPCC GL default emission factor of 0.01 kg N_2O-N/kg sewage-N produced (IPCC, 1996)[1].

[1] The IPCC (2006) gives a default value for the N_2O emissions from domestic wastewater nitrogen effluent of 0.005 (0.0005 - 0.25) kg N_2O-N/kg N. However, the IPCC EF from the 1996 guidelines has been used.

MN_2O and MN_2 are the mass ratio. i.e. 44/28 to convert the discharged units in mass of total N to emissions in mass N_2O.

For households

A large part of the diet originates from seafood, fish or sea mammals, but imported fabricated foods are expected to continue to take over an increasing part of human energy consumption. Due to weather conditions most of fresh food comes from wild animals or fish. Greenland has a production of lamb and a limited supply of vegetables; still most of the produced foods are imported from outside (Mulvad et al., 2007).

In Greenland, the traditional diet based on meat and fish has undergone diversification towards more carbohydrates with the development of a monetary economy; in 1855 the protein content of a mean diet was 377 g protein, whereas 80 years later, in 1935 – 43, the protein content of a mean diet was 257 g protein (Périssé and François, 1981). Today, the majority of young urbanised Greenlandic Inuit have Western dietary habits and consume less meat from marine mammals, terrestrial mammals and birds than Inuit from the hunting districts; Dietary profiles of Canadian Baffin Island Inuit with a high consumption of traditional foods have shown a mean daily protein intake of 144-199 g/day in 41- to 61-year-old (Laursen et al, 2001).

As no data on the protein intake are available a protein intake of 171.5 g/day, i.e. the average of the Canadian Inuit were adopted, as it is assumed that the protein intake has declined even more since 1935 due to increased number of urbanised Greenlandic Inuit. For comparison the Danish yearly protein consumption according to FAOSTAT has increased from 98 g/day in 1990 to 112 g/day in 2005. Using this number, the yearly protein intakes may be derived by multiplying with the population number and days in a year. Based on the above it was decided to set the protein intake to the average value of the Canadian Inuit data, 171.5 g/day. The N-content in effluent wastewater in Greenland was calculated the equation shown above.

From industries

The production of residue products from the fish industry in Greenland amounts to around 14,000 tons per year (Nielsen et al, 2005). Overall the waste amount from the Greenland halibut production is around 40 %, while the waste amount from codfish production is 50 %; this governs only the fish production including pre-processing.

According to IPCC, the fraction of nitrogen in protein is 0.16 (IPCC, 1996). The IPCC reports a range of 0.3 to 3.1 kg total N/ton fish referring to effluent loads from cod filleting; i.e. 0.0031. The report also presents values of the total N content of untreated wastewater from the fish industry in the range of 400-1000 mg/l corresponding to a fraction of corresponding. However, as it was not possible to find data for all fish groups, and as it was not possible to determine that fraction of fish, which was pre-processed and how big a fraction that was sold without pre-processing, the below approach was adopted.

From the EC BAT note (EC, 2003) the total N-content of untreated wastewater from the fishing industry was reported to be between 400 and 1000 mg/L with an average value of 700 mg/L. The number was multiplied by the water used within the fishing industry reported for 2004 to 2010 by Statistics Greenland. The effluent N-content for 1990 to 2003 was set equal to the estimated value for 2003.

Emissions

Emission of N_2O from wastewater handling is shown in Table 16.8.8.

Table 16.8.8 N_2O emissions from households and industries 1990-2010.

	1990	1991	1992	1993	1994	1995	1996
N_2O emission, effluents households, Gg	0.0096	0.0096	0.0096	0.0096	0.0096	0.0097	0.0097
N_2O emission, effluents industries, Gg	0.0383	0.0383	0.0383	0.0383	0.0383	0.0383	0.0383
N_2O emission, effluents sum, Gg	0.0479	0.0479	0.0479	0.0479	0.0479	0.0479	0.0480
continued	1997	1998	1999	2000	2001	2002	2003
N_2O emission, effluents households, Gg	0.0097	0.0097	0.0097	0.0097	0.0098	0.0098	0.0098
N_2O emission, effluents industries, Gg	0.0383	0.0383	0.0383	0.0383	0.0383	0.0383	0.0383
N_2O emission, effluents sum, Gg	0.0480	0.0480	0.0480	0.0480	0.0480	0.0481	0.0481
continued	2004	2005	2006	2007	2008	2009	2010
N_2O emission, effluents households, Gg	0.0099	0.0099	0.0098	0.0098	0.0098	0.0098	0.0098
N_2O emission, effluents industries, Gg	0.0383	0.0382	0.0385	0.0389	0.0409	0.0320	0.0302
N_2O emission, effluents sum, Gg	0.0481	0.0481	0.0483	0.0487	0.0507	0.0418	0.0399

Total emission of N_2O increased until 2008 due to an increase in the emission from industrial effluents. However, in 2009 and 2010 total emission of N_2O decreased due to a temporarily decrease in industrial effluents primaryly caused by a decrease in the catches of shrimps.

16.8.4 Waste incineration

Source category description

In Greenland waste incineration is carried out both with and without energy recovery. According to IPCC Guidelines the emissions associated with waste incineration for energy production is included in the energy sector more specifically in the source category 1.A1a Public Electricity and Heat Production. The emissions from waste incineration without energy recovery is reported in source category 6.C. Waste Incineration. Additionally in Greenland open burning of waste occurs at landfill sites. Emissions associated with this are also reported under sector 6.C. Waste Incineration.

Methodological issues

The methodology used follows the IPCC Guidelines. For waste incineration the Danish emission factors are used, as it is trusted that they are also a good representation of Greenlandic conditions.

Neither the revised 1996 IPCC Guidelines (IPCC, 1997) nor the Good Practice Guidance (IPCC, 2000) contains a methodology for estimating emissions from open burning, therefore the methodology provided in the 2006 IPCC Guidelines (IPCC, 2006) is used.

The emission factors used for both waste incineration and open burning are included in Section 16.8.4.4.

Activity data

The amount of waste incinerated without energy recovery is presented in Table 16.8.9. The activity data is provided by the method described in Section 16.8.2.

Table 16.8.9 Activity data for waste incineration without energy recovery, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Waste incinerated without energy recovery, Mg	NO	NO	NO	NO	56	225	795	1 240	2 663	2 896	3 148
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Waste incinerated without energy recovery, Mg	3 306	3 391	3 415	3 437	3 461	3 485	3 468	3 444	3 466	3 486	

The open burning of waste is assumed to be 80 % of the waste deposited to landfills (Survey on waste by Carl Bro, 1996 and 2001). The activity data for open burning is presented in Table 8.10. The activity data for open burning is provided by the method described in Section 16.8.2.

Table 16.8.10 Activity data for open burning of waste, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Open burning of waste, Mg	16 566	16 713	16 808	16 955	17 140	17 235	17 033	16 922	16 093	14 930	12 920
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Open burning of waste, Mg	12 979	12 483	11 804	11 263	11 329	11 350	11 355	11 335	11 371	11 470	

Emission factors

Waste incineration

For waste incineration without energy recovery the same emission factors have been assumed as for waste incineration with energy recovery. The emission factors refer to the Danish emission factors (Nielsen et al., 2010). The greenhouse gas emission factors are shown in Table 16.8.11.

Table 16.8.11 Emission factors for greenhouse gases from waste incineration.

	Emission factor	Unit
CO_2	32.5	Kg pr GJ
CH_4	30	G pr GJ
N_2O	4	G pr GJ

The emission factors used for the indirect greenhouse gases are shown in table 16.8.12.

Table 16.8.12 Emission factors for indirect greenhouse gases from waste incineration.

	NO_x	SO_2	NMVOC	CO
Waste incineration, g pr GJ	100	6	50	1000

Open burning

For open burning emissions are calculated using the methodology, standard parameters and emission factors provided by the 2006 IPCC Guidelines.

The CH_4 emission factor used is the recommended and default is 6,500 g per tonne MSW wet weight. This factor refers to US EPA (2001).

For N_2O a default emission factor of 150 g/t MSW dry weight is recommended (IPCC, 2006) this is corrected for the dry matter content to acquire an N_2O emission factor of 214 g per tonne MSW wet weight.

For calculating the CO_2 emission the dry matter content, carbon content and the fossil carbon content of the waste fractions are used. The parameters are included in Table 16.8.13.

Table 16.8.13 Parameter used in calculating CO_2 emissions from open burning.

	Dry matter content	Total carbon content, %	Fossil carbon content as percent of total carbon
Paper	0,9	46	1
Cardboard	0,9	46	1
Plastics	1,0	75	100
Organic waste	0,4	38	0
Other	0,9	3	100

Source: 2006 IPCC Guidelines, Volume 5, Chapter 2, Table 2.4

An oxidation factor of 58 % is assumed for open burning (IPCC, 2006).

The emission factors for NO_x, SO_2, NMVOC and CO are presented in Table 16.8.14. The emission factors are from the US EPA (1992).

Table 16.8.14 Emission factors for indirect greenhouse gases from open burning of waste.

	NO_x	SO_2	NMVOC	CO
Open burning of municipal refuse, kg pr Mg	3	0.5	15	42

Emissions

Total emission of greenhouse gases from sector 6.C. Waste Incineration is shown in Table 16.8.15. Figure 16.8.2 shows total emission of greenhouse gases from sector 6.C. Waste incineration is shown in Figure 16.8.1.

Table 16.8.15 Greenhouse gas emissions from waste incineration.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2, Gg	2.6	2.6	2.6	2.6	2.7	2.7	2.9	3.1	3.5	3.4	3.2
CH_4, Mg	107.7	108.6	109.2	110.2	111.4	112.1	111.0	110.4	105.4	98.0	85.0
N_2O, Mg	3.5	3.6	3.6	3.6	3.7	3.7	3.7	3.7	3.6	3.3	2.9
CO_2 eqv., Gg	5.9	6.0	6.0	6.0	6.1	6.2	6.4	6.5	6.8	6.5	5.9
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
CO_2, Gg	3.3	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
CH_4, Mg	85.4	82.2	77.8	74.3	74.7	74.9	74.9	74.8	75.0	75.7	
N_2O, Mg	2.9	2.8	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	
CO_2 eqv., Gg	6.0	5.8	5.6	5.4	5.5	5.5	5.5	5.4	5.5	5.5	

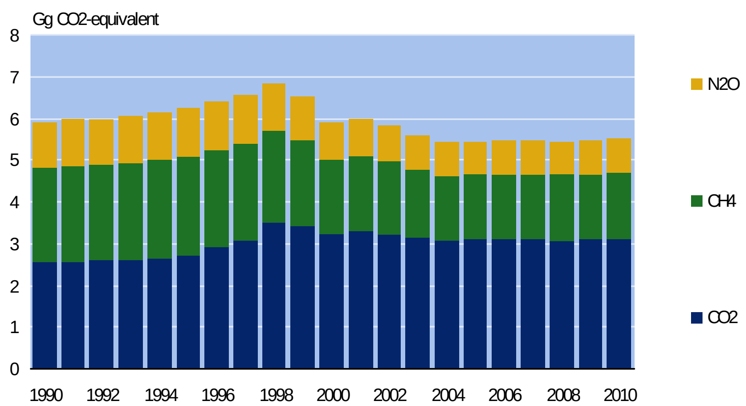

Figure 16.8.1 Emission of greenhouse gases from waste incineration.

The emissions of indirect greenhouse gases from waste incineration are shown in Table 16.8.16.

Table 16.8.16 Emissions of indirect greenhouse gases from waste incineration, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NO_x	49.7	50.1	50.4	50.9	51.5	51.9	51.9	52.1	51.1	47.8	42.1
SO_2	8.3	8.4	8.4	8.5	8.6	8.6	8.6	8.5	8.2	7.6	6.6
NMVOC	248.5	250.7	252.1	254.3	257.1	258.6	255.9	254.5	242.8	225.5	195.5
CO	695.8	701.9	705.9	712.1	720.4	726.1	723.7	723.7	703.9	657.5	575.7
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
NO_x	42.4	41.0	39.0	37.4	37.6	37.7	37.7	37.6	37.8	38.1	
SO_2	6.7	6.4	6.1	5.8	5.9	5.9	5.9	5.9	5.9	5.9	
NMVOC	196.4	189.0	178.9	170.7	171.7	172.1	172.1	171.8	172.4	173.9	
CO	579.8	559.9	531.6	509.1	512.1	513.3	513.3	512.2	514.0	518.3	

16.8.5 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for the waste sector. The uncertainties for the activity data and emission factors are shown in Table 16.8.17.

Table 16.8.17 Uncertainties for activity data and emission factors for the waste sector.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
6C Waste incineration	CO_2	10	25
6A Solid Waste Disposal on Land	CH_4	10	100
6C Waste incineration	CH_4	10	50
6B Wastewater Handling	N_2O	30	100
6C Waste incineration	N_2O	10	100

The amount of waste incinerated and burned is relatively well known and the uncertainty is set to 10 %. The same is the case for the waste deposited to landfills. For waste water handling an uncertainty of 30 % on the activity data has been assumed.

Regarding the emission factor uncertainty, a value of 100 % has been used for CH_4 from solid waste disposal, N_2O from wastewater treatment and N_2O from waste incineration. This is in the same range as recommended by the IPCC GPG. For CO_2 and CH_4 from waste incineration emission factor uncertainties of 25 % and 50 % respectively have been chosen.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 16.8.18.

Table 16.8.18 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2010 %	Trend uncertainty %
GHG	62	-10.6	± 22.3
CO_2	27	22.3	± 17.3
CH_4	73	-6.6	± 14.1
N_2O	98	-17.3	± 33.0

16.8.6 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, data on solid waste disposal, waste water handling and waste incineration has gone through a great deal of quality work with regard to accuracy, comparability and completeness.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Annual data on solid waste disposal, waste water handling and waste incineration are compared with previous years and large discrepancies are checked.

Safely stored and quality checked activity data are then processed by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly.

Time series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked in the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

16.8.7 Source specific recalculations and improvements

The sector *Waste Water Handling* (6B) was included in the inventory for the first time in the 2010 emission inventory submission. No improvements have been carried out regarding waste water handling in the 2012 submission.

However, due to revisions in population statistics minor revisions have been conducted in the first order decay model for estimation of emission of CH_4 from solid waste disposals. The update includes the years 1990-2009.

Table 16.8.19 shows recalculations in the energy sector compared with the 2011 submission. The changes are of neglible importance.

Table 16.8.19 Changes in GHG emission in the waste sector compared with the 2011 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Previous inventory, Gg CO_2 eqv.	24.7	24.8	24.9	25.0	25.2	25.4	25.6	25.8	26.0	25.7	25.1
Recalculated, Gg CO_2 eqv.	24.4	24.5	24.6	24.7	24.9	25.0	25.3	25.5	25.8	25.5	24.9
Change in Gg CO_2 eqv.	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2
Change in pct.	-1.4	-1.4	-1.4	-1.4	-1.3	-1.3	-1.2	-1.1	-0.8	-0.8	-0.8
continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Previous inventory, Gg CO_2 eqv.	25.2	25.1	24.8	24.6	24.6	24.7	25.0	25.5	22.1	-	
Recalculated, Gg CO_2 eqv.	25.0	24.9	24.6	24.4	24.4	24.5	24.5	25.1	22.4	21.8	
Change in Gg CO_2 eqv.	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.5	-0.3	0.2	-	
Change in pct.	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-2.0	-1.3	1.1	-	

16.8.8 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Improved data on solid waste disposals

In future inventories attempts will be made in order to improve data on solid waste disposals in general. Statistics Greenland has encouraged the municipal technical departments with responsibility for waste handling to start gathering data on the yearly amounts of waste handled. Statistics Greenland hope to start obtaining these annually data in 2013.

2) Improved data on waste water handling

In future inventories attempts will be made in order to improve data on waste water handling in general. However, at the moment the municipal technical departments seem to have no data on waste water handling at all.

16.8.9 References

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16.9 Other

In CRF Sector 7, there are no activities and emissions or removals for the inventory of Greenland.

16.10 Recalculations and improvements

The 2012 submission is the third year where Greenland on the request of the ERT has submitted a full CRF.

For recalculations and improvements please refer to Sections 16.3 - 16.8 and Section 16.11.

16.11 KP-LULUCF

16.11.1 General information

In the following text, the abbreviations used are in accordance with definitions in the IPCC guidelines:

A:	Afforestation
R:	Reforestation
D:	Deforestation
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the Danish definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

Definition of forest and any other criteria

For the estimation of anthropogenic emissions by sources and removals by sinks associated with afforestation (A), reforestation (R) and deforestation (D) since 1990 under Article 3.3 and forest management (FM) under Article 3.4 of the Kyoto Protocol, the following forest definition will be applied:

- Minimum values for tree crown cover: 10 % tree crown cover for forests.
- Minimum values for land area: 0.5 ha.
- Minimum value for tree height: trees must be able to reach a minimum height of 5 m in the site.

In addition, the forest area includes temporarily unstocked areas, smaller open areas in the forest needed for management purposes and fire breaks. Forests in national parks, reserves or areas under special protection are included. Windbreaks and groves covering more than 0.5 ha and with a minimum width of 20 m are also considered as forests.

Woody biomass does not exist outside the forest and hence not reported under Cropland and Grassland.

Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

As regards the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, it has been decided to include emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of EU Land Parcel Information System (LPIS), detailed crop information data on field level, soil mapping and sample plots from the national forest inventory (NFI).

Inventories of emissions and removals under Article 3.3 and Article 3.4 are prepared for 2009, and reported annually in 2010 together with the other greenhouse gas inventory information.

Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The definition of afforestation, reforestation and deforestation is in accordance with the GPG (IPCC 2003).

Afforestation or reforestation is identified when areas have wooded treecover and fulfils the forest definition given above. The time of the AF is given by the time of action, i.e. planting of trees. No deforestation and reforestation is reported for Greenland as this is not occurring. All types of establishment of forest (AF or RF) are considered human induced.

As no reforestation has taken place Table 5(KP-I)A.1.2 "Units of land harvested since the beginning of the commitment period" is filled in as included elsewhere although it is not occurring.

As for the forest management (Article 3.4), the forest areas fulfilling the definition given above are included under this activity. All forest areas are considered managed except for the remote Qinngua-valley.

For Cropland and Grassland the area accounted for under Art. 3.4 has been estimated with the best knowledge from the Greenlandic Agricultural Consulting Services. As the agriculture in Greenland is economically subsidized the area is estimated with a high accuracy. Only areas that are reported as CL and GL are included in the accounted area.

Description of precedence conditions and/or hierarchy among article 3.4 activities and how they have been consistently applied in determining how land was classified

All Forest activities have precedence, after this Cropland activities and then Grassland activities.

Afforestation has precedence. All land converted to forest are included as afforested area. Deforestated areas are not reported as this is not occurring. The following categories in the Convention reporting are included under afforestation:

- 5A25 OL to A

FM activities are only related to:

- 5A1 Forest remaining Forest

CM activities are related to:

- 5B22 GL to CL

GM activities area related to:

- 5C1 GL remaining GL

No elected land has left land that is not accounted for. Land conversion between elected activities (FM, CM and GM) has been allowed but is currently not occurring. No land elected under 3.4 activities has been converted to Other Land. Other land converted to elected activities is included in the respective category. As a consequence there has been a steady increase in the land which is accounted for under Art. 3.3 and Art. 3.4 with 14 hectares from 1990 to 2009.

The Land Use matrix developed for the purpose of reporting Art. 3.3 and 3.4 activities for 2008 are shown in Table 16.11.1.

Table 16.11.1 Land Use matrix for art. 3.3 and 3.4 activities in 2010.

From previous inventory year / To current inventory		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	0,03	NO						0,03
	Deforestation		NA						NA
Article 3.4 activities	Forest Management (if elected)		NO	0,20					0,20
	Cropland Management(4) (if elected)	NO	NO		0,01	NO	NA		0,01
	Grazing Land Management(4) (if elected)	NO	NO		NO	241,99	NA		241,99
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		NO	NO	NO	NO	NO	NA	216.366,37	216.366,37
Total area at the end of the current inventory year		0,03	NA,NO	0,20	0,01	241,99	NA	216.366,37	216.608,60

16.11.2 Spatial assessment unit used for determining the areas of the units of land under Article 3.3

Afforestation and reforestation are identified as areas which not were covered by forest in 1990. The increase in the forest area is planted.

Methodology used to develop the land transition matrix

The land use matrix is based on the best available data. No vector maps exist of the individual forests, cropland and grassland.

Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The forests have been given individual names. For the Cropland and Grassland area no identification has been made.

16.11.3Afforestation, Reforestation & Deforestation (ARD)

Methods for carbon stock change and GHG emission and removal estimates

For afforestation the carbon stock change in the period 1990 - 2009 is based both on the area of afforestation and the information on species composition.

In the afforestation a steady increase in carbon stock is found.

Description of the methodologies and the underlying assumptions used

See Chapter 7.

Justification when omitting any carbon pool or GHG emissions/removals from ARD

C stock changes in the soil is not expected due to the cold climate to occur and hence following the guidelines for a Tier 1 approach. As the afforestation is made by hand planting no damages of the existing soil C is expected to take place.

Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out has been performed in the emission and removal estimates.

Changes in data and methods since the previous submission (recalculations)

No recalculation has been performed.

Uncertainty estimates

Uncertainty estimates are given in Table 16.11.2.

Table 16.11.2 Uncertainty estimates for 1990 and 2010 for the KP sector. No growth is assumed in AR areas and hence no uncertainty is given.

		Activity data, %	Emission factor, %	Combined uncertainty	Emission Gg CO^2 yr^{-1}	Total uncertain-ty, %	Uncertain-ty 95 %, Gg CO_2 eqv.	Emission Gg CO^2 yr^{-1}	Total uncertain ty, %	Uncertainty 95 %, Gg CO_2 eqv.
						1990			2010	
KP total					0,179	55,136	0,099	1,564	68,387	1,070
A. Article 3.3 activities					IE,NA,NR	-	-	IE,NA,NR	-	-
B. Article 3.4 activities					0,179	57,821	0,104	1,564	68,565	1,072
KP A.1.1 Afforestation and Reforestation										
Area subject to the activity					0,000			0,028		
Area of organic soils(8)					0,000			0,003		
Net CO_2 emissions/removals (9)					0,0			IE,NA,NR		
Carbon stock change in above-ground biomass(5), (6)	Net change	15	50	52,2	0,0	-	-	NA	-	-
Carbon stock change in below-ground biomass(5), (6)	Net change	15	50	52,2	0,0	-	-	NA	-	-
Net carbon stock change in litter (5)		15	50	52,2	0,0	-	-	IE	-	-
Net carbon stock change in dead wood(5)		15	50	52,2	0,0	-	-	NA	-	-
KP A.2 Deforestation										
Area subject to the activity					NO			NO		
Area of organic soils					NO			NO		
Net CO_2 emissions/removals					NO			NO		
KP B.1 Forest Management										
Area subject to the activity		-	-	-	-	-	-	0,205		
Area of organic soils(8)		-	-	-	-	-	-	0,025		
Net CO_2 emissions/removals (9)		-	-	-	-	-	-	-0,037	36,0	0,0
Carbon stock change in above-ground biomass(5), (6)	Net change	15	50	52,2	-	-	-	0,006	52,2	0,0
Carbon stock change in below-ground biomass(5), (6)	Net change	15	50	52,2	-	-	-	0,002	52,2	0,0
Net carbon stock change in dead wood(5)		15	50	52,2	-	-	-	0,001	52,2	0,0
KP B.2 Cropland Management										
Area subject to the activity					NA	-	-	0,007		
Area of organic soils(8)					NA	-	-	0,002		
Net CO_2 emissions/removals (9)					IE,NA	-	-	0,030	90,6	0,0
Carbon stock change in above-ground biomass(5), (6)	Net change	10	50	51,0	NA	-	-	NA	-	-
Carbon stock change in below-ground biomass(5), (6)	Net change	10	50	51,0	IE	-	-	IE	-	-
Organic soils (10)		10	90	90,6	NA	-	-	0,0	90,6	0,0
KP B.3 Grassland Management										
Area subject to the activity		0,00	0,00	0,00	242,0			242,0		
Area of organic soils(8)		0,00	0,00	0,00	7,368			7,494		

Continued										
Net CO_2 emissions/removals (9)		0,0	0,0	0,0	0,171	57,8	0,1	1,567	71,5	1,1
Carbon stock change in above-ground biomass(5), (6)	Net change	10	50	51,0	0,097	51,0	0,0	-0,094	51,0	0,0
Carbon stock change in below-ground biomass(5), (6)	Net change	10	50	51,0	IE	-	-	IE	-	-
Organic soils (10)		10	90	90,6	-0,1	90,6	0,1	-0,333	90,6	0,3
KP-II 4 Lime consumption										
Total amount of lime applied					18,5			9,3		
Emission		0	0	0,0	0,008	50,2	0,0	0,004	50,2	0,0
Carbon		5	50	50,2	0,008	50,2	0,0	0,000	0,0	0,0

Information on other methodological issues
See Chapter 16.7.

The year of the onset of an activity, if after 2008
Not applicable.

16.11.4 Forest Management (FM)

Methods for carbon stock change and GHG emission and removal estimates
See Chapter 16.7 in LULUCF on "Forest remaining forest (5.A.1)".

Methodologies and the underlying assumptions
See Chapter 16.7 in LULUCF on "Forest remaining forest (5.A.1)".

Omission of pools from FM
C changes in forest soils are omitted and hereby following GPG 2003 guidelines at a Tier 1 level.

Factoring out
No factoring out has been performed.

Recalculations
No recalculation has been performed.

Uncertainty estimates
See table 16.11.2

Information on other methodological issues
See Chapter 16.7 in LULUCF on "Forest remaining forest (5.A.1)".

The year of the onset of an activity, if after 2008
Not applicable.

16.11.5 Cropland Management (CM)

Methods for carbon stock change and GHG emission and removal estimates
Methodologies and the underlying assumptions used

The area with agricultural Cropland is reported as the area given in Statistics Greenland.

The same methodology as used in the Convention reporting is used in the KP reporting.

Omission of pool from CM
Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under Cropland as these are not occurring. Therefore only aboveground living biomasses are reported under Cropland. Below-ground biomass is included in above-ground biomass.

Factoring out
No factoring out has been made.

Recalculations
No recalculation has been performed.

Uncertainty estimates
See Table 16.11.2.

Information on other methodological issues
None.

The year of the onset of an activity, if after 2008
Not applicable.

16.11.6 Grazing land management (GM)

Methods for carbon stock change and GHG emission and removal estimates
Grazing land is defined as land improved grassland and unmanaged grassland.

Description of the methodologies and the underlying assumptions used
The major part of the grassland is unmanaged (241,000 hectare). Only 1089 hectares is improved grassland with occasional reseeding and fertiliser application. The methodology used is the default Tier 1. This is in accordance with IPCC GPG 2003 (3.4.1.2.1.2) as the total emission from LULUCF consists of less than 0.14 % of the total emission from Greenland.

Omission of pools from GM
Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under Cropland as these are not occurring. Therefore only aboveground living biomasses are reported under Cropland. Below-ground biomass is included in above-ground biomass.

Factoring out
No factoring out has been made.

Recalculations
No recalculation has been performed.

Uncertainty estimates
See table 16.11.2.

Information on other methodological issues
None.

The year of the onset of an activity, if after 2008
Not applicable.

16.11.7 Article 3.3

Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced
All forests in Greenland are planted except for the Qinngua valley, which is in a remote area.

Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation
No deforestation is occurring and therefore not applicable.

Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested
Not applicable.

16.11.8 Article 3.4

Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced
Forest Management
In Forest Management all forest areas are under management and changes in carbon stock are hence seen as human induced.

Cropland Management
Due to the cold climate and the recent increase in temperature it has only very recently been possible to grow agricultural crops in Greenland with the first fields established around 2001. Today it is estimated that 6.5 hectares are regularly ploughed.

Grassland Management
Due to the cold climate in Greenland and the recent increase in temperature it has only recently been valuable to introduce management activities in the grassland to increase the crop yield. This is well documented in the Greenlandic subsidiary system to the farmers.

Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year
No further information is available.

Information relating to Forest Management
No further information is available.

16.11.9 Other information

Key category analysis for Article 3.3 activities and any elected activities under Article 3.4
According to the IPCC Good Practice Guidance for LULUCF a category that is identified as key in the UNFCCC inventory should also be considered key under the Kyoto Protocol (IPCC, 2003).

No LULUCF categories are reported as a key source. The total emission from the LULUCF sector is only 0.14 % of the total emission from Greenland.

16.11.10 Information relating to Article 6

There are no Article 6 projects (Joint Implementation) on the Greenlandic territory.

16.12 Annex 1 Key categories

A Key Category Analysis (KCA) for year 1990 and 2010 for Greenland has been carried out in accordance with the IPCC Good Practice Guidance. For 1990 a level KCA has been carried out.

The base year in the analysis is the year 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the greenhouse F-gases HFC, PFC and SF_6. The KCA approach is a Tier 1 quantitative analysis.

The level assessment of the Tier 1 KCA is a ranking of the source categories in accordance to their relative contribution to the national total of greenhouse gases calculated in CO_2 equivalents. The level key categories are found from the list of source categories ranked according to their contribution in descending order. Level key categories are those from the top of the list and of which the sum constitutes 95 % of the national total.

The trend assessment of the Tier 1 KCA is a ranking of the source categories according to their contribution to the trend of the national total of greenhouse gases, calculated in CO_2 equivalents, from the base year to the year under consideration. The trend of the source category is calculated relative to that of the national totals and the trend is then weighted with the contribution, according to the level assessment. The ranking is in descending order. As for the level assessment, the cut-off point for the sum of contribution to the trend is 95 % and the source categories from the top of the list to the cut-off line are trend key categories.

16.12.1 The result of the Key Category Analysis for Greenland for the year 1990 and 2010

The entries in the results of KCA in Tables 16.12.1 to 16.12.3 for the years 1990 and 2010 are composed from CRFs for those years in this report. Note that base-year estimates are not used in the level assessment analysis for year 2010, but are only included in Table 16.12.2 to make it more uniform with Tables 16.12.1 and 16.12.3.

The result of the Tier 1 KCA level assessment for Greenland for 1990 is shown in Table 16.12.1. For the assessment, 5 categories were identified as key categories and marked as shaded, refer Table 16.12.1.

The result of the Tier 1 KCA level assessment for Greenland for 2010 is shown in Table 16.12.2. For the assessment, 6 categories were identified as key categories, refer Table 16.12.2.

The result of the Tier 1 KCA trend assessment for Greenland for 1990/1995-2010 is shown in Table 16.12.3. For the trend assessment, 10 categories were identified as key categories, refer Table 16.12.3. Note that according to the GPG, the analysis implies that contributions to the trend are all calculated as mathematically positive to be able to perform the ranking. The LULUCF activities are in the table included with their sign, i.e. emissions: +, removals: -.

In Table 16.12.4 a summary of Key Category Analysis for Greenland is given for level assessment for year 1990/95 and 2010 and for trend for years 1990-2010. All the categories are listed by sector and key sources are shown with their ranking.

Table 16.12.1 Key Category Analysis base year 1990/1995, level assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment GRL – inventory						
A IPCC Source Categories (LULUCF included)			B Direct GHG	C Base Year Estimate Ex,o Gg CO_2 eqv	D Base Year Level Assessment Lx,o	E Base Year Cumulative total of Col. D
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.131	0.7964	0.7964
Energy	Civil aviation		CO_2	38.321	0.0581	0.8545
Energy	Road transportation		CO_2	36.564	0.0555	0.9100
Energy	Domestic navigation		CO_2	21.064	0.0319	0.9419
Waste	Wastewater handling		N_2O	14.852	0.0225	0.9644
Agriculture	Enteric fermentation		CH_4	6.018	0.0091	0.9735
Waste	Solid waste disposal on land		CH_4	3.636	0.0055	0.9791
Waste	Waste incineration		CO2	2.550	0.0039	0.9829
Waste	Waste incineration		CH_4	2.261	0.0034	0.9864
Energy	Combustion excluding transport	Other fuels	CO_2	1.674	0.0025	0.9889
Energy	Combustion excluding transport		N_2O	1.392	0.0021	0.9910
Agriculture	Direct emissions from agricultural soils		N_2O	1.281	0.0019	0.9930
Waste	Waste incineration		N_2O	1.099	0.0017	0.9946
Energy	Combustion excluding transport		CH_4	0.951	0.0014	0.9961
Agriculture	Indirect emissions from agricultural soils		N_2O	0.697	0.0011	0.9971
Agriculture	Manure management		N_2O	0.641	0.0010	0.9981
Energy	Civil aviation		N_2O	0.336	0.0005	0.9986
Solvents and other product use	Solvents		CO_2	0.263	0.0004	0.9990
LULUCF	Grassland remaining grassland		CO_2	0.214	0.0003	0.9993
Agriculture	Manure management		CH_4	0.140	0.0002	0.9995
Energy	Road transportation		N_2O	0.093	0.0001	0.9997
Energy	Road transportation		CH_4	0.064	0.0001	0.9998
Energy	Domestic navigation		N_2O	0.054	0.0001	0.9999
Industry	Consumption of SF6		SF_6	0.036	0.0001	0.9999
Energy	Domestic navigation		CH_4	0.030	0.0000	1.0000
Industry	Consumption of HFC's		HFCs	0.025	0.0000	1.0000
Energy	Civil aviation		CH_4	0.006	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.000	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.000	0.0000	1.0000
Energy	Fugitive emissions from fuel		CO_2	0.000	0.0000	1.0000
Energy	Fugitive emissions from fuel		CH_4	0.000	0.0000	1.0000
Energy	Fugitive emissions from fuel		N_2O	0.000	0.0000	1.0000
Industry	Limestone and dolomite use		CO_2	0.000	0.0000	1.0000
LULUCF	Forest land remaining forest		CO_2	0.000	0.0000	1.0000
LULUCF	Conversion to cropland		CO_2	0.000	0.0000	1.0000
Total				659.39	1.0000	

Table 16.12.2 Key Category Analysis year 2010, level assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment GRL – inventory								
A IPCC Source Categories (LULUCF included)			B Direct GHG	C Base Year Estimate Ex,o Gg CO_2 eqv	D Year 2010 Estimate Ex,t Gg CO_2 eqv	E Year 2010 Level Assessment Lx,t	F Year 2010 Cumulative total of Col. E
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.1306	559.2926	0.7802	0.7802
Energy	Civil aviation		CO_2	38.3214	46.3022	0.0646	0.8448
Energy	Road transportation		CO_2	36.5641	34.1080	0.0476	0.8924
Energy	Domestic navigation		CO_2	21.0639	27.4321	0.0383	0.9306
Waste	Wastewater handling		N_2O	14.8521	12.3837	0.0173	0.9479
Industry	Consumption of HFC's		HFCs	0.0245	6.7706	0.0094	0.9574
Energy	Combustion excluding transport	Other fuels	CO_2	1.6743	6.6343	0.0093	0.9666
Agriculture	Enteric fermentation		CH_4	6.0175	5.5315	0.0077	0.9743
Waste	Solid waste disposal on land		CH_4	3.6356	3.9186	0.0055	0.9798
Waste	Waste incineration		CO_2	2.5505	3.1200	0.0044	0.9841
Agriculture	Direct emissions from agricultural soils		N_2O	1.2808	1.9692	0.0027	0.9869
Energy	Combustion excluding transport		N_2O	1.3922	1.6466	0.0023	0.9892
Waste	Waste incineration		CH_4	2.2613	1.5887	0.0022	0.9914
LULUCF	Grassland remaining grassland		CO_2	0.2142	1.4281	0.0020	0.9934
Agriculture	Indirect emissions from agricultural soils		N_2O	0.6968	1.0531	0.0015	0.9949
Energy	Combustion excluding transport		CH_4	0.9511	1.0145	0.0014	0.9963
Waste	Waste incineration		N_2O	1.0990	0.8063	0.0011	0.9974
Agriculture	Manure management		N_2O	0.6407	0.6665	0.0009	0.9983
Energy	Civil aviation		N_2O	0.3357	0.4057	0.0006	0.9989
Solvents and other product use	Solvents		CO_2	0.2634	0.2059	0.0003	0.9992
Agriculture	Manure management		CH_4	0.1403	0.1289	0.0002	0.9994
Energy	Road transportation		CH_4	0.0641	0.1138	0.0002	0.9995
Energy	Road transportation		N_2O	0.0932	0.0888	0.0001	0.9996
Energy	Domestic navigation		N_2O	0.0536	0.0704	0.0001	0.9997
Energy	Fugitive emissions from fuel		CH_4	0.0000	0.0440	0.0001	0.9998
Energy	Domestic navigation		CH_4	0.0302	0.0397	0.0001	0.9999
LULUCF	Forest land remaining forest		CO_2	0.0000	-0.0371	0.0001	0.9999
LULUCF	Conversion to cropland		CO_2	0.0000	0.0298	0.0000	1.0000
Energy	Fugitive emissions from fuel		CO_2	0.0000	0.0171	0.0000	1.0000
Energy	Civil aviation		CH_4	0.0057	0.0069	0.0000	1.0000
Industry	Limestone and dolomite use		CO_2	0.0000	0.0049	0.0000	1.0000
Industry	Consumption of SF_6		SF_6	0.0359	0.0030	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.0001	0.0001	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.0000	0.0001	0.0000	1.0000
Energy	Fugitive emissions from fuel		N_2O	0.0000	0.0001	0.0000	1.0000
Total				659.39	716.79	1.000	

Table 16.12.3 Key Category Analysis years 1990/1995-2010, trend assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance)								
Tier 1 Analysis - Trend Assessment GRL – inventory								
A			B	C	D	E	F	G
IPCC Source Categories (LULUCF included)			Direct GHG	Base Year Estimate Ex,o Gg CO_2 eq	Year 2010 Estimate Ex,t Gg CO_2 eq	Trend Assess-ment Tx,t	Contri bution to Trend	Cumul. total of col. F
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.1306	559.2926	0.0175	0.2458	0.2458
Industry	Consumption of HFC's		HFCs	0.0245	6.7706	0.0102	0.1436	0.3894
Energy	Road transportation		CO_2	36.5641	34.1080	0.0086	0.1200	0.5094
Energy	Combustion excluding transport	Other fuels	CO_2	1.6743	6.6343	0.0073	0.1025	0.6119
Energy	Civil aviation		CO_2	38.3214	46.3022	0.0070	0.0989	0.7108
Energy	Domestic navigation		CO_2	21.0639	27.4321	0.0069	0.0965	0.8073
Waste	Wastewater handling		N_2O	14.8521	12.3837	0.0057	0.0801	0.8874
LULUCF	Grassland remaining grassland		CO_2	0.2142	1.4281	0.0018	0.0254	0.9128
Agriculture	Enteric fermentation		CH_4	6.0175	5.5315	0.0015	0.0215	0.9343
Waste	Waste incineration		CH_4	2.2613	1.5887	0.0013	0.0185	0.9529
Agriculture	Direct emissions from agricultural soils		N_2O	1.2808	1.9692	0.0009	0.0123	0.9651
Waste	Waste incineration		N_2O	1.0990	0.8063	0.0006	0.0083	0.9734
Waste	Waste incineration		CO_2	2.5505	3.1200	0.0005	0.0074	0.9808
Agriculture	Indirect emissions from agricultural soils		N_2O	0.6968	1.0531	0.0004	0.0063	0.9871
Energy	Combustion excluding transport		N_2O	1.3922	1.6466	0.0002	0.0028	0.9899
Solvents and other product use	Solvents		CO_2	0.2634	0.2059	0.0001	0.0017	0.9916
Energy	Road transportation		CH_4	0.0641	0.1138	0.0001	0.0009	0.9926
Energy	Fugitive emissions from fuel		CH_4	0.0000	0.0440	0.0001	0.0009	0.9935
Energy	Civil aviation		N_2O	0.3357	0.4057	0.0001	0.0009	0.9944
LULUCF	Forest land remaining forest		CO_2	0.0000	-0.0371	0.0001	0.0008	0.9952
Industry	Consumption of SF6		SF_6	0.0359	0.0030	0.0001	0.0008	0.9959
Waste	Solid waste disposal on land		CH_4	3.6356	3.9186	0.0001	0.0007	0.9967
Agriculture	Manure management		N_2O	0.6407	0.6665	0.0000	0.0006	0.9973
LULUCF	Conversion to cropland		CO_2	0.0000	0.0298	0.0000	0.0006	0.9979
Agriculture	Manure management		CH_4	0.1403	0.1289	0.0000	0.0005	0.9984
Energy	Combustion excluding transport		CH_4	0.9511	1.0145	0.0000	0.0004	0.9988
Energy	Fugitive emissions from fuel		CO_2	0.0000	0.0171	0.0000	0.0004	0.9992
Energy	Road transportation		N_2O	0.0932	0.0888	0.0000	0.0003	0.9995
Energy	Domestic navigation		N_2O	0.0536	0.0704	0.0000	0.0003	0.9997
Energy	Domestic navigation		CH_4	0.0302	0.0397	0.0000	0.0001	0.9999
Industry	Limestone and dolomite use		CO_2	0.0000	0.0049	0.0000	0.0001	1.0000
Energy	Civil aviation		CH_4	0.0057	0.0069	0.0000	0.0000	1.0000
Energy	Fugitive emissions from fuel		N_2O	0.0000	0.0001	0.0000	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.0000	0.0001	0.0000	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.0001	0.0001	0.0000	0.0000	1.0000
Total				659.39	716.79		1.0000	

Table 16.12.4 Summary of Key Category Analysis for Greenland for level assessment for year 1990/95 and 2010 and for trend for years 1990-2010.

Summary of Key Category analysis for Greenland						
IPCC Source Categories (LULUCF included)			GHG	Key categories with number according to ranking in analysis Identification criteria		
				Level Tier1 1990	Level Tier1 2010	Trend Tier1 1990-2010
Energy	Combustion excluding transport	Liquid fuels	CO_2	1	1	1
Energy	Combustion excluding transport	Other fuels	CO_2			4
Energy	Combustion excluding transport		CH_4			
Energy	Combustion excluding transport		N_2O			
Energy	Road transportation		CO_2	3	3	3
Energy	Road transportation		CH_4			
Energy	Road transportation		N_2O			
Energy	Civil aviation		CO_2	2	2	5
Energy	Civil aviation		CH_4			
Energy	Civil aviation		N_2O			
Energy	Domestic navigation		CO_2	4	4	6
Energy	Domestic navigation		CH_4			
Energy	Domestic navigation		N_2O			
Energy	Fugitive emissions from fuel		CO_2			
Energy	Fugitive emissions from fuel		CH_4			
Energy	Fugitive emissions from fuel		N_2O			
Industry	Limestone and dolomite use		CO_2			
Industry	Asphalt roofing		CO_2			
Industry	Road Paving with asphalt		CO_2			
Industry	Consumption of HFC's		HFCs		6	2
Industry	Consumption of SF_6		SF_6			
Solvents and other product use	Solvents		CO_2			
Agriculture	Enteric fermentation		CH_4			9
Agriculture	Manure management		CH_4			
Agriculture	Manure management		N_2O			
Agriculture	Direct emissions from agricultural soils		N_2O			
Agriculture	Indirect emissions from agricultural soils		N_2O			
Waste	Solid waste disposal on land		CH_4			
Waste	Wastewater handling		N_2O	5	5	7
Waste	Waste incineration		CO_2			
Waste	Waste incineration		CH_4			10
Waste	Waste incineration		N_2O			
LULUCF	Forest land remaining forest		CO_2			
LULUCF	Conversion to cropland		CO_2			
LULUCF	Grassland remaining grassland		CO_2			8

16.13 Annex 2 Detailed discussion of methodology and data for estimating CO_2 emission from fossil fuel combustion

Detailed information regarding the methodology and input data used to calculate CO_2 emissions from fossil fuel combustion is included in Section 16.3.

16.14 Annex 3 Other detailed methodological descriptions for individual source or sink categories

All methodological descriptions are included in Sections 16.3 – 16.8 and Section 16.11.

16.15 Annex 4 CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

See Section 16.3.5.1 of this annex for the results of the comparison between the sectoral and reference approach.

16.16 Annex 5 Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

16.16.1 GHG inventory

The Greenlandic greenhouse gas emission inventories for 1990-2010 include all sources identified by the Revised 1996 IPCC Guidelines and the 2000 IPCC Good Practice Guidance except the following:

In the Solvent and other product use sector currently no N_2O emissions are included in CRF category 3D, Greenland will try to obtain activity data if they exist for uses of N_2O.

Direct and indirect CH_4 emissions from agricultural soils are not estimated. Direct and indirect soil emissions are considered of minor importance for CH_4. No methodology is recommended in IPCC-GPG.

In the LULUCF sector emissions/removals from wetlands, settlements and other land are currently not estimated due to the lack of available data. The lack of data availability is also an issue for other aspects of LULUCF, e.g. harvested wood products. For more detail please see Section 16. 7.

In the Waste sector CO_2 emissions from managed waste disposal on land are not estimated. According to the 1996 IPCC Guidelines: "Decomposition of organic material derived from biomass sources (e.g., crops, forests), which are re-grown on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology.".

16.16.2KP-LULUCF inventory

The KP-LULUCF inventory is considered complete. The carbon pools not estimated has been documented as not being sources, please see Section 16.11 for further documentation.

16.17 Annex 6 Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

No additional information for Greenland is deemed relevant.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eqv	Input data Gg CO_2 eqv	Input data %	Input data %	%	%	%	%	%	%	%
1A Liquid fuels	CO_2	621	667	2	5	5.385	5.014	-0.012	1.012	-0.059	2.862	2.862
1A Municipal waste	CO_2	2	7	2	25	25.080	0.232	0.007	0.010	0.183	0.028	0.185
1A Liquid fuels	CH_4	1	1	2	100	100.020	0.148	0.000	0.002	-0.007	0.005	0.009
1A Municipal waste	CH_4	0	0	2	100	100.020	0.007	0.000	0.000	0.006	0.000	0.006
1A Biomass	CH_4	0	0	2	100	100.020	0.009	0.000	0.000	0.007	0.000	0.007
1A Liquid fuels	N_2O	2	2	2	500	500.004	1.388	0.000	0.003	0.010	0.009	0.013
1A Municipal waste	N_2O	0	0	2	500	500.004	0.070	0.000	0.000	0.055	0.000	0.055
1A Biomass	N_2O	0	0	2	200	200.010	0.034	0.000	0.000	0.027	0.001	0.027
1B2 Oil exploration	CO_2	0	0	2	1 000	1 000.002	0.024	0.000	0.000	0.026	0.000	0.026
1B2 Oil exploration	CH_4	0	0	2	200	200.010	0.012	0.000	0.000	0.013	0.000	0.013
1B2 Oil exploration	N_2O	0	0	2	1 000	1 000.002	0.000	0.000	0.000	0.000	0.000	0.000
2A3 Limestone and dolomite use	CO_2	0	0	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
2A5 Asphalt roofing	CO_2	0	0	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2A6 Road paving with asphalt	CO_2	0	0	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2F Consumption of HFC	HFC	0	7	10	50	50.990	0.467	0.010	0.010	0.496	0.141	0.516
2F Consumption of SF_6	SF_6	0	0	10	50	50.990	0.000	0.000	0.000	-0.003	0.000	0.003
3A Paint application	CO_2	0	0	10	15	18.028	0.000	0.000	0.000	0.000	0.000	0.000
3B Degreasing and dry cleaning	CO_2	0	0	10	15	18.028	0.000	0.000	0.000	0.000	0.000	0.000
3C Chemical products, manufacturing and processing	CO_2	0	0	10	15	18.028	0.000	0.000	0.000	0.000	0.000	0.000
3D5 Other	CO_2	0	0	10	20	22.361	0.006	0.000	0.000	-0.002	0.004	0.005
4A Enteric Fermentation	CH_4	6	6	10	100	100.499	0.776	-0.002	0.008	-0.153	0.119	0.193
4B Manure Management	CH_4	0	0	10	100	100.499	0.018	0.000	0.000	-0.004	0.003	0.005
4B Manure Management	N_2O	1	1	10	100	100.499	0.093	0.000	0.001	-0.005	0.014	0.015
4D1 Direct N_2O emissions from agricultural soils	N_2O	0	1	20	50	53.852	0.098	0.001	0.002	0.059	0.056	0.082

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eqv	Input data Gg CO_2 eqv	Input data %	Input data %	%	%	%	%	%	%	%
Continued												
4D2 Pasture range and paddock	N_2O	1	1	20	25	32.016	0.030	0.000	0.001	-0.008	0.028	0.030
4D3 Indirect N_2O emissions from agricultural soils (Atmospheric deposition)	N_2O	1	1	20	50	53.852	0.079	0.000	0.002	0.022	0.045	0.050
5A Forest	CO_2	0	0	5	50	50.249	-0.003	0.000	0.000	-0.003	0.000	0.003
5B Cropland	CO_2	0	0	5	50	50.249	0.002	0.000	0.000	0.002	0.000	0.002
5C Grassland	CO_2	0	1	5	50	50.249	0.100	0.002	0.002	0.091	0.015	0.092
6A Solid Waste Disposal on Land	CH_4	4	4	10	100	100.499	0.550	0.000	0.006	-0.005	0.084	0.084
6B Wastewater Handling	N_2O	15	12	30	100	104.403	1.804	-0.006	0.019	-0.570	0.797	0.979
6C Waste incineration	CO_2	3	3	10	25	26.926	0.117	0.001	0.005	0.013	0.067	0.068
6C Waste incineration	CH_4	2	2	10	50	50.990	0.113	-0.001	0.002	-0.066	0.034	0.074
6C Waste incineration	N_2O	1	1	10	100	100.499	0.113	-0.001	0.001	-0.059	0.017	0.061
Total		659	717				31,598					9,534
Total uncertainties				Overall uncertainty in the year (%):			5.621			Trend uncertainty (%):		3.088

17 Information regarding the aggregated submission for Denmark and Greenland

This chapter contains information on the aggregated submission for Denmark and Greenland submitted under the Kyoto Protocol. This chapter contains a trend discussion, a tier 1 uncertainty analysis, information on the aggregated reference approach, information relating to key categories and information on recalculations. Sector specific information is included for Denmark in Chapter 3-11 and for Greenland in Chapter 16.

The institutional arrangements and the overall QA/QC plan are described in Chapter 1. This description covers all the Danish submissions to the European Union, the UNFCCC and the Kyoto Protocol, and therefore information regarding the national system is not presented in this chapter. Information on the specific QA/QC activities concerning the aggregated submission is presented in Chapter 17.7.

In Chapter 17.6 a description of the aggregation process is provided. The chapter explains the technical issues in aggregating two CRF submissions, including the software used in the process and the handling of background data.

17.1 Trends in emissions

Due to the small emission originating from Greenland the trends for Denmark and Greenland are practically identical to the trends for Denmark presented in Chapter 2.

17.1.1 Greenhouse Gas Emissions

The greenhouse gas emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure 1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2010. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2010 to the national total in CO_2 equivalents excluding LULUCF (Land Use and Land Use Change and Forestry) with 80.0 % followed by N_2O with 9.6 %, CH_4 9.0 % and F-gases (HFCs, PFCs and SF_6) with 1.4 %. Seen over the time series from 1990 to 2010 these percentages have been increasing for F-gases, almost constant for CO_2 and CH_4 and falling for N_2O. Stationary combustion plants, transport and agriculture represent the largest categories, followed by industrial processes, waste and solvents, see Figure 1. The net CO_2 uptake by LULUCF in 2010 is 3.5 % of the total emission in CO_2 equivalents excl. LULUCF. The national total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 10.8 % from 1990 to 2010 and decreased 15.8 % including LULUCF. Comments on the overall trends seen in Figure 19.1 are given in the sections below on the individual greenhouse gases.

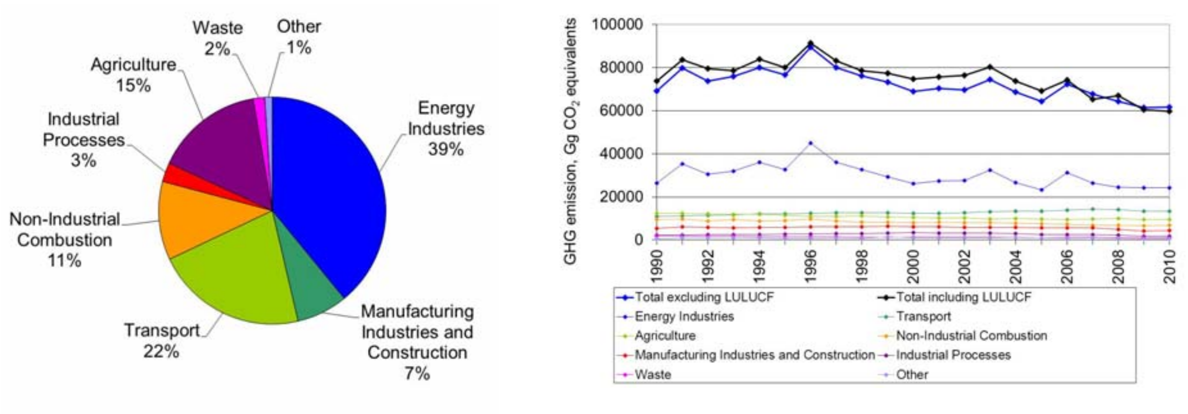

Figure 17.1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors for 2010 (excluding LULUCF) and time series for 1990 to 2010 (including LULUCF).

17.1.2 Carbon dioxide

The largest source to the emission of CO_2 is the energy sector, which includes combustion of fossil fuels like oil, coal and natural gas (Figure 17.2). Energy Industries contribute with 48 % of the emissions (excl. LULUCF). About 27 % come from the transport sector. The main reason for the fluctuations during the time series is the variations in electricity import/export. The CO_2 emission (excl. LULUCF) increased by 1 % from 2009 to 2010. The main reason for this increase was the cold winter which caused increased emissions from non-industrial combustion plants. In 2010, the CO_2 emission (excl. LULUCF) was 7.4 % lower than the emission in 1990.

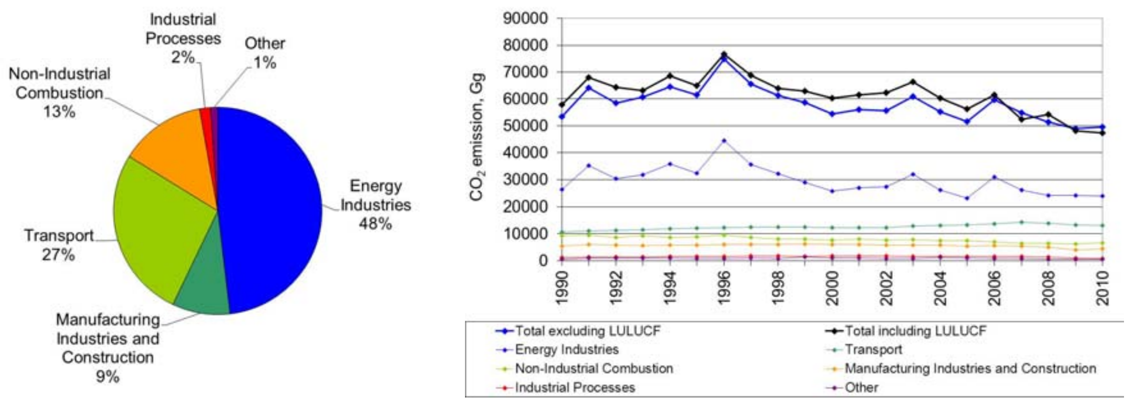

Figure 17.2 CO_2 emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

17.1.3 Nitrous oxide

Agriculture is the most important N_2O emission source in 2010 contributing 91 % (Figure 17.3) of which N_2O from agricultural soils accounts for 84 %. N_2O is emitted as a result of microbial processes in the soil. Substantial emissions also come from drainage water and coastal waters where nitrogen is converted to N_2O through bacterial processes. However, the nitrogen converted in these processes originates mainly from the agricultural use of manure and nitrogen fertilisers. The main reason for the drop in the emissions of N_2O in the agricultural sector of 35 % from 1990 to 2010 is legislation to improve the utilisation of nitrogen in manure. The legislation has resulted in less nitrogen excreted per unit of livestock produced and a considerable reduction in the use of nitrogen fertilisers. The basis for the N_2O emission is then reduced. Combustion of fossil fuels in the energy sector, both stationary and mobile sources, contributes 7 %. The N_2O emission from transport contributes by 2 % in 2010. This emission has increased during the nineties because of the increase in the use of catalyst cars. Production of nitric acid stopped in 2004 and the emissions from industrial processes is therefore not occurring from 2005 onwards. Other sources include e.g. use of N_2O for anaesthesia reported under Solvent and Other Product Use.

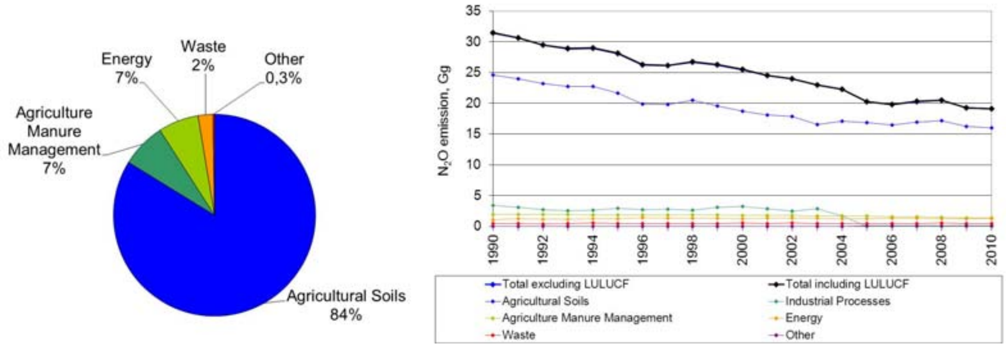

Figure 17.3 N_2O emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

17.1.4 Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities contributing in 2010 with 75 %, waste (15 %), public power and district heating plants (4 %), see Figure 17.4. The emission from agriculture derives from enteric fermentation and management of animal manure contributing with 52 % and 23 % of the national CH_4 emission in 2010. The CH_4 emission from public power and district heating plants increased in the nineties, mainly 1992-1996, due to the increasing use of gas engines in the decentralised cogeneration plant sector. Up to 3 % of the natural gas in the gas engines is not combusted. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption has decreased and hence the CH_4 emission has decreased. Over the time series from 1990 to 2010, the emission of CH_4 from enteric fermentation has decreased 12 % due to the decrease in the number of cattle. However, the emission from manure management has in the same period increased 30 % due to a change in traditional stable systems towards an increase in slurry-based stable systems. Altogether, the emission of CH_4 from the agriculture sector has decreased by 2.3 % from 1990 to 2010. The emission of CH_4 from waste has decreased 46 % since 1990 due to an increase in the incineration of waste and hence a steep drop in the amount of waste deposited in landfills.

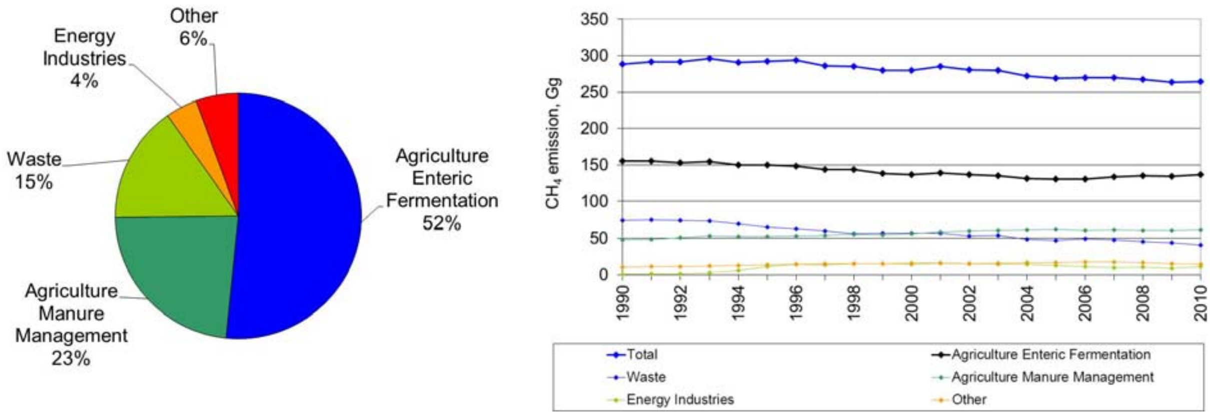

Figure 17.4 CH_4 emissions. Distribution according to the main sectors (2010) and time series for 1990 to 2010.

17.1.5 HFCs, PFCs and SF_6

This part of the Danish KP inventory only comprises a full data set for all substances from 1995. From 1995 to 2000, there has been a continuous and substantial increase in the contribution from the range of F-gases as a whole, calculated as the sum of emissions in CO_2 equivalents, see Figure 17.5. This increase is simultaneous with the increase in the emission of HFCs. For the time series 2000-2010, the increase is lower than for the years 1995 to 2000. The increase from 1995 to 2010 for the total F-gas emission is 164 %. SF_6 contributed considerably to the F-gas sum in earlier years, with 33 % in 1995. Environmental awareness and regulation of this gas under Danish law has reduced its use in industry, see Figure 17.5. A further result is that the contribution of SF_6 to F-gases in 2010 was only 4.4 %. The use of HFCs has increased several folds. HFCs have, therefore, become the even more dominant F-gases, comprising 67 % in 1995, but 94 % in 2010. HFCs are mainly used as a refrigerant. Danish legislation regulates the use of F-gases, e.g. since January 1, 2007 new HFC-based refrigerant stationary systems are forbidden. Refill of old systems are still allowed. The use of air conditioning in mobile systems and the amount of HFC for this purpose increases.

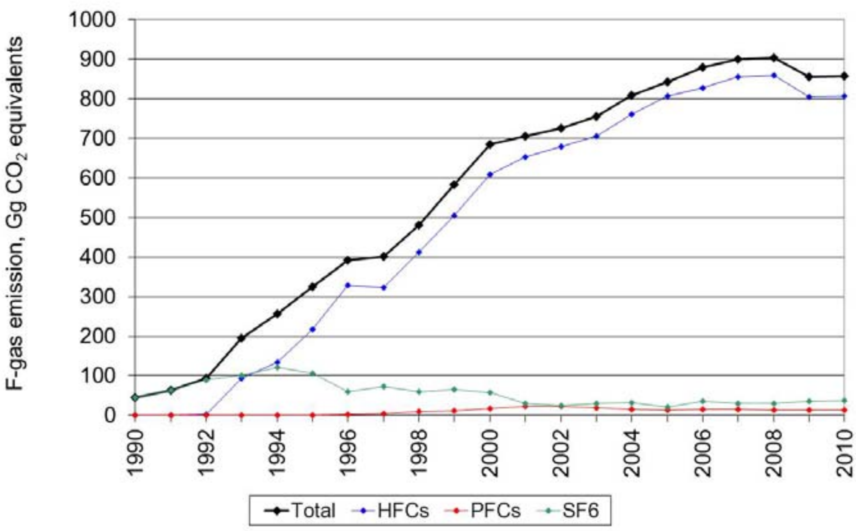

Figure 17.5 F-gas emissions. Time series for 1990 to 2010.

17.2 The reference approach

In addition to the sector-specific CO_2 emission inventories (the national approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference Manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the national approach.

The reference approach for Denmark and Greenland is an aggregation of the individual reference approaches for the two. The reference approach for Denmark is described in Chapter 3.4 and the reference approach for Greenland is included in Annex 9.

In 2010 the fuel consumption rates in the two approaches differ by 0.68 % and the CO_2 emission differs by 0.75 %. In the period 1990-2010 both the fuel consumption and the CO_2 emission differ by less than 2.0%. The differences are below 1 % for all years except 1998 and 2001. This is almost identical to the reference approach for Denmark, due to the very small emission from Greenland compared to Denmark. According to IPCC Good Practice Guidance (IPCC 2000) the difference should be within 2 %. A comparison of the national approach and the reference approach is illustrated in Figure 17.6. The relatively high difference in 2009 is a result of an increased statistical difference in the Danish energy statistics in 2009, see Chapter 3.4.

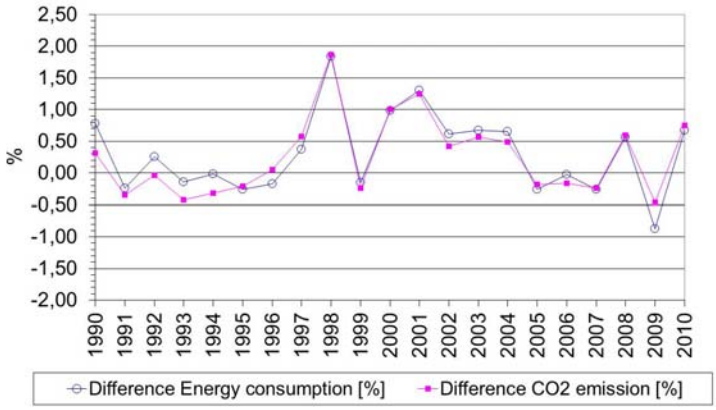

Figure 17.6 Comparison of the reference approach and the national approach.

17.3 Uncertainties

An uncertainty estimate has been calculated for Denmark and Greenland. The uncertainty estimate for Denmark is included in Chapter 1.7 and for Greenland in Chapter 16.

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates cover 100 % of the total net greenhouse gas emissions and removals. The emissions from Greenland have been treated separately due to the uncertainties being different than the uncertainties in the Danish inventory. The uncertainty of the Greenlandic emissions has almost no effect on the overall uncertainty estimate, due to the low emissions originating from Greenland.

The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 17.1. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total net GHG emission from Denmark and Greenland is estimated with an uncertainty of ±6.8 % and the trend in net GHG emission since 1990/1995 has been estimated to be -19.4 % ± 3.8 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on N_2O from leaching, CH_4 emission from solid waste disposal on land, N_2O from synthetic fertilizer, N_2O from animal waste applied to soils, CO_2 from forest remaining forest and CO_2 from cropland, organic soil are the largest sources of uncertainty for the aggregated greenhouse gas inventory for Greenland and Denmark.

Table 17.1 Uncertainties 1990-2010.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	6.8	-19.4	3.8
CO_2	6.3	-18.3	3.9
CH_4	19.0	-8.4	13.3
N_2O	43	-39	13
F-gases	48	162	62

The uncertainties for the activity rates and emission factors are shown in Table 17.2.

Table 17.2 Uncertainties 2010 for activity rates and emission factors.

	IPCC Source category	Gas	Base year emission Input data Gg CO_2 eqv.	2010 emission Input data Gg CO_2 eqv.	Activity data uncertainty Input data %	Emission factor uncertainty Input data %
Denmark	Stationary Combustion, Coal	CO_2	23833,91	15224,21	0,9	0,5
Denmark	Stationary Combustion, BKB	CO_2	10,97	2,58	3,0	5,0
Denmark	Stationary Combustion, Coke	CO_2	137,80	84,13	1,9	5,0
Denmark	Stationary Combustion, Fossil waste	CO_2	573,46	1409,93	5,0	10,0
Denmark	Stationary Combustion, Petroleum coke	CO_2	410,28	477,50	5,0	5,0
Denmark	Stationary Combustion, Residual oil	CO_2	2439,57	879,77	1,0	2,0
Denmark	Stationary Combustion, Gas oil	CO_2	4546,79	1577,45	2,4	4,0
Denmark	Stationary Combustion, Kerosene	CO_2	365,68	3,89	2,8	5,0
Denmark	Stationary Combustion, LPG	CO_2	163,82	88,86	2,2	5,0
Denmark	Stationary Combustion, Refinery gas	CO_2	816,13	816,87	1,0	2,0
Denmark	Stationary Combustion, Natural gas	CO_2	4335,40	10606,96	1,0	0,4
Denmark	Stationary Combustion, SOLID	CH_4	12,88	4,36	1,0	100,0
Denmark	Stationary Combustion, LIQUID	CH_4	2,78	1,30	1,1	100,0
Denmark	Stationary Combustion, GAS	CH_4	3,13	6,73	1,0	100,0
Denmark	Natural gas fuelled engines, GAS	CH_4	4,64	233,89	1,0	2,0
Denmark	Stationary Combustion, WASTE	CH_4	0,77	1,37	5,0	100,0
Denmark	Stationary Combustion, BIOMASS	CH_4	96,94	132,79	12,8	100,0
Denmark	Biogas fuelled engines, BIOMASS	CH_4	1,48	27,63	3,8	10,0
Denmark	Stationary Combustion, SOLID	N_2O	68,11	41,56	1,0	400,0
Denmark	Stationary Combustion, LIQUID	N_2O	42,83	13,72	1,1	1000,0
Denmark	Stationary Combustion, GAS	N_2O	16,38	35,66	1,0	750,0
Denmark	Stationary Combustion, WASTE	N_2O	6,58	15,69	5,0	400,0
Denmark	Stationary Combustion, BIOMASS	N_2O	37,92	93,32	2,2	1000,0
Denmark	Transport, Road transport	CO_2	9281,85	12107,89	2,0	5,0
Denmark	Transport, Military	CO_2	119,01	107,05	2,0	5,0
Denmark	Transport, Railways	CO_2	296,75	242,19	2,0	5,0
Denmark	Transport, Navigation (small boats)	CO_2	47,92	99,40	41,0	5,0
Denmark	Transport, Navigation (large vessels)	CO_2	747,83	493,76	11,0	5,0
Denmark	Transport, Fisheries	CO_2	590,60	574,83	2,0	5,0
Denmark	Transport, Agriculture	CO_2	1272,47	1272,96	24,0	5,0
Denmark	Transport, Forestry	CO_2	35,68	16,99	30,0	5,0
Denmark	Transport, Industry (mobile)	CO_2	839,28	1036,72	41,0	5,0
Denmark	Transport, Residential	CO_2	39,06	62,78	35,0	5,0
Denmark	Transport, Commercial/institutional	CO_2	73,72	172,88	35,0	5,0
Denmark	Transport, Civil aviation	CO_2	242,69	155,61	10,0	5,0
Denmark	Transport, Road transport	CH_4	52,87	13,52	2,0	40,0
Denmark	Transport, Military	CH_4	0,11	0,07	2,0	100,0
Denmark	Transport, Railways	CH_4	0,26	0,15	2,0	100,0
Denmark	Transport, Navigation (small boats)	CH_4	0,35	0,51	41,0	100,0
Denmark	Transport, Navigation (large vessels)	CH_4	0,33	0,23	11,0	100,0
Denmark	Transport, Fisheries	CH_4	0,27	0,29	2,0	100,0
Denmark	Transport, Agriculture	CH_4	2,20	2,02	24,0	100,0
Denmark	Transport, Forestry	CH_4	0,44	0,06	30,0	100,0
Denmark	Transport, Industry (mobile)	CH_4	1,25	0,79	41,0	100,0
Denmark	Transport, Residential	CH_4	1,07	1,37	35,0	100,0
Denmark	Transport, Commercial/institutional	CH_4	2,08	3,35	35,0	100,0
Denmark	Transport, Civil aviation	CH_4	0,15	0,08	10,0	100,0
Denmark	Transport, Road transport	N_2O	92,74	119,49	2,0	50,0
Denmark	Transport, Military	N_2O	1,15	1,14	2,0	1000,0

	IPCC Source category	Gas	Base year emission Input data Gg CO_2 eqv.	2010 emission Input data Gg CO_2 eqv.	Activity data uncertainty Input data %	Emission factor uncertainty Input data %
Denmark	Transport, Railways	N_2O	2,54	2,07	2,0	1000,0
Denmark	Transport, Navigation (small boats)	N_2O	0,39	1,08	41,0	1000,0
Denmark	Transport, Navigation (large vessels)	N_2O	14,60	9,64	11,0	1000,0
Denmark	Transport, Fisheries	N_2O	11,50	11,28	2,0	1000,0
Denmark	Transport, Agriculture	N_2O	15,27	16,70	24,0	1000,0
Denmark	Transport, Forestry	N_2O	0,17	0,17	30,0	1000,0
Denmark	Transport, Industry (mobile)	N_2O	10,62	13,63	41,0	1000,0
Denmark	Transport, Residential	N_2O	0,19	0,33	35,0	1000,0
Denmark	Transport, Commercial/institutional	N_2O	0,34	0,82	35,0	1000,0
Denmark	Transport, Civil aviation	N_2O	3,19	2,63	10,0	1000,0
Denmark	1.B.2 Flaring in refinery	CO_2	22,61	18,93	11,0	2,0
Denmark	1.B.2 Flaring off-shore	CO_2	299,69	333,32	7,5	2,0
Denmark	1.B.2 Land based activities	CO_2	0,00	0,01	2,0	40,0
Denmark	1.B.2 Off-shore activities	CO_2	2,38	4,61	2,0	30,0
Denmark	1.B.2 Transmission of natural gas	CO_2	0,00	0,00	15,0	2,0
Denmark	1.B.2 Distribution of natural gas	CO_2	0,00	0,00	25,0	10,0
Denmark	1.B.2 Venting in gas storage	CO_2	0,00	0,00	15,0	2,0
Denmark	1.B.2. Flaring in refinery	CH_4	1,32	0,13	11,0	15,0
Denmark	1.B.2. Flaring off-shore	CH_4	0,48	0,54	7,5	125,0
Denmark	1.B.2 Refinery processes	CH_4	0,78	46,61	1,0	125,0
Denmark	1.B.2 Land based activities	CH_4	17,16	17,68	2,0	40,0
Denmark	1.B.2 Off-shore activities	CH_4	14,87	37,40	2,0	30,0
Denmark	1.B.2 Transmission of natural gas	CH_4	3,57	0,56	15,0	2,0
Denmark	1.B.2 Distribution of natural gas	CH_4	5,36	2,99	25,0	10,0
Denmark	1.B.2 Venting in gas storage	CH_4	0,00	1,20	15,0	2,0
Denmark	1.B.2 Flaring in refinery	N_2O	0,13	0,05	11,0	1000,0
Denmark	1.B.2 Flaring off-shore	N_2O	0,70	0,78	7,5	1000,0
Denmark	2A1 Cement production	CO_2	882,40	672,22	1,0	2,0
Denmark	2A2 Lime production	CO_2	115,53	45,64	5,0	5,0
Denmark	2A3 Limestone and dolomite use	CO_2	13,69	45,56	5,0	5,0
Denmark	2A5 Asphalt roofing	CO_2	0,02	0,02	5,0	25,0
Denmark	2A6 Road paving with asphalt	CO_2	1,76	1,73	5,0	25,0
Denmark	2A7 Glass and Glass wool	CO_2	55,35	31,08	5,0	2,0
Denmark	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0,80	2,12	5,0	5,0
Denmark	2C1 Iron and steel production	CO_2	28,45	0,00	5,0	5,0
Denmark	2D2 Food and Drink	CO_2	4,45	1,56	5,0	5,0
Denmark	2G Lubricants	CO_2	49,71	33,18	2,0	5,0
Denmark	2B2 Nitric acid production	N_2O	1042,90	0,00	2,0	25,0
Denmark	2F Consumption of HFC	HFC	217,73	800,25	10,0	50,0
Denmark	2F Consumption of PFC	PFC	0,50	13,27	10,0	50,0
Denmark	2F Consumption of SF_6	SF_6	107,34	37,88	10,0	50,0
Denmark	3A Paint application	CO_2	15,87	7,96	10,0	15,0
Denmark	3B Degreasing and dry cleaning	CO_2	0,00	0,00	10,0	15,0
Denmark	3C Chemical products, manufacturing and processing	CO_2	18,92	12,31	10,0	15,0
Denmark	3D5 Other	CO_2	57,45	41,75	10,0	20,0
Denmark	3D5 Consumption of fireworks	CO_2	0,06	0,23	8,0	100,0
Denmark	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0,00	10,66	5,0	5,0
Denmark	3D3 Use of tobacco	N_2O	0,23	0,17	20,0	30,0
Denmark	3D3 Use of charcoal for BBQ	N_2O	0,07	0,08	10,0	100,0
Denmark	3D3 Consumption of fireworks	N_2O	0,77	3,25	8,0	100,0

	IPCC Source category	Gas	Base year emission Input data Gg CO_2 eqv.	2010 emission Input data Gg CO_2 eqv.	Activity data uncertainty Input data %	Emission factor uncertainty Input data %
Denmark	4A Enteric Fermentation	CH_4	3246,93	2856,34	2,0	20,0
Denmark	4B Manure Management	CH_4	993,17	1287,89	5,0	20,0
Denmark	4F Field burning of agricultural residues	CH_4	1,82	2,09	25,0	50,0
Denmark	4.B Manure Management	N_2O	599,78	421,25	22,4	50,0
Denmark	4.D1.1 Synthetic Fertilizer	N_2O	2405,10	1139,27	25,2	100,0
Denmark	4.D1.2 Animal waste applied to soils	N_2O	1111,74	1154,31	30,0	100,0
Denmark	4.D1.3 N-fixing crops	N_2O	269,47	238,05	20,0	100,0
Denmark	4.D1.4 Crop Residue	N_2O	361,22	314,72	20,0	100,0
Denmark	4.D1.5 Cultivation of histosols	N_2O	225,96	162,97	20,0	100,0
Denmark	4.D.2 Grassing animals	N_2O	310,98	197,43	25,5	100,0
Denmark	4.D3 Atmospheric deposition	N_2O	455,15	287,88	18,7	100,0
Denmark	4.D3 Leaching	N_2O	2452,21	1415,36	20,0	100,0
Denmark	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	27,92	41,39	20,0	100,0
Denmark	4.F Field Burning of Agricultural Residues	N_2O	0,70	0,80	25,0	50,0
Denmark	5.A.1 Broadleaves	CO_2	-707,93	-3752,23	15,0	50,0
Denmark	5.A.1 Conifers	CO_2	-136,39	-1937,07	15,0	50,0
Denmark	5.A.2 Broadleaves	CO_2	2,62	177,81	15,0	50,0
Denmark	5.A.2 Conifers	CO_2	5,80	-177,44	15,0	50,0
Denmark	5(II) Forest Land.	N_2O	15,66	12,03	30,0	75,0
Denmark	5.B Cropland, Living biomass	CO_2	177,17	102,04	10,0	50,0
Denmark	5.B Cropland, Dead organic matter	CO_2	6,97	1,21	10,0	50,0
Denmark	5.B Cropland, Mineral soils	CO_2	1415,32	1151,64	10,0	75,0
Denmark	5.B Cropland, Organic soils	CO_2	2419,79	1745,15	10,0	90,0
Denmark	5(III) Disturbance, Land converted to cropland	N_2O	3,22	0,62	50,0	75,0
Denmark	5.C Grassland, Living biomass	CO_2	185,91	33,53	10,0	50,0
Denmark	5.C Grassland, Dead organic matter	CO_2	36,65	2,43	10,0	50,0
Denmark	5.C Grassland, Mineral soils	CO_2	0,45	5,04	10,0	75,0
Denmark	5.C Grassland, Organic soils	CO_2	182,90	144,89	10,0	90,0
Denmark	5.D Wetlands, Living biomass	CO_2	0,47	-5,33	10,0	50,0
Denmark	5.D Wetlands, Dead organic matter	CO_2	0,11	0,10	10,0	100,0
Denmark	5.D Wetlands, Soils	CO_2	86,08	5,07	10,0	100,0
Denmark	5(II) Wetlands	N_2O	0,13	0,13	10,0	100,0
Denmark	5.E Settlements, Living biomass	CO_2	104,44	134,37	10,0	50,0
Denmark	5(IV) Cropland Limestone	CO_2	622,92	185,27	5,0	50,0
Denmark	5(V) Biomass Burning	CH_4	0,55	0,01	50,0	30,0
Denmark	5(V) Biomass Burning	N_2O	0,45	0,02	50,0	30,0
Denmark	6 A. Solid Waste Disposal on Land	CH_4	1477,21	692,82	10,0	117,9
Denmark	6 B. Wastewater Handling	CH_4	66,25	75,39	44,0	78,0
Denmark	6 B. Wastewater Handling - Direct	N_2O	27,24	51,25	37,0	98,0
Denmark	6 B. Wastewater Handling - Indirect	N_2O	82,25	32,60	59,0	39,0
Denmark	6.D Accidental fires, buildings	CO_2	11,46	11,14	10,0	300,0
Denmark	6.D Accidental fires, vehicles	CO_2	6,88	7,11	10,0	500,0
Denmark	6.C Incineration of corpses	CH_4	0,01	0,01	1,0	150,0
Denmark	6.C Incineration of carcasses	CH_4	0,00	0,01	40,0	150,0
Denmark	6.D Compost production	CH_4	26,65	80,42	40,0	100,0
Denmark	6.D Accidental fires, buildings	CH_4	1,35	1,36	10,0	500,0
Denmark	6.D Accidental fires, vehicles	CH_4	0,30	0,31	10,0	700,0
Denmark	6.C Incineration of corpses	N_2O	0,19	0,19	1,0	150,0
Denmark	6.C Incineration of carcasses	N_2O	0,01	0,10	40,0	150,0
Denmark	6.D Compost production	N_2O	11,21	42,65	40,0	100,0

	IPCC Source category	Gas	Base year emission Input data Gg CO_2 eqv.	2010 emission Input data Gg CO_2 eqv.	Activity data uncertainty Input data %	Emission factor uncertainty Input data %
Greenland	1A, Liquid fuels	CO_2	621,08	667,13	2,0	5,0
Greenland	1A, Municipal waste	CO_2	1,67	6,63	2,0	25,0
Greenland	1A, Liquid fuels	CH_4	1,02	1,06	2,0	100,0
Greenland	1A, Municipal waste	CH_4	0,01	0,05	2,0	100,0
Greenland	1A, Biomass	CH_4	0,02	0,06	2,0	100,0
Greenland	1A, Liquid fuels	N_2O	1,82	1,99	2,0	500,0
Greenland	1A, Municipal waste	N_2O	0,03	0,10	2,0	500,0
Greenland	1A, Biomass	N_2O	0,03	0,12	2,0	200,0
Greenland	1B Oil exploration	CO_2	0,00	0,02	2,0	1000,0
Greenland	1B Oil exploration	CH_4	0,00	0,04	2,0	200.0
Greenland	1B Oil exploration	N_2O	0,00	0,00	2,0	1000,0
Greenland	2A3 Limestone and dolomite use	CO_2	0,00	0,00	5,0	5,0
Greenland	2A5 Asphalt roofing	CO_2	0,00	0,00	5,0	25,0
Greenland	2A6 Road paving with asphalt	CO_2	0,00	0,00	5,0	25,0
Greenland	2F Consumption of HFC	HFC	0,02	6,77	10,0	50,0
Greenland	2F Consumption of SF_6	SF_6	0,04	0,00	10,0	50,0
Greenland	3A Paint application	CO_2	0,01	0,01	10,0	15,0
Greenland	3B Degreasing and dry cleaning	CO_2	0,00	0,00	10,0	15,0
Greenland	3C Chemical products, manufacturing and processing	CO_2	0,00	0,00	10,0	15,0
Greenland	3D5 Other	CO_2	0,25	0,20	10,0	20,0
Greenland	4A Enteric Fermentation	CH_4	6,02	5,53	10,0	100,0
Greenland	4B Manure Management	CH_4	0,14	0,13	10,0	100,0
Greenland	4.B Manure Management	N_2O	0,64	0,67	10,0	100,0
Greenland	4D1 Direct N_2O emissions from agricultural soils	N_2O	0,48	1,31	20,0	50,0
Greenland	4D2 Pasture range and paddock,	N_2O	0,80	0,66	20,0	25,0
Greenland	4D3 Indirect N_2O emissions from agricultural soils	N_2O	0,70	1,05	20,0	50,0
Greenland	5A Forest	CO_2	0,00	-0,04	5,0	50,0
Greenland	5B Cropland	CO_2	0,00	0,03	5,0	50,0
Greenland	5.C Grassland	CO_2	0,21	1,43	5,0	50,0
Greenland	6A Solid Waste Disposal on Land	CH_4	3,64	3,92	10,0	100,0
Greenland	6B Wastewater Handling	N_2O	14,85	12,38	30,0	100,0
Greenland	6C Waste incineration	CO_2	2,55	3,12	10,0	25,0
Greenland	6C Waste incineration	CH_4	2,26	1,59	10,0	50,0
Greenland	6C Waste incineration	N_2O	1,10	0,81	10,0	100,0

17.4 Key category analysis

A tier 1 key category analysis (KCA) has been carried out on emissions from Denmark and Greenland. The key category analysis for Denmark is included in Chapter 1.5 and Annex 1, and the key category analysis for Greenland is included in Chapter 16.

The KCA for 1990 and 2010 has been carried out in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance. The KCA has been carried out at CRF level, which is slightly more aggregated than the KCA carried out for Denmark. The categorisation used results in a total of 122 source categories of which 29 are LULUCF categories.

The KCA for Denmark and Greenland includes a total of six different analyses:

- base year, reporting year and trend,
- including and excluding LULUCF.

The six different KCA for Denmark and Greenland point out 16-23 key source categories each and a total of 29 different key source categories. The number of key categories in each of the main sectors are: Energy 9, Industrial Proc. 3, Solvents and other product use 0, Agriculture 9, LULUCF 7 and Waste 1.

The KCA for Denmark and Greenland are shown in Tables 17.3-17.8. An overview for all KCA is given in Table 17.9.

The KCA for **1990** including LULUCF points out 23 key categories (17 key categories for the KCA excluding LULUCF). Stationary combustion of solid fuel is the main source category accounting for 32 % of the emission[1]. CO_2 emission from stationary combustion of liquid fuel, CO_2 emission from road transport and CO_2 emission from stationary combustion of gaseous fuels account for 16 %, 12 % and 6 %, respectively.

The KCA for **2010** including LULUCF points out 23 key categories (17 key categories for the KCA excluding LULUCF). CO_2 emission from stationary combustion of solid fuel is the main source category accounting for 21 % of the emission[1]. CO_2 emission from road transport, CO_2 from stationary combustion of gaseous fuels and CO_2 emission from stationary combustion of liquid fuel account for 17 %, 15 % and 11 %, respectively.

The KCA for **trend (1990-2010)** including LULUCF points out 22 key categories (16 key categories for the KCA excluding LULUCF). CO_2 emission from stationary combustion of gaseous fuels is the main trend source category accounting for 23 % of the aggregated trend value[1]. CO_2 emission from road transport, CO_2 emission from stationary combustion of solid fuels, CO_2 emission from forest land remaining forest land, broadleaves, CO_2 emission from stationary combustion of liquid fuels and CO_2 emission from forest land remaining forest land, conifers account for 15 %, 13 %, 9 %, 7 % and 6 %, respectively.

[1] Data for the KCA including LULUCF.

Table 17.3 Key Category Analysis for Denmark and Greenland, level assessment for the base year, excl. LULUCF.

IPCC Source Categories (LULUCF excluded)		GHG	Base Year Estimate Ex,o Gg CO_2 eqv	Base Year Level Assessment Lx,o	Base Year Cumulative total
Energy	Combustion excluding transport, Solid Fuels	CO_2	23982.67	0.3452	0.3452
Energy	Combustion excluding transport, Liquid Fuels	CO_2	12237.23	0.1761	0.5213
Energy	Road transportation	CO_2	9318.42	0.1341	0.6554
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	4335.40	0.0624	0.7178
Agriculture	Enteric Fermentation	CH_4	3252.95	0.0468	0.7646
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	2452.80	0.0353	0.7999
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	2405.15	0.0346	0.8345
Waste	Solid Waste Disposal Sites	CH_4	1480.84	0.0213	0.8559
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1112.06	0.0160	0.8719
Industrial processes	Nitric acid production	N_2O	1042.90	0.0150	0.8869
Agriculture	Manure Management	CH_4	993.31	0.0143	0.9012
Industrial processes	Cement production	CO_2	882.40	0.0127	0.9139
Energy	Domestic navigation	CO_2	816.81	0.0118	0.9256
Agriculture	Manure Management	N_2O	600.42	0.0086	0.9343
Energy	Combustion excluding transport, Other Fuels	CO_2	575.14	0.0083	0.9425
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	455.25	0.0066	0.9491
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	361.27	0.0052	0.9543
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	311.78	0.0045	0.9588
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2	299.69	0.0043	0.9631
Energy	Railways	CO_2	296.75	0.0043	0.9674
Energy	Civil aviation	CO_2	281.01	0.0040	0.9714
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O	269.47	0.0039	0.9753
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	226.03	0.0033	0.9785
Industrial processes	Foam Blowing	HFC	182.58	0.0026	0.9812
Industrial processes	Lime production	CO_2	115.53	0.0017	0.9828
Energy	Combustion excluding transport, Biomass	CH_4	98.86	0.0014	0.9843
Energy	Road transportation	N_2O	92.83	0.0013	0.9856
Waste	N_2O indirect from human sewage	N_2O	85.23	0.0012	0.9868
Energy	Combustion excluding transport, Liquid Fuels	N_2O	83.40	0.0012	0.9880
Energy	Combustion excluding transport, Solid Fuels	N_2O	68.11	0.0010	0.9890
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6	67.62	0.0010	0.9900
Waste	Waste Water Handling	CH_4	66.24	0.0010	0.9909
Solvents and other product use	Other solvent	CO_2	57.75	0.0008	0.9918
Energy	Road transportation	CH_4	52.94	0.0008	0.9925
Industrial processes	Other, lubricants	CO_2	49.71	0.0007	0.9932
Energy	Combustion excluding transport, Biomass	N_2O	41.58	0.0006	0.9938
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O	39.11	0.0006	0.9944
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	35.68	0.0005	0.9949
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	32.03	0.0005	0.9954
Waste	Waste, other	CH_4	28.27	0.0004	0.9958
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	27.92	0.0004	0.9962
Industrial processes	Bricks	CO_2	23.02	0.0003	0.9965
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	22.61	0.0003	0.9968
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	18.92	0.0003	0.9971
Waste	Waste, other	CO_2	18.34	0.0003	0.9974
Industrial processes	Glass production	CO_2	17.41	0.0003	0.9976
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	16.38	0.0002	0.9979
Solvents and other product use	Paint application	CO_2	15.88	0.0002	0.9981
Energy	Domestic navigation	N_2O	15.05	0.0002	0.9983
Industrial processes	Expanded clay	CO_2	14.93	0.0002	0.9985
Industrial processes	Limestone and dolomite use	CO_2	13.69	0.0002	0.9987

Continued					
Energy	Combustion excluding transport, Solid Fuels	CH_4	12.88	0.0002	0.9989
Waste	Waste, other	N_2O	11.20	0.0002	0.9991
Energy	Combustion excluding transport, Liquid Fuels	CH_4	11.13	0.0002	0.9992
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	7.77	0.0001	0.9993
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	5.36	0.0001	0.9994
Industrial processes	Food and drink	CO_2	4.45	0.0001	0.9995
Industrial processes	Electrical equipment	SF_6	3.91	0.0001	0.9995
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	3.57	0.0001	0.9996
Energy	Civil aviation	N_2O	3.53	0.0001	0.9996
Energy	Combustion excluding transport, Other Fuels	N_2O	2.99	0.0000	0.9997
Waste	Waste incineration	CO_2	2.55	0.0000	0.9997
Energy	Railways	N_2O	2.54	0.0000	0.9998
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	2.38	0.0000	0.9998
Waste	Waste incineration	CH_4	2.27	0.0000	0.9998
Agriculture	Field Burning of Agricultural Residues	CH_4	1.82	0.0000	0.9998
Industrial processes	Road Paving with asphalt	CO_2	1.76	0.0000	0.9999
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4	1.32	0.0000	0.9999
Waste	Waste incineration	N_2O	1.30	0.0000	0.9999
Solvents and other product use	Other solvent	N_2O	1.06	0.0000	0.9999
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.80	0.0000	0.9999
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	0.78	0.0000	0.9999
Energy	Domestic navigation	CH_4	0.71	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O	0.70	0.0000	1.0000
Agriculture	Field Burning of Agricultural Residues	N_2O	0.70	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.48	0.0000	1.0000
Energy	Combustion excluding transport, Other Fuels	CH_4	0.36	0.0000	1.0000
Energy	Railways	CH_4	0.26	0.0000	1.0000
Energy	Civil aviation	CH_4	0.16	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O	0.13	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.02	0.0000	1.0000
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.00	0.0000	1.0000
Solvents and other product use	Degreasing and Dry Cleaning	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CH_4	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O	0.00	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.00	0.0000	1.0000
Industrial processes	Aerosols	HFC	0.00	0.0000	1.0000
Industrial processes	Magnesium Production	SF_6	0.00	0.0000	1.0000
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	0.00	0.0000	1.0000
Total			69480.25	1.000	

Table 17.4 Key Category Analysis for Denmark and Greenland, level assessment for the base year, incl. LULUCF.

IPCC Source Categories (LULUCF included)		GHG	Base Year Estimate Ex,o Gg CO_2 eqv	Base Year Level Assessment Lx,o	Base Year Cumulative total
Energy	Combustion excluding transport, Solid Fuels	CO_2	23982.67	0.3173	0.3173
Energy	Combustion excluding transport, Liquid Fuels	CO_2	12237.23	0.1619	0.4791
Energy	Road transportation	CO_2	9318.42	0.1233	0.6024
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	4335.40	0.0574	0.6598
Agriculture	Enteric Fermentation	CH_4	3252.95	0.0430	0.7028
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	2452.80	0.0324	0.7353
LULUCF	Cropland, 5B Cropland rem. Cr. Organic soils	CO_2	2418.86	0.0320	0.7673
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	2405.15	0.0318	0.7991
Waste	Solid Waste Disposal Sites	CH_4	1480.84	0.0196	0.8187
LULUCF	Cropland, 5B Cropland rem. Cr. Mineral soils	CO_2	1415.33	0.0187	0.8374
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1112.06	0.0147	0.8521
Industrial processes	Nitric acid production	N_2O	1042.90	0.0138	0.8659
Agriculture	Manure Management	CH_4	993.31	0.0131	0.8790
Industrial processes	Cement production	CO_2	882.40	0.0117	0.8907
Energy	Domestic navigation	CO_2	816.81	0.0108	0.9015
LULUCF	Forest Land remaining Forest L., 5A1 Broadleaves	CO_2	707.93	0.0094	0.9109
LULUCF	Agricultural lime application, 5IV Cropland Limestone	CO_2	622.93	0.0082	0.9191
Agriculture	Manure Management	N_2O	600.42	0.0079	0.9271
Energy	Combustion excluding transport, Other Fuels	CO_2	575.14	0.0076	0.9347
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	455.25	0.0060	0.9407
Agriculture	Agriculture soils, direct emissions, Crop Residue	N_2O	361.27	0.0048	0.9455
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	311.78	0.0041	0.9496
Energy	Fugitive emissions, 1B2c2ii, Flaring gas	CO_2	299.69	0.0040	0.9536
Energy	Railways	CO_2	296.75	0.0039	0.9575
Energy	Civil aviation	CO_2	281.01	0.0037	0.9612
Agriculture	Agriculture soils, direct emissions, N-fixing Crops	N_2O	269.47	0.0036	0.9648
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	226.03	0.0030	0.9678
LULUCF	Grassland, 5C Grassland rem. Grassland. Organic soils	CO_2	182.73	0.0024	0.9702
Industrial processes	Foam Blowing	HFC	182.58	0.0024	0.9726
LULUCF	Grassland, 5C Land converted to Grassland, Living biomass	CO_2	179.37	0.0024	0.9750
LULUCF	Cropland, 5B Cropland remaining Cr. Living biomass	CO_2	149.93	0.0020	0.9769
LULUCF	Forest Land remaining Forest L., 5A1 Conifers	CO_2	136.39	0.0018	0.9787
Industrial processes	Lime production	CO_2	115.53	0.0015	0.9803
LULUCF	Settlements, 5E Total settlements	CO_2	104.44	0.0014	0.9817
Energy	Combustion excluding transport, Biomass	CH_4	98.86	0.0013	0.9830
Energy	Road transportation	N_2O	92.83	0.0012	0.9842
LULUCF	Wetlands, 5D Wetlands, soils	CO_2	86.08	0.0011	0.9853
Waste	N_2O indirect from human sewage	N_2O	85.23	0.0011	0.9865
Energy	Combustion excluding transport, Liquid Fuels	N_2O	83.40	0.0011	0.9876
Energy	Combustion excluding transport, Solid Fuels	N_2O	68.11	0.0009	0.9885
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6	67.62	0.0009	0.9894
Waste	Waste Water Handling	CH_4	66.24	0.0009	0.9902
Solvents and other product use	Other solvent	CO_2	57.75	0.0008	0.9910
Energy	Road transportation	CH_4	52.94	0.0007	0.9917
Industrial processes	Other, lubricants	CO_2	49.71	0.0007	0.9924
Energy	Combustion excluding transport, Biomass	N_2O	41.58	0.0006	0.9929
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O	39.11	0.0005	0.9934
LULUCF	Grassland, 5C Land converted to Cropland. Dead Org. Matter	CO_2	36.65	0.0005	0.9939
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	35.68	0.0005	0.9944
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	32.03	0.0004	0.9948
Waste	Waste, other	CH_4	28.27	0.0004	0.9952
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	27.92	0.0004	0.9955

Continued					
LULUCF	Cropland, 5B Land converted to Cropland. Living biomass	CO_2	27.23	0.0004	0.9959
Industrial processes	Bricks	CO_2	23.02	0.0003	0.9962
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	22.61	0.0003	0.9965
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	18.92	0.0003	0.9968
Waste	Waste, other	CO_2	18.34	0.0002	0.9970
Industrial processes	Glass production	CO_2	17.41	0.0002	0.9972
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	16.38	0.0002	0.9975
Solvents and other product use	Paint application	CO_2	15.88	0.0002	0.9977
LULUCF	Non-CO2 drainage of soils and wetlands, 5IID Forest Land.	N_2O	15.66	0.0002	0.9979
Energy	Domestic navigation	N_2O	15.05	0.0002	0.9981
Industrial processes	Expanded clay	CO_2	14.93	0.0002	0.9983
Industrial processes	Limestone and dolomite use	CO_2	13.69	0.0002	0.9984
Energy	Combustion excluding transport, Solid Fuels	CH_4	12.88	0.0002	0.9986
Waste	Waste, other	N_2O	11.20	0.0001	0.9988
Energy	Combustion excluding transport, Liquid Fuels	CH_4	11.13	0.0001	0.9989
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	7.77	0.0001	0.9990
LULUCF	Cropland, 5B Land converted to Cropland. Dead Org. Matter	CO_2	6.97	0.0001	0.9991
LULUCF	Grassland, 5C Grassland rem. Grassland. Living biomass	CO_2	6.19	0.0001	0.9992
LULUCF	Land converted to Forest L., 5A2 Conifers	CO_2	5.80	0.0001	0.9993
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	5.36	0.0001	0.9993
Industrial processes	Food and drink	CO_2	4.45	0.0001	0.9994
Industrial processes	Electrical equipment	SF_6	3.91	0.0001	0.9994
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	3.57	0.0000	0.9995
Energy	Civil aviation	N_2O	3.53	0.0000	0.9995
LULUCF	N_2O Disturbance, Land converted to cropland, 5III Cropland	N_2O	3.22	0.0000	0.9996
Energy	Combustion excluding transport, Other Fuels	N_2O	2.99	0.0000	0.9996
LULUCF	Land converted to Forest L., 5A2 Broadleaves	CO_2	2.62	0.0000	0.9997
Waste	Waste incineration	CO_2	2.55	0.0000	0.9997
Energy	Railways	N_2O	2.54	0.0000	0.9997
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	2.38	0.0000	0.9998
Waste	Waste incineration	CH_4	2.27	0.0000	0.9998
Agriculture	Field Burning of Agricultural Residues	CH_4	1.82	0.0000	0.9998
Industrial processes	Road Paving with asphalt	CO_2	1.76	0.0000	0.9998
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4	1.32	0.0000	0.9999
Waste	Waste incineration	N_2O	1.30	0.0000	0.9999
Solvents and other product use	Other solvent	N_2O	1.06	0.0000	0.9999
LULUCF	Cropland, 5B Land converted to Cropland. Organic soils	CO_2	0.93	0.0000	0.9999
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.80	0.0000	0.9999
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	0.78	0.0000	0.9999
LULUCF	Grassland, 5C Land converted to Grassland, Organic soils	CO_2	0.73	0.0000	0.9999
Energy	Domestic navigation	CH_4	0.71	0.0000	0.9999
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O	0.70	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	N_2O	0.70	0.0000	1.0000
LULUCF	Biomass burning, 5V Biomass burning	CH_4	0.55	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.48	0.0000	1.0000
LULUCF	Wetlands, 5D Wetlands Living biomass	CO_2	0.47	0.0000	1.0000
LULUCF	Grassland, 5C Land converted to Grassland, Mineral soils	CO_2	0.45	0.0000	1.0000
LULUCF	Biomass burning, 5V Biomass burning	N_2O	0.45	0.0000	1.0000
Energy	Combustion excluding transport, Other Fuels	CH_4	0.36	0.0000	1.0000
Energy	Railways	CH_4	0.26	0.0000	1.0000
Energy	Civil aviation	CH_4	0.16	0.0000	1.0000
LULUCF	Non-CO2 drainage of soils and wetlands, 5IID Wetlands. Peatland	N_2O	0.13	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O	0.13	0.0000	1.0000
LULUCF	Wetlands, 5D Wetlands, dead org. matter	CO_2	0.11	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.02	0.0000	1.0000
LULUCF	Cropland, 5B Land converted to Cropland. Mineral soils	CO_2	0.01	0.0000	1.0000
LULUCF	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.00	0.0000	1.0000

Continued					
LULUCF	Degreasing and Dry Cleaning	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CH_4	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O	0.00	0.0000	1.0000
LULUCF	Forest Land remaining Forest L., 5A1 Larch (Greenland)	CO_2	0.00	0.0000	1.0000
LULUCF	Forest Land remaining Forest L., 5A1 Other Conifers (Greenland)	CO_2	0.00	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.00	0.0000	1.0000
Industrial processes	Aerosols	HFC	0.00	0.0000	1.0000
Industrial processes	Magnesium Production	SF_6	0.00	0.0000	1.0000
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	0.00	0.0000	1.0000
Total			75592.40	1.000	

Table 17.5 Key Category Analysis for Denmark and Greenland, level assessment for the reporting year, excl. LULUCF.

IPCC Source Categories (LULUCF excluded)		GHG	Reporting Year Estimate Ex,t Gg CO_2 eqv	Reporting Year Level Assessment Lx,t	Reporting Year Cumulative total
Energy	Combustion excluding transport, Solid Fuels	CO_2	15310.92	0.2478	0.2478
Energy	Road transportation	CO_2	12141.92	0.1965	0.4444
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	10606.96	0.1717	0.6160
Energy	Combustion excluding transport, Liquid Fuels	CO_2	7647.84	0.1238	0.7398
Agriculture	Enteric Fermentation	CH_4	2861.87	0.0463	0.7862
Energy	Combustion excluding transport, Other Fuels	CO_2	1416.57	0.0229	0.8091
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	1416.31	0.0229	0.8320
Agriculture	Manure Management	CH_4	1288.02	0.0208	0.8529
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1154.65	0.0187	0.8715
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	1140.00	0.0185	0.8900
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	705.82	0.0114	0.9014
Waste	Solid Waste Disposal Sites	CH_4	696.74	0.0113	0.9127
Industrial processes	Cement production	CO_2	672.22	0.0109	0.9236
Energy	Domestic navigation	CO_2	620.60	0.0100	0.9336
Agriculture	Manure Management	N_2O	421.91	0.0068	0.9405
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2	333.32	0.0054	0.9459
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	314.83	0.0051	0.9510
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	287.98	0.0047	0.9556
Energy	Railways	CO_2	242.19	0.0039	0.9595
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	240.62	0.0039	0.9634
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O	238.05	0.0039	0.9673
Energy	Civil aviation	CO_2	201.91	0.0033	0.9705
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	198.10	0.0032	0.9738
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	163.11	0.0026	0.9764
Energy	Combustion excluding transport, Biomass	CH_4	161.26	0.0026	0.9790
Energy	Road transportation	N_2O	119.58	0.0019	0.9809
Energy	Combustion excluding transport, Biomass	N_2O	102.11	0.0017	0.9826
Industrial processes	Foam Blowing	HFC	87.29	0.0014	0.9840
Waste	Waste, other	CH_4	82.09	0.0013	0.9853
Waste	Waste Water Handling	CH_4	75.39	0.0012	0.9866
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O	60.60	0.0010	0.9875
Energy	Combustion excluding transport, Liquid Fuels	N_2O	59.22	0.0010	0.9885
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	55.09	0.0009	0.9894
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	46.61	0.0008	0.9901
Industrial processes	Lime production	CO_2	45.64	0.0007	0.9909
Industrial processes	Limestone and dolomite use	CO_2	45.57	0.0007	0.9916
Waste	Waste, other	N_2O	42.65	0.0007	0.9923
Solvents and other product use	Other solvent	CO_2	42.18	0.0007	0.9930
Energy	Combustion excluding transport, Solid Fuels	N_2O	41.56	0.0007	0.9937
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	41.39	0.0007	0.9943
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	35.66	0.0006	0.9949
Waste	N_2O indirect from human sewage	N_2O	35.63	0.0006	0.9955
Industrial processes	Other, lubricants	CO_2	33.18	0.0005	0.9960
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6	23.69	0.0004	0.9964

Continued					
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	18.93	0.0003	0.9967
Waste	Waste, other	CO_2	18.24	0.0003	0.9970
Industrial processes	Aerosols	HFC	16.71	0.0003	0.9973
Industrial processes	Bricks	CO_2	15.76	0.0003	0.9975
Industrial processes	Electrical equipment	SF_6	14.19	0.0002	0.9978
Solvents and other product use	Other solvent	N_2O	14.16	0.0002	0.9980
Energy	Road transportation	CH_4	13.64	0.0002	0.9982
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	12.31	0.0002	0.9984
Energy	Domestic navigation	N_2O	10.79	0.0002	0.9986
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	10.47	0.0002	0.9988
Energy	Combustion excluding transport, Liquid Fuels	CH_4	10.15	0.0002	0.9989
Industrial processes	Glass production	CO_2	9.33	0.0002	0.9991
Solvents and other product use	Paint application	CO_2	7.97	0.0001	0.9992
Energy	Combustion excluding transport, Other Fuels	N_2O	7.12	0.0001	0.9993
Industrial processes	Expanded clay	CO_2	6.00	0.0001	0.9994
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	4.62	0.0001	0.9995
Energy	Combustion excluding transport, Solid Fuels	CH_4	4.36	0.0001	0.9996
Waste	Waste incineration	CO_2	3.12	0.0001	0.9996
Energy	Civil aviation	N_2O	3.03	0.0000	0.9997
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	2.99	0.0000	0.9997
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	2.12	0.0000	0.9997
Agriculture	Field Burning of Agricultural Residues	CH_4	2.09	0.0000	0.9998
Energy	Railways	N_2O	2.07	0.0000	0.9998
Industrial processes	Road Paving with asphalt	CO_2	1.73	0.0000	0.9998
Waste	Waste incineration	CH_4	1.60	0.0000	0.9999
Industrial processes	Food and drink	CO_2	1.56	0.0000	0.9999
Energy	Fugitive emissions , 1B2c Venting	CH_4	1.20	0.0000	0.9999
Waste	Waste incineration	N_2O	1.10	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	N_2O	0.80	0.0000	0.9999
Energy	Domestic navigation	CH_4	0.78	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O	0.78	0.0000	1.0000
Energy	Combustion excluding transport, Other Fuels	CH_4	0.65	0.0000	1.0000
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	0.56	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.54	0.0000	1.0000
Energy	Railways	CH_4	0.15	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4	0.13	0.0000	1.0000
Energy	Civil aviation	CH_4	0.09	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O	0.05	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4	0.04	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.02	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.02	0.0000	1.0000
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O	0.00	0.0000	1.0000
Solvents and other product use	Degreasing and Dry Cleaning	CO_2	0.00	0.0000	1.0000
Industrial processes	Nitric acid production	N_2O	0.00	0.0000	1.0000

Continued					
Industrial processes	Magnesium Production	SF_6	0.00	0.0000	1.0000
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O	0.00	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.00	0.0000	1.0000
Total			61780.80	1.000	

Table 17.6 Key Category Analysis for Denmark and Greenland, level assessment for the reporting year, incl. LULUCF.

IPCC Source Categories (LULUCF included)		GHG	Reporting Year Estimate Ex,t Gg CO_2 eqv	Reporting Year Level Assessment Lx,t	Reporting Year Cumulative total
Energy	Combustion excluding transport, Solid Fuels	CO_2	15310.92	0.2146	0.2146
Energy	Road transportation	CO_2	12141.92	0.1702	0.3847
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	10606.96	0.1486	0.5334
Energy	Combustion excluding transport, Liquid Fuels	CO_2	7647.84	0.1072	0.6405
LULUCF	Forest Land remaining Forest L., 5A1 Broadleaves	CO_2	3752.23	0.0526	0.6931
Agriculture	Enteric Fermentation	CH_4	2861.87	0.0401	0.7332
LULUCF	Forest Land remaining Forest L., 5A1 Conifers	CO_2	1937.07	0.0271	0.7604
LULUCF	Cropland, 5B Cropland rem. Cr. Organic soils	CO_2	1727.98	0.0242	0.7846
Energy	Combustion excluding transport, Other Fuels	CO_2	1416.57	0.0199	0.8044
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	1416.31	0.0198	0.8243
Agriculture	Manure Management	CH_4	1288.02	0.0181	0.8423
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1154.65	0.0162	0.8585
LULUCF	Cropland, 5B Cropland rem. Cr. Mineral soils	CO_2	1152.47	0.0162	0.8747
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	1140.00	0.0160	0.8907
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	705.82	0.0099	0.9005
Waste	Solid Waste Disposal Sites	CH_4	696.74	0.0098	0.9103
Industrial processes	Cement production	CO_2	672.22	0.0094	0.9197
Energy	Domestic navigation	CO_2	620.60	0.0087	0.9284
Agriculture	Manure Management	N_2O	421.91	0.0059	0.9343
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2	333.32	0.0047	0.9390
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	314.83	0.0044	0.9434
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	287.98	0.0040	0.9475
Energy	Railways	CO_2	242.19	0.0034	0.9509
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	240.62	0.0034	0.9542
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O	238.05	0.0033	0.9576
Energy	Civil aviation	CO_2	201.91	0.0028	0.9604
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	198.10	0.0028	0.9632
LULUCF	Agricultural lime application, 5IV Cropland Limestone	CO_2	185.27	0.0026	0.9658
LULUCF	Land converted to Forest L., 5A2 Broadleaves	CO_2	177.81	0.0025	0.9683
LULUCF	Land converted to Forest L., 5A2 Conifers	CO_2	177.44	0.0025	0.9707
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	163.11	0.0023	0.9730
Energy	Combustion excluding transport, Biomass	CH_4	161.26	0.0023	0.9753
LULUCF	Settlements, 5E Total settlements	CO_2	134.37	0.0019	0.9772
LULUCF	Grassland, 5C Grassland rem. Grassland. Organic soils	CO_2	132.60	0.0019	0.9790
Energy	Road transportation	N_2O	119.58	0.0017	0.9807
Energy	Combustion excluding transport, Biomass	N_2O	102.11	0.0014	0.9821
LULUCF	Cropland, 5B Cropland remaining Cr. Living biomass	CO_2	99.58	0.0014	0.9835
Industrial processes	Foam Blowing	HFC	87.29	0.0012	0.9848
Waste	Waste, other	CH_4	82.09	0.0012	0.9859
Waste	Waste Water Handling	CH_4	75.39	0.0011	0.9870
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O	60.60	0.0008	0.9878
Energy	Combustion excluding transport, Liquid Fuels	N_2O	59.22	0.0008	0.9886
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	55.09	0.0008	0.9894
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	46.61	0.0007	0.9901
Industrial processes	Lime production	CO_2	45.64	0.0006	0.9907
Industrial processes	Limestone and dolomite use	CO_2	45.57	0.0006	0.9913
Waste	Waste, other	N_2O	42.65	0.0006	0.9919
Solvents and other product use	Other solvent	CO_2	42.18	0.0006	0.9925
Energy	Combustion excluding transport, Solid Fuels	N_2O	41.56	0.0006	0.9931
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	41.39	0.0006	0.9937
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	35.66	0.0005	0.9942
Waste	N_2O indirect from human sewage	N_2O	35.63	0.0005	0.9947

Continued					
Industrial processes	Other, lubricants	CO_2	33.18	0.0005	0.9952
LULUCF	Grassland, 5C Land converted to Grassland, Living biomass	CO_2	26.63	0.0004	0.9955
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6	23.69	0.0003	0.9959
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	18.93	0.0003	0.9961
Waste	Waste, other	CO_2	18.24	0.0003	0.9964
LULUCF	Cropland, 5B Land converted to Cropland. Organic soils	CO_2	17.20	0.0002	0.9966
Industrial processes	Aerosols	HFC	16.71	0.0002	0.9969
Industrial processes	Bricks	CO_2	15.76	0.0002	0.9971
Industrial processes	Electrical equipment	SF_6	14.19	0.0002	0.9973
Solvents and other product use	Other solvent	N_2O	14.16	0.0002	0.9975
Energy	Road transportation	CH_4	13.64	0.0002	0.9977
LULUCF	Grassland, 5C Land converted to Grassland, Organic soils	CO_2	13.51	0.0002	0.9979
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	12.31	0.0002	0.9980
LULUCF	Non-CO2 drainage of soils and wetlands, 5IID Forest Land.	N_2O	12.03	0.0002	0.9982
Energy	Domestic navigation	N_2O	10.79	0.0002	0.9984
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	10.47	0.0001	0.9985
Energy	Combustion excluding transport, Liquid Fuels	CH_4	10.15	0.0001	0.9986
Industrial processes	Glass production	CO_2	9.33	0.0001	0.9988
Solvents and other product use	Paint application	CO_2	7.97	0.0001	0.9989
Energy	Combustion excluding transport, Other Fuels	N_2O	7.12	0.0001	0.9990
LULUCF	Grassland, 5C Grassland rem. Grassland. Living biomass	CO_2	7.10	0.0001	0.9991
Industrial processes	Expanded clay	CO_2	6.00	0.0001	0.9992
LULUCF	Wetlands, 5D Wetlands Living biomass	CO_2	5.33	0.0001	0.9992
LULUCF	Wetlands, 5D Wetlands, soils	CO_2	5.07	0.0001	0.9993
LULUCF	Grassland, 5C Land converted to Grassland, Mineral soils	CO_2	5.04	0.0001	0.9994
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	4.62	0.0001	0.9994
Energy	Combustion excluding transport, Solid Fuels	CH_4	4.36	0.0001	0.9995
Waste	Waste incineration	CO_2	3.12	0.0000	0.9996
Energy	Civil aviation	N_2O	3.03	0.0000	0.9996
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	2.99	0.0000	0.9996
LULUCF	Cropland, 5B Land converted to Cropland. Living biomass	CO_2	2.46	0.0000	0.9997
LULUCF	Grassland, 5C Land converted to Cropland. Dead Org. Matter	CO_2	2.43	0.0000	0.9997
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	2.12	0.0000	0.9997
Agriculture	Field Burning of Agricultural Residues	CH_4	2.09	0.0000	0.9998
Energy	Railways	N_2O	2.07	0.0000	0.9998
Industrial processes	Road Paving with asphalt	CO_2	1.73	0.0000	0.9998
Waste	Waste incineration	CH_4	1.60	0.0000	0.9998
Industrial processes	Food and drink	CO_2	1.56	0.0000	0.9999
LULUCF	Cropland, 5B Land converted to Cropland. Dead Org. Matter	CO_2	1.21	0.0000	0.9999
Energy	Fugitive emissions , 1B2c Venting	CH_4	1.20	0.0000	0.9999
Waste	Waste incineration	N_2O	1.10	0.0000	0.9999
LULUCF	Cropland, 5B Land converted to Cropland. Mineral soils	CO_2	0.83	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	N_2O	0.80	0.0000	0.9999
Energy	Domestic navigation	CH_4	0.78	0.0000	0.9999
Energy	Fugitive emissions, 1B2c2ii, Flaring gas	N_2O	0.78	0.0000	1.0000
Energy	Combustion excluding transport, Other Fuels	CH_4	0.65	0.0000	1.0000
LULUCF	N_2O Disturbance, Land converted to cropland, 5III Cropland	N_2O	0.62	0.0000	1.0000
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	0.56	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.54	0.0000	1.0000
Energy	Railways	CH_4	0.15	0.0000	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands, 5IID Wetlands. Peatland	N_2O	0.13	0.0000	1.0000
Energy	Fugitive emissions, 1B2c2i, Flaring oil	CH_4	0.13	0.0000	1.0000
LULUCF	Wetlands, 5D Wetlands, dead org. matter	CO_2	0.10	0.0000	1.0000
Energy	Civil aviation	CH_4	0.09	0.0000	1.0000

Continued					
Energy	Fugitive emissions, 1B2c2i, Flaring oil	N_2O	0.05	0.0000	1.0000
Energy	Fugitive emissions, 1B2ai Oil Exploration	CH_4	0.04	0.0000	1.0000
LULUCF	Forest Land remaining Forest L., 5A1 Other Conifers (Greenland)	CO_2	0.03	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.02	0.0000	1.0000
LULUCF	Biomass burning, 5V Biomass burning	N_2O	0.02	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.02	0.0000	1.0000
LULUCF	Biomass burning, 5V Biomass burning	CH_4	0.01	0.0000	1.0000
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.00	0.0000	1.0000
LULUCF	Forest Land remaining Forest L., 5A1 Larch (Greenland)	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions, 1B2c Venting	CO_2	0.00	0.0000	1.0000
Energy	Fugitive emissions, 1B2ai Oil Exploration	N_2O	0.00	0.0000	1.0000
Solvents and other product use	Degreasing and Dry Cleaning	CO_2	0.00	0.0000	1.0000
Industrial processes	Nitric acid production	N_2O	0.00	0.0000	1.0000
Industrial processes	Magnesium Production	SF_6	0.00	0.0000	1.0000
Energy	Fugitive emissions, 1B2aii Oil Production	N_2O	0.00	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.00	0.0000	1.0000
Total			71357.39	1.000	

Table 17.7 Key Category Analysis for Denmark and Greenland, trend assessment, excl. LULUCF.

IPCC Source Categories (LULUCF excluded)		GHG	Base Year Estimate Ex,o Gg CO_2 eqv.	Year 2010 Estimate Ex,t Gg CO_2 eqv.	Trend Assess-ment Tx,t	Contri-bution to Trend	Cumulative total
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	4335.40	10606.96	0.0972	0.2487	0.2487
Energy	Combustion excluding transport, Solid Fuels	CO_2	23982.67	15310.92	0.0866	0.2215	0.4702
Energy	Road transportation	CO_2	9318.42	12141.92	0.0555	0.1420	0.6122
Energy	Combustion excluding transport, Liquid Fuels	CO_2	12237.23	7647.84	0.0465	0.1191	0.7313
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	2405.15	1140.00	0.0144	0.0368	0.7681
Industrial processes	Nitric acid production	N_2O	1042.90	0.00	0.0133	0.0342	0.8023
Energy	Combustion excluding transport, Other Fuels	CO_2	575.14	1416.57	0.0130	0.0333	0.8356
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	2452.80	1416.31	0.0110	0.0282	0.8638
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	35.68	705.82	0.0097	0.0248	0.8886
Waste	Solid Waste Disposal Sites	CH_4	1480.84	696.74	0.0089	0.0228	0.9114
Agriculture	Manure Management	CH_4	993.31	1288.02	0.0058	0.0149	0.9264
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	7.77	240.62	0.0034	0.0086	0.9350
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1112.06	1154.65	0.0024	0.0061	0.9411
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	455.25	287.98	0.0017	0.0043	0.9454
Industrial processes	Cement production	CO_2	882.40	672.22	0.0016	0.0041	0.9495
Agriculture	Manure Management	N_2O	600.42	421.91	0.0016	0.0041	0.9536
Energy	Domestic navigation	CO_2	816.81	620.60	0.0015	0.0039	0.9575
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	311.78	198.10	0.0011	0.0029	0.9604
Industrial processes	Foam Blowing	HFC	182.58	87.29	0.0011	0.0028	0.9632
Energy	Combustion excluding transport, Biomass	CH_4	98.86	161.26	0.0011	0.0027	0.9659
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2	299.69	333.32	0.0010	0.0025	0.9684
Energy	Combustion excluding transport, Biomass	N_2O	41.58	102.11	0.0009	0.0024	0.9708
Industrial processes	Lime production	CO_2	115.53	45.64	0.0008	0.0021	0.9729
Waste	Waste, other	CH_4	28.27	82.09	0.0008	0.0021	0.9750
Energy	Civil aviation	CO_2	281.01	201.91	0.0007	0.0018	0.9767
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	0.78	46.61	0.0007	0.0017	0.9784
Waste	N_2O indirect from human sewage	N_2O	85.23	35.63	0.0006	0.0015	0.9799
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	226.03	163.11	0.0005	0.0014	0.9813
Energy	Road transportation	N_2O	92.83	119.58	0.0005	0.0014	0.9827
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laborato-ries	SF_6	67.62	23.69	0.0005	0.0013	0.9840
Energy	Road transportation	CH_4	52.94	13.64	0.0005	0.0012	0.9852
Industrial processes	Limestone and dolomite use	CO_2	13.69	45.57	0.0005	0.0012	0.9865
Waste	Waste, other	N_2O	11.20	42.65	0.0005	0.0012	0.9877
Agriculture	Enteric Fermentation	CH_4	3252.95	2861.87	0.0004	0.0011	0.9888
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	32.03	55.09	0.0004	0.0010	0.9898

Continued							
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O	39.11	60.60	0.0004	0.0010	0.9907
Energy	Railways	CO_2	296.75	242.19	0.0003	0.0008	0.9915
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	16.38	35.66	0.0003	0.0008	0.9923
Energy	Combustion excluding transport, Solid Fuels	N_2O	68.11	41.56	0.0003	0.0007	0.9930
Industrial processes	Aerosols	HFC	0.00	16.71	0.0002	0.0006	0.9936
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	27.92	41.39	0.0002	0.0006	0.9942
Waste	Waste Water Handling	CH_4	66.24	75.39	0.0002	0.0006	0.9948
Energy	Combustion excluding transport, Liquid Fuels	N_2O	83.40	59.22	0.0002	0.0006	0.9954
Solvents and other product use	Other solvent	N_2O	1.06	14.16	0.0002	0.0005	0.9959
Industrial processes	Other, lubricants	CO_2	49.71	33.18	0.0002	0.0004	0.9963
Industrial processes	Electrical equipment	SF_6	3.91	14.19	0.0002	0.0004	0.9967
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	0.00	10.47	0.0002	0.0004	0.9971
Solvents and other product use	Other solvent	CO_2	57.75	42.18	0.0001	0.0003	0.9974
Industrial processes	Expanded clay	CO_2	14.93	6.00	0.0001	0.0003	0.9977
Energy	Combustion excluding transport, Solid Fuels	CH_4	12.88	4.36	0.0001	0.0003	0.9979
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	361.27	314.83	0.0001	0.0002	0.9982
Industrial processes	Glass production	CO_2	17.41	9.33	0.0001	0.0002	0.9984
Solvents and other product use	Paint application	CO_2	15.88	7.97	0.0001	0.0002	0.9986
Industrial processes	Bricks	CO_2	23.02	15.76	0.0001	0.0002	0.9988
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	18.92	12.31	0.0001	0.0002	0.9990
Energy	Combustion excluding transport, Other Fuels	N_2O	2.99	7.12	0.0001	0.0002	0.9991
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	3.57	0.56	0.0000	0.0001	0.9992
Energy	Domestic navigation	N_2O	15.05	10.79	0.0000	0.0001	0.9993
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	2.38	4.62	0.0000	0.0001	0.9994
Industrial processes	Food and drink	CO_2	4.45	1.56	0.0000	0.0001	0.9995
Waste	Waste, other	CO_2	18.34	18.24	0.0000	0.0001	0.9996
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	5.36	2.99	0.0000	0.0001	0.9996
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O	269.47	238.05	0.0000	0.0001	0.9997
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.80	2.12	0.0000	0.0001	0.9997
Energy	Fugitive emissions , 1B2c Venting	CH_4	0.00	1.20	0.0000	0.0000	0.9998
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	22.61	18.93	0.0000	0.0000	0.9998
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4	1.32	0.13	0.0000	0.0000	0.9999
Waste	Waste incineration	CO_2	2.55	3.12	0.0000	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	CH_4	1.82	2.09	0.0000	0.0000	0.9999
Waste	Waste incineration	CH_4	2.27	1.60	0.0000	0.0000	0.9999
Energy	Combustion excluding transport, Other Fuels	CH_4	0.36	0.65	0.0000	0.0000	0.9999
Energy	Combustion excluding transport, Liquid Fuels	CH_4	11.13	10.15	0.0000	0.0000	1.0000

Continued

Energy	Railways	N_2O	2.54	2.07	0.0000	0.0000	1.0000
Agriculture	Field Burning of Agricultural Residues	N_2O	0.70	0.80	0.0000	0.0000	1.0000
Industrial processes	Road Paving with asphalt	CO_2	1.76	1.73	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O	0.70	0.78	0.0000	0.0000	1.0000
Energy	Domestic navigation	CH_4	0.71	0.78	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.48	0.54	0.0000	0.0000	1.0000
Energy	Civil aviation	N_2O	3.53	3.03	0.0000	0.0000	1.0000
Energy	Railways	CH_4	0.26	0.15	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O	0.13	0.05	0.0000	0.0000	1.0000
Waste	Waste incineration	N_2O	1.30	1.10	0.0000	0.0000	1.0000
Energy	Civil aviation	CH_4	0.16	0.09	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4	0.00	0.04	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.00	0.02	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CO_2	0.00	0.00	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.00	0.00	0.0000	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.02	0.02	0.0000	0.0000	1.0000
Solvents and other product use	Degreasing and Dry Cleaning	CO_2	0.00	0.00	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O	0.00	0.00	0.0000	0.0000	1.0000
Industrial processes	Magnesium Production	SF_6	0.00	0.00	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O	0.00	0.00	0.0000	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.00	0.00	0.0000	0.0000	1.0000
Total			69480.25	61780.80		1.0000	

Table 17.8 Key Category Analysis for Denmark and Greenland, trend assessment, incl. LULUCF.

IPCC Source Categories (LULUCF included)		GHG	Base Year Estimate Ex,o Gg CO_2 eqv	Year 2010 Estimate Ex,t Gg CO_2 eqv	Trend Assess-ment Tx,t	Contri-bution to Trend	Cumulative total
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	4335.403	10606.963	0.0941	0.2310	0.2310
Energy	Road transportation	CO_2	9318.417	12141.920	0.0612	0.1503	0.3813
Energy	Combustion excluding transport, Solid Fuels	CO_2	23982.671	15310.915	0.0534	0.1310	0.5123
LULUCF	Forest Land remaining Forest L., 5A1 Broadleaves	CO_2	-707.931	-3752.235	0.0385	0.0945	0.6068
Energy	Combustion excluding transport, Liquid Fuels	CO_2	12237.232	7647.841	0.0294	0.0722	0.6790
LULUCF	Forest Land remaining Forest L., 5A1 Conifers	CO_2	-136.385	-1937.073	0.0235	0.0576	0.7366
Energy	Combustion excluding transport, Other Fuels	CO_2	575.139	1416.569	0.0126	0.0309	0.7676
Industrial processes	Nitric acid production	N_2O	1042.902	0.000	0.0111	0.0273	0.7949
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	2405.150	1140.000	0.0106	0.0260	0.8209
Industrial processes	Refrigeration and AC Equipment	HFC and PFC	35.677	705.823	0.0090	0.0220	0.8429
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	2452.803	1416.313	0.0074	0.0183	0.8612
Waste	Solid Waste Disposal Sites	CH_4	1480.842	696.739	0.0066	0.0162	0.8773
Agriculture	Manure Management	CH_4	993.313	1288.018	0.0064	0.0158	0.8931
LULUCF	Agricultural lime application, 5IV Cropland Limestone	CO_2	622.931	185.270	0.0042	0.0103	0.9034
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	1112.058	1154.645	0.0034	0.0084	0.9118
Agriculture	Enteric Fermentation	CH_4	3252.947	2861.867	0.0031	0.0077	0.9195
Energy	Combustion excluding transport, Gaseous Fuels	CH_4	7.769	240.617	0.0031	0.0076	0.9272
LULUCF	Cropland, 5B Cropland rem. Cr. Organic soils	CO_2	2418.857	1727.985	0.0030	0.0072	0.9344
LULUCF	Land converted to Forest L., 5A2 Conifers	CO_2	5.802	-177.441	0.0024	0.0059	0.9403
LULUCF	Land converted to Forest L., 5A2 Broadleaves	CO_2	2.624	177.808	0.0023	0.0057	0.9460
LULUCF	Grassland, 5C Land converted to Grassland, Living biomass	CO_2	179.370	26.629	0.0016	0.0038	0.9499
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2	299.695	333.323	0.0012	0.0030	0.9528
Energy	Combustion excluding transport, Biomass	CH_4	98.862	161.261	0.0011	0.0026	0.9555
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	455.251	287.982	0.0010	0.0026	0.9581
Energy	Combustion excluding transport, Biomass	N_2O	41.576	102.112	0.0009	0.0022	0.9603
LULUCF	Wetlands, 5D Wetlands, soils	CO_2	86.080	5.067	0.0009	0.0021	0.9624
Agriculture	Manure Management	N_2O	600.423	421.914	0.0008	0.0020	0.9644
Industrial processes	Foam Blowing	HFC	182.578	87.289	0.0008	0.0019	0.9664
Waste	Waste, other	CH_4	28.268	82.088	0.0008	0.0019	0.9683
Agriculture	Agriculture soils, pasture, range and paddock	N_2O	311.784	198.097	0.0007	0.0017	0.9700
LULUCF	Settlements, 5E Total settlements	CO_2	104.438	134.372	0.0007	0.0016	0.9716
Industrial processes	Lime production	CO_2	115.532	45.642	0.0006	0.0015	0.9732
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4	0.778	46.607	0.0006	0.0015	0.9747
Energy	Road transportation	N_2O	92.830	119.577	0.0006	0.0015	0.9761
Industrial processes	Cement production	CO_2	882.402	672.224	0.0005	0.0013	0.9774
Energy	Domestic navigation	CO_2	816.811	620.597	0.0005	0.0012	0.9787

Continued							
Industrial processes	Limestone and dolomite use	CO_2	13.692	45.568	0.0005	0.0011	0.9798
Waste	Waste, other	N_2O	11.198	42.646	0.0004	0.0011	0.9809
Waste	N_2O indirect from human sewage	N_2O	85.233	35.634	0.0004	0.0011	0.9820
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6	67.616	23.687	0.0004	0.0010	0.9830
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4	32.030	55.088	0.0004	0.0010	0.9839
Energy	Road transportation	CH_4	52.935	13.636	0.0004	0.0009	0.9849
Waste	N2O direct, Domestic and Commercial Wastewater	N_2O	39.113	60.601	0.0004	0.0009	0.9858
LULUCF	Grassland, 5C Land converted to Cropland. Dead Org. Matter	CO_2	36.653	2.427	0.0004	0.0009	0.9867
Energy	Civil aviation	CO_2	281.013	201.915	0.0003	0.0008	0.9875
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	361.266	314.834	0.0003	0.0008	0.9882
Energy	Combustion excluding transport, Gaseous Fuels	N_2O	16.380	35.658	0.0003	0.0007	0.9890
Waste	Waste Water Handling	CH_4	66.244	75.389	0.0003	0.0007	0.9897
LULUCF	Cropland, 5B Cropland remaining Cr. Living biomass	CO_2	149.935	99.577	0.0003	0.0007	0.9904
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O	269.467	238.047	0.0003	0.0007	0.9911
LULUCF	Cropland, 5B Land converted to Cropland. Living biomass	CO_2	27.230	2.459	0.0003	0.0006	0.9917
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O	226.026	163.105	0.0003	0.0006	0.9923
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O	27.923	41.386	0.0002	0.0006	0.9929
Industrial processes	Aerosols	HFC	0.000	16.707	0.0002	0.0005	0.9935
LULUCF	Cropland, 5B Land converted to Cropland. Organic soils	CO_2	0.928	17.196	0.0002	0.0005	0.9940
LULUCF	Grassland, 5C Grassland rem. Grassland. Organic soils	CO_2	182.726	132.598	0.0002	0.0005	0.9945
Energy	Combustion excluding transport, Solid Fuels	N_2O	68.113	41.558	0.0002	0.0004	0.9949
Solvents and other product use	Other solvent	N_2O	1.062	14.160	0.0002	0.0004	0.9953
LULUCF	Grassland, 5C Land converted to Grassland, Organic soils	CO_2	0.732	13.513	0.0002	0.0004	0.9958
Industrial processes	Electrical equipment	SF_6	3.908	14.195	0.0001	0.0004	0.9961
LULUCF	Cropland, 5B Cropland rem. Cr. Mineral soils	CO_2	1415.326	1152.472	0.0001	0.0004	0.9965
Industrial processes	Other i.e. Fibre Optics	HFC and PFC	0.000	10.467	0.0001	0.0003	0.9968
Energy	Combustion excluding transport, Liquid Fuels	N_2O	83.402	59.221	0.0001	0.0003	0.9971
Industrial processes	Other, lubricants	CO_2	49.706	33.178	0.0001	0.0002	0.9973
Industrial processes	Expanded clay	CO_2	14.929	5.996	0.0001	0.0002	0.9975
Energy	Combustion excluding transport, Solid Fuels	CH_4	12.876	4.365	0.0001	0.0002	0.9977
LULUCF	Wetlands, 5D Wetlands Living biomass	CO_2	0.473	-5.327	0.0001	0.0002	0.9979
Solvents and other product use	Paint application	CO_2	15.875	7.971	0.0001	0.0002	0.9980
Industrial processes	Glass production	CO_2	17.407	9.332	0.0001	0.0002	0.9982
Energy	Combustion excluding transport, Other Fuels	N_2O	2.988	7.118	0.0001	0.0002	0.9983
LULUCF	Grassland, 5C Land converted to Grassland, Mineral soils	CO_2	0.454	5.044	0.0001	0.0002	0.9985
LULUCF	Cropland, 5B Land converted to Cropland. Dead Org. Matter	CO_2	6.966	1.213	0.0001	0.0001	0.9986
Solvents and other product use	Other solvent	CO_2	57.754	42.180	0.0001	0.0001	0.9988

Continued							
Waste	Waste, other	CO_2	18.340	18.242	0.0000	0.0001	0.9989
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2	18.924	12.314	0.0000	0.0001	0.9990
Energy	Railways	CO_2	296.745	242.185	0.0000	0.0001	0.9991
Industrial processes	Bricks	CO_2	23.016	15.755	0.0000	0.0001	0.9992
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2	2.381	4.618	0.0000	0.0001	0.9993
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4	3.568	0.556	0.0000	0.0001	0.9993
LULUCF	Grassland, 5C Grassland rem. Grassland. Living biomass	CO_2	6.187	7.099	0.0000	0.0001	0.9994
Industrial processes	Food and drink	CO_2	4.450	1.557	0.0000	0.0001	0.9995
LULUCF	N_2O Disturbance, Land converted to cropland, 5III Cropland	N_2O	3.217	0.624	0.0000	0.0001	0.9995
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.800	2.119	0.0000	0.0000	0.9996
Energy	Domestic navigation	N_2O	15.047	10.787	0.0000	0.0000	0.9996
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4	5.362	2.989	0.0000	0.0000	0.9997
Energy	Fugitive emissions , 1B2c Venting	CH_4	0.000	1.197	0.0000	0.0000	0.9997
Energy	Combustion excluding transport, Liquid Fuels	CH_4	11.130	10.148	0.0000	0.0000	0.9997
Waste	Waste incineration	CO_2	2.550	3.120	0.0000	0.0000	0.9998
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4	1.323	0.132	0.0000	0.0000	0.9998
LULUCF	Cropland, 5B Land converted to Cropland. Mineral soils	CO_2	-0.006	-0.829	0.0000	0.0000	0.9998
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2	22.607	18.933	0.0000	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	CH_4	1.824	2.092	0.0000	0.0000	0.9999
LULUCF	Non-CO_2 drainage of soils and wetlands, 5IID Forest Land.	N_2O	15.659	12.034	0.0000	0.0000	0.9999
LULUCF	Biomass burning, 5V Biomass burning	CH_4	0.549	0.013	0.0000	0.0000	0.9999
Energy	Combustion excluding transport, Other Fuels	CH_4	0.361	0.646	0.0000	0.0000	0.9999
LULUCF	Biomass burning, 5V Biomass burning	N_2O	0.449	0.017	0.0000	0.0000	0.9999
Industrial processes	Road Paving with asphalt	CO_2	1.762	1.729	0.0000	0.0000	0.9999
Agriculture	Field Burning of Agricultural Residues	N_2O	0.698	0.801	0.0000	0.0000	1.0000
Waste	Waste incineration	CH_4	2.272	1.605	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O	0.704	0.781	0.0000	0.0000	1.0000
Energy	Domestic navigation	CH_4	0.710	0.783	0.0000	0.0000	1.0000
Energy	Civil aviation	N_2O	3.525	3.033	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4	0.479	0.541	0.0000	0.0000	1.0000
Energy	Railways	CH_4	0.259	0.153	0.0000	0.0000	1.0000
Waste	Waste incineration	N_2O	1.296	1.099	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O	0.128	0.051	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4	0.000	0.044	0.0000	0.0000	1.0000
Energy	Civil aviation	CH_4	0.158	0.091	0.0000	0.0000	1.0000
LULUCF	Forest Land remaining Forest L., 5A1 Other Conifers (Greenland)	CO_2	0.000	-0.035	0.0000	0.0000	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands, 5IID Wetlands. Peatland	N_2O	0.135	0.135	0.0000	0.0000	1.0000
Energy	Railways	N_2O	2.535	2.070	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2	0.000	0.017	0.0000	0.0000	1.0000
LULUCF	Wetlands, 5D Wetlands, dead org. matter	CO_2	0.109	0.101	0.0000	0.0000	1.0000

Continued							
LULUCF	Forest Land remaining Forest L., 5A1 Larch (Greenland)	CO_2	0.000	-0.003	0.0000	0.0000	1.0000
Industrial processes	Asphalt roofing	CO_2	0.019	0.017	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2c Venting	CO_2	0.000	0.001	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO_2	0.005	0.003	0.0000	0.0000	1.0000
Solvents and other product use	Degreasing and Dry Cleaning	CO_2	0.000	0.000	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O	0.000	0.000	0.0000	0.0000	1.0000
Industrial processes	Magnesium Production	SF_6	0.000	0.000	0.0000	0.0000	1.0000
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O	0.000	0.000	0.0000	0.0000	1.0000
Industrial processes	Iron and steel production	CO_2	0.000	0.000	0.0000	0.0000	1.0000
Total			73903.754	59611.507		1.000	

Table 17.9 Key Category Analysis for Denmark and Greenland, overview.

IPCC Source Categories		GHG	Excluding LULUCF Level Tier1 1990	Excluding LULUCF Level Tier1 2010	Excluding LULUCF Trend Tier1 1990-2010	Including LULUCF Level Tier1 1990	Including LULUCF Level Tier1 2010	Including LULUCF Trend Tier1 1990-2010
Energy	Combustion excluding transport, Liquid Fuels	CO_2	2	4	4	2	4	5
Energy	Combustion excluding transport, Solid Fuels	CO_2	1	1	2	1	1	3
Energy	Combustion excluding transport, Gaseous Fuels	CO_2	4	3	1	4	3	1
Energy	Combustion excluding transport, Other Fuels	CO_2	15	6	7	19	9	7
Energy	Combustion excluding transport, Liquid Fuels	CH_4						
Energy	Combustion excluding transport, Solid Fuels	CH_4						
Energy	Combustion excluding transport, Gaseous Fuels	CH_4			12			17
Energy	Combustion excluding transport, Biomass	CH_4						
Energy	Combustion excluding transport, Other Fuels	CH_4						
Energy	Combustion excluding transport, Liquid Fuels	N_2O						
Energy	Combustion excluding transport, Solid Fuels	N_2O						
Energy	Combustion excluding transport, Gaseous Fuels	N_2O						
Energy	Combustion excluding transport, Biomass	N_2O						
Energy	Combustion excluding transport, Other Fuels	N_2O						
Energy	Road transportation	CO_2	3	2	3	3	2	2
Energy	Road transportation	CH_4						
Energy	Road transportation	N_2O						
Energy	Civil aviation	CO_2						
Energy	Civil aviation	CH_4						
Energy	Civil aviation	N_2O						
Energy	Domestic navigation	CO_2	13	14		15	18	
Energy	Domestic navigation	CH_4						
Energy	Domestic navigation	N_2O						
Energy	Railways	CO_2					23	
Energy	Railways	CH_4						
Energy	Railways	N_2O						
Energy	Fugitive emissions , 1B2ai Oil Exploration	CO_2						
Energy	Fugitive emissions , 1B2ai Oil Exploration	CH_4						
Energy	Fugitive emissions , 1B2ai Oil Exploration	N_2O						
Energy	Fugitive emissions , 1B2aii Oil Production	CO_2						
Energy	Fugitive emissions , 1B2aii Oil Production	CH_4						
Energy	Fugitive emissions , 1B2aii Oil Production	N_2O						
Energy	Fugitive emissions , 1B2aiv, Oil refining and storage	CH_4						
Energy	Fugitive emissions , 1B2b Natural gas transmission and distribution	CO2						
Energy	Fugitive emissions , 1B2biii, Gas transmission	CH_4						

Continued								
Energy	Fugitive emissions , 1B2biv, Gas distribution	CH_4						
Energy	Fugitive emissions , 1B2c Venting	CO_2						
Energy	Fugitive emissions , 1B2c Venting	CH_4						
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CO_2		16		23	20	22
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	CH_4						
Energy	Fugitive emissions , 1B2c2ii, Flaring gas	N_2O						
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CO_2						
Energy	Fugitive emissions , 1B2c2i, Flaring oil	CH_4						
Energy	Fugitive emissions , 1B2c2i, Flaring oil	N_2O						
Industrial processes	Cement production	CO_2	12	13	15	14	17	
Industrial processes	Lime production	CO_2						
Industrial processes	Limestone and dolomite use	CO_2						
Industrial processes	Asphalt roofing	CO_2						
Industrial processes	Road Paving with asphalt	CO_2						
Industrial processes	Glass production	CO_2						
Industrial processes	Bricks	CO_2						
Industrial processes	Expanded clay	CO_2						
Industrial processes	Nitric acid production	N_2O	10		6	12		8
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2						
Industrial processes	Iron and steel production	CO_2						
Industrial processes	Food and drink	CO_2						
Industrial processes	Refrigeration and AC Equipment	HFC and PFC		11	9		15	10
Industrial processes	Foam Blowing	HFC						
Industrial processes	Aerosols	HFC						
Industrial processes	Electrical equipment	SF_6						
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories	SF_6						
Industrial processes	Other i.e. Fibre Optics	HFC and PFC						
Industrial processes	Magnesium Production	SF_6						
Industrial processes	Other, lubricants	CO_2						
Solvents and other product use	Paint application	CO_2						
Solvents and other product use	Degreasing and Dry Cleaning	CO_2						
Solvents and other product use	Chemical Products, Manufacture and Processing	CO_2						
Solvents and other product use	Other solvent	CO_2						
Solvents and other product use	Other solvent	N_2O						

Continued								
Agriculture	Enteric Fermentation	CH_4	5	5		5	6	16
Agriculture	Manure Management	CH_4	11	8	11	13	11	13
Agriculture	Manure management	N_2O	14	15	16	18	19	
Agriculture	Agriculture soils, direct emissions , Synthetic Fertilizers	N_2O	7	10	5	8	14	9
Agriculture	Agriculture soils, direct emissions , Animal Manure Appl. to Soils	N_2O	9	9	13	11	12	15
Agriculture	Agriculture soils, direct emissions , N-fixing Crops	N_2O						
Agriculture	Agriculture soils, direct emissions , Crop Residue	N_2O	17	17		21	21	
Agriculture	Agriculture soils, direct emissions , Cultivation of Histosols	N_2O						
Agriculture	Agriculture soils, direct emissions , Sludge	N_2O						
Agriculture	Agriculture soils, pasture, range and paddock	N_2O				22		
Agriculture	Agriculture soils, indirect, Atmospheric Deposition	N_2O	16		14	20	22	
Agriculture	Agriculture soils, indirect, Nitrogen Leaching and Run-off	N_2O	6	7	8	6	10	11
Agriculture	Field Burning of Agricultural Residues	CH_4						
Agriculture	Field Burning of Agricultural Residues	N_2O						
Waste	Solid Waste Disposal Sites	CH_4	8	12	10	9	16	12
Waste	N_2O direct, Domestic and Commercial Wastewater	N_2O						
Waste	N_2O indirect from human sewage	N_2O						
Waste	Waste Water Handling	CH_4						
Waste	Waste incineration	CO_2						
Waste	Waste incineration	CH_4						
Waste	Waste incineration	N_2O						
Waste	Waste, other	CO_2						
Waste	Waste, other	CH_4						
Waste	Waste, other	N_2O						
LULUCF	Forest Land remaining Forest L., 5A1 Broadleaves	CO_2				16	5	4
LULUCF	Forest Land remaining Forest L., 5A1 Conifers	CO_2					7	6
LULUCF	Forest Land remaining Forest L., 5A1 Larch (Greenland)	CO_2						
LULUCF	Forest Land remaining Forest L., 5A1 Other Conifers (Greenland)	CO_2						
LULUCF	Land converted to Forest L., 5A2 Broadleaves	CO_2						20
LULUCF	Land converted to Forest L., 5A2 Conifers	CO_2						19
LULUCF	Cropland, 5B Cropland rem. Cr. Organic soils	CO_2				7	8	18
LULUCF	Cropland, 5B Cropland rem. Cr. Mineral soils	CO_2				10	13	
LULUCF	Cropland, 5B Cropland remaining Cr. Living biomass	CO_2						
LULUCF	Cropland, 5B Land converted to Cropland. Organic soils	CO_2						
LULUCF	Cropland, 5B Land converted to Cropland. Mineral soils	CO_2						
LULUCF	Cropland, 5B Land converted to Cropland. Living biomass	CO_2						
LULUCF	Cropland, 5B Land converted to Cropland. Dead Org. Matter	CO_2						
LULUCF	Grassland, 5C Grassland rem. Grassland. Organic soils	CO_2						
LULUCF	Grassland, 5C Grassland rem. Grassland. Living biomass	CO_2						
LULUCF	Grassland, 5C Land converted to Grassland, Living biomass	CO_2						21
LULUCF	Grassland, 5C Land converted to Cropland. Dead Org. Matter	CO2						

Continued								
LULUCF	Grassland, 5C Land converted to Grassland, Organic soils	CO_2						
LULUCF	Grassland, 5C Land converted to Grassland, Mineral soils	CO_2						
LULUCF	Wetlands, 5D Wetlands Living biomass	CO_2						
LULUCF	Wetlands, 5D Wetlands, dead org. matter	CO_2						
LULUCF	Wetlands, 5D Wetlands, soils	CO_2						
LULUCF	Settlements, 5E Total settlements	CO_2						
LULUCF	Non-CO_2 drainage of soils and wetlands, 5IID Forest Land.	N_2O						
LULUCF	Non-CO_2 drainage of soils and wetlands, 5IID Wetlands. Peatland	N_2O						
LULUCF	N_2O Disturbance, Land converted to cropland, 5III Cropland	N_2O						
LULUCF	Agricultural lime application, 5IV Cropland Limestone	CO_2				17		14
LULUCF	Biomass burning, 5V Biomass burning	CH_4						
LULUCF	Biomass burning, 5V Biomass burning	N_2O						

17.4.1 Key category analysis for KP-LULUCF

The contribution from Greenland to the KP-LULUCF inventory is miniscule the same categories are therefore identified as key as for the submission from Denmark, see Chapter 11.9 for more information.

17.5 Recalculations

17.5.1 Implications for emission levels

For the national total CO_2 equivalent emissions without Land-Use, Land-Use Change and Forestry, the general impact of the improvements and recalculations performed is small and the changes for the whole time series are between 0.84 % (1990) and -0.54 % (2009). Therefore, the implications of the recalculations on the level and on the trend, 1990-2009, of this national total are small, refer Table 17.10.

For the national total CO_2 equivalent emissions with Land-Use, Land-Use Change and Forestry, the general impact of the recalculations is larger due to recalculations in the LULUCF sector. The changes vary between –3.28 % (2007) and +7.65 % (2008), refer Table 17.10.

The impact of recalculation in the Greenlandic inventory is insignificant compared to the recalculations in the Danish inventory. Therefore the explanations and justifications are not repeated in this Chapter. Detailed information on the recalculations in the Danish inventory is provided in Chapter 10 and in the sectoral Chapters 3-8. The recalculations carried out for the Greenlandic inventory are described in Chapter 16.

Table 17.10 Recalculation performed on national total for 1990-2009. Differences in pct of CO_2 eqv between this submission and the October 2011 submission for Denmark under the Kyoto Protocol, i.e. Denmark & Greenland.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total CO_2 eqv. Emissions with Land-Use Change and Forestry	2.57	3.08	3.55	3.46	2.68	2.71	1.82	2.27	2.75	2.13
Total CO_2 eqv. Emissions without Land-Use Change and Forestry	0.84	0.81	0.82	0.71	0.62	0.49	0.33	0.39	0.33	0.38
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total CO_2 eqv. Emissions with Land-Use Change and Forestry	4.47	3.79	4.51	3.81	3.99	1.67	-1.27	-3.28	7.65	-0.15
Total CO_2 eqv. Emissions without Land-Use Change and Forestry	0.32	0.24	0.27	0.31	0.21	0.13	0.04	0.09	-0.21	-0.54

Table 17.11 Recalculation for CO_2 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for Denmark under the Kyoto Protocol, i.e. Denmark & Greenland.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	1 424	2 083	2 328	2 252	1 894	1 902	1 478	1 708	2 019	1 558
1. Energy	203	254	222	194	203	170	148	173	168	224
1.A. Fuel Combustion Activities	178	204	170	151	159	135	110	119	128	139
1.A.1. Energy Industries	195	240	252	274	172	118	106	200	448	263
1.A.2. Manufacturing Industries and Construction	-27	-50	-96	-125	15	24	-1	-2	-2	-2
1.A.3. Transport	0	0	0	0	0	0	0	0	0	0
1.A.4. Other Sectors	11	14	14	3	-28	-6	5	-79	-318	-122
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	25	50	52	43	44	35	38	54	40	84
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
2.A. Mineral Products	-	-	-	-	-	-	-	-	-	-
2.B. Chemical Industry	-	-	-	-	-	-	-	-	-	-
2.C. Metal Production	-	-	-	-	-	-	-	-	-	-
2.D. Other Production	-	-	-	-	-	-	-	-	-	-
2.G. Other	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-43	-26	-15	-26	-7	-	-	-	-	-
4. Agriculture	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	1 268	1 859	2 126	2 088	1 702	1 737	1 335	1 540	1 855	1 339
5.A. Forest Land	-121	134	-221	180	-177	48	-87	-35	422	-153
5.B. Cropland	1 442	1 650	2 253	1 852	1 792	1 631	1 353	1 515	1 374	1 360
5.C. Grassland	-68	62	74	38	61	32	40	26	23	78
5.D. Wetlands	0	0	0	3	0	3	0	3	3	0
5.E. Settlements	15	13	21	15	26	23	29	30	34	54
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-4	-4	-4	-4	-4	-5	-5	-5	-5	-5
6.C. Waste Incineration	0	0	0	0	0	0	0	0	0	0
6.D. Other	-4	-4	-4	-4	-4	-5	-5	-5	-5	-6
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	3 167	2 795	3 313	2 996	2 921	1 260	-760	-1 992	5 009	323
1. Energy	193	207	208	295	240	219	228	295	113	88
1.A. Fuel Combustion Activities	135	145	156	240	173	175	174	169	96	80
1.A.1. Energy Industries	130	130	144	228	242	273	247	174	182	134
1.A.2. Manufacturing Industries and Construction	8	17	13	20	15	22	25	13	3	66
1.A.3. Transport	0	0	0	0	8	6	10	1	-68	31
1.A.4. Other Sectors	-2	-2	0	-8	-93	-126	-107	-19	-20	-154
1.A.5. Other	-	-	-	-	1	0	0	0	0	2
1.B. Fugitive Emissions from Fuels	58	61	52	54	68	44	54	126	16	8
2. Industrial Processes	-	-	-	-	-	-	-	0	-	-
2.A. Mineral Products	-	-	-	-	-	-	-	0	-	-
2.B. Chemical Industry	-	-	-	-	-	-	-	-	-	-
2.C. Metal Production	-	-	-	-	-	-	-	-	-	-
2.D. Other Production	-	-	-	-	-	-	-	-	-	-
2.G. Other	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	0	0	0	0
4. Agriculture	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	2 979	2 594	3 110	2 707	2 685	1 047	-982	-2 280	4 903	241
5.A. Forest Land	1 390	1 166	1 495	1 311	1 298	1 133	-2 175	-3 379	3 857	-866
5.B. Cropland	1 484	1 327	1 549	1 309	1 307	-157	1 131	1 036	981	1 043
5.C. Grassland	53	47	16	29	20	8	-1	-4	-6	-10
5.D. Wetlands	0	0	0	0	0	0	0	0	0	0
5.E. Settlements	51	54	50	58	60	61	63	67	71	74

Continued										
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-5	-5	-5	-6	-5	-6	-6	-7	-7	-6
6.C. Waste Incineration	0	0	0	0	0	0	0	0	0	0
6.D. Other	-6	-5	-5	-6	-5	-6	-6	-7	-7	-7

Table 17.12 Recalculation for CH_4 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for Denmark under the Kyoto Protocol, i.e. Denmark & Greenland.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	358.6	350.7	344.3	328.9	228.2	177.4	124.1	105.2	57.8	34.9
1. Energy	-3.2	-0.3	10.6	47.9	-9.1	-9.4	-9.9	-9.1	-5.0	-5.3
1.A. Fuel Combustion Activities	-3.2	-0.4	10.6	47.9	-10.7	-10.7	-11.2	-11.1	-7.0	-7.4
1.A.1. Energy Industries	3.8	8.2	15.1	45.8	0.0	0.1	0.5	0.5	0.6	0.5
1.A.2. Manufacturing Industries and Construction	-0.7	-1.5	-2.3	-2.8	0.0	0.0	0.0	0.0	-0.1	-0.1
1.A.3. Transport	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3
1.A.4. Other Sectors	-6.6	-7.4	-2.6	4.6	-11.0	-11.1	-12.0	-11.9	-7.9	-8.2
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	1.6	1.3	1.3	2.1	2.1	2.1
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	-	-
4. Agriculture	-4.0	12.2	29.2	17.0	24.2	30.8	24.2	46.0	33.1	40.1
4.A. Enteric Fermentation	-21.2	-13.5	-3.6	-14.6	-9.8	-6.7	-12.7	-3.1	-15.9	-10.4
4.B. Manure Management	17.2	25.6	32.8	31.5	34.0	37.5	36.9	49.1	49.0	50.5
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Waste	365.2	338.9	304.4	264.0	213.0	156.0	109.8	68.3	29.6	0.1
6.A. Solid Waste Disposal on Land	366.4	340.1	305.7	265.2	214.2	157.3	111.2	69.6	30.8	1.2
6.B. Waste-water Handling	-	-	-	-	-	-	-	-	-	0.1
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-1.1	-1.2	-1.3	-1.1	-1.1	-1.3	-1.3	-1.3	-1.1	-1.2
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	14.9	-40.9	-29.8	-57.4	-76.8	-83.2	-112.1	-210.7	-214.5	-317.4
1. Energy	-7.5	-9.4	-9.7	-12.7	-14.6	-19.1	-23.1	-25.8	-24.4	-16.2
1.A. Fuel Combustion Activities	-10.3	-11.9	-12.2	-15.1	-17.2	-21.2	-25.3	-30.2	-24.5	-17.9
1.A.1. Energy Industries	0.5	0.5	0.4	0.4	0.4	1.6	1.5	1.7	1.2	1.3
1.A.2. Manufacturing Industries and Construction	0.0	0.0	-0.4	-0.5	-0.6	-1.8	-1.5	-1.5	-1.3	-1.0
1.A.3. Transport	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.1	0.0	0.2
1.A.4. Other Sectors	-11.1	-12.7	-12.5	-15.4	-17.3	-21.2	-25.7	-30.5	-24.5	-18.4
1.A.5. Other	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B. Fugitive Emissions from Fuels	2.8	2.5	2.5	2.5	2.5	2.2	2.2	4.4	0.1	1.8
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	-	-
4. Agriculture	42.8	12.9	60.7	65.4	81.5	109.9	111.4	44.8	62.8	-22.2
4.A. Enteric Fermentation	-14.0	-34.3	-2.8	-3.7	5.8	-0.2	1.2	-2.2	8.3	-63.8
4.B. Manure Management	56.8	47.3	63.5	69.1	75.7	110.1	110.2	47.0	54.4	41.6
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
6. Waste	-20.4	-44.5	-80.9	-110.2	-144.3	-174.1	-200.5	-229.7	-252.9	-279.1
6.A. Solid Waste Disposal on Land	-19.3	-43.7	-80.6	-109.9	-143.7	-173.4	-199.5	-228.7	-251.7	-274.6
6.B. Waste-water Handling	0.1	0.4	0.8	1.0	0.6	0.4	0.3	0.3	0.2	0.3
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-1.2	-1.2	-1.1	-1.3	-1.1	-1.2	-1.2	-1.4	-1.3	-4.8

Table 17.13 Recalculation for N_2O performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for Denmark under the Kyoto Protocol, i.e. Denmark & Greenland.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total National Emissions and Removals	64.1	65.3	56.2	44.6	69.5	30.1	31.1	36.0	31.4	25.6
1. Energy	1.3	0.8	-0.1	0.6	3.0	3.9	3.8	3.6	5.5	1.5
1.A. Fuel Combustion Activities	1.3	0.8	-0.1	0.6	3.0	3.9	3.8	3.6	5.5	1.5
1.A.1. Energy Industries	0.7	1.3	1.7	3.7	0.0	0.0	1.3	1.9	5.8	1.5
1.A.2. Manufacturing Industries and Construction	1.3	0.3	-1.0	-2.0	4.0	4.8	3.4	3.6	4.5	2.2
1.A.3. Transport	-0.7	-0.8	-0.8	-0.9	-1.0	-0.9	-0.9	-0.8	-0.7	-0.6
1.A.4. Other Sectors	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	-1.1	-4.1	-1.6
1.A.5. Other	-	-	-	-	-	-	-	-	-	-
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4. Agriculture	62.4	64.5	56.3	44.0	66.5	26.2	27.3	32.4	25.9	24.1
4.A. Enteric Fermentation	-	-	-	-	-	-	-	-	-	-
4.B. Manure Management	-4.3	-3.1	-1.3	-3.7	-2.7	-2.6	-4.0	-2.0	-5.4	-4.4
4.D. Agricultural Soils	66.7	67.6	57.7	47.7	69.2	28.8	31.3	34.5	31.3	28.4
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
5.A. Forest Land	0.4	-	0.0	-	0.0	0.0	-	-	0.0	-
5.B. Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.C. Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.D. Wetlands	-	-	-	-	-	-	-	-	-	-
5.E. Settlements	-	-	-	-	-	-	-	-	-	-
5.F. Other Land	-	-	-	-	-	-	-	-	-	-
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
6.B. Waste-water Handling	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-	-	-	-	-	-	-	-	-	-
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total National Emissions and Removals	17.6	11.4	15.5	-0.2	-11.8	-44.4	-79.9	-13.9	-27.7	-97.5
1. Energy	3.1	1.6	0.7	-1.0	-3.5	-5.1	-6.4	-7.6	-8.0	-5.2
1.A. Fuel Combustion Activities	3.1	1.6	0.7	-1.0	-3.5	-5.1	-6.4	-7.8	-8.0	-5.2
1.A.1. Energy Industries	0.0	-1.5	-2.5	-3.9	-5.3	-6.0	-8.3	-10.5	-10.5	-10.0
1.A.2. Manufacturing Industries and Construction	3.6	2.8	2.8	2.8	2.3	2.2	2.6	2.7	2.6	3.3
1.A.3. Transport	-0.5	0.3	0.4	0.5	0.7	0.8	0.8	0.4	-0.3	0.7
1.A.4. Other Sectors	-0.1	-0.1	0.0	-0.4	-1.2	-2.1	-1.5	-0.4	0.2	0.8
1.A.5. Other	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B. Fugitive Emissions from Fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
2. Industrial Processes	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use	0.3	0.3	0.3	0.4	0.4	-3.1	-26.5	-24.0	-16.8	-19.3
4. Agriculture	14.5	9.8	14.8	0.6	-8.8	-36.0	-46.8	18.3	-2.6	-72.2
4.A. Enteric Fermentation	-	-	-	-	-	-	-	-	-	-
4.B. Manure Management	-5.7	-11.9	-2.9	-2.7	0.9	-26.7	-35.4	3.8	7.7	-3.3
4.D. Agricultural Soils	20.2	21.8	17.7	3.3	-9.8	-9.3	-11.4	14.5	-10.2	-68.8
4.F. Field Burning of Agricultural Residues	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry (net)	0.1	0.1	0.1	0.1	0.6	0.1	0.1	0.1	0.1	0.1
5.A. Forest Land	-	-	-	-	0.5	-	0.0	-	-	-
5.B. Cropland	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5.C. Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.D. Wetlands	-	-	-	-	-	-	-	-	-	-
5.E. Settlements	-	-	-	-	-	-	-	-	-	-
5.F. Other Land	-	-	-	-	-	-	-	-	-	-

Continued										
5.G. Other	-	-	-	-	-	-	-	-	-	-
6. Waste	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.7	-0.5	-1.0
6.B. Waste-water Handling	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.7	-0.5	0.1
6.C. Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.D. Other	-	-	-	-	-	-	-	0.0	0.0	-1.0

Table 17.14 Recalculation for HFCs, PFCs and SF_6 performed in the 2012 submission for 1990-2009. Differences in Gg CO_2 eqv. between this and the October 2011 submission for Denmark under the Kyoto Protocol, i.e. Denmark & Greenland.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC	-	-	-	-	-	-	-	-	-	-
PFC	-	-	-	-	-	-	-	-	-	-
SF_6	-	-	0.0	-	-	-	-	-	-	-0.5
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HFC	-	-	-	-	-	-	-	0.0	-	-
PFC	-	-	-	-	-	-	-	-	-	-
SF_6	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4

17.6 Technical description of the aggregation of the emission inventories of Denmark and Greenland

In order to accommodate the request of the ERT of full inclusion of the Greenlandic emission data in the full CRF format, Denmark operates separate installations for Denmark and Greenland (and the Faroe Islands). The country identification codes provided by the UNFCCC secretariat are DNM for Denmark and GRL for Greenland (FRO for the Faroe Islands). Two additional installations are necessary to enable the submission of aggregated submissions under the Kyoto Protocol (Denmark and Greenland) and under UNFCCC (Denmark, Greenland and the Faroe Islands). The country identification codes provided by the UNFCCC secretariat are DKE for the submission under the Kyoto Protocol (Denmark and Greenland) and DNK for the UNFCCC submission (Denmark, Greenland and the Faroe Islands).

These five versions of CRF Reporter are installed on separate virtual MS Windows XP machines. The installations are at the AU VMWare environment, which is operated and maintained by the IT department at AU. As such backups of these systems are performed routinely on a daily basis.

For the aggregation of the submissions three IT tools are used.

- EU CRF Aggregator developed by the European Environment Agency – Aggregation of global CRF variables
- NERI CRF Aggregator developed by NERI (Now DCE) – Aggregation of local CRF variables
- MS Excel

The three main work processes in connection with the aggregation of the submissions are:

- In the EU CRF Aggregator the following work processes take place:
    - Aggregation of global variables; sum of emissions and activity data, notation keys and comments.

    - As input data the xml submission files from the CRF Reporter installations for DNM (Denmark), GRL (Greenland) and FRO (Faroe Islands) are used.
    - As output file a CRF Reporter xml import file is generated. This file is then imported in the installation for the aggregated submission, DKE (KP) or DNK (UNFCCC).

- In NERI CRF Aggregator the following work processes take place:
    - Aggregation of local variables; sum of emissions and activity data, notation keys and comments. Aggregation of additional information variables either as sums or uniform values.
    - As input data the simple CRF Reporter xml files from the CRF Reporter installations for DNM (Denmark), GRL (Greenland) and FRO (Faroe Islands) are used.
    - As output file a CRF Reporter simple xml import file is generated. This file is then imported in the installation for the aggregated submission, DKE (KP) or DNK (UNFCCC).

- In MS Excel the following work processes take place:
    - Aggregation of additional information variables where average values or weighted average values are used.
    - Aggregation of KP-LULUCF/NIR-1 and KP-LULUCF/NIR-2.
    - The aggregated data is at the moment copy/pasted from the CRF Reporter installations of Denmark and Greenland to Excel aggregated and copy/pasted back to the CRF Reporter installations of the KP submission (DKE).

Efforts are ongoing to ensure the highest possible degree of automation to avoid the risk of errors during the manual work processes.

17.7 QA/QC of the aggregated submission for Denmark and Greenland

The QA/QC procedures for the Danish inventory are described in Chapter 1.6 and the sectoral chapters. Please refer to Chapter 1.6 for a general description of the QA/QC system, and the structural setup of the Danish QA/QC system for the greenhouse gas inventory. The QA/QC procedures carried out by Greenlandic authorities for the Greenlandic inventory are described in Chapter 16. The following focuses on the specific QA/QC measures carried out at NERI both on the data (CRF tables and documentation) received from Greenland and the QC checks carried out for the aggregated versions of the inventory for reporting to the Kyoto Protocol and the UNFCCC. The PM's relevant for this are listed in Table 17.15.

Table 17.15 PM's specific to the handling of Greenlandic emission data and the aggregated submissions.

Data Storage level 4	3.Completeness	DS.4.3.3	Check that the no sources where methodology exists in the IPCC guidelines are reported as NE by Greenland.
	4.Consistency	DS.4.4.2	Check time series consistency of the reporting by Greenland prior to aggregating the final submissions.
	5.Correctness	DS.4.5.1	Check that the aggregated submissions for Denmark under the Kyoto Protocol and the UNFCCC match the sum of the individual submissions.
		DS.4.5.2	Check that additional information and information related to land-use changes has been correctly aggregated compared to the individual submissions of Denmark and Greenland.
	7.Transparency	DS.4.7.2	Perform QA on the documentation report provided by the Government of Greenland.

Data Storage level 4	3.Completeness	DS.4.3.3	Check that no sources where a methodology exists in the IPCC guidelines or good practice guidance are reported as NE by Greenland

A check is made to filter any NE's from the CRF tables. If any greenhouse gas emissions are reported as NE, it is checked whether methodologies exist in the IPCC guidelines or the IPCC good practice guidance. If methodologies do exist efforts are made to quickly estimate and report emissions. No categories where methodology exists were identified for the submission of Denmark and Greenland.

Data Storage level 4	4.Consistency	DS.4.4.2	Check time series consistency of the reporting of Greenland and the Faroe Islands prior to aggregating the final submissions

The time series for all pollutants in the submissions from Greenland and the Faroe Islands are checked at the CRF 3 level for large variations in the time series. Any large variations are explained or corrected in cooperation with the authorities in Greenland and the Faroe Islands.

Data Storage level 4	5.Correctness	DS.4.5.1	Check that the aggregated submissions for Denmark under the Kyoto Protocol and the UNFCCC matches the sum of the individual submissions

To ensure that the submission for Denmark under the Kyoto Protocol matches the sum of the submissions of Denmark and Greenland a spreadsheet check has been implemented to ensure complete correctness of the submitted inventory. The same procedure is followed for the submission under the UNFCCC, where it is ensured that the submitted emissions equate to the sum of Denmark, Greenland and the Faroe Islands. Special attention is paid to the additional information provided in the CRF, e.g. for the agricultural sector. Certain parameters cannot simply be added, e.g. animal weights. In these cases a weighted average is reported in the CRF tables.

The check has for the 2012 submission been extended to also cover area information reported in the KP-LULUCF tables (NIR-2).

Data Storage level 4	5.Correctness	DS.4.5.2	Check that additional information and information related to land-use changes has been correctly aggregated compared to the individual submissions of Denmark and Greenland.

The CRF submission for Denmark and Greenland is checked to see if the additional information has been aggregated correctly. The additional information is mainly related to the agricultural and waste sectors.

Data Storage level 4	7.Transparency	DS.4.7.2	Perform QA on the documentation report provided by the Government of Greenland

The documentation report is received by NERI from the Government of Greenland in the early spring every year. The documentation report is included in the NIR as Chapter 16. NERI experts read and provide comments on the report to the Government of Greenland, so that any questions are resolved prior to the UNFCCC reporting deadline of April 15.

Annex 1 - Key category analysis

Description of the methodology used for identifying key categories

Key Category Analysis (KCA) tier 1 and 2 for year 1990 and 2010 for Denmark (excluding Greenland and Faroe Islands) has been carried out in accordance with the IPCC Good Practice Guidance / IPCC Guidelines (2006). The KCA has been carried out excl. and incl. the LULUCF sector. KCA (tier 1) have also been worked out for Greenland and for Denmark and Greenland; refer to Chapter 16 and Chapter 17, respectively.

The base year in the analysis is the year 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the greenhouse F-gases HFC, PFC and SF_6. The KCA approaches are

- a tier 1 quantitative analysis and
- a tier 2 approach using tier 1 uncertainties.

The level assessment of the tier 1 KCA is a ranking of the source categories in accordance to their relative contribution to the national total of greenhouse gases calculated in CO_2 equivalent units. The level key categories are found from the list of source categories ranked according to their contribution in descending order. Level key categories are those from the top of the list and of which the sum constitutes 95 % of the national total.

The trend assessment of the tier 1 KCA is a ranking of the source categories according to their contribution to the trend of the national total of greenhouse gases, calculated in CO_2 equivalents, from the base year to the year under consideration. The trend of the source category is calculated relative to that of the national totals and the trend is then weighted with the contribution, according to the level assessment. The ranking is in descending order. As for the level assessment, the cut-off point for the sum of contribution to the trend is 95 % and the source categories from the top of the list to the cut-off line are trend key categories.

In addition, a tier 2 KCA has been carried out to provide additional insight into categories being key sources. The categorisation used is as for the tier 1 analysis and the uncertainties used are tier 1 uncertainties as listed in Annex 7.

The level tier 2 KCA is a ranking of the categories according to their relative contribution to the national total multiplied by the uncertainty of the emission of the category as the combined uncertainty on activity data and on emission factor. Chosen for cut of for key categories in the analysis is 90 %.

The trend tier 2 KCA is a ranking of the categories according to their relative contribution to the trend 1990-2010 of the national total multiplied by the uncertainty of the emission of the category. Chosen for cut of for key categories in the analysis is 90 %.

Since the level KCA is carried out for 1990 and 2010 (exclusive and inclusive LULUCF) and for tier 1 and 2 a total 12 KCA tables for Denmark (excluding Greenland and Faroe Islands) has been worked out along the suggestions in the GPG Tables 7.A1-2. Further, two overview tables based on the GPG Table 7.A3 (exclusive and inclusive LULUCF) are shown. The overview table shows summary results of the KCA for 1990 for 2010 and for the trend 1990-2010.

The inclusion of the LULUCF sector in the level analysis implies that the emissions in this sector are all calculated positive, i.e. the absolute value of removals are included. Note also that according to the GPG, the analysis implies that contributions to the trend are all calculated as mathematically positive to be able to perform the ranking. The LULUCF activities are in the table included with their sign, i.e. emissions: +, removals: -.

The level of disaggregation

The starting-point for source categories is GPG Table 7.1. This table constitutes a suggested list of source categories for the KCA. It is mentioned in the GPG that categories for the KCA should be chosen in a way so that emissions from a single category are estimated with the same method and the same emission factor. Therefore, for categories in Table 7.1, which in our Corinair database are composed of activities with different emission factors or estimated with different methods, splits were made accordingly.

The categorisation has been somewhat revised compared to the 2011 submission. The categories follow the categorisation used for the uncertainty analyses, cf Annex 7.

The source categories in the KCA for stationary combustion are defined according to the greenhouse gas and fuel. For CH_4 and N_2O fuels are aggregated to the fuel categories solid, liquid, gas, waste and biomass.

Table A1.1 KCA source categories for stationary combustion.

CRF, part of category	KCA category	GHG
1A1, 1A2 and 1A4	Stationary Combustion, Coal	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, BKB	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Coke	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Fossil waste	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Petroleum coke	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Residual oil	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Gas oil	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Kerosene	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, LPG	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Refinery gas	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, Natural gas	CO_2
1A1, 1A2 and 1A4	Stationary Combustion, SOLID	CH_4
1A1, 1A2 and 1A4	Stationary Combustion, LIQUID	CH_4
1A1, 1A2 and 1A4	Stationary Combustion, GAS	CH_4
1A1, 1A2 and 1A4	Natural gas fuelled engines, GAS	CH_4
1A1, 1A2 and 1A4	Stationary Combustion, WASTE	CH_4
1A1, 1A2 and 1A4	Stationary Combustion, BIOMASS	CH_4
1A1, 1A2 and 1A4	Biogas fuelled engines, BIOMASS	CH_4
1A1, 1A2 and 1A4	Stationary Combustion, SOLID	N_2O
1A1, 1A2 and 1A4	Stationary Combustion, LIQUID	N_2O
1A1, 1A2 and 1A4	Stationary Combustion, GAS	N_2O
1A1, 1A2 and 1A4	Stationary Combustion, WASTE	N_2O
1A1, 1A2 and 1A4	Stationary Combustion, BIOMASS	N_2O

KCA source categories for mobile combustion are shown in Table A1-2. The categorisation is used for both CO_2, CH_4 and N_2O.

Table A1.2 KCA source categories for mobile combustion.

CRF, part of category	KCA category	GHG
1.A.3.b	Transport, Road transport	CO_2
1.A.5.b	Transport, Military	CO_2
1.A.3.c	Transport, Railways	CO_2
1.A.3.d (part)	Transport, Navigation (small boats)	CO_2
1.A.3.d (part)	Transport, Navigation (large vessels)	CO_2
1.A.4.c (part)	Transport, Fisheries	CO_2
1.A.4.c (part)	Transport, Agriculture	CO_2
1.A.4.c (part)	Transport, Forestry	CO_2
1.A.2.f (part)	Transport, Industry (mobile)	CO_2
1.A.4.b (part)	Transport, Residential	CO_2
1.A.4.a (part)	Transport, Commercial/institutional	CO_2
1.A.3.a	Transport, Civil aviation	CO_2
1.A.3.b	Transport, Road transport	CH_4
1.A.5.b	Transport, Military	CH_4
1.A.3.c	Transport, Railways	CH_4
1.A.3.d (part)	Transport, Navigation (small boats)	CH_4
1.A.3.d (part)	Transport, Navigation (large vessels)	CH_4
1.A.4.c (part)	Transport, Fisheries	CH_4
1.A.4.c (part)	Transport, Agriculture	CH_4
1.A.4.c (part)	Transport, Forestry	CH_4
1.A.2.f (part)	Transport, Industry (mobile)	CH_4
1.A.4.b (part)	Transport, Residential	CH_4
1.A.4.a (part)	Transport, Commercial/institutional	CH_4
1.A.3.a	Transport, Civil aviation	CH_4
1.A.3.b	Transport, Road transport	N_2O
1.A.5.b	Transport, Military	N_2O
1.A.3.c	Transport, Railways	N_2O
1.A.3.d (part)	Transport, Navigation (small boats)	N_2O
1.A.3.d (part)	Transport, Navigation (large vessels)	N_2O
1.A.4.c (part)	Transport, Fisheries	N_2O
1.A.4.c (part)	Transport, Agriculture	N_2O
1.A.4.c (part)	Transport, Forestry	N_2O
1.A.2.f (part)	Transport, Industry (mobile)	N_2O
1.A.4.b (part)	Transport, Residential	N_2O
1.A.4.a (part)	Transport, Commercial/institutional	N_2O
1.A.3.a	Transport, Civil aviation	N_2O

For fugitive emissions, the categorisation used in the KCA is shown in Table A1-3.

Table A1-3 KCA source categories for fugitive emissions.

CRF and KCA category	GHG
1.B.2 Flaring in refinery	CO_2
1.B.2 Flaring off-shore	CO_2
1.B.2 Land based activities	CO_2
1.B.2 Off-shore activities	CO_2
1.B.2 Transmission of natural gas	CO_2
1.B.2 Distribution of natural gas	CO_2
1.B.2 Venting in gas storage	CO_2
1.B.2. Flaring in refinery	CH_4
1.B.2. Flaring off-shore	CH_4
1.B.2 Refinery processes	CH_4
1.B.2 Land based activities	CH_4
1.B.2 Off-shore activities	CH_4
1.B.2 Transmission of natural gas	CH_4
1.B.2 Distribution of natural gas	CH_4
1.B.2 Venting in gas storage	CH_4
1.B.2 Flaring in refinery	N_2O
1.B.2 Flaring off-shore	N_2O

KCA categories for industry are shown in Table A1-4. All data can be found in CRF. Base year for the consumption of HFC, PFC and SF_6 is 1995.

Table A1-4 KCA source categories for industry.

CRF and KCA category	GHG
2A1 Cement production	CO_2
2A2 Lime production	CO_2
2A3 Limestone and dolomite use	CO_2
2A5 Asphalt roofing	CO_2
2A6 Road paving with asphalt	CO_2
2A7 Glass and Glass wool	CO_2
2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2
2C1 Iron and steel production	CO_2
2D2 Food and Drink	CO_2
2G Lubricants	CO_2
2B2 Nitric acid production	N_2O
2F Consumption of HFC	HFC
2F Consumption of PFC	PFC
2F Consumption of SF_6	SF_6

KCA categories for solvents are shown in Table A1-5. All data can be found in CRF.

Table A1-5 KCA source categories for solvents.

CRF and KCA category	GHG
3A Paint application	CO_2
3B Degreasing and dry cleaning	CO_2
3C Chemical products, manufacturing and processing	CO_2
3D5 Other	CO_2
3D5 Consumption of fireworks	CO_2
3D1 Other - Use of N_2O for Anaesthesia	N_2O
3D3 Use of tobacco	N_2O
3D3 Use of charcoal for BBQ	N_2O
3D3 Consumption of fireworks	N_2O

KCA categories for agriculture are shown in Table A1-6. All data can be found in CRF.

Table A1-6 KCA source categories for agriculture.

CRF and KCA category	GHG
4A Enteric Fermentation	CH_4
4B Manure Management	CH_4
4F Field burning of agricultural residues	CH_4
4.B Manure Management	N_2O
4.D1.1 Synthetic Fertilizer	N_2O
4.D1.2 Animal waste applied to soils	N_2O
4.D1.3 N-fixing crops	N_2O
4.D1.4 Crop Residue	N_2O
4.D1.5 Cultivation of histosols	N_2O
4.D.2 Grassing animals	N_2O
4.D3 Atmospheric deposition	N_2O
4.D3 Leaching	N_2O
4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O
4.F Field Burning of Agricultural Residues	N_2O

For LULUCF the categorisation used for this KCA is according to Table A1-7. KCA have been estimated both including and excluding LULUCF.

Table A1-7 KCA source categories for LULUCF.

CRF and KCA category	GHG
5.A.1 Broadleaves	CO_2
5.A.1 Conifers	CO_2
5.A.2 Broadleaves	CO_2
5.A.2 Conifers	CO_2
5(II) Forest Land.	N_2O
5.B Cropland, Living biomass	CO_2
5.B Cropland, Dead organic matter	CO_2
5.B Cropland, Mineral soils	CO_2
5.B Cropland, Organic soils	CO_2
5(III) Disturbance, Land converted to cropland	N_2O
5.C Grassland, Living biomass	CO_2
5.C Grassland, Dead organic matter	CO_2
5.C Grassland, Mineral soils	CO_2
5.C Grassland, Organic soils	CO_2
5.D Wetlands, Living biomass	CO_2
5.D Wetlands, Dead organic matter	CO_2
5.D Wetlands, Soils	CO_2
5(II) Wetlands	N_2O
5.E Settlements, Living biomass	CO_2
5(IV) Cropland Limestone	CO_2
5(V) Biomass Burning	CH_4
5(V) Biomass Burning	N_2O

KCA categories for the waste sector are shown in Table A1-8.

Table A1-8 KCA source categories for the waste sector.

CRF and KCA category	GHG
6 A. Solid Waste Disposal on Land	CH_4
6 B. Wastewater Handling	CH_4
6 B. Wastewater Handling - Direct	N_2O
6 B. Wastewater Handling - Indirect	N_2O
6.D Accidental fires, buildings	CO_2
6.D Accidental fires, vehicles	CO_2
6.C Incineration of corpses	CH_4
6.C Incineration of carcasses	CH_4
6.D Compost production	CH_4
6.D Accidental fires, buildings	CH_4
6.D Accidental fires, vehicles	CH_4
6.C Incineration of corpses	N_2O
6.C Incineration of carcasses	N_2O
6.D Compost production	N_2O

The choice of categories identifies 127 categories for the analysis excluding LULUCF and 149 categories for the analysis including LULUCF.

The result of the Key Category Analysis for Denmark for the year 1990 and 2010

The entries for the KCA are composed from the databases producing the CRF inventory and from CRFs.

An overview of results of the KCA excluding LULUCF are shown in Table A1-9 and results of the KCA including LULUCF in Table A1-10. The number of key source categories for each of the KCA are shown in Table A1-11. The 12 different KCA for Denmark point out 24-32 key source categories. Seven source categories are key in all 12 KCA:

- Transport, Road transport, CO_2
- Transport, Transport industry (mobile), CO_2
- 4B Manure Management, CH_4
- 4D1.1 Syntehetic Fertilizer, N_2O
- 4D1.2 Animal waste applied to soils, N_2O
- 4D3 Leaching, N_2O
- 6A Solid waste disposal on land, CH_4

In addition *5A1 Broadleaves, CO_2* and *5B Cropland, Organic soils, CO_2* are key source categories for all KCA including LULUCF.

The 12 different KCA point out a total of 54 different key source categories (out of the total 149 source categories), see Table A1-9 and Table A1-10.

The tier 1 approach point out mainly the large emission sources as key categories and thus CO_2 emission from stationary and mobile combustion are important key categories. The tier 2 approach point out some of the sources with larger uncertainty rates.

The list below gives an overview of the different KCA for Denmark (not including Greenland) that are presented in Table A1-12 – Table A1-23.

Table A1-12 KCA for Denmark, level assessment base year excl. LULUCF, tier 1.
Table A1-13 KCA for Denmark, level assessment base year incl. LULUCF, tier 1.
Table A1-14 KCA for Denmark, level assessment 2010 excl. LULUCF, tier 1.
Table A1-15 KCA for Denmark, level assessment 2010 incl. LULUCF, tier 1.
Table A1-16 KCA for Denmark, trend assessment 1990-2010 excl. LULUCF, tier 1.
Table A1-17 KCA for Denmark, trend assessment 1990-2010 incl. LULUCF, tier 1.
Table A1-18 KCA for Denmark, level assessment base year excl. LULUCF, tier 2.
Table A1-19 KCA for Denmark, level assessment base year incl. LULUCF, tier 2.
Table A1-20 KCA for Denmark, level assessment 2010 excl. LULUCF, tier 2.
Table A1-21 KCA for Denmark, level assessment 2010 incl. LULUCF, tier 2.
Table A1-22 KCA for Denmark, trend assessment 1990-2010 excl. LULUCF, tier 2.
Table A1-23 KCA for Denmark, trend assessment 1990-2010 incl. LULUCF, tier 2.

Level 1990

The two approaches point out different main key categories. The key categories accounting for more than 5 % of the emission (tier 2: uncertainty of emission) each are shown below for the two approaches.

Tier 1:	
Stationary Combustion, Coal	CO_2
Transport, Road transport	CO_2
Stationary Combustion, Gas oil	CO_2
Stationary Combustion, Natural gas	CO_2

Tier 2:	
4.D3 Leaching	N_2O
4.D1.1 Syntehetic Fertilizer	N_2O
5.B Cropland, Organic soils	CO_2
6 A. Solid Waste Disposal on Land	CH_4
4.D1.2 Animal waste applied to soils	N_2O

Level 2010

The two approaches point out different main key categories. The key categories accounting for more than 5 % of the emission (tier 2: uncertainty of emission) each are shown below for the two approaches.

Tier 1:	
Stationary Combustion, Coal	CO_2
Transport, Road transport	CO_2
Stationary Combustion, Natural gas	CO_2
5.A.1 Broadleaves	CO_2

Tier 2:	
5.A.1 Broadleaves	CO_2
5.B Cropland, Organic soils	CO_2
4.D3 Leaching	N_2O
4.D1.2 Animal waste applied to soils	N_2O
4.D1.1 Syntehetic Fertilizer	N_2O
5.A.1 Conifers	CO_2
Stationary Combustion, BIOMASS	N_2O

Trend 1990-2010

The two approaches point out different main key categories. The key categories accounting for more than 5 % of the emission trend (tier 2: emission trend uncertainty) each are shown below for the two approaches.

Tier 1:	
Stationary Combustion, Natural gas	CO_2
Transport, Road transport	CO_2
Stationary Combustion, Coal	CO_2
5.A.1 Broadleaves	CO_2
Stationary Combustion, Gas oil	CO_2
5.A.1 Conifers	CO_2

Tier 2:	
5.A.1 Broadleaves	CO_2
5.A.1 Conifers	CO_2
4.D1.1 Syntehetic Fertilizer	N_2O
Stationary Combustion, BIOMASS	N_2O
6 A. Solid Waste Disposal on Land	CH_4
4.D3 Leaching	N_2O

Table A1-9 Summary of KCA for Denmark, level and trend for 1990-2010, excl. LULUCF, tier 1 and tier 2.

IPCC Source Categories (LULUCF excluded)		GHG	Key categories with number according to ranking in analysis					
			Identification criteria					
			Level Tier 1 1990	Level Tier 1 2010	Trend Tier 1 1990-2010	Level Tier 2 1990	Level Tier 2 2010	Trend Tier 2 1990-2010
Energy	Stationary Combustion, Coal	CO_2	1	1	2	18	22	20
Energy	Stationary Combustion, BKB	CO_2						
Energy	Stationary Combustion, Coke	CO_2						
Energy	Stationary Combustion, Fosssil waste	CO_2	20	7	8		21	14
Energy	Stationary Combustion, Petroleum coke	CO_2	22	20	20			
Energy	Stationary Combustion, Residual oil	CO_2	7	13	5			
Energy	Stationary Combustion, Gas oil	CO_2	3	5	4	20		13
Energy	Stationary Combustion, Kerosene	CO_2	23		13			
Energy	Stationary Combustion, LPG	CO_2						
Energy	Stationary Combustion, Refinery gas	CO_2	16	14	24			
Energy	Stationary Combustion, Natural gas	CO_2	4	3	1		26	18
Energy	Stationary Combustion, SOLID	CH_4						
Energy	Stationary Combustion, LIQUID	CH_4						
Energy	Stationary Combustion, GAS	CH_4						
Energy	Natural gas fuelled engines, GAS	CH_4			15			
Energy	Stationary Combustion, WASTE	CH_4						
Energy	Stationary Combustion, BIOMASS	CH_4					25	23
Energy	Biogas fuelled engines, BIOMASS	CH_4						
Energy	Stationary Combustion, SOLID, N_2O	N_2O				16	19	17
Energy	Stationary Combustion, LIQUID, N_2O	N_2O				8	23	6
Energy	Stationary Combustion, GAS, N_2O	N_2O				24	13	10
Energy	Stationary Combustion, WASTE, N_2O	N_2O						25
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O				9	4	4
Energy	Transport, Road transport	CO_2	2	2	3	6	6	8
Energy	Transport, Military	CO_2						
Energy	Transport, Railways	CO_2		25				
Energy	Transport, Navigation (small boats)	CO_2						
Energy	Transport, Navigation (large vessels)	CO_2	17	19	16			
Energy	Transport, Fisheries	CO_2	19	18				
Energy	Transport, Agriculture	CO_2	10	9	18	14	11	
Energy	Transport, Forestry	CO_2						
Energy	Transport, Industry (mobile)	CO_2	15	12	14	11	8	11
Energy	Transport, Residential	CO_2						
Energy	Transport, Commercial/institutional	CO_2			23			
Energy	Transport, Civil aviation	CO_2						
Energy	Transport, Road transport	CH_4						
Energy	Transport, Military	CH_4						
Energy	Transport, Railways	CH_4						
Energy	Transport, Navigation (small boats)	CH_4						
Energy	Transport, Navigation (large vessels)	CH_4						
Energy	Transport, Fisheries	CH_4						
Energy	Transport, Agriculture	CH_4						
Energy	Transport, Forestry	CH_4						
Energy	Transport, Industry (mobile)	CH_4						

Continued								
Energy	Transport, Residential	CH_4						
Energy	Transport, Commercial/institutional	CH_4						
Energy	Transport, Civil aviation	CH_4						
Energy	Transport, Road transport	N_2O						
Energy	Transport, Military	N_2O						
Energy	Transport, Railways	N_2O						
Energy	Transport, Navigation (small boats)	N_2O						
Energy	Transport, Navigation (large vessels)	N_2O				23	28	
Energy	Transport, Fisheries	N_2O				25	27	
Energy	Transport, Agriculture	N_2O				22	18	
Energy	Transport, Forestry	N_2O						
Energy	Transport, Industry (mobile)	N_2O					24	24
Energy	Transport, Residential	N_2O						
Energy	Transport, Commercial/institutional	N_2O						
Energy	Transport, Civil aviation	N_2O						
Energy	1.B.2 Flaring in refinery	CO_2						
Energy	1.B.2 Flaring off-shore	CO_2	26	22				
Energy	1.B.2 Land based activities	CO_2						
Energy	1.B.2 Off-shore activities	CO_2						
Energy	1.B.2 Transmission of natural gas	CO_2						
Energy	1.B.2 Distribution of natural gas	CO_2						
Energy	1.B.2 Venting in gas storage	CO_2						
Energy	1.B.2. Flaring in refinery	CH_4						
Energy	1.B.2. Flaring off-shore	CH_4						
Energy	1.B.2 Refinery processes	CH_4						22
Energy	1.B.2 Land based activities	CH_4						
Energy	1.B.2 Off-shore activities	CH_4						
Energy	1.B.2 Transmission of natural gas	CH_4						
Energy	1.B.2 Distribution of natural gas	CH_4						
Energy	1.B.2 Venting in gas storage	CH_4						
Energy	1.B.2 Flaring in refinery	N_2O						
Energy	1.B.2 Flaring off-shore	N_2O						
Industrial Proc.	2A1 Cement production	CO_2	14	17	22			
Industrial Proc.	2A2 Lime production	CO_2						
Industrial Proc.	2A3 Limestone and dolomite use	CO_2						
Industrial Proc.	2A5 Asphalt roofing	CO_2						
Industrial Proc.	2A6 Road paving with asphalt	CO_2						
Industrial Proc.	2A7 Glass and Glass wool	CO_2						
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2						
Industrial Proc.	2C1 Iron and steel production	CO_2						
Industrial Proc.	2D2 Food and Drink	CO_2						
Industrial Proc.	2G Lubricants	CO_2						
Industrial Proc.	2B2 Nitric acid production	N_2O	12		7	17		7
Industrial Proc.	2F Consumption of HFC	HFC		15	10		9	5
Industrial Proc.	2F Consumption of PFC	PFC						
Industrial Proc.	2F Consumption of SF_6	SF_6						
Solvent and Other Prod. Use	3A Paint application	CO_2						
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2						
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2						
Solvent and Other Prod. Use	3D5 Other	CO_2						

Continued

Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2						
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O						
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O						
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O						
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O						
Agriculture	4A Enteric Fermentation	CH_4	5	4		5	7	
Agriculture	4B Manure Management	CH_4	13	8	12	21	14	15
Agriculture	4F Field burning af agricultural residues	CH_4						
Agriculture	4.B Manure Management	N_2O	18	21	21	12	16	21
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	8	11	6	2	3	1
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	11	10	17	4	2	9
Agriculture	4.D1.3 N-fixing crops	N_2O				15	15	
Agriculture	4.D1.4 Crop Residue	N_2O	24	23		10	10	
Agriculture	4.D1.5 Cultivation of histosols	N_2O				19	20	
Agriculture	4.D.2 Grassing animals	N_2O	25			13	17	16
Agriculture	4.D3 Atmospheric deposition	N_2O	21	24	19	7	12	12
Agriculture	4.D3 Leaching	N_2O	6	6	9	1	1	2
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O						
Agriculture	4.F Field Burning of Agricultural Residues	N_2O						
Waste	6 A. Solid Waste Disposal on Land	CH_4	9	16	11	3	5	3
Waste	6 B. Wastewater Handling	CH_4						
Waste	6 B. Wastewater Handling - Direct	N_2O						
Waste	6 B. Wastewater Handling - Indirect	N_2O						
Waste	6.D Accidental fires, buildings	CO_2						
Waste	6.D Accidental fires, vehicles	CO_2						
Waste	6.C Incineration of corpses	CH_4						
Waste	6.C Incineration of carcasses	CH_4						
Waste	6.D Compost production	CH_4						19
Waste	6.D Accidental fires, buildings	CH_4						
Waste	6.D Accidental fires, vehicles	CH_4						
Waste	6.C Incineration of corpses	N_2O						
Waste	6.C Incineration of carcasses	N_2O						
Waste	6.D Compost production	N_2O						

Table A1-10 Summary of KCA for Denmark, level and trend for 1990-2010, incl. LULUCF, tier 1 and tier 2.

IPCC Source Categories (LULUCF included)		GHG	Key categories with number according to ranking in analysis					
			Identification criteria					
			Level Tier 1 1990	Level Tier 1 2010	Trend Tier 1 1990-2010	Level Tier 2 1990	Level Tier 2 2010	Trend Tier 2 1990-2010
Energy	Stationary Combustion, Coal	CO_2	1	1	3	22	26	
Energy	Stationary Combustion, BKB	CO_2						
Energy	Stationary Combustion, Coke	CO_2						
Energy	Stationary Combustion, Fosssil waste	CO_2	24	10	8		25	16
Energy	Stationary Combustion, Petroleum coke	CO_2	26	24	26			
Energy	Stationary Combustion, Residual oil	CO_2	7	17	7			
Energy	Stationary Combustion, Gas oil	CO_2	3	8	5	24		18
Energy	Stationary Combustion, Kerosene	CO_2	27		19			
Energy	Stationary Combustion, LPG	CO_2						
Energy	Stationary Combustion, Refinery gas	CO_2	18	18	25			
Energy	Stationary Combustion, Natural gas	CO_2	4	3	1		31	22
Energy	Stationary Combustion, SOLID	CH_4						
Energy	Stationary Combustion, LIQUID	CH_4						
Energy	Stationary Combustion, GAS	CH_4						
Energy	Natural gas fuelled engines, GAS	CH_4			22			
Energy	Stationary Combustion, WASTE	CH_4						
Energy	Stationary Combustion, BIOMASS	CH_4					29	28
Energy	Biogas fuelled engines, BIOMASS	CH_4						
Energy	Stationary Combustion, SOLID, N_2O	N_2O				20	23	30
Energy	Stationary Combustion, LIQUID, N_2O	N_2O				10	27	11
Energy	Stationary Combustion, GAS, N_2O	N_2O				29	17	13
Energy	Stationary Combustion, WASTE, N_2O	N_2O						
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O				11	7	4
Energy	Transport, Road transport	CO_2	2	2	2	8	10	9
Energy	Transport, Military	CO_2						
Energy	Transport, Railways	CO_2	32	29				
Energy	Transport, Navigation (small boats)	CO_2						
Energy	Transport, Navigation (large vessels)	CO_2	19	23	28			
Energy	Transport, Fisheries	CO_2	23	22	30			
Energy	Transport, Agriculture	CO_2	11	12	21	18	15	25
Energy	Transport, Forestry	CO_2						
Energy	Transport, Industry (mobile)	CO_2	17	16	16	14	12	15
Energy	Transport, Residential	CO_2						
Energy	Transport, Commercial/institutional	CO_2			29			
Energy	Transport, Civil aviation	CO_2						
Energy	Transport, Road transport	CH_4						
Energy	Transport, Military	CH_4						
Energy	Transport, Railways	CH_4						
Energy	Transport, Navigation (small boats)	CH_4						
Energy	Transport, Navigation (large vessels)	CH_4						
Energy	Transport, Fisheries	CH_4						
Energy	Transport, Agriculture	CH_4						
Energy	Transport, Forestry	CH_4						
Energy	Transport, Industry (mobile)	CH_4						

Continued

Energy	Transport, Residential	CH_4						
Energy	Transport, Commercial/institutional	CH_4						
Energy	Transport, Civil aviation	CH_4						
Energy	Transport, Road transport	N_2O						
Energy	Transport, Military	N_2O						
Energy	Transport, Railways	N_2O						
Energy	Transport, Navigation (small boats)	N_2O						
Energy	Transport, Navigation (large vessels)	N_2O				28		
Energy	Transport, Fisheries	N_2O					32	
Energy	Transport, Agriculture	N_2O				27	22	
Energy	Transport, Forestry	N_2O						
Energy	Transport, Industry (mobile)	N_2O					28	31
Energy	Transport, Residential	N_2O						
Energy	Transport, Commercial/institutional	N_2O						
Energy	Transport, Civil aviation	N_2O						
Energy	1.B.2 Flaring in refinery	CO_2						
Energy	1.B.2 Flaring off-shore	CO_2	31	26	31			
Energy	1.B.2 Land based activities	CO_2						
Energy	1.B.2 Off-shore activities	CO_2						
Energy	1.B.2 Transmission of natural gas	CO_2						
Energy	1.B.2 Distribution of natural gas	CO_2						
Energy	1.B.2 Venting in gas storage	CO_2						
Energy	1.B.2. Flaring in refinery	CH_4						
Energy	1.B.2. Flaring off-shore	CH_4						
Energy	1.B.2 Refinery processes	CH_4						27
Energy	1.B.2 Land based activities	CH_4						
Energy	1.B.2 Off-shore activities	CH_4						
Energy	1.B.2 Transmission of natural gas	CH_4						
Energy	1.B.2 Distribution of natural gas	CH_4						
Energy	1.B.2 Venting in gas storage	CH_4						
Energy	1.B.2 Flaring in refinery	N_2O						
Energy	1.B.2 Flaring off-shore	N_2O						
Industrial Proc.	2A1 Cement production	CO_2	16	21				
Industrial Proc.	2A2 Lime production	CO_2						
Industrial Proc.	2A3 Limestone and dolomite use	CO_2						
Industrial Proc.	2A5 Asphalt roofing	CO_2						
Industrial Proc.	2A6 Road paving with asphalt	CO_2						
Industrial Proc.	2A7 Glass and Glass wool	CO_2						
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2						
Industrial Proc.	2C1 Iron and steel production	CO_2						
Industrial Proc.	2D2 Food and Drink	CO_2						
Industrial Proc.	2G Lubricants	CO_2						
Industrial Proc.	2B2 Nitric acid production	N_2O	14		9	21		10
Industrial Proc.	2F Consumption of HFC	HFC		19	12		13	7
Industrial Proc.	2F Consumption of PFC	PFC						
Industrial Proc.	2F Consumption of SF_6	SF_6						
Solvent and Other Prod. Use	3A Paint application	CO_2						
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2						
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2						
Solvent and Other Prod. Use	3D5 Other	CO_2						

Continued								
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2						
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O						
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O						
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O						
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O						
Agriculture	4A Enteric Fermentation	CH_4	5	5	23	7	11	
Agriculture	4B Manure Management	CH_4	15	11	14	25	18	17
Agriculture	4F Field burning af agricultural residues	CH_4						
Agriculture	4.B Manure Management	N_2O	22	25		15	20	
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	8	15	10	2	5	3
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	12	13	20	5	4	8
Agriculture	4.D1.3 N-fixing crops	N_2O		30		19	19	
Agriculture	4.D1.4 Crop Residue	N_2O	28	27		13	14	
Agriculture	4.D1.5 Cultivation of histosols	N_2O				23	24	
Agriculture	4.D.2 Grassing animals	N_2O	29			16	21	29
Agriculture	4.D3 Atmospheric deposition	N_2O	25	28		9	16	21
Agriculture	4.D3 Leaching	N_2O	6	9	13	1	3	6
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O						
Agriculture	4.F Field Burning of Agricultural Residues	N_2O						
LULUCF	5.A.1 Broadleaves	CO_2	20	4	4	12	1	1
LULUCF	5.A.1 Conifers	CO_2		6	6		6	2
LULUCF	5.A.2 Broadleaves	CO_2						20
LULUCF	5.A.2 Conifers	CO_2			27			19
LULUCF	5(II) Forest Land.	N_2O						
LULUCF	5.B Cropland, Living biomass	CO_2						
LULUCF	5.B Cropland, Dead organic matter	CO_2						
LULUCF	5.B Cropland, Mineral soils	CO_2	13	14	18	6	8	
LULUCF	5.B Cropland, Organic soils	CO_2	10	7	11	3	2	12
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O						
LULUCF	5.C Grassland, Living biomass	CO_2	30		24			26
LULUCF	5.C Grassland, Dead organic matter	CO_2						
LULUCF	5.C Grassland, Mineral soils	CO_2						
LULUCF	5.C Grassland, Organic soils	CO_2				26	30	
LULUCF	5.D Wetlands, Living biomass	CO_2						
LULUCF	5.D Wetlands, Dead organic matter	CO_2						
LULUCF	5.D Wetlands, Soils	CO_2						23
LULUCF	5(II) Wetlands	N_2O						
LULUCF	5.E Settlements, Living biomass	CO_2						
LULUCF	5(IV) Cropland Limestone	CO_2	21		17	17		14
LULUCF	5(V) Biomass Burning	CH_4						
LULUCF	5(V) Biomass Burning	N_2O						
Waste	6 A. Solid Waste Disposal on Land	CH_4	9	20	15	4	9	5
Waste	6 B. Wastewater Handling	CH_4						
Waste	6 B. Wastewater Handling - Direct	N_2O						
Waste	6 B. Wastewater Handling - Indirect	N_2O						
Waste	6.D Accidental fires, buildings	CO_2						
Waste	6.D Accidental fires, vehicles	CO_2						
Waste	6.C Incineration of corpses	CH_4						
Waste	6.C Incineration of carcasses	CH_4						
Waste	6.D Compost production	CH_4						24

Continued		
Waste	6.D Accidental fires, buildings	CH_4
Waste	6.D Accidental fires, vehicles	CH_4
Waste	6.C Incineration of corpses	N_2O
Waste	6.C Incineration of carcasses	N_2O
Waste	6.D Compost production	N_2O

Table A1-11 Summary of KCA for Denmark, number of key source categories in each of the KCA.

	Level Tier 1 1990	Level Tier 1 2009	Trend Tier 1 1990-2009	Level Tier 2 1990	Level Tier 2 2009	Trend Tier 2 1990-2009
Excluding LULUCF	26	25	24	25	28	24
Including LULUCF	32	30	31	29	32	31

Table A1-12 KCA for Denmark, level assessment base year excl. LULUCF, tier 1.

Tier 1 Analysis			DK - inventory		
IPCC Source Categories (LULUCF excluded)		GHG	Base Year Estimate	Base Year Level Assessment	Base Year Cumulative Total of Lx,o
			Ex,o	Lx,o	
			Mt CO_2 eq		
Energy	Stationary Combustion, Coal	CO_2	23.834	0.346	0.346
Energy	Transport, Road transport	CO_2	9.282	0.135	0.480
Energy	Stationary Combustion, Gas oil	CO_2	4.547	0.066	0.546
Energy	Stationary Combustion, Natural gas	CO_2	4.335	0.063	0.609
Agriculture	4A Enteric Fermentation	CH_4	3.247	0.047	0.656
Agriculture	4.D3 Leaching	N_2O	2.452	0.036	0.692
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.035	0.727
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	0.035	0.762
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.530	0.022	0.784
Energy	Transport, Agriculture	CO_2	1.272	0.018	0.803
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	0.016	0.819
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.015	0.834
Agriculture	4B Manure Management	CH_4	0.993	0.014	0.848
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.013	0.861
Energy	Transport, Industry (mobile)	CO_2	0.839	0.012	0.873
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.012	0.885
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.011	0.896
Agriculture	4.B Manure Management	N_2O	0.600	0.009	0.905
Energy	Transport, Fisheries	CO_2	0.591	0.009	0.913
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	0.008	0.922
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.007	0.928
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.006	0.934
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.005	0.940
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.005	0.945
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.005	0.949
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.004	0.954
Energy	Transport, Railways	CO_2	0.297	0.004	0.958
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.004	0.962
Energy	Transport, Civil aviation	CO_2	0.243	0.004	0.965
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.003	0.969
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.003	0.972
Energy	Stationary Combustion, LPG	CO_2	0.164	0.002	0.974
Energy	Stationary Combustion, Coke	CO_2	0.138	0.002	0.976
Energy	Transport, Military	CO_2	0.119	0.002	0.978
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.002	0.980
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.002	0.981
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.001	0.983
Energy	Transport, Road transport	N_2O	0.093	0.001	0.984
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.082	0.001	0.985
Energy	Transport, Commercial/institutional	CO_2	0.074	0.001	0.986
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.001	0.987
Waste	6 B. Wastewater Handling	CH_4	0.066	0.001	0.988
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.001	0.989
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.001	0.990
Energy	Transport, Road transport	CH_4	0.053	0.001	0.991
Industrial Proc.	2G Lubricants	CO_2	0.050	0.001	0.991
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.001	0.992
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.001	0.993
Energy	Transport, Residential	CO_2	0.039	0.001	0.993
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.001	0.994
Energy	Transport, Forestry	CO_2	0.036	0.001	0.994
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.995
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.000	0.995
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.000	0.995
Waste	6.D Compost production	CH_4	0.027	0.000	0.996

Continued					
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.000	0.996
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.019	0.000	0.996
Energy	1.B.2 Land based activities	CH_4	0.017	0.000	0.997
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.000	0.997
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.000	0.997
Energy	Transport, Agriculture	N_2O	0.015	0.000	0.997
Energy	1.B.2 Off-shore activities	CH_4	0.015	0.000	0.998
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.000	0.998
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.000	0.998
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.000	0.998
Energy	Transport, Fisheries	N_2O	0.011	0.000	0.998
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.000	0.999
Waste	6.D Compost production	N_2O	0.011	0.000	0.999
Energy	Stationary Combustion, BKB	CO_2	0.011	0.000	0.999
Energy	Transport, Industry (mobile)	N_2O	0.011	0.000	0.999
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.000	0.999
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.000	0.999
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.000	0.999
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.000	0.999
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.000	0.999
Energy	Transport, Civil aviation	N_2O	0.003	0.000	0.999
Energy	Stationary Combustion, GAS	CH_4	0.003	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.000	1.000
Energy	Transport, Railways	N_2O	0.003	0.000	1.000
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.000	1.000
Energy	Transport, Commercial/institutional	CH_4	0.002	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.000	1.000
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.000	1.000
Energy	1.B.2 Refinery processes	CH_4	0.001	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.000	1.000
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000

Continued					
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.000	1.000
Total			68.938	1.000	

Table A1-13 KCA for Denmark, level assessment base year incl. LULUCF, tier 1.

Tier 1 Analysis			DK - inventory		
IPCC Source Categories (LULUCF included)		GHG	Base Year Estimate	Base Year Level Assessment	Base Year Cumulative Total of Lx,o
			Ex,o	Lx,o	
			Mt CO_2 eq		
Energy	Stationary Combustion, Coal	CO_2	23.834	0.324	0.324
Energy	Transport, Road transport	CO_2	9.282	0.126	0.450
Energy	Stationary Combustion, Gas oil	CO_2	4.547	0.062	0.512
Energy	Stationary Combustion, Natural gas	CO_2	4.335	0.059	0.571
Agriculture	4A Enteric Fermentation	CH_4	3.247	0.044	0.615
Agriculture	4.D3 Leaching	N_2O	2.452	0.033	0.649
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.033	0.682
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	0.033	0.714
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.530	0.021	0.735
LULUCF	5.B Cropland, Organic soils	CO_2	1.343	0.018	0.753
Energy	Transport, Agriculture	CO_2	1.272	0.017	0.771
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	0.015	0.786
LULUCF	5.B Cropland, Mineral soils	CO_2	1.054	0.014	0.800
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.014	0.814
Agriculture	4B Manure Management	CH_4	0.993	0.014	0.828
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.012	0.840
Energy	Transport, Industry (mobile)	CO_2	0.839	0.011	0.851
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.011	0.862
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.010	0.873
LULUCF	5.A.1 Broadleaves	CO_2	0.659	0.009	0.882
LULUCF	5(IV) Cropland Limestone	CO_2	0.623	0.008	0.890
Agriculture	4.B Manure Management	N_2O	0.600	0.008	0.898
Energy	Transport, Fisheries	CO_2	0.591	0.008	0.906
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	0.008	0.914
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.006	0.920
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.006	0.926
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.005	0.931
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.005	0.936
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.004	0.940
LULUCF	5.C Grassland, Living biomass	CO_2	0.304	0.004	0.944
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.004	0.948
Energy	Transport, Railways	CO_2	0.297	0.004	0.952
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.004	0.956
Energy	Transport, Civil aviation	CO_2	0.243	0.003	0.959
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.003	0.962
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.003	0.965
LULUCF	5.B Cropland, Living biomass	CO_2	0.174	0.002	0.968
Energy	Stationary Combustion, LPG	CO_2	0.164	0.002	0.970
Energy	Stationary Combustion, Coke	CO_2	0.138	0.002	0.972
LULUCF	5.C Grassland, Organic soils	CO_2	0.137	0.002	0.973
Energy	Transport, Military	CO_2	0.119	0.002	0.975
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.002	0.977
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.001	0.978
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.001	0.979
Energy	Transport, Road transport	N_2O	0.093	0.001	0.981
LULUCF	5.E Settlements, Living biomass	CO_2	0.090	0.001	0.982
LULUCF	5.D Wetlands, Soils	CO_2	0.086	0.001	0.983
Waste	6.B Wastewater Handling - Indirect	N_2O	0.082	0.001	0.984
Energy	Transport, Commercial/institutional	CO_2	0.074	0.001	0.985

Continued					
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.001	0.986
Waste	6 B. Wastewater Handling	CH_4	0.066	0.001	0.987
LULUCF	5.A.1 Conifers	CO_2	0.066	0.001	0.988
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.001	0.989
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.001	0.989
Energy	Transport, Road transport	CH_4	0.053	0.001	0.990
Industrial Proc.	2G Lubricants	CO_2	0.050	0.001	0.991
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.001	0.992
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.001	0.992
Energy	Transport, Residential	CO_2	0.039	0.001	0.993
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.001	0.993
Energy	Transport, Forestry	CO_2	0.036	0.000	0.994
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.032	0.000	0.994
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.994
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.000	0.995
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.000	0.995
Waste	6.D Compost production	CH_4	0.027	0.000	0.996
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.000	0.996
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.019	0.000	0.996
Energy	1.B.2 Land based activities	CH_4	0.017	0.000	0.996
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.000	0.997
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.000	0.997
LULUCF	5(II) Forest Land.	N_2O	0.016	0.000	0.997
Energy	Transport, Agriculture	N_2O	0.015	0.000	0.997
Energy	1.B.2 Off-shore activities	CH_4	0.015	0.000	0.997
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.000	0.998
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.000	0.998
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.000	0.998
Energy	Transport, Fisheries	N_2O	0.011	0.000	0.998
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.000	0.998
Waste	6.D Compost production	N_2O	0.011	0.000	0.998
Energy	Stationary Combustion, BKB	CO_2	0.011	0.000	0.999
Energy	Transport, Industry (mobile)	N_2O	0.011	0.000	0.999
LULUCF	5.A.2 Conifers	CO_2	0.007	0.000	0.999
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.000	0.999
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.000	0.999
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.006	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.000	0.999
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.000	0.999
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.000	0.999
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.000	0.999
LULUCF	5.A.2 Broadleaves	CO_2	0.003	0.000	0.999
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.003	0.000	0.999
Energy	Transport, Civil aviation	N_2O	0.003	0.000	0.999
Energy	Stationary Combustion, GAS	CH_4	0.003	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.000	1.000
Energy	Transport, Railways	N_2O	0.003	0.000	1.000
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.000	1.000
Energy	Transport, Commercial/institutional	CH_4	0.002	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.000	1.000
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.000	1.000

Continued					
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.000	1.000
LULUCF	5.C Grassland, Mineral soils	CO_2	0.001	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.000	1.000
Energy	1.B.2 Refinery processes	CH_4	0.001	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.001	0.000	1.000
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.000	1.000
LULUCF	5.D Wetlands, Living biomass	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.000	1.000
Total			73.544	1.000	

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Table A1-14 KCA for Denmark, level assessment 2010 excl. LULUCF, tier 1.

Tier 1 Analysis		DK - inventory			
IPCC Source Categories (LULUCF excluded)		GHG	Latest Year Estimate	Latest Year Level Assessment	Latest Year Cumulative Total of Lx,t
			Ex,t	Lx,t	
			Mt CO_2 eq		
Energy	Stationary Combustion, Coal	CO_2	15.224	0.249	0.249
Energy	Transport, Road transport	CO_2	12.108	0.198	0.447
Energy	Stationary Combustion, Natural gas	CO_2	10.607	0.173	0.620
Agriculture	4A Enteric Fermentation	CH_4	2.856	0.047	0.667
Energy	Stationary Combustion, Gas oil	CO_2	1.577	0.026	0.693
Agriculture	4.D3 Leaching	N_2O	1.415	0.023	0.716
Energy	Stationary Combustion, Fosssil waste	CO_2	1.410	0.023	0.739
Agriculture	4B Manure Management	CH_4	1.288	0.021	0.760
Energy	Transport, Agriculture	CO_2	1.273	0.021	0.781
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.154	0.019	0.800
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	1.139	0.019	0.819
Energy	Transport, Industry (mobile)	CO_2	1.037	0.017	0.835
Energy	Stationary Combustion, Residual oil	CO_2	0.880	0.014	0.850
Energy	Stationary Combustion, Refinery gas	CO_2	0.817	0.013	0.863
Industrial Proc.	2F Consumption of HFC	HFC	0.800	0.013	0.876
Waste	6 A. Solid Waste Disposal on Land	CH_4	0.777	0.013	0.889
Industrial Proc.	2A1 Cement production	CO_2	0.672	0.011	0.900
Energy	Transport, Fisheries	CO_2	0.575	0.009	0.909
Energy	Transport, Navigation (large vessels)	CO_2	0.494	0.008	0.917
Energy	Stationary Combustion, Petroleum coke	CO_2	0.477	0.008	0.925
Agriculture	4.B Manure Management	N_2O	0.421	0.007	0.932
Energy	1.B.2 Flaring off-shore	CO_2	0.333	0.005	0.938
Agriculture	4.D1.4 Crop Residue	N_2O	0.315	0.005	0.943
Agriculture	4.D3 Atmospheric deposition	N_2O	0.288	0.005	0.947
Energy	Transport, Railways	CO_2	0.242	0.004	0.951
Agriculture	4.D1.3 N-fixing crops	N_2O	0.238	0.004	0.955
Energy	Natural gas fuelled engines, GAS	CH_4	0.234	0.004	0.959
Agriculture	4.D.2 Grassing animals	N_2O	0.197	0.003	0.962
Energy	Transport, Commercial/institutional	CO_2	0.173	0.003	0.965
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.163	0.003	0.968
Energy	Transport, Civil aviation	CO_2	0.156	0.003	0.970
Energy	Stationary Combustion, BIOMASS	CH_4	0.133	0.002	0.973
Energy	Transport, Road transport	N_2O	0.119	0.002	0.975
Energy	Transport, Military	CO_2	0.107	0.002	0.976
Energy	Transport, Navigation (small boats)	CO_2	0.099	0.002	0.978
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.093	0.002	0.979
Energy	Stationary Combustion, LPG	CO_2	0.089	0.001	0.981
Energy	Stationary Combustion, Coke	CO_2	0.084	0.001	0.982
Waste	6.D Compost production	CH_4	0.080	0.001	0.984
Waste	6 B. Wastewater Handling	CH_4	0.075	0.001	0.985
Energy	Transport, Residential	CO_2	0.063	0.001	0.986
Waste	6 B. Wastewater Handling - Direct	N_2O	0.051	0.001	0.987
Energy	1.B.2 Refinery processes	CH_4	0.047	0.001	0.987
Industrial Proc.	2A2 Lime production	CO_2	0.046	0.001	0.988
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.046	0.001	0.989
Waste	6.D Compost production	N_2O	0.043	0.001	0.990
Solvent and Other Prod. Use	3D5 Other	CO_2	0.042	0.001	0.990
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.042	0.001	0.991
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.041	0.001	0.992

Continued					
Industrial Proc.	2F Consumption of SF_6	SF_6	0.038	0.001	0.992
Energy	1.B.2 Off-shore activities	CH_4	0.037	0.001	0.993
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.036	0.001	0.994
Industrial Proc.	2G Lubricants	CO_2	0.033	0.001	0.994
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.033	0.001	0.995
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.031	0.001	0.995
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.028	0.000	0.996
Energy	1.B.2 Flaring in refinery	CO_2	0.019	0.000	0.996
Energy	1.B.2 Land based activities	CH_4	0.018	0.000	0.996
Energy	Transport, Forestry	CO_2	0.017	0.000	0.996
Energy	Transport, Agriculture	N_2O	0.017	0.000	0.997
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.016	0.000	0.997
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.014	0.000	0.997
Energy	Transport, Industry (mobile)	N_2O	0.014	0.000	0.997
Energy	Transport, Road transport	CH_4	0.014	0.000	0.998
Industrial Proc.	2F Consumption of PFC	PFC	0.013	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.012	0.000	0.998
Energy	Transport, Fisheries	N_2O	0.011	0.000	0.998
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.000	0.998
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.011	0.000	0.999
Energy	Transport, Navigation (large vessels)	N_2O	0.010	0.000	0.999
Solvent and Other Prod. Use	3A Paint application	CO_2	0.008	0.000	0.999
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.000	0.999
Energy	Stationary Combustion, GAS	CH_4	0.007	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.005	0.000	0.999
Energy	Stationary Combustion, SOLID	CH_4	0.004	0.000	0.999
Energy	Stationary Combustion, Kerosene	CO_2	0.004	0.000	0.999
Energy	Transport, Commercial/institutional	CH_4	0.003	0.000	0.999
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.003	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.003	0.000	0.999
Energy	Transport, Civil aviation	N_2O	0.003	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.003	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.002	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.000	1.000
Energy	Transport, Railways	N_2O	0.002	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.002	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.001	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.001	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.001	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.001	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	1.000

Continued					
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Industrial Proc.	2C1 Iron and steel production	CO_2	0.000	0.000	1.000
Industrial Proc.	2B2 Nitric acid production	N_2O	0.000	0.000	1.000
Total			61.150	1.000	

Table A1-15 KCA for Denmark, level assessment 2010 incl. LULUCF, tier 1.

Tier 1 Analysis			DK - inventory		
IPCC Source Categories (LULUCF included)		GHG	Latest Year Estimate	Latest Year Level Asses-sment	Latest Year Cumulative Total of Lx,t
			Ex,t	Lx,t	
			Mt CO_2 eq		
Energy	Stationary Combustion, Coal	CO_2	15.224	0.215	0.215
Energy	Transport, Road transport	CO_2	12.108	0.171	0.387
Energy	Stationary Combustion, Natural gas	CO_2	10.607	0.150	0.537
LULUCF	5.A.1 Broadleaves	CO_2	3.845	0.054	0.591
Agriculture	4A Enteric Fermentation	CH_4	2.856	0.040	0.632
LULUCF	5.A.1 Conifers	CO_2	2.036	0.029	0.661
LULUCF	5.B Cropland, Organic soils	CO_2	1.745	0.025	0.685
Energy	Stationary Combustion, Gas oil	CO_2	1.577	0.022	0.708
Agriculture	4.D3 Leaching	N_2O	1.415	0.020	0.728
Energy	Stationary Combustion, Fosssil waste	CO_2	1.410	0.020	0.748
Agriculture	4B Manure Management	CH_4	1.288	0.018	0.766
Energy	Transport, Agriculture	CO_2	1.273	0.018	0.784
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.154	0.016	0.800
LULUCF	5.B Cropland, Mineral soils	CO_2	1.151	0.016	0.816
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	1.139	0.016	0.833
Energy	Transport, Industry (mobile)	CO_2	1.037	0.015	0.847
Energy	Stationary Combustion, Residual oil	CO_2	0.880	0.012	0.860
Energy	Stationary Combustion, Refinery gas	CO_2	0.817	0.012	0.871
Industrial Proc.	2F Consumption of HFC	HFC	0.800	0.011	0.883
Waste	6 A. Solid Waste Disposal on Land	CH_4	0.777	0.011	0.894
Industrial Proc.	2A1 Cement production	CO_2	0.672	0.010	0.903
Energy	Transport, Fisheries	CO_2	0.575	0.008	0.911
Energy	Transport, Navigation (large vessels)	CO_2	0.494	0.007	0.918
Energy	Stationary Combustion, Petroleum coke	CO_2	0.477	0.007	0.925
Agriculture	4.B Manure Management	N_2O	0.421	0.006	0.931
Energy	1.B.2 Flaring off-shore	CO_2	0.333	0.005	0.936
Agriculture	4.D1.4 Crop Residue	N_2O	0.315	0.004	0.940
Agriculture	4.D3 Atmospheric deposition	N_2O	0.288	0.004	0.944
Energy	Transport, Railways	CO_2	0.242	0.003	0.948
Agriculture	4.D1.3 N-fixing crops	N_2O	0.238	0.003	0.951
Energy	Natural gas fuelled engines, GAS	CH_4	0.234	0.003	0.954
Agriculture	4.D.2 Grassing animals	N_2O	0.197	0.003	0.957
Energy	Transport, Commercial/institutional	CO_2	0.173	0.002	0.959
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.163	0.002	0.962
LULUCF	5(IV) Cropland Limestone	CO_2	0.157	0.002	0.964
Energy	Transport, Civil aviation	CO_2	0.156	0.002	0.966
LULUCF	5.C Grassland, Organic soils	CO_2	0.145	0.002	0.968
LULUCF	5.E Settlements, Living biomass	CO_2	0.134	0.002	0.970
LULUCF	5.A.2 Conifers	CO_2	0.134	0.002	0.972
Energy	Stationary Combustion, BIOMASS	CH_4	0.133	0.002	0.974
Energy	Transport, Road transport	N_2O	0.119	0.002	0.976
Energy	Transport, Military	CO_2	0.107	0.002	0.977
Energy	Transport, Navigation (small boats)	CO_2	0.099	0.001	0.979
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.093	0.001	0.980
Energy	Stationary Combustion, LPG	CO_2	0.089	0.001	0.981
Energy	Stationary Combustion, Coke	CO_2	0.084	0.001	0.982
Waste	6.D Compost production	CH_4	0.080	0.001	0.983
Waste	6 B. Wastewater Handling	CH_4	0.075	0.001	0.985
Energy	Transport, Residential	CO_2	0.063	0.001	0.985
LULUCF	5.B Cropland, Living biomass	CO_2	0.060	0.001	0.986

Continued					
Waste	6 B. Wastewater Handling - Direct	N_2O	0.051	0.001	0.987
Energy	1.B.2 Refinery processes	CH_4	0.047	0.001	0.988
LULUCF	5.A.2 Broadleaves	CO_2	0.046	0.001	0.988
Industrial Proc.	2A2 Lime production	CO_2	0.046	0.001	0.989
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.046	0.001	0.990
Waste	6.D Compost production	N_2O	0.043	0.001	0.990
Solvent and Other Prod. Use	3D5 Other	CO_2	0.042	0.001	0.991
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.042	0.001	0.991
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.041	0.001	0.992
Industrial Proc.	2F Consumption of SF_6	SF_6	0.038	0.001	0.992
Energy	1.B.2 Off-shore activities	CH_4	0.037	0.001	0.993
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.036	0.001	0.994
LULUCF	5.C Grassland, Living biomass	CO_2	0.034	0.000	0.994
Industrial Proc.	2G Lubricants	CO_2	0.033	0.000	0.994
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.033	0.000	0.995
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.031	0.000	0.995
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.028	0.000	0.996
Energy	1.B.2 Flaring in refinery	CO_2	0.019	0.000	0.996
Energy	1.B.2 Land based activities	CH_4	0.018	0.000	0.996
Energy	Transport, Forestry	CO_2	0.017	0.000	0.997
Energy	Transport, Agriculture	N_2O	0.017	0.000	0.997
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.016	0.000	0.997
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.014	0.000	0.997
Energy	Transport, Industry (mobile)	N_2O	0.014	0.000	0.997
Energy	Transport, Road transport	CH_4	0.014	0.000	0.998
Industrial Proc.	2F Consumption of PFC	PFC	0.013	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.012	0.000	0.998
LULUCF	5(II) Forest Land.	N_2O	0.012	0.000	0.998
Energy	Transport, Fisheries	N_2O	0.011	0.000	0.998
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.000	0.998
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.011	0.000	0.999
Energy	Transport, Navigation (large vessels)	N_2O	0.010	0.000	0.999
Solvent and Other Prod. Use	3A Paint application	CO_2	0.008	0.000	0.999
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.000	0.999
Energy	Stationary Combustion, GAS	CH_4	0.007	0.000	0.999
LULUCF	5.D Wetlands, Living biomass	CO_2	0.005	0.000	0.999
LULUCF	5.D Wetlands, Soils	CO_2	0.005	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.005	0.000	0.999
Energy	Stationary Combustion, SOLID	CH_4	0.004	0.000	0.999
Energy	Stationary Combustion, Kerosene	CO_2	0.004	0.000	0.999
Energy	Transport, Commercial/institutional	CH_4	0.003	0.000	0.999
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.003	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.003	0.000	0.999
Energy	Transport, Civil aviation	N_2O	0.003	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.003	0.000	1.000
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.003	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.002	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.000	1.000
Energy	Transport, Railways	N_2O	0.002	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.002	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.000	1.000

Continued					
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.001	0.000	1.000
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.001	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.001	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.001	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.001	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
LULUCF	5.C Grassland, Mineral soils	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Industrial Proc.	2C1 Iron and steel production	CO_2	0.000	0.000	1.000
Industrial Proc.	2B2 Nitric acid production	N_2O	0.000	0.000	1.000
Total			70.662	1.000	

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Table A1-16 KCA for Denmark, trend assessment 1990-2010 excl. LULUCF, tier 1.

Tier 1 Analysis		DK - inventory					
IPCC Source Categories (LU-LUCF excluded)		GHG	Base Year Estimate	Latest Year Estimate	Trend Assessment	Contribution to Trend	Cumulative
			Ex,o	Ex,t	Tx,t		
			Mt CO_2 eq	Mt CO_2 eq			
Energy	Stationary Combustion, Natural gas	CO_2	4.335	10.607	0.0981	0.235	0.235
Energy	Stationary Combustion, Coal	CO_2	23.834	15.224	0.0858	0.205	0.440
Energy	Transport, Road transport	CO_2	9.282	12.108	0.0562	0.134	0.574
Energy	Stationary Combustion, Gas oil	CO_2	4.547	1.577	0.0356	0.085	0.659
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.880	0.0186	0.045	0.704
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	1.139	0.0144	0.034	0.738
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.000	0.0134	0.032	0.771
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	1.410	0.0131	0.031	0.802
Agriculture	4.D3 Leaching	N_2O	2.452	1.415	0.0110	0.026	0.828
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.800	0.0088	0.021	0.849
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.530	0.777	0.0084	0.020	0.869
Agriculture	4B Manure Management	CH_4	0.993	1.288	0.0059	0.014	0.883
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.004	0.0046	0.011	0.895
Energy	Transport, Industry (mobile)	CO_2	0.839	1.037	0.0042	0.010	0.905
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.234	0.0033	0.008	0.913
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.494	0.0025	0.006	0.919
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	1.154	0.0024	0.006	0.924
Energy	Transport, Agriculture	CO_2	1.272	1.273	0.0021	0.005	0.929
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.288	0.0017	0.004	0.933
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.477	0.0016	0.004	0.937
Agriculture	4.B Manure Management	N_2O	0.600	0.421	0.0016	0.004	0.941
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.672	0.0016	0.004	0.945
Energy	Transport, Commercial/institutional	CO_2	0.074	0.173	0.0016	0.004	0.949
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.817	0.0013	0.003	0.952
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.197	0.0011	0.003	0.955
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.333	0.0010	0.002	0.957
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.093	0.0009	0.002	0.959
Energy	Transport, Civil aviation	CO_2	0.243	0.156	0.0009	0.002	0.961
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.038	0.0008	0.002	0.963
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.099	0.0008	0.002	0.965
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.046	0.0008	0.002	0.967
Waste	6.D Compost production	CH_4	0.027	0.080	0.0008	0.002	0.969
Energy	Stationary Combustion, LPG	CO_2	0.164	0.089	0.0008	0.002	0.971
Energy	Transport, Fisheries	CO_2	0.591	0.575	0.0007	0.002	0.973
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.133	0.0007	0.002	0.974
Energy	1.B.2 Refinery processes	CH_4	0.001	0.047	0.0007	0.002	0.976
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.082	0.033	0.0006	0.001	0.977
Energy	Stationary Combustion, Coke	CO_2	0.138	0.084	0.0006	0.001	0.979
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.163	0.0005	0.001	0.980
Energy	Transport, Road transport	N_2O	0.093	0.119	0.0005	0.001	0.981
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.046	0.0005	0.001	0.983
Energy	Transport, Road transport	CH_4	0.053	0.014	0.0005	0.001	0.984
Waste	6.D Compost production	N_2O	0.011	0.043	0.0005	0.001	0.985
Energy	Transport, Residential	CO_2	0.039	0.063	0.0004	0.001	0.986
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.051	0.0004	0.001	0.987
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.028	0.0004	0.001	0.988
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.0004	0.001	0.989
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.014	0.0004	0.001	0.989

Continued

Energy	1.B.2 Off-shore activities	CH_4	0.015	0.037	0.0004	0.001	0.990
Agriculture	4A Enteric Fermentation	CH_4	3.247	2.856	0.0003	0.001	0.991
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.036	0.0003	0.001	0.992
Energy	Transport, Railways	CO_2	0.297	0.242	0.0003	0.001	0.992
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.042	0.0003	0.001	0.993
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.031	0.0003	0.001	0.994
Waste	6 B. Wastewater Handling	CH_4	0.066	0.075	0.0002	0.001	0.994
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.041	0.0002	0.001	0.995
Energy	Transport, Forestry	CO_2	0.036	0.017	0.0002	0.001	0.995
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.013	0.0002	0.000	0.996
Industrial Proc.	2G Lubricants	CO_2	0.050	0.033	0.0002	0.000	0.996
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthe-sia	N_2O	0.000	0.011	0.0002	0.000	0.997
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.016	0.0001	0.000	0.997
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.042	0.0001	0.000	0.997
Energy	Stationary Combustion, BKB	CO_2	0.011	0.003	0.0001	0.000	0.998
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.004	0.0001	0.000	0.998
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.008	0.0001	0.000	0.998
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.315	0.0001	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.019	0.012	0.0001	0.000	0.998
Energy	Transport, Industry (mobile)	N_2O	0.011	0.014	0.0001	0.000	0.998
Energy	Stationary Combustion, GAS	CH_4	0.003	0.007	0.0001	0.000	0.999
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.010	0.0000	0.000	0.999
Energy	Transport, Agriculture	N_2O	0.015	0.017	0.0000	0.000	0.999
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.001	0.0000	0.000	0.999
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.003	0.0000	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.005	0.0000	0.000	0.999
Energy	1.B.2 Land based activities	CH_4	0.017	0.018	0.0000	0.000	0.999
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.002	0.0000	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.003	0.0000	0.000	0.999
Energy	Transport, Commercial/institutional	CH_4	0.002	0.003	0.0000	0.000	0.999
Energy	Transport, Military	CO_2	0.119	0.107	0.0000	0.000	0.999
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.002	0.0000	0.000	0.999
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.001	0.0000	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.001	0.0000	0.000	1.000
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.019	0.0000	0.000	1.000
Energy	Transport, Fisheries	N_2O	0.011	0.011	0.0000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	0.0000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.007	0.0000	0.000	1.000
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.238	0.0000	0.000	1.000
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.011	0.0000	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.001	0.0000	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.000	0.001	0.0000	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.002	0.0000	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.001	0.0000	0.000	1.000
Energy	Transport, Civil aviation	N_2O	0.003	0.003	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	0.0000	0.000	1.000

Continued

Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Railways	N_2O	0.003	0.002	0.0000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.002	0.0000	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.001	0.0000	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.001	0.0000	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.001	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.002	0.0000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	0.0000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	0.0000	0.000	1.000
Total			68.938	61.150			

Table A1-17 KCA for Denmark, trend assessment 1990-2010 incl. LULUCF, tier 1.

Tier 1 Analysis		DK	- inventory				
IPCC Source Categories (LU-LUCF included)		GHG	Base Year Estimate	Latest Year Estimate	Trend Assessment	Contribution to Trend	Cumulative
			Ex,o	Ex,t	Tx,t		
			Mt CO_2 eq	Mt CO_2 eq			
Energy	Stationary Combustion, Natural gas	CO_2	4.335	10.607	0.0963	0.206	0.206
Energy	Transport, Road transport	CO_2	9.282	12.108	0.0620	0.132	0.338
Energy	Stationary Combustion, Coal	CO_2	23.834	15.224	0.0565	0.121	0.459
LULUCF	5.A.1 Broadleaves	CO_2	-0.659	-3.845	0.0417	0.089	0.548
Energy	Stationary Combustion, Gas oil	CO_2	4.547	1.577	0.0288	0.062	0.609
LULUCF	5.A.1 Conifers	CO_2	-0.066	-2.036	0.0266	0.057	0.666
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.880	0.0150	0.032	0.698
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	1.410	0.0128	0.027	0.726
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.000	0.0115	0.025	0.750
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	1.139	0.0111	0.024	0.774
LULUCF	5.B Cropland, Organic soils	CO_2	1.343	1.745	0.0089	0.019	0.793
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.800	0.0085	0.018	0.811
Agriculture	4.D3 Leaching	N_2O	2.452	1.415	0.0079	0.017	0.828
Agriculture	4B Manure Management	CH_4	0.993	1.288	0.0065	0.014	0.842
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.530	0.777	0.0063	0.014	0.856
Energy	Transport, Industry (mobile)	CO_2	0.839	1.037	0.0048	0.010	0.866
LULUCF	5(IV) Cropland Limestone	CO_2	0.623	0.157	0.0048	0.010	0.876
LULUCF	5.B Cropland, Mineral soils	CO_2	1.054	1.151	0.0040	0.009	0.885
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.004	0.0040	0.009	0.893
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	1.154	0.0034	0.007	0.900
Energy	Transport, Agriculture	CO_2	1.272	1.273	0.0032	0.007	0.907
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.234	0.0031	0.007	0.914
Agriculture	4A Enteric Fermentation	CH_4	3.247	2.856	0.0029	0.006	0.920
LULUCF	5.C Grassland, Living biomass	CO_2	0.304	0.034	0.0029	0.006	0.926
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.817	0.0021	0.004	0.931
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.477	0.0020	0.004	0.935
LULUCF	5.A.2 Conifers	CO_2	0.007	-0.134	0.0019	0.004	0.939
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.494	0.0016	0.003	0.942
Energy	Transport, Commercial/institutional	CO_2	0.074	0.173	0.0015	0.003	0.946
Energy	Transport, Fisheries	CO_2	0.591	0.575	0.0013	0.003	0.948
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.333	0.0012	0.003	0.951
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.288	0.0011	0.002	0.953
LULUCF	5.B Cropland, Living biomass	CO_2	0.174	0.060	0.0011	0.002	0.956
Agriculture	4.B Manure Management	N_2O	0.600	0.421	0.0009	0.002	0.958
LULUCF	5.D Wetlands, Soils	CO_2	0.086	0.005	0.0009	0.002	0.960
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.093	0.0008	0.002	0.961
LULUCF	5.E Settlements, Living biomass	CO_2	0.090	0.134	0.0008	0.002	0.963
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.099	0.0008	0.002	0.965
Waste	6.D Compost production	CH_4	0.027	0.080	0.0008	0.002	0.967
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.197	0.0008	0.002	0.968
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.133	0.0007	0.002	0.970
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.038	0.0007	0.001	0.971
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.046	0.0007	0.001	0.973
Energy	1.B.2 Refinery processes	CH_4	0.001	0.047	0.0006	0.001	0.974
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.672	0.0006	0.001	0.975
Energy	Stationary Combustion, LPG	CO_2	0.164	0.089	0.0006	0.001	0.977
Energy	Transport, Road transport	N_2O	0.093	0.119	0.0006	0.001	0.978
LULUCF	5.A.2 Broadleaves	CO_2	0.003	0.046	0.0006	0.001	0.979
Energy	Transport, Civil aviation	CO_2	0.243	0.156	0.0006	0.001	0.980

Continued							
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.046	0.0005	0.001	0.981
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.082	0.033	0.0005	0.001	0.982
Waste	6.D Compost production	N_2O	0.011	0.043	0.0005	0.001	0.983
LULUCF	5.C Grassland, Organic soils	CO_2	0.137	0.145	0.0005	0.001	0.984
Energy	Transport, Residential	CO_2	0.039	0.063	0.0004	0.001	0.985
Energy	Transport, Road transport	CH_4	0.053	0.014	0.0004	0.001	0.986
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.051	0.0004	0.001	0.987
Energy	Stationary Combustion, Coke	CO_2	0.138	0.084	0.0004	0.001	0.988
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.028	0.0004	0.001	0.988
Energy	1.B.2 Off-shore activities	CH_4	0.015	0.037	0.0003	0.001	0.989
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.032	0.003	0.0003	0.001	0.990
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.0003	0.001	0.991
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.036	0.0003	0.001	0.991
Waste	6 B. Wastewater Handling	CH_4	0.066	0.075	0.0003	0.001	0.992
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.014	0.0003	0.001	0.992
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.315	0.0003	0.001	0.993
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.163	0.0003	0.001	0.994
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.238	0.0003	0.001	0.994
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.041	0.0003	0.001	0.995
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.031	0.0002	0.000	0.995
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.042	0.0002	0.000	0.996
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.013	0.0002	0.000	0.996
Energy	Transport, Forestry	CO_2	0.036	0.017	0.0002	0.000	0.996
Solvent and Other Prod. Use	3D1 Other - Use of N2O for Anaesthe-sia	N_2O	0.000	0.011	0.0001	0.000	0.997
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.016	0.0001	0.000	0.997
Energy	Transport, Military	CO_2	0.119	0.107	0.0001	0.000	0.997
Industrial Proc.	2G Lubricants	CO_2	0.050	0.033	0.0001	0.000	0.997
Energy	Stationary Combustion, BKB	CO_2	0.011	0.003	0.0001	0.000	0.998
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.004	0.0001	0.000	0.998
LULUCF	5.D Wetlands, Living biomass	CO_2	0.000	-0.005	0.0001	0.000	0.998
Energy	Transport, Industry (mobile)	N_2O	0.011	0.014	0.0001	0.000	0.998
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.042	0.0001	0.000	0.998
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.008	0.0001	0.000	0.998
Energy	Transport, Agriculture	N_2O	0.015	0.017	0.0001	0.000	0.999
Energy	Stationary Combustion, GAS	CH_4	0.003	0.007	0.0001	0.000	0.999
Energy	1.B.2 Land based activities	CH_4	0.017	0.018	0.0001	0.000	0.999
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.006	0.001	0.0000	0.000	0.999
Solvent and Other Prod. Use	3C Chemical products, manufactur-ing and processing	CO_2	0.019	0.012	0.0000	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.005	0.0000	0.000	0.999
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.003	0.0000	0.000	0.999
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.001	0.0000	0.000	0.999
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.010	0.0000	0.000	0.999
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.002	0.0000	0.000	0.999
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.003	0.001	0.0000	0.000	0.999
Energy	Transport, Fisheries	N_2O	0.011	0.011	0.0000	0.000	0.999
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.011	0.0000	0.000	0.999
Energy	Transport, Commercial/institutional	CH_4	0.002	0.003	0.0000	0.000	0.999
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.007	0.0000	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.002	0.0000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.003	0.0000	0.000	1.000

Continued							
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.001	0.0000	0.000	1.000
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.001	0.0000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	0.0000	0.000	1.000
Energy	Transport, Railways	CO_2	0.297	0.242	0.0000	0.000	1.000
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.001	0.0000	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.001	0.0000	0.000	1.000
LULUCF	5(II) Forest Land.	N_2O	0.016	0.012	0.0000	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.002	0.0000	0.000	1.000
LULUCF	5.C Grassland, Mineral soils	CO_2	0.001	0.000	0.0000	0.000	1.000
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.019	0.0000	0.000	1.000
Energy	Transport, Commercial/institutional	N_2O	0.000	0.001	0.0000	0.000	1.000
Energy	Transport, Residential	CH_4	0.001	0.001	0.0000	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.001	0.000	0.0000	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	0.0000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.002	0.0000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	0.0000	0.000	1.000
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.001	0.0000	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.002	0.0000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.001	0.0000	0.000	1.000
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.001	0.0000	0.000	1.000
Energy	Transport, Military	N_2O	0.001	0.001	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Residential	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.001	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	0.0000	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Civil aviation	N_2O	0.003	0.003	0.0000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	0.0000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Railways	N_2O	0.003	0.002	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	0.0000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	0.0000	0.000	1.000
Total			72.094	58.622			

Table A1-18 KCA for Denmark, level assessment base year excl. LULUCF, tier 2.

Tier 2 Analysis			DK - inventory		
IPCC Source Categories (LULUCF excluded)		GHG	Base Year Estimate	Base Year Level Assessment	Base Year Cumulative Total of Lx,o
			Ex,o	Lx,o	
			Mt CO_2 eq		
Agriculture	4.D3 Leaching	N_2O	2.501	0.159	0.159
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.480	0.158	0.317
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.748	0.111	0.429
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.161	0.074	0.503
Agriculture	4A Enteric Fermentation	CH_4	0.653	0.042	0.544
Energy	Transport, Road transport	CO_2	0.500	0.032	0.576
Agriculture	4.D3 Atmospheric deposition	N_2O	0.463	0.030	0.606
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.428	0.027	0.633
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.379	0.024	0.657
Agriculture	4.D1.4 Crop Residue	N_2O	0.368	0.023	0.680
Energy	Transport, Industry (mobile)	CO_2	0.347	0.022	0.703
Agriculture	4.B Manure Management	N_2O	0.329	0.021	0.724
Agriculture	4.D.2 Grassing animals	N_2O	0.321	0.020	0.744
Energy	Transport, Agriculture	CO_2	0.312	0.020	0.764
Agriculture	4.D1.3 N-fixing crops	N_2O	0.275	0.018	0.781
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.272	0.017	0.799
Industrial Proc.	2B2 Nitric acid production	N_2O	0.262	0.017	0.815
Energy	Stationary Combustion, Coal	CO_2	0.245	0.016	0.831
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.230	0.015	0.846
Energy	Stationary Combustion, Gas oil	CO_2	0.213	0.014	0.859
Agriculture	4B Manure Management	CH_4	0.205	0.013	0.872
Energy	Transport, Agriculture	N_2O	0.153	0.010	0.882
Energy	Transport, Navigation (large vessels)	N_2O	0.146	0.009	0.891
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.123	0.008	0.899
Energy	Transport, Fisheries	N_2O	0.115	0.007	0.906
Industrial Proc.	2F Consumption of HFC	HFC	0.111	0.007	0.914
Energy	Transport, Industry (mobile)	N_2O	0.106	0.007	0.920
Energy	Stationary Combustion, BIOMASS	CH_4	0.098	0.006	0.927
Energy	Transport, Navigation (large vessels)	CO_2	0.090	0.006	0.932
Energy	Stationary Combustion, Fosssil waste	CO_2	0.064	0.004	0.936
Waste	6 B. Wastewater Handling	CH_4	0.059	0.004	0.940
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.058	0.004	0.944
Industrial Proc.	2F Consumption of SF_6	SF_6	0.055	0.003	0.947
Energy	Stationary Combustion, Residual oil	CO_2	0.054	0.003	0.951
Energy	Stationary Combustion, Natural gas	CO_2	0.048	0.003	0.954
Energy	Transport, Road transport	N_2O	0.046	0.003	0.957
Waste	6.D Accidental fires, vehicles	CO_2	0.034	0.002	0.959
Waste	6.D Accidental fires, buildings	CO_2	0.034	0.002	0.961
Energy	Transport, Civil aviation	N_2O	0.032	0.002	0.963
Energy	Transport, Fisheries	CO_2	0.032	0.002	0.965
Energy	Stationary Combustion, Petroleum coke	CO_2	0.029	0.002	0.967
Waste	6.D Compost production	CH_4	0.029	0.002	0.969
Waste	6 B. Wastewater Handling - Direct	N_2O	0.029	0.002	0.971
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.002	0.973
Energy	Transport, Civil aviation	CO_2	0.027	0.002	0.974
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.026	0.002	0.976
Energy	Transport, Commercial/institutional	CO_2	0.026	0.002	0.978
Energy	Transport, Railways	N_2O	0.025	0.002	0.979
Energy	1.B.2 Flaring off-shore	CO_2	0.023	0.001	0.981

Continued					
Energy	Transport, Road transport	CH_4	0.021	0.001	0.982
Energy	Stationary Combustion, Kerosene	CO_2	0.021	0.001	0.983
Energy	Transport, Navigation (small boats)	CO_2	0.020	0.001	0.985
Industrial Proc.	2A1 Cement production	CO_2	0.020	0.001	0.986
Energy	Stationary Combustion, Refinery gas	CO_2	0.018	0.001	0.987
Energy	Transport, Railways	CO_2	0.016	0.001	0.988
Energy	Transport, Residential	CO_2	0.014	0.001	0.989
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.001	0.990
Solvent and Other Prod. Use	3D5 Other	CO_2	0.013	0.001	0.991
Waste	6.D Compost production	N_2O	0.012	0.001	0.991
Energy	Transport, Military	N_2O	0.011	0.001	0.992
Energy	Transport, Forestry	CO_2	0.011	0.001	0.993
Energy	Stationary Combustion, LPG	CO_2	0.009	0.001	0.993
Industrial Proc.	2A2 Lime production	CO_2	0.008	0.001	0.994
Energy	Stationary Combustion, Coke	CO_2	0.007	0.000	0.994
Energy	1.B.2 Flaring off-shore	N_2O	0.007	0.000	0.995
Energy	1.B.2 Land based activities	CH_4	0.007	0.000	0.995
Waste	6.D Accidental fires, buildings	CH_4	0.007	0.000	0.996
Energy	Transport, Military	CO_2	0.006	0.000	0.996
Energy	1.B.2 Off-shore activities	CH_4	0.004	0.000	0.996
Energy	Transport, Navigation (small boats)	N_2O	0.004	0.000	0.997
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.003	0.000	0.997
Energy	Transport, Commercial/institutional	N_2O	0.003	0.000	0.997
Energy	Stationary Combustion, GAS	CH_4	0.003	0.000	0.997
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.003	0.000	0.997
Solvent and Other Prod. Use	3A Paint application	CO_2	0.003	0.000	0.998
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.000	0.998
Industrial Proc.	2G Lubricants	CO_2	0.003	0.000	0.998
Energy	1.B.2 Flaring in refinery	CO_2	0.003	0.000	0.998
Energy	Transport, Agriculture	CH_4	0.002	0.000	0.998
Energy	Transport, Commercial/institutional	CH_4	0.002	0.000	0.998
Waste	6.D Accidental fires, vehicles	CH_4	0.002	0.000	0.999
Industrial Proc.	2C1 Iron and steel production	CO_2	0.002	0.000	0.999
Energy	Transport, Residential	N_2O	0.002	0.000	0.999
Energy	Transport, Forestry	N_2O	0.002	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.001	0.000	0.999
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	0.999
Energy	1.B.2 Flaring in refinery	N_2O	0.001	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.000	0.999
Agriculture	4F Field burning af agricultural residues	CH_4	0.001	0.000	0.999
Energy	1.B.2 Refinery processes	CH_4	0.001	0.000	0.999
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.001	0.000	0.999
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.000	1.000
Energy	1.B.2 Off-shore activities	CO_2	0.001	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.001	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.000	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.000	0.000	1.000

Continued					
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Industrial Proc.	2F Consumption of PFC	PFC	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Natural gas fuelled engines, GAS	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.000	1.000
Total			15.696	1.000	

Table A1-19 KCA for Denmark, level assessment base year incl. LULUCF, tier 2.

Tier 2 Analysis		DK - inventory			
IPCC Source Categories (LULUCF included)		GHG	Base Year Estimate	Base Year Level Assessment	Base Year Cumulative Total of Lx,o
			Ex,o	Lx,o	
			Mt CO_2 eq		
Agriculture	4.D3 Leaching	N_2O	2.501	0.124	0.124
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.480	0.123	0.246
LULUCF	5.B Cropland, Organic soils	CO_2	2.191	0.108	0.354
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.748	0.086	0.441
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.161	0.057	0.498
LULUCF	5.B Cropland, Mineral soils	CO_2	1.071	0.053	0.551
Agriculture	4A Enteric Fermentation	CH_4	0.653	0.032	0.583
Energy	Transport, Road transport	CO_2	0.500	0.025	0.608
Agriculture	4.D3 Atmospheric deposition	N_2O	0.463	0.023	0.631
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.428	0.021	0.652
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.379	0.019	0.670
LULUCF	5.A.1 Broadleaves	CO_2	0.370	0.018	0.689
Agriculture	4.D1.4 Crop Residue	N_2O	0.368	0.018	0.707
Energy	Transport, Industry (mobile)	CO_2	0.347	0.017	0.724
Agriculture	4.B Manure Management	N_2O	0.329	0.016	0.740
Agriculture	4.D.2 Grassing animals	N_2O	0.321	0.016	0.756
LULUCF	5(IV) Cropland Limestone	CO_2	0.313	0.015	0.772
Energy	Transport, Agriculture	CO_2	0.312	0.015	0.787
Agriculture	4.D1.3 N-fixing crops	N_2O	0.275	0.014	0.801
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.272	0.013	0.814
Industrial Proc.	2B2 Nitric acid production	N_2O	0.262	0.013	0.827
Energy	Stationary Combustion, Coal	CO_2	0.245	0.012	0.839
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.230	0.011	0.850
Energy	Stationary Combustion, Gas oil	CO_2	0.213	0.011	0.861
Agriculture	4B Manure Management	CH_4	0.205	0.010	0.871
LULUCF	5.C Grassland, Organic soils	CO_2	0.166	0.008	0.879
Energy	Transport, Agriculture	N_2O	0.153	0.008	0.887
Energy	Transport, Navigation (large vessels)	N_2O	0.146	0.007	0.894
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.123	0.006	0.900
Energy	Transport, Fisheries	N_2O	0.115	0.006	0.906
Industrial Proc.	2F Consumption of HFC	HFC	0.111	0.005	0.911
Energy	Transport, Industry (mobile)	N_2O	0.106	0.005	0.917
Energy	Stationary Combustion, BIOMASS	CH_4	0.098	0.005	0.921
LULUCF	5.C Grassland, Living biomass	CO_2	0.095	0.005	0.926
Energy	Transport, Navigation (large vessels)	CO_2	0.090	0.004	0.930
LULUCF	5.B Cropland, Living biomass	CO_2	0.090	0.004	0.935
LULUCF	5.D Wetlands, Soils	CO_2	0.087	0.004	0.939
LULUCF	5.A.1 Conifers	CO_2	0.071	0.004	0.943
Energy	Stationary Combustion, Fosssil waste	CO_2	0.064	0.003	0.946
Waste	6 B. Wastewater Handling	CH_4	0.059	0.003	0.949
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.058	0.003	0.952
Industrial Proc.	2F Consumption of SF_6	SF_6	0.055	0.003	0.954
Energy	Stationary Combustion, Residual oil	CO_2	0.054	0.003	0.957
LULUCF	5.E Settlements, Living biomass	CO_2	0.053	0.003	0.960
Energy	Stationary Combustion, Natural gas	CO_2	0.048	0.002	0.962
Energy	Transport, Road transport	N_2O	0.046	0.002	0.964
Waste	6.D Accidental fires, vehicles	CO_2	0.034	0.002	0.966
Waste	6.D Accidental fires, buildings	CO_2	0.034	0.002	0.968
Energy	Transport, Civil aviation	N_2O	0.032	0.002	0.969
Energy	Transport, Fisheries	CO_2	0.032	0.002	0.971

Continued					
Energy	Stationary Combustion, Petroleum coke	CO_2	0.029	0.001	0.972
Waste	6.D Compost production	CH_4	0.029	0.001	0.974
Waste	6 B. Wastewater Handling - Direct	N_2O	0.029	0.001	0.975
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.001	0.977
Energy	Transport, Civil aviation	CO_2	0.027	0.001	0.978
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.026	0.001	0.979
Energy	Transport, Commercial/institutional	CO_2	0.026	0.001	0.981
Energy	Transport, Railways	N_2O	0.025	0.001	0.982
Energy	1.B.2 Flaring off-shore	CO_2	0.023	0.001	0.983
Energy	Transport, Road transport	CH_4	0.021	0.001	0.984
Energy	Stationary Combustion, Kerosene	CO_2	0.021	0.001	0.985
Energy	Transport, Navigation (small boats)	CO_2	0.020	0.001	0.986
Industrial Proc.	2A1 Cement production	CO_2	0.020	0.001	0.987
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.019	0.001	0.988
Energy	Stationary Combustion, Refinery gas	CO_2	0.018	0.001	0.989
Energy	Transport, Railways	CO_2	0.016	0.001	0.990
Energy	Transport, Residential	CO_2	0.014	0.001	0.990
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.001	0.991
Solvent and Other Prod. Use	3D5 Other	CO_2	0.013	0.001	0.992
LULUCF	5(II) Forest Land.	N_2O	0.013	0.001	0.992
Waste	6.D Compost production	N_2O	0.012	0.001	0.993
Energy	Transport, Military	N_2O	0.011	0.001	0.993
Energy	Transport, Forestry	CO_2	0.011	0.001	0.994
Energy	Stationary Combustion, LPG	CO_2	0.009	0.000	0.994
Industrial Proc.	2A2 Lime production	CO_2	0.008	0.000	0.995
Energy	Stationary Combustion, Coke	CO_2	0.007	0.000	0.995
Energy	1.B.2 Flaring off-shore	N_2O	0.007	0.000	0.995
Energy	1.B.2 Land based activities	CH_4	0.007	0.000	0.996
Waste	6.D Accidental fires, buildings	CH_4	0.007	0.000	0.996
Energy	Transport, Military	CO_2	0.006	0.000	0.996
Energy	1.B.2 Off-shore activities	CH_4	0.004	0.000	0.997
Energy	Transport, Navigation (small boats)	N_2O	0.004	0.000	0.997
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.004	0.000	0.997
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.003	0.000	0.997
Energy	Transport, Commercial/institutional	N_2O	0.003	0.000	0.997
Energy	Stationary Combustion, GAS	CH_4	0.003	0.000	0.997
LULUCF	5.A.2 Conifers	CO_2	0.003	0.000	0.998
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.003	0.000	0.998
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.003	0.000	0.998
Solvent and Other Prod. Use	3A Paint application	CO_2	0.003	0.000	0.998
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.000	0.998
Industrial Proc.	2G Lubricants	CO_2	0.003	0.000	0.998
Energy	1.B.2 Flaring in refinery	CO_2	0.003	0.000	0.998
Energy	Transport, Agriculture	CH_4	0.002	0.000	0.999
Energy	Transport, Commercial/institutional	CH_4	0.002	0.000	0.999
Waste	6.D Accidental fires, vehicles	CH_4	0.002	0.000	0.999
Industrial Proc.	2C1 Iron and steel production	CO_2	0.002	0.000	0.999
Energy	Transport, Residential	N_2O	0.002	0.000	0.999
Energy	Transport, Forestry	N_2O	0.002	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.001	0.000	0.999
LULUCF	5.A.2 Broadleaves	CO_2	0.001	0.000	0.999
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	0.999
Energy	1.B.2 Flaring in refinery	N_2O	0.001	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.000	0.999

Continued					
Agriculture	4F Field burning af agricultural residues	CH_4	0.001	0.000	0.999
Energy	1.B.2 Refinery processes	CH_4	0.001	0.000	0.999
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.001	0.000	1.000
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.000	1.000
Energy	1.B.2 Off-shore activities	CO_2	0.001	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.001	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.000	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.000	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.000	1.000
LULUCF	5.C Grassland, Mineral soils	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.000	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Industrial Proc.	2F Consumption of PFC	PFC	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
LULUCF	5.D Wetlands, Living biomass	CO_2	0.000	0.000	1.000
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Natural gas fuelled engines, GAS	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.000	1.000
Total			20.246	1.000	

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Table A1-20 KCA for Denmark, level assessment 2010 excl. LULUCF, tier 2.

Tier 2 Analysis			DK - inventory		
IPCC Source Categories (LULUCF excluded)		GHG	Latest Year Estimate	Latest Year Level Asses-sment	Latest Year Cumulative Total of Lx,t
			Ex,t	Lx,t	
			Mt CO_2 eq		
Agriculture	4.D3 Leaching	N_2O	1.443	0.115	0.115
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.205	0.096	0.211
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	1.175	0.094	0.304
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.933	0.074	0.379
Waste	6 A. Solid Waste Disposal on Land	CH_4	0.820	0.065	0.444
Energy	Transport, Road transport	CO_2	0.652	0.052	0.496
Agriculture	4A Enteric Fermentation	CH_4	0.574	0.046	0.542
Energy	Transport, Industry (mobile)	CO_2	0.428	0.034	0.576
Industrial Proc.	2F Consumption of HFC	HFC	0.408	0.032	0.608
Agriculture	4.D1.4 Crop Residue	N_2O	0.321	0.026	0.634
Energy	Transport, Agriculture	CO_2	0.312	0.025	0.659
Agriculture	4.D3 Atmospheric deposition	N_2O	0.293	0.023	0.682
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.267	0.021	0.703
Agriculture	4B Manure Management	CH_4	0.266	0.021	0.724
Agriculture	4.D1.3 N-fixing crops	N_2O	0.243	0.019	0.744
Agriculture	4.B Manure Management	N_2O	0.231	0.018	0.762
Agriculture	4.D.2 Grassing animals	N_2O	0.204	0.016	0.778
Energy	Transport, Agriculture	N_2O	0.167	0.013	0.792
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.166	0.013	0.805
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.166	0.013	0.818
Energy	Stationary Combustion, Fosssil waste	CO_2	0.158	0.013	0.831
Energy	Stationary Combustion, Coal	CO_2	0.157	0.012	0.843
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.137	0.011	0.854
Energy	Transport, Industry (mobile)	N_2O	0.136	0.011	0.865
Energy	Stationary Combustion, BIOMASS	CH_4	0.134	0.011	0.876
Energy	Stationary Combustion, Natural gas	CO_2	0.117	0.009	0.885
Energy	Transport, Fisheries	N_2O	0.113	0.009	0.894
Energy	Transport, Navigation (large vessels)	N_2O	0.096	0.008	0.901
Waste	6.D Compost production	CH_4	0.087	0.007	0.908
Energy	Stationary Combustion, Gas oil	CO_2	0.074	0.006	0.914
Waste	6 B. Wastewater Handling	CH_4	0.068	0.005	0.920
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.063	0.005	0.925
Energy	Transport, Commercial/institutional	CO_2	0.061	0.005	0.929
Energy	Transport, Road transport	N_2O	0.060	0.005	0.934
Energy	Transport, Navigation (large vessels)	CO_2	0.060	0.005	0.939
Energy	1.B.2 Refinery processes	CH_4	0.058	0.005	0.944
Waste	6 B. Wastewater Handling - Direct	N_2O	0.054	0.004	0.948
Waste	6.D Compost production	N_2O	0.046	0.004	0.952
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.042	0.003	0.955
Energy	Transport, Navigation (small boats)	CO_2	0.041	0.003	0.958
Waste	6.D Accidental fires, vehicles	CO_2	0.036	0.003	0.961
Energy	Stationary Combustion, Petroleum coke	CO_2	0.034	0.003	0.964
Waste	6.D Accidental fires, buildings	CO_2	0.033	0.003	0.966
Energy	Transport, Fisheries	CO_2	0.031	0.002	0.969
Energy	Transport, Civil aviation	N_2O	0.026	0.002	0.971
Energy	1.B.2 Flaring off-shore	CO_2	0.026	0.002	0.973
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.023	0.002	0.975
Energy	Transport, Residential	CO_2	0.022	0.002	0.977
Energy	Transport, Railways	N_2O	0.021	0.002	0.978

Continued					
Energy	Stationary Combustion, Residual oil	CO_2	0.020	0.002	0.980
Industrial Proc.	2F Consumption of SF_6	SF_6	0.019	0.002	0.981
Energy	Stationary Combustion, Refinery gas	CO_2	0.018	0.001	0.983
Energy	Transport, Civil aviation	CO_2	0.017	0.001	0.984
Industrial Proc.	2A1 Cement production	CO_2	0.015	0.001	0.985
Energy	Transport, Railways	CO_2	0.013	0.001	0.986
Energy	Transport, Military	N_2O	0.011	0.001	0.987
Energy	1.B.2 Off-shore activities	CH_4	0.011	0.001	0.988
Energy	Transport, Navigation (small boats)	N_2O	0.011	0.001	0.989
Solvent and Other Prod. Use	3D5 Other	CO_2	0.009	0.001	0.990
Energy	Transport, Commercial/institutional	N_2O	0.008	0.001	0.990
Energy	1.B.2 Flaring off-shore	N_2O	0.008	0.001	0.991
Energy	1.B.2 Land based activities	CH_4	0.007	0.001	0.992
Waste	6.D Accidental fires, buildings	CH_4	0.007	0.001	0.992
Industrial Proc.	2F Consumption of PFC	PFC	0.007	0.001	0.993
Energy	Stationary Combustion, GAS	CH_4	0.007	0.001	0.993
Energy	Transport, Military	CO_2	0.006	0.000	0.994
Energy	Transport, Road transport	CH_4	0.005	0.000	0.994
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.000	0.995
Energy	Transport, Forestry	CO_2	0.005	0.000	0.995
Energy	Stationary Combustion, LPG	CO_2	0.005	0.000	0.995
Energy	Stationary Combustion, Coke	CO_2	0.004	0.000	0.996
Energy	Stationary Combustion, SOLID	CH_4	0.004	0.000	0.996
Energy	Transport, Commercial/institutional	CH_4	0.004	0.000	0.996
Energy	Transport, Residential	N_2O	0.003	0.000	0.997
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.003	0.000	0.997
Industrial Proc.	2A2 Lime production	CO_2	0.003	0.000	0.997
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.003	0.000	0.997
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.003	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.002	0.000	0.998
Waste	6.D Accidental fires, vehicles	CH_4	0.002	0.000	0.998
Energy	1.B.2 Flaring in refinery	CO_2	0.002	0.000	0.998
Energy	Transport, Agriculture	CH_4	0.002	0.000	0.998
Industrial Proc.	2G Lubricants	CO_2	0.002	0.000	0.998
Energy	Transport, Forestry	N_2O	0.002	0.000	0.999
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.002	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.000	0.999
Solvent and Other Prod. Use	3A Paint application	CO_2	0.001	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.001	0.000	0.999
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	0.999
Energy	Stationary Combustion, LIQUID	CH_4	0.001	0.000	0.999
Agriculture	4F Field burning of agricultural residues	CH_4	0.001	0.000	0.999
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.001	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000

Continued					
Energy	Stationary Combustion, Kerosene	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.000	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.000	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Industrial Proc.	2C1 Iron and steel production	CO_2	0.000	0.000	1.000
Industrial Proc.	2B2 Nitric acid production	N_2O	0.000	0.000	1.000
Total			12.560	1.000	

Table A1-21 KCA for Denmark, level assessment 2010 incl. LULUCF, tier 2.

Tier 2 Analysis			DK - inventory		
IPCC Source Categories (LULUCF included)		GHG	Latest Year Estimate	Latest Year Level Assessment	Latest Year Cumulative Total of Lx,t
			Ex,t	Lx,t	
			Mt CO_2 eq		
LULUCF	5.A.1 Broadleaves	CO_2	1.959	0.106	0.106
LULUCF	5.B Cropland, Organic soils	CO_2	1.580	0.085	0.191
Agriculture	4.D3 Leaching	N_2O	1.443	0.078	0.269
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.205	0.065	0.334
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	1.175	0.063	0.397
LULUCF	5.A.1 Conifers	CO_2	1.011	0.055	0.451
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.933	0.050	0.502
LULUCF	5.B Cropland, Mineral soils	CO_2	0.871	0.047	0.549
Waste	6 A. Solid Waste Disposal on Land	CH_4	0.820	0.044	0.593
Energy	Transport, Road transport	CO_2	0.652	0.035	0.628
Agriculture	4A Enteric Fermentation	CH_4	0.574	0.031	0.659
Energy	Transport, Industry (mobile)	CO_2	0.428	0.023	0.682
Industrial Proc.	2F Consumption of HFC	HFC	0.408	0.022	0.704
Agriculture	4.D1.4 Crop Residue	N_2O	0.321	0.017	0.721
Energy	Transport, Agriculture	CO_2	0.312	0.017	0.738
Agriculture	4.D3 Atmospheric deposition	N_2O	0.293	0.016	0.754
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.267	0.014	0.768
Agriculture	4B Manure Management	CH_4	0.266	0.014	0.783
Agriculture	4.D1.3 N-fixing crops	N_2O	0.243	0.013	0.796
Agriculture	4.B Manure Management	N_2O	0.231	0.012	0.808
Agriculture	4.D.2 Grassing animals	N_2O	0.204	0.011	0.819
Energy	Transport, Agriculture	N_2O	0.167	0.009	0.828
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.166	0.009	0.837
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.166	0.009	0.846
Energy	Stationary Combustion, Fosssil waste	CO_2	0.158	0.008	0.855
Energy	Stationary Combustion, Coal	CO_2	0.157	0.008	0.863
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.137	0.007	0.870
Energy	Transport, Industry (mobile)	N_2O	0.136	0.007	0.878
Energy	Stationary Combustion, BIOMASS	CH_4	0.134	0.007	0.885
LULUCF	5.C Grassland, Organic soils	CO_2	0.131	0.007	0.892
Energy	Stationary Combustion, Natural gas	CO_2	0.117	0.006	0.898
Energy	Transport, Fisheries	N_2O	0.113	0.006	0.904
Energy	Transport, Navigation (large vessels)	N_2O	0.096	0.005	0.910
LULUCF	5(IV) Cropland Limestone	CO_2	0.093	0.005	0.915
LULUCF	5.A.2 Broadleaves	CO_2	0.093	0.005	0.920
LULUCF	5.A.2 Conifers	CO_2	0.093	0.005	0.925
Waste	6.D Compost production	CH_4	0.087	0.005	0.929
Energy	Stationary Combustion, Gas oil	CO_2	0.074	0.004	0.933
LULUCF	5.E Settlements, Living biomass	CO_2	0.069	0.004	0.937
Waste	6 B. Wastewater Handling	CH_4	0.068	0.004	0.941
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.063	0.003	0.944
Energy	Transport, Commercial/institutional	CO_2	0.061	0.003	0.947
Energy	Transport, Road transport	N_2O	0.060	0.003	0.950
Energy	Transport, Navigation (large vessels)	CO_2	0.060	0.003	0.954
Energy	1.B.2 Refinery processes	CH_4	0.058	0.003	0.957
Waste	6 B. Wastewater Handling - Direct	N_2O	0.054	0.003	0.960
LULUCF	5.B Cropland, Living biomass	CO_2	0.052	0.003	0.963
Waste	6.D Compost production	N_2O	0.046	0.002	0.965
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.042	0.002	0.967

Continued					
Energy	Transport, Navigation (small boats)	CO_2	0.041	0.002	0.969
Waste	6.D Accidental fires, vehicles	CO_2	0.036	0.002	0.971
Energy	Stationary Combustion, Petroleum coke	CO_2	0.034	0.002	0.973
Waste	6.D Accidental fires, buildings	CO_2	0.033	0.002	0.975
Energy	Transport, Fisheries	CO_2	0.031	0.002	0.977
Energy	Transport, Civil aviation	N_2O	0.026	0.001	0.978
Energy	1.B.2 Flaring off-shore	CO_2	0.026	0.001	0.980
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.023	0.001	0.981
Energy	Transport, Residential	CO_2	0.022	0.001	0.982
Energy	Transport, Railways	N_2O	0.021	0.001	0.983
Energy	Stationary Combustion, Residual oil	CO_2	0.020	0.001	0.984
Industrial Proc.	2F Consumption of SF_6	SF_6	0.019	0.001	0.985
Energy	Stationary Combustion, Refinery gas	CO_2	0.018	0.001	0.986
Energy	Transport, Civil aviation	CO_2	0.017	0.001	0.987
LULUCF	5.C Grassland, Living biomass	CO_2	0.017	0.001	0.988
Industrial Proc.	2A1 Cement production	CO_2	0.015	0.001	0.989
Energy	Transport, Railways	CO_2	0.013	0.001	0.990
Energy	Transport, Military	N_2O	0.011	0.001	0.990
Energy	1.B.2 Off-shore activities	CH_4	0.011	0.001	0.991
Energy	Transport, Navigation (small boats)	N_2O	0.011	0.001	0.991
LULUCF	5(II) Forest Land.	N_2O	0.010	0.001	0.992
Solvent and Other Prod. Use	3D5 Other	CO_2	0.009	0.001	0.992
Energy	Transport, Commercial/institutional	N_2O	0.008	0.000	0.993
Energy	1.B.2 Flaring off-shore	N_2O	0.008	0.000	0.993
Energy	1.B.2 Land based activities	CH_4	0.007	0.000	0.994
Waste	6.D Accidental fires, buildings	CH_4	0.007	0.000	0.994
Industrial Proc.	2F Consumption of PFC	PFC	0.007	0.000	0.994
Energy	Stationary Combustion, GAS	CH_4	0.007	0.000	0.995
Energy	Transport, Military	CO_2	0.006	0.000	0.995
Energy	Transport, Road transport	CH_4	0.005	0.000	0.995
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.000	0.996
Energy	Transport, Forestry	CO_2	0.005	0.000	0.996
LULUCF	5.D Wetlands, Soils	CO_2	0.005	0.000	0.996
Energy	Stationary Combustion, LPG	CO_2	0.005	0.000	0.996
Energy	Stationary Combustion, Coke	CO_2	0.004	0.000	0.997
Energy	Stationary Combustion, SOLID	CH_4	0.004	0.000	0.997
LULUCF	5.C Grassland, Mineral soils	CO_2	0.004	0.000	0.997
Energy	Transport, Commercial/institutional	CH_4	0.004	0.000	0.997
Energy	Transport, Residential	N_2O	0.003	0.000	0.997
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.003	0.000	0.998
Industrial Proc.	2A2 Lime production	CO_2	0.003	0.000	0.998
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.003	0.000	0.998
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.003	0.000	0.998
LULUCF	5.D Wetlands, Living biomass	CO_2	0.003	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.002	0.000	0.998
Waste	6.D Accidental fires, vehicles	CH_4	0.002	0.000	0.999
Energy	1.B.2 Flaring in refinery	CO_2	0.002	0.000	0.999
Energy	Transport, Agriculture	CH_4	0.002	0.000	0.999
Industrial Proc.	2G Lubricants	CO_2	0.002	0.000	0.999
Energy	Transport, Forestry	N_2O	0.002	0.000	0.999
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.002	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.000	0.999
Solvent and Other Prod. Use	3A Paint application	CO_2	0.001	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.001	0.000	0.999

Continued					
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.000	0.999
Energy	Stationary Combustion, LIQUID	CH_4	0.001	0.000	0.999
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.001	0.000	0.999
Agriculture	4F Field burning af agricultural residues	CH_4	0.001	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CH_4	0.001	0.000	1.000
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.001	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.001	0.000	1.000
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.001	0.000	1.000
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.001	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.001	0.000	1.000
Energy	1.B.2 Flaring in refinery	N_2O	0.001	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.000	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.000	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	1.000
Energy	Stationary Combustion, Kerosene	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	1.000
Energy	Stationary Combustion, BKB	CO_2	0.000	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	1.000
Industrial Proc.	2C1 Iron and steel production	CO_2	0.000	0.000	1.000
Industrial Proc.	2B2 Nitric acid production	N_2O	0.000	0.000	1.000
Total			18.553	1.000	

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Table A1-22 KCA for Denmark, trend assessment 1990-2010 excl. LULUCF, tier 2.

Tier 2 Analysis		DK - inventory					
IPCC Source Categories (LU-LUCF excluded)		GHG	Base Year Estimate	Latest Year Estimate	Trend Assessment	Contribution to Trend	Cumulative
			Ex,o	Ex,t	Tx,t		
			Mt CO_2 eq	Mt CO_2 eq			
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	1.139	1.4862	0.165	0.165
Agriculture	4.D3 Leaching	N_2O	2.452	1.415	1.1229	0.125	0.290
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.477	0.693	1.0593	0.118	0.407
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.093	0.8667	0.096	0.504
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.800	0.4495	0.050	0.554
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.014	0.3520	0.039	0.593
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.000	0.3366	0.037	0.630
Energy	Transport, Road transport	CO_2	9.282	12.108	0.3033	0.034	0.664
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	1.154	0.2558	0.028	0.692
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.036	0.2301	0.026	0.718
Energy	Transport, Industry (mobile)	CO_2	0.839	1.037	0.1755	0.019	0.737
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.288	0.1707	0.019	0.756
Energy	Stationary Combustion, Gas oil	CO_2	4.547	1.577	0.1670	0.019	0.775
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	1.410	0.1463	0.016	0.791
Agriculture	4B Manure Management	CH_4	0.993	1.288	0.1219	0.014	0.805
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.197	0.1172	0.013	0.818
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.042	0.1093	0.012	0.830
Energy	Stationary Combustion, Natural gas	CO_2	4.335	10.607	0.1080	0.012	0.842
Waste	6.D Compost production	CH_4	0.027	0.080	0.0888	0.010	0.852
Energy	Stationary Combustion, Coal	CO_2	23.834	15.224	0.0882	0.010	0.861
Agriculture	4.B Manure Management	N_2O	0.600	0.421	0.0878	0.010	0.871
Energy	1.B.2 Refinery processes	CH_4	0.001	0.047	0.0833	0.009	0.880
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.133	0.0686	0.008	0.888
Energy	Transport, Industry (mobile)	N_2O	0.011	0.014	0.0613	0.007	0.895
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.016	0.0572	0.006	0.901
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.163	0.0553	0.006	0.907
Energy	Transport, Commercial/institutional	CO_2	0.074	0.173	0.0552	0.006	0.914
Energy	Transport, Agriculture	CO_2	1.272	1.273	0.0516	0.006	0.919
Waste	6.D Compost production	N_2O	0.011	0.043	0.0511	0.006	0.925
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.010	0.0480	0.005	0.930
Energy	Transport, Agriculture	N_2O	0.015	0.017	0.0460	0.005	0.935
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.038	0.0424	0.005	0.940
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.880	0.0414	0.005	0.945
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.082	0.033	0.0414	0.005	0.949
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.051	0.0412	0.005	0.954
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.099	0.0341	0.004	0.958
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.494	0.0297	0.003	0.961
Energy	Transport, Road transport	N_2O	0.093	0.119	0.0271	0.003	0.964
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.004	0.0265	0.003	0.967
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.041	0.0246	0.003	0.970
Waste	6 B. Wastewater Handling	CH_4	0.066	0.075	0.0217	0.002	0.972
Energy	Transport, Road transport	CH_4	0.053	0.014	0.0194	0.002	0.974
Energy	Transport, Fisheries	N_2O	0.011	0.011	0.0157	0.002	0.976
Energy	Transport, Residential	CO_2	0.039	0.063	0.0144	0.002	0.978
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.477	0.0117	0.001	0.979
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.001	0.0107	0.001	0.980
Energy	1.B.2 Off-shore activities	CH_4	0.015	0.037	0.0106	0.001	0.981
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.004	0.0102	0.001	0.982

Continued							
Energy	Transport, Civil aviation	CO_2	0.243	0.156	0.0097	0.001	0.983
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.013	0.0095	0.001	0.984
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.315	0.0081	0.001	0.985
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.333	0.0076	0.001	0.986
Energy	Transport, Commercial/institutional	N_2O	0.000	0.001	0.0076	0.001	0.987
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.234	0.0075	0.001	0.988
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.007	0.0073	0.001	0.989
Energy	Transport, Forestry	CO_2	0.036	0.017	0.0065	0.001	0.989
Agriculture	4A Enteric Fermentation	CH_4	3.247	2.856	0.0064	0.001	0.990
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.046	0.0058	0.001	0.991
Energy	Stationary Combustion, GAS	CH_4	0.003	0.007	0.0057	0.001	0.991
Energy	Stationary Combustion, LPG	CO_2	0.164	0.089	0.0045	0.000	0.992
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.011	0.0043	0.000	0.992
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.028	0.0041	0.000	0.993
Energy	Transport, Fisheries	CO_2	0.591	0.575	0.0040	0.000	0.993
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.003	0.0037	0.000	0.994
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.672	0.0036	0.000	0.994
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.046	0.0034	0.000	0.994
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.817	0.0030	0.000	0.995
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.042	0.0030	0.000	0.995
Energy	Stationary Combustion, Coke	CO_2	0.138	0.084	0.0029	0.000	0.995
Energy	Transport, Civil aviation	N_2O	0.003	0.003	0.0029	0.000	0.996
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.0026	0.000	0.996
Energy	Transport, Railways	N_2O	0.003	0.002	0.0026	0.000	0.996
Energy	Transport, Residential	N_2O	0.000	0.000	0.0024	0.000	0.997
Energy	Transport, Commercial/institutional	CH_4	0.002	0.003	0.0023	0.000	0.997
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.001	0.0023	0.000	0.997
Energy	Transport, Military	N_2O	0.001	0.001	0.0017	0.000	0.997
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.001	0.0017	0.000	0.998
Energy	Transport, Railways	CO_2	0.297	0.242	0.0016	0.000	0.998
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.008	0.0016	0.000	0.998
Energy	1.B.2 Land based activities	CH_4	0.017	0.018	0.0014	0.000	0.998
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.031	0.0014	0.000	0.998
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.238	0.0012	0.000	0.998
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.001	0.0012	0.000	0.998
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.019	0.012	0.0012	0.000	0.999
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.011	0.0011	0.000	0.999
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.005	0.0011	0.000	0.999
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.001	0.0010	0.000	0.999
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	0.0009	0.000	0.999
Industrial Proc.	2G Lubricants	CO_2	0.050	0.033	0.0009	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.003	0.0007	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.001	0.0006	0.000	0.999
Energy	Stationary Combustion, BKB	CO_2	0.011	0.003	0.0006	0.000	0.999
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.001	0.0006	0.000	0.999
Energy	Transport, Industry (mobile)	CH_4	0.001	0.001	0.0005	0.000	0.999
Energy	Transport, Forestry	CH_4	0.000	0.000	0.0005	0.000	1.000
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	0.0004	0.000	1.000
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.002	0.0004	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.001	0.0003	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	0.0003	0.000	1.000

Continued							
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	0.0003	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.001	0.0003	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.002	0.0002	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.001	0.0002	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	0.0002	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	0.0002	0.000	1.000
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.019	0.0002	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.001	0.0001	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.002	0.0001	0.000	1.000
Energy	Transport, Military	CO_2	0.119	0.107	0.0001	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.002	0.0001	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	0.0001	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.002	0.0001	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	0.0000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	0.0000	0.000	1.000
Total			68.885	61.066			

Table A1-23 KCA for Denmark, trend assessment 1990-2010 incl. LULUCF, tier 2.

Tier 2 Analysis		DK	- inventory				
IPCC Source Categories (LU-LUCF included)		GHG	Base Year Estimate	Latest Year Estimate	Trend Assessment	Contribution to Trend	Cumulative
			Ex,o	Ex,t	Tx,t		
			Mt CO_2 eq	Mt CO_2 eq			
LULUCF	5.A.1 Broadleaves	CO_2	-0.708	-3.752	2.0221	0.169	0.169
LULUCF	5.A.1 Conifers	CO_2	-0.136	-1.937	1.2347	0.103	0.272
Agriculture	4.D1.1 Syntehetic Fertilizer	N_2O	2.405	1.139	1.0903	0.091	0.363
Energy	Stationary Combustion, BIOMASS, N_2O	N_2O	0.038	0.093	0.8381	0.070	0.433
Waste	6 A. Solid Waste Disposal on Land	CH_4	1.477	0.693	0.7793	0.065	0.498
Agriculture	4.D3 Leaching	N_2O	2.452	1.415	0.7543	0.063	0.561
Industrial Proc.	2F Consumption of HFC	HFC	0.218	0.800	0.4252	0.036	0.597
Agriculture	4.D1.2 Animal waste applied to soils	N_2O	1.112	1.154	0.3636	0.030	0.627
Energy	Transport, Road transport	CO_2	9.282	12.108	0.3340	0.028	0.655
Industrial Proc.	2B2 Nitric acid production	N_2O	1.043	0.000	0.2802	0.023	0.679
Energy	Stationary Combustion, LIQUID, N_2O	N_2O	0.043	0.014	0.2758	0.023	0.702
LULUCF	5.B Cropland, Organic soils	CO_2	2.420	1.745	0.2401	0.020	0.722
Energy	Stationary Combustion, GAS, N_2O	N_2O	0.016	0.036	0.2250	0.019	0.740
LULUCF	5(IV) Cropland Limestone	CO_2	0.623	0.185	0.2112	0.018	0.758
Energy	Transport, Industry (mobile)	CO_2	0.839	1.037	0.1996	0.017	0.775
Energy	Stationary Combustion, Fosssil waste	CO_2	0.573	1.410	0.1415	0.012	0.787
Agriculture	4B Manure Management	CH_4	0.993	1.288	0.1347	0.011	0.798
Energy	Stationary Combustion, Gas oil	CO_2	4.547	1.577	0.1297	0.011	0.809
LULUCF	5.A.2 Conifers	CO_2	0.006	-0.177	0.1268	0.011	0.819
LULUCF	5.A.2 Broadleaves	CO_2	0.003	0.178	0.1223	0.010	0.830
Agriculture	4.D3 Atmospheric deposition	N_2O	0.455	0.288	0.1055	0.009	0.838
Energy	Stationary Combustion, Natural gas	CO_2	4.335	10.607	0.1045	0.009	0.847
LULUCF	5.D Wetlands, Soils	CO_2	0.086	0.005	0.0859	0.007	0.854
Waste	6.D Compost production	CH_4	0.027	0.080	0.0847	0.007	0.861
Energy	Transport, Agriculture	CO_2	1.272	1.273	0.0819	0.007	0.868
LULUCF	5.C Grassland, Living biomass	CO_2	0.186	0.034	0.0788	0.007	0.875
Energy	1.B.2 Refinery processes	CH_4	0.001	0.047	0.0766	0.006	0.881
Energy	Stationary Combustion, BIOMASS	CH_4	0.097	0.133	0.0738	0.006	0.887
Agriculture	4.D.2 Grassing animals	N_2O	0.311	0.197	0.0721	0.006	0.893
Energy	Stationary Combustion, SOLID, N_2O	N_2O	0.068	0.042	0.0702	0.006	0.899
Energy	Transport, Industry (mobile)	N_2O	0.011	0.014	0.0681	0.006	0.905
Agriculture	4A Enteric Fermentation	CH_4	3.247	2.856	0.0664	0.006	0.910
Energy	Transport, Agriculture	N_2O	0.015	0.017	0.0592	0.005	0.915
Energy	Stationary Combustion, WASTE, N_2O	N_2O	0.007	0.016	0.0555	0.005	0.920
Energy	Stationary Combustion, Coal	CO_2	23.834	15.224	0.0539	0.005	0.925
Energy	Transport, Commercial/institutional	CO_2	0.074	0.173	0.0536	0.004	0.929
Waste	6.D Compost production	N_2O	0.011	0.043	0.0483	0.004	0.933
Agriculture	4.B Manure Management	N_2O	0.600	0.421	0.0443	0.004	0.937
Waste	6 B. Wastewater Handling - Direct	N_2O	0.027	0.051	0.0410	0.003	0.940
LULUCF	5.E Settlements, Living biomass	CO_2	0.104	0.134	0.0343	0.003	0.943
Energy	Transport, Navigation (small boats)	CO_2	0.048	0.099	0.0335	0.003	0.946
Agriculture	4.D1.4 Crop Residue	N_2O	0.361	0.315	0.0334	0.003	0.949
Industrial Proc.	2F Consumption of SF_6	SF_6	0.107	0.038	0.0329	0.003	0.951
Energy	Stationary Combustion, Residual oil	CO_2	2.440	0.880	0.0320	0.003	0.954
Waste	6 B. Wastewater Handling - Indirect	N_2O	0.082	0.033	0.0316	0.003	0.957
Energy	Transport, Road transport	N_2O	0.093	0.119	0.0300	0.003	0.959
Agriculture	4.D1.3 N-fixing crops	N_2O	0.269	0.238	0.0293	0.002	0.962

Continued							
Energy	Transport, Navigation (large vessels)	N_2O	0.015	0.010	0.0279	0.002	0.964
LULUCF	5.B Cropland, Living biomass	CO_2	0.177	0.102	0.0274	0.002	0.966
Energy	Transport, Fisheries	N_2O	0.011	0.011	0.0272	0.002	0.969
Waste	6 B. Wastewater Handling	CH_4	0.066	0.075	0.0265	0.002	0.971
Agriculture	4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	0.028	0.041	0.0258	0.002	0.973
Agriculture	4.D1.5 Cultivation of histosols	N_2O	0.226	0.163	0.0252	0.002	0.975
Energy	Stationary Combustion, Kerosene	CO_2	0.366	0.004	0.0221	0.002	0.977
LULUCF	5.C Grassland, Dead organic matter	CO_2	0.037	0.002	0.0184	0.002	0.978
Energy	Transport, Navigation (large vessels)	CO_2	0.748	0.494	0.0172	0.001	0.980
Energy	Transport, Road transport	CH_4	0.053	0.014	0.0155	0.001	0.981
Energy	Transport, Residential	CO_2	0.039	0.063	0.0148	0.001	0.982
LULUCF	5.B Cropland, Mineral soils	CO_2	1.415	1.152	0.0147	0.001	0.984
Energy	Stationary Combustion, Petroleum coke	CO_2	0.410	0.477	0.0139	0.001	0.985
Waste	6.D Accidental fires, vehicles	CO_2	0.007	0.007	0.0105	0.001	0.986
Energy	Transport, Navigation (small boats)	N_2O	0.000	0.001	0.0102	0.001	0.987
Energy	1.B.2 Off-shore activities	CH_4	0.015	0.037	0.0102	0.001	0.987
Energy	1.B.2 Flaring off-shore	CO_2	0.300	0.333	0.0096	0.001	0.988
Industrial Proc.	2F Consumption of PFC	PFC	0.001	0.013	0.0087	0.001	0.989
Energy	Stationary Combustion, SOLID	CH_4	0.013	0.004	0.0080	0.001	0.990
Waste	6.D Accidental fires, buildings	CO_2	0.011	0.011	0.0077	0.001	0.990
Energy	Transport, Commercial/institutional	N_2O	0.000	0.001	0.0073	0.001	0.991
Energy	Transport, Fisheries	CO_2	0.591	0.575	0.0072	0.001	0.991
Energy	Natural gas fuelled engines, GAS	CH_4	0.005	0.234	0.0069	0.001	0.992
Energy	Transport, Civil aviation	CO_2	0.243	0.156	0.0059	0.000	0.992
Energy	Stationary Combustion, GAS	CH_4	0.003	0.007	0.0056	0.000	0.993
Energy	Stationary Combustion, Refinery gas	CO_2	0.816	0.817	0.0048	0.000	0.993
Energy	Transport, Forestry	CO_2	0.036	0.017	0.0047	0.000	0.994
LULUCF	5.C Grassland, Mineral soils	CO_2	0.000	0.005	0.0047	0.000	0.994
Industrial Proc.	2A2 Lime production	CO_2	0.116	0.046	0.0044	0.000	0.995
LULUCF	5.D Wetlands, Living biomass	CO_2	0.000	-0.005	0.0039	0.000	0.995
Energy	Biogas fuelled engines, BIOMASS	CH_4	0.001	0.028	0.0038	0.000	0.995
Solvent and Other Prod. Use	3D3 Consumption of fireworks	N_2O	0.001	0.003	0.0035	0.000	0.995
Industrial Proc.	2A3 Limestone and dolomite use	CO_2	0.014	0.046	0.0033	0.000	0.996
Energy	Stationary Combustion, LPG	CO_2	0.164	0.089	0.0031	0.000	0.996
LULUCF	5.B Cropland, Dead organic matter	CO_2	0.007	0.001	0.0030	0.000	0.996
Energy	1.B.2 Flaring off-shore	N_2O	0.001	0.001	0.0029	0.000	0.996
Energy	Transport, Military	N_2O	0.001	0.001	0.0029	0.000	0.997
LULUCF	5.C Grassland, Organic soils	CO_2	0.183	0.145	0.0025	0.000	0.997
Energy	Transport, Residential	N_2O	0.000	0.000	0.0024	0.000	0.997
Energy	Transport, Commercial/institutional	CH_4	0.002	0.003	0.0024	0.000	0.997
LULUCF	5(III) Disturbance, Land converted to cropland	N_2O	0.003	0.001	0.0024	0.000	0.998
Industrial Proc.	2C1 Iron and steel production	CO_2	0.028	0.000	0.0022	0.000	0.998
Energy	1.B.2 Land based activities	CH_4	0.017	0.018	0.0021	0.000	0.998
Energy	Stationary Combustion, Coke	CO_2	0.138	0.084	0.0019	0.000	0.998
Waste	6.D Accidental fires, buildings	CH_4	0.001	0.001	0.0018	0.000	0.998
Solvent and Other Prod. Use	3D5 Other	CO_2	0.057	0.042	0.0013	0.000	0.998
Energy	Stationary Combustion, LIQUID	CH_4	0.003	0.001	0.0013	0.000	0.998
Solvent and Other Prod. Use	3A Paint application	CO_2	0.016	0.008	0.0011	0.000	0.998
Industrial Proc.	2A1 Cement production	CO_2	0.882	0.672	0.0011	0.000	0.999

Continued							
Energy	1.B.2 Off-shore activities	CO_2	0.002	0.005	0.0011	0.000	0.999
Solvent and Other Prod. Use	3D1 Other - Use of N_2O for Anaesthesia	N_2O	0.000	0.011	0.0010	0.000	0.999
Energy	Stationary Combustion, WASTE	CH_4	0.001	0.001	0.0010	0.000	0.999
Industrial Proc.	2A7 Glass and Glass wool	CO_2	0.055	0.031	0.0010	0.000	0.999
Energy	Transport, Civil aviation	N_2O	0.003	0.003	0.0009	0.000	0.999
Energy	Transport, Military	CO_2	0.119	0.107	0.0008	0.000	0.999
Energy	Transport, Residential	CH_4	0.001	0.001	0.0007	0.000	0.999
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing	CO_2	0.019	0.012	0.0007	0.000	0.999
Energy	1.B.2 Flaring in refinery	N_2O	0.000	0.000	0.0007	0.000	0.999
Waste	6.D Accidental fires, vehicles	CH_4	0.000	0.000	0.0006	0.000	0.999
LULUCF	5(II) Forest Land.	N_2O	0.016	0.012	0.0006	0.000	0.999
Industrial Proc.	2G Lubricants	CO_2	0.050	0.033	0.0005	0.000	0.999
Energy	Stationary Combustion, BKB	CO_2	0.011	0.003	0.0005	0.000	0.999
Energy	1.B.2 Distribution of natural gas	CH_4	0.005	0.003	0.0005	0.000	0.999
Agriculture	4F Field burning af agricultural residues	CH_4	0.002	0.002	0.0005	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CH_4	0.004	0.001	0.0005	0.000	1.000
Energy	Transport, Railways	N_2O	0.003	0.002	0.0004	0.000	1.000
Energy	Transport, Forestry	CH_4	0.000	0.000	0.0004	0.000	1.000
Energy	Transport, Forestry	N_2O	0.000	0.000	0.0004	0.000	1.000
Energy	Transport, Agriculture	CH_4	0.002	0.002	0.0003	0.000	1.000
LULUCF	5(V) Biomass Burning	CH_4	0.001	0.000	0.0003	0.000	1.000
Energy	Transport, Navigation (small boats)	CH_4	0.000	0.001	0.0003	0.000	1.000
Energy	Transport, Industry (mobile)	CH_4	0.001	0.001	0.0003	0.000	1.000
Energy	Transport, Railways	CO_2	0.297	0.242	0.0003	0.000	1.000
LULUCF	5(V) Biomass Burning	N_2O	0.000	0.000	0.0003	0.000	1.000
Energy	1.B.2. Flaring off-shore	CH_4	0.000	0.001	0.0003	0.000	1.000
Solvent and Other Prod. Use	3D5 Consumption of fireworks	CO_2	0.000	0.000	0.0003	0.000	1.000
Energy	1.B.2 Venting in gas storage	CH_4	0.000	0.001	0.0002	0.000	1.000
Energy	1.B.2. Flaring in refinery	CH_4	0.001	0.000	0.0002	0.000	1.000
Waste	6.C Incineration of carcasses	N_2O	0.000	0.000	0.0002	0.000	1.000
Industrial Proc.	2D2 Food and Drink	CO_2	0.004	0.002	0.0002	0.000	1.000
Agriculture	4.F Field Burning of Agricultural Residues	N_2O	0.001	0.001	0.0002	0.000	1.000
Industrial Proc.	2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	0.001	0.002	0.0001	0.000	1.000
Energy	1.B.2 Flaring in refinery	CO_2	0.023	0.019	0.0001	0.000	1.000
Industrial Proc.	2A6 Road paving with asphalt	CO_2	0.002	0.002	0.0001	0.000	1.000
Energy	Transport, Fisheries	CH_4	0.000	0.000	0.0001	0.000	1.000
Waste	6.C Incineration of corpses	N_2O	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Railways	CH_4	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Civil aviation	CH_4	0.000	0.000	0.0001	0.000	1.000
Energy	Transport, Navigation (large vessels)	CH_4	0.000	0.000	0.0000	0.000	1.000
LULUCF	5(II) Wetlands	N_2O	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of charcoal for BBQ	N_2O	0.000	0.000	0.0000	0.000	1.000
Energy	Transport, Military	CH_4	0.000	0.000	0.0000	0.000	1.000
LULUCF	5.D Wetlands, Dead organic matter	CO_2	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of carcasses	CH_4	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3D3 Use of tobacco	N_2O	0.000	0.000	0.0000	0.000	1.000
Waste	6.C Incineration of corpses	CH_4	0.000	0.000	0.0000	0.000	1.000

Continued							
Energy	1.B.2 Land based activities	CO_2	0.000	0.000	0.0000	0.000	1.000
Industrial Proc.	2A5 Asphalt roofing	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Distribution of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Venting in gas storage	CO_2	0.000	0.000	0.0000	0.000	1.000
Energy	1.B.2 Transmission of natural gas	CO_2	0.000	0.000	0.0000	0.000	1.000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning	CO_2	0.000	0.000	0.0000	0.000	1.000
Total			73.309	58.895			

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Annex 2 - Detailed discussion of methodology and data for estimation of CO_2 emission from fossil fuel combustion

Please refer to Annex 3A and 3B.

Annex 3 - Other detailed methodological descriptions for individual source or sink categories (where relevant)

Annex 3A - Stationary combustion

Annex 3A-1 Correspondence list between SNAP and CRF source categories

Table 3A-1.1 Correspondence list between SNAP and CRF source categories for stationary combustion.

SNAP_id	SNAP	CRF_id	CRF_name
010100	Public power	1A1a	Electricity and heat production
010101	Combustion plants >= 300 MW (boilers)	1A1a	Electricity and heat production
010102	Combustion plants >= 50 and < 300 MW (boilers)	1A1a	Electricity and heat production
010103	Combustion plants < 50 MW (boilers)	1A1a	Electricity and heat production
010104	Gas turbines	1A1a	Electricity and heat production
010105	Stationary engines	1A1a	Electricity and heat production
010200	District heating plants	1A1a	Electricity and heat production
010201	Combustion plants >= 300 MW (boilers)	1A1a	Electricity and heat production
010202	Combustion plants >= 50 and < 300 MW (boilers)	1A1a	Electricity and heat production
010203	Combustion plants < 50 MW (boilers)	1A1a	Electricity and heat production
010204	Gas turbines	1A1a	Electricity and heat production
010205	Stationary engines	1A1a	Electricity and heat production
010300	Petroleum refining plants	1A1b	Petroleum refining
010301	Combustion plants >= 300 MW (boilers)	1A1b	Petroleum refining
010302	Combustion plants >= 50 and < 300 MW (boilers)	1A1b	Petroleum refining
010303	Combustion plants < 50 MW (boilers)	1A1b	Petroleum refining
010304	Gas turbines	1A1b	Petroleum refining
010305	Stationary engines	1A1b	Petroleum refining
010306	Process furnaces	1A1b	Petroleum refining
010400	Solid fuel transformation plants	1A1c	Manufacture of solid fuels and other energy industries
010401	Combustion plants >= 300 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010402	Combustion plants >= 50 and < 300 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010403	Combustion plants < 50 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010404	Gas turbines	1A1c	Manufacture of solid fuels and other energy industries
010405	Stationary engines	1A1c	Manufacture of solid fuels and other energy industries
010406	Coke oven furnaces	1A1c	Manufacture of solid fuels and other energy industries
010407	Other (coal gasification, liquefaction, ...)	1A1c	Manufacture of solid fuels and other energy industries
010500	Coal mining, oil/gas extraction, pipeline compressors	1A1c	Manufacture of solid fuels and other energy industries
010501	Combustion plants >= 300 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010502	Combustion plants >= 50 and < 300 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010503	Combustion plants < 50 MW (boilers)	1A1c	Manufacture of solid fuels and other energy industries
010504	Gas turbines	1A1c	Manufacture of solid fuels and other energy industries
010505	Stationary engines	1A1c	Manufacture of solid fuels and other energy industries
020100	Commercial and institutional plants (t)	1A4a i	Commercial/Institutional plants
020101	Combustion plants >= 300 MW (boilers)	1A4a i	Commercial/Institutional plants
020102	Combustion plants >= 50 and < 300 MW (boilers)	1A4a i	Commercial/Institutional plants
020103	Combustion plants < 50 MW (boilers)	1A4a i	Commercial/Institutional plants
020104	Stationary gas turbines	1A4a i	Commercial/Institutional plants
020105	Stationary engines	1A4a i	Commercial/Institutional plants
020106	Other stationary equipments (n)	1A4a i	Commercial/Institutional plants
020200	Residential plants	1A4b i	Residential plants
020201	Combustion plants >= 50 MW (boilers)	1A4b i	Residential plants
020202	Combustion plants < 50 MW (boilers)	1A4b i	Residential plants
020203	Gas turbines	1A4b i	Residential plants
020204	Stationary engines	1A4b i	Residential plants
020205	Other equipments (stoves, fireplaces, cooking,...) [1)]	1A4b i	Residential plants
020300	Plants in agriculture, forestry and aquaculture	1A4c i	Agriculture/Forestry/Fishing, Stationary
020301	Combustion plants >= 50 MW (boilers)	1A4c i	Agriculture/Forestry/Fishing, Stationary
020302	Combustion plants < 50 MW (boilers)	1A4c i	Agriculture/Forestry/Fishing, Stationary
020303	Stationary gas turbines	1A4c i	Agriculture/Forestry/Fishing, Stationary
020304	Stationary engines	1A4c i	Agriculture/Forestry/Fishing, Stationary
020305	Other stationary equipments (n)	1A4c i	Agriculture/Forestry/Fishing, Stationary
030100	Comb. in boilers, gas turbines and stationary	1A2f i	Industry-Other
030101	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
030102	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
030103	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
030104	Gas turbines	1A2f i	Industry-Other
030105	Stationary engines	1A2f i	Industry-Other
030106	Other stationary equipments (n)	1A2f i	Industry-Other

Continued			
030200	Process furnaces without contact	1A2f i	Industry-Other
030203	Blast furnace cowpers	1A2a	Industry-Iron and steel
030204	Plaster furnaces	1A2f i	Industry-Other
030205	Other furnaces	1A2f i	Industry-Other
030400	Iron and steel	1A2a	Iron and steel
030401	Combustion plants >= 300 MW (boilers)	1A2a	Iron and steel
030402	Combustion plants >= 50 and < 300 MW (boilers)	1A2a	Iron and steel
030403	Combustion plants < 50 MW (boilers)	1A2a	Iron and steel
030404	Gas turbines	1A2a	Iron and steel
030405	Stationary engines	1A2a	Iron and steel
030406	Other stationary equipments (n)	1A2a	Iron and steel
030500	Non-ferrous metals	1A2b	Non-ferrous metals
030501	Combustion plants >= 300 MW (boilers)	1A2b	Non-ferrous metals
030502	Combustion plants >= 50 and < 300 MW (boilers)	1A2b	Non-ferrous metals
030503	Combustion plants < 50 MW (boilers)	1A2b	Non-ferrous metals
030504	Gas turbines	1A2b	Non-ferrous metals
030505	Stationary engines	1A2b	Non-ferrous metals
030506	Other stationary equipments (n)	1A2b	Non-ferrous metals
030600	Chemical and petrochemical	1A2c	Chemicals
030601	Combustion plants >= 300 MW (boilers)	1A2c	Chemicals
030602	Combustion plants >= 50 and < 300 MW (boilers)	1A2c	Chemicals
030603	Combustion plants < 50 MW (boilers)	1A2c	Chemicals
030604	Gas turbines	1A2c	Chemicals
030605	Stationary engines	1A2c	Chemicals
030606	Other stationary equipments (n)	1A2c	Chemicals
030700	Non-metallic minerals	1A2f i	Industry-Other
030701	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
030702	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
030703	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
030704	Gas turbines	1A2f i	Industry-Other
030705	Stationary engines	1A2f i	Industry-Other
030706	Other stationary equipments (n)	1A2f i	Industry-Other
030800	Mining and Quarrying	1A2f i	Industry-Other
030801	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
030802	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
030803	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
030804	Gas turbines	1A2f i	Industry-Other
030805	Stationary engines	1A2f i	Industry-Other
030806	Other stationary equipments (n)	1A2f i	Industry-Other
030900	Food and tobacco	1A2e	Food processing, beverages and tobacco
030901	Combustion plants >= 300 MW (boilers)	1A2e	Food processing, beverages and tobacco
030902	Combustion plants >= 50 and < 300 MW (boilers)	1A2e	Food processing, beverages and tobacco
030903	Combustion plants < 50 MW (boilers)	1A2e	Food processing, beverages and tobacco
030904	Gas turbines	1A2e	Food processing, beverages and tobacco
030905	Stationary engines	1A2e	Food processing, beverages and tobacco
030906	Other stationary equipments (n)	1A2e	Food processing, beverages and tobacco
031000	Textile and leather	1A2f i	Industry-Other
031001	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
031002	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031003	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031004	Gas turbines	1A2f i	Industry-Other
031005	Stationary engines	1A2f i	Industry-Other
031006	Other stationary equipments (n)	1A2f i	Industry-Other
031100	Paper, pulp and print	1A2d	Pulp, Paper and Print
031101	Combustion plants >= 300 MW (boilers)	1A2d	Pulp, Paper and Print
031102	Combustion plants >= 50 and < 300 MW (boilers)	1A2d	Pulp, Paper and Print
031103	Combustion plants < 50 MW (boilers)	1A2d	Pulp, Paper and Print
031104	Gas turbines	1A2d	Pulp, Paper and Print
031105	Stationary engines	1A2d	Pulp, Paper and Print
031106	Other stationary equipments (n)	1A2d	Pulp, Paper and Print
031200	Transport equipment	1A2f i	Industry-Other
031201	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other

Continued			
031202	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031203	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031204	Gas turbines	1A2f i	Industry-Other
031205	Stationary engines	1A2f i	Industry-Other
031206	Other stationary equipments (n)	1A2f i	Industry-Other
031300	Machinery	1A2f i	Industry-Other
031301	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
031302	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031303	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031304	Gas turbines	1A2f i	Industry-Other
031305	Stationary engines	1A2f i	Industry-Other
031306	Other stationary equipments (n)	1A2f i	Industry-Other
031400	Wood and wood products	1A2f i	Industry-Other
031401	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
031402	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031403	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031404	Gas turbines	1A2f i	Industry-Other
031405	Stationary engines	1A2f i	Industry-Other
031406	Other stationary equipments (n)	1A2f i	Industry-Other
031500	Construction	1A2f i	Industry-Other
031501	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
031502	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031503	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031504	Gas turbines	1A2f i	Industry-Other
031505	Stationary engines	1A2f i	Industry-Other
031506	Other stationary equipments (n)	1A2f i	Industry-Other
031600	Cement production	1A2f i	Industry-Other
031601	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
031602	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
031603	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
031604	Gas turbines	1A2f i	Industry-Other
031605	Stationary engines	1A2f i	Industry-Other
031606	Other stationary equipments (n)	1A2f i	Industry-Other
032000	Non-specified (industry)	1A2f i	Industry-Other
032001	Combustion plants >= 300 MW (boilers)	1A2f i	Industry-Other
032002	Combustion plants >= 50 and < 300 MW (boilers)	1A2f i	Industry-Other
032003	Combustion plants < 50 MW (boilers)	1A2f i	Industry-Other
032004	Gas turbines	1A2f i	Industry-Other
032005	Stationary engines	1A2f i	Industry-Other
032006	Other stationary equipments (n)	1A2f i	Industry-Other

[1)] Stoves, fireplaces and cooking is included in the sector 020200 or 020202 in the Danish inventory.

Annex 3A-2 Fuel rate

Table 3A-2.1 Fuel consumption rate for stationary combustion plants 2010, PJ.

fuel_type	fuel_gr_abbr	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SOLID	ANODE CARBON										
	COAL	253.4	344.3	286.8	300.8	323.4	270.3	371.9	276.3	234.3	196.5
	BROWN COAL BRI.	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	COKE OVEN COKE	1.3	1.4	1.2	1.2	1.2	1.3	1.2	1.3	1.3	1.4
LIQUID	PETROLEUM COKE	4.5	4.4	4.3	5.7	7.5	5.3	5.9	6.0	5.3	6.8
	RESIDUAL OIL	31.4	37.5	37.8	32.1	45.5	32.3	37.0	25.9	29.3	23.0
	GAS OIL	61.4	65.0	56.1	62.0	53.9	53.7	58.0	51.1	48.4	47.5
	KEROSENE	5.1	0.9	0.8	0.8	0.6	0.6	0.5	0.4	0.4	0.3
	NAPHTA										
	ORIMULSION						19.9	36.8	40.5	32.6	34.2
	LPG	2.6	2.7	2.5	2.6	2.6	2.7	3.0	2.5	2.5	2.2
	REFINERY GAS	14.2	14.5	14.9	15.4	16.4	20.8	21.4	16.9	15.2	15.7
GAS	NATURAL GAS	76.1	86.1	90.5	102.5	114.6	132.7	156.3	164.5	178.7	187.9
WASTE	WASTE	15.5	16.7	17.8	19.4	20.3	22.9	25.0	26.8	26.6	29.1
	INDUSTR. WASTES										
BIOMASS	WOOD	18.2	20.0	21.0	22.2	21.9	21.8	23.4	23.4	22.9	24.3
	STRAW	12.5	13.3	13.9	13.4	12.7	13.1	13.5	13.9	13.9	13.7
	BIO OIL	0.7	0.7	0.7	0.8	0.2	0.3	0.1	0.0	0.0	0.0
	BIOGAS	0.8	0.9	0.9	1.1	1.3	1.8	2.0	2.4	2.6	2.6
	BIO PROD GAS					0.1	0.0	0.0	0.0	0.0	0.1

Continued

fuel_type	fuel_gr_abbr	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SOLID	ANODE CARBON										0.0
	COAL	164.7	174.3	174.7	239.0	182.5	154.0	232.0	194.1	170.5	167.7
	BROWN COAL BRI.	0.0	0.0	0.0	0.0					0.0	0.0
	COKE OVEN COKE	1.2	1.1	1.1	1.0	1.1	1.0	1.0	1.1	1.0	0.8
LIQUID	PETROLEUM COKE	6.8	7.8	7.8	8.0	8.4	8.1	8.5	9.2	6.9	5.9
	RESIDUAL OIL	18.1	20.4	25.4	27.4	23.3	20.8	24.7	18.4	14.3	13.0
	GAS OIL	41.3	43.6	38.6	38.9	35.8	31.7	26.6	21.6	20.9	23.6
	KEROSENE	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.1	0.1	0.1
	NAPHTA										
	ORIMULSION	34.1	30.2	23.8	1.9	0.0					
	LPG	2.0	1.7	1.5	1.7	1.8	1.8	2.0	1.7	1.5	1.4
	REFINERY GAS	15.6	15.8	15.2	16.6	15.9	15.3	16.1	15.9	14.8	15.4
GAS	NATURAL GAS	186.1	193.8	193.6	195.9	195.1	187.4	191.1	171.0	171.9	164.8
WASTE	WASTE	30.4	32.7	35.1	36.6	37.3	37.8	36.9	38.1	39.6	37.5
	INDUSTR. WASTES							1.5	1.6	2.0	1.7
BIOMASS	WOOD	27.5	30.8	31.6	38.9	43.9	49.7	52.1	60.3	63.6	66.1
	STRAW	12.2	13.7	15.7	16.9	17.9	18.5	18.5	18.8	15.9	17.4
	BIO OIL	0.0	0.2	0.1	0.4	0.6	0.8	1.1	1.2	1.8	1.7
	BIOGAS	2.9	3.0	3.3	3.5	3.7	3.8	3.9	3.9	3.9	4.2
	BIO PROD GAS	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3

Continued

fuel_type	fuel_gr_abbr	2010
SOLID	ANODE CARBON	0.0
	COAL	162.5
	BROWN COAL BRI.	0.0
	COKE OVEN COKE	0.7
LIQUID	PETROLEUM COKE	5.1
	RESIDUAL OIL	11.2
	GAS OIL	21.3
	KEROSENE	0.1
	NAPHTA	
	ORIMULSION	
	LPG	1.4
	REFINERY GAS	14.3
GAS	NATURAL GAS	186.7
WASTE	WASTE	36.7

Continued		
	INDUSTR. WASTES	1.4
BIOMASS	WOOD	80.1
	STRAW	23.6
	BIO OIL	1.9
	BIOGAS	4.3
	BIO PROD GAS	0.2

Table 3A-2.2 Detailed fuel consumption data for stationary combustion plants, PJ. 1990 – 2010

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SOLID	ANODE CARBON	1A2f i	032000										
	COAL	1A1a	010100	8.5	12.9	10.2	8.2						
			010101	207.9	294.7	241.8	256.3	284.7	233.2	333.6	244.3	206.2	172.0
			010102	14.0	11.0	13.2	15.4	18.9	19.4	22.6	17.1	14.2	12.8
			010103					0.5	0.4	0.1			
			010104					0.3	0.3	0.3	0.1		
			010105					0.0					
			010200	6.0	6.6	5.2	3.6						
			010202					1.1	0.7				
			010203					1.4	1.0	0.7	0.2	0.1	0.0
		1A2c	030600	0.1	0.1	0.1	0.7	0.7	0.6	0.6	0.5	0.5	0.5
		1A2d	031100	1.3	1.7	1.1	0.7	0.7		0.0			
			031102						0.1	0.0			
		1A2e	030900	4.0	3.8	2.9	3.4	2.5	2.0	1.1	1.2	1.1	0.9
			030902						1.0	1.4	1.5	1.4	1.4
			030903										
		1A2f i	030100	1.6	1.5	0.9	0.8						
			030102					0.5	0.4	0.4	0.3	0.7	0.1
			030103					0.3	0.4	0.4	0.5	0.3	0.2
			030106										
			030700	0.2			0.2	0.3	0.3	0.8	0.6	0.7	1.1
			030800	1.6	1.9	1.7	1.9	1.6	1.3	1.3	1.5	1.4	0.9
			031200	0.0	0.0	0.0	0.0						
			031300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
			031400										
			031600	5.0	6.0	6.6	6.6	6.9	7.2	7.1	7.2	6.6	5.6
			032000				0.0						
		1A4a i	020100	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	
		1A4b i	020200	0.6	1.1	0.9	0.8	0.6	0.4	0.1	0.1	0.1	0.1
		1A4c i	020300	2.5	2.9	2.2	2.1	2.3	1.8	1.4	1.2	0.9	0.7
			020304										
	BROWN COAL BRI.	1A2f i	030100										
			030800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		1A4a i	020100	0.0	0.0		0.0	0.0	0.0	0.0	0.0		
		1A4b i	020200	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0
		1A4c i	020300	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
	COKE OVEN COKE	1A2a	030400	0.0	0.0								0.0
		1A2e	030900	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
			030902										
			030903										
		1A2f i	030100										
			030700	0.8	1.0	0.9	0.8	0.9	0.1	0.1	0.1	0.1	0.1
			030800	0.0								0.0	0.0
			031200	0.0	0.0				0.0	0.0	0.0	0.0	
			031300	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
			031400	0.0	0.0	0.0	0.0	0.0	0.0				
			032000	0.0	0.0	0.0	0.0		0.9	0.9	0.9	1.0	1.0
		1A4b i	020200	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
LIQUID	PETROLEUM COKE	1A1a	010100				1.2						
			010102					3.5	0.9				

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			010200										
		1A2a	030400										0.0
		1A2c	030600				0.0						
		1A2d	031100	0.0	0.0	0.0							
		1A2e	030900				0.1						
		1A2f i	030100										
			030700	0.2						0.1	0.0	0.0	0.0
			030800	0.1	0.1	0.1	0.0	0.1	0.2				0.0
			031000	0.0	0.0	0.0			0.0				
			031300	0.0	0.0	0.0			0.0	0.0		0.0	0.0
			031400	0.0	0.0	0.0	0.0	0.0	0.0				
			031600	2.5	3.0	3.2	3.2	3.5	3.7	5.0	5.2	4.8	6.4
			032000						0.0				
		1A4a i	020100	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		1A4b i	020200	0.8	0.7	0.5	0.5	0.4	0.2	0.4	0.3	0.2	0.2
		1A4c i	020300	0.8	0.5	0.4	0.4		0.1	0.3	0.3	0.2	0.1
	RESIDUAL OIL	1A1a	010100	0.8	0.4	1.8	0.8						
			010101	6.5	9.6	8.3	7.8	21.5	8.5	11.6	5.2	8.9	6.0
			010102	0.7	0.4	0.5	0.7	0.7	2.5	4.5	2.7	2.9	1.6
			010103					0.2	0.3	0.0	0.2	0.0	0.0
			010104					0.0	0.0	0.0	0.0	0.0	0.0
			010105					0.0	0.0	0.0	0.0	0.0	0.0
			010200	2.0	2.2	1.1	0.9						
			010202					0.2	0.5	0.5	0.4	0.2	0.1
			010203					1.1	1.1	1.6	1.3	1.5	1.6
		1A1b	010306	1.3	2.0	3.6	3.5	3.3	2.3	2.2	1.6	1.1	1.1
		1A2a	030400	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2b	030500	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
		1A2c	030600	2.3	2.5	2.6	1.9	1.8	1.6	1.6	1.5	1.3	0.7
		1A2d	031100	1.0	1.0	0.7	0.8	0.6	0.5	0.1	0.2	0.2	0.1
			031102						0.0	0.1			
		1A2e	030900	7.1	7.4	7.3	6.6	6.7	5.2	5.0	4.3	4.7	4.7
			030902						0.2	0.4	0.4	0.4	0.4
			030903										
		1A2f i	030100	1.3	1.3	1.3	1.4						
			030102					0.8	0.8	0.8	0.7	0.6	0.6
			030103					0.2	0.2	0.1	0.1	0.1	0.2
			030104								0.1		
			030105										
			030700	0.8	2.6	2.2	0.6	0.7	0.2	0.7	0.3		0.8
			030800	0.4	0.3	0.4	0.4	0.5	0.6	0.5	0.7	0.7	0.5
			031000	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.0
			031200	0.2	0.2	0.2	0.1	0.1	0.1	0.0		0.0	0.0
			031300	0.7	0.6	0.7	0.6	0.4	0.2	0.2	0.1	0.1	0.1
			031400	0.4	0.4	0.3	0.4	0.4	0.4	0.5	0.6	0.5	0.4
			031500	1.0	1.5	1.6	0.5	0.2	0.2	0.4	0.2	0.2	0.1
			031600	1.8	2.2	2.4	2.4	2.6	2.8	1.8	1.9	2.5	0.9
			032000	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
		1A4a i	020100	1.1	0.9	0.6	0.5	0.7	0.7	0.7	0.7	0.4	0.5
			020103					0.1	0.1				
		1A4b i	020200	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.1
		1A4c i	020300	1.2	1.3	1.6	1.7	1.9	2.6	3.1	2.5	2.6	2.4
			020302										
			020304									0.0	0.0
	GAS OIL	1A1a	010100	0.3	0.5	0.7	0.3						
			010101					0.0	0.1	0.0	0.1	0.1	0.3
			010102					0.0	0.0	0.0	0.0	0.0	0.1
			010103						0.0	0.0	0.0	0.0	0.0
			010104		0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0
			010105					0.1	0.1	0.1	0.1	0.1	0.1
			010200	1.9	0.8	0.7	0.9						
			010202					0.1	0.2	0.8	0.5	0.4	0.3

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			010203					1.0	0.7	0.8	0.7	0.8	0.4
		1A1b	010306		0.0	0.0	0.0	0.0	0.0	0.0	0.1		
		1A2a	030400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2b	030500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2c	030600	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1
			030602										
			030604										
		1A2d	031100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
			031102										
		1A2e	030900	0.1	0.4	0.4	0.3	0.2	0.4	0.5	0.4	0.3	0.6
			030902										
			030904										
		1A2f i	030100										
			030102					0.0	0.0	0.0	0.0	0.0	0.0
			030103					0.0	0.0	0.0	0.0	0.0	0.0
			030104								0.0	0.0	0.0
			030105					0.0				0.0	0.0
			030700	0.1	0.2	0.2	0.1	0.1	0.2	0.4	0.5	0.5	0.2
			030800	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
			031000	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
			031200	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1
			031300	0.1	0.3	0.3	0.2	0.2	0.4	0.5	0.4	0.4	0.6
			031400	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1
			031600										
			032000	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3
		1A4a i	020100	11.8	10.6	9.1	9.0	7.2	6.6	6.6	6.1	5.4	5.8
			020102					0.2		0.0		0.0	
			020103					0.0		0.1	0.1	0.1	0.0
			020105					0.0	0.0	0.0	0.0	0.0	0.0
		1A4b i	020200	46.5	50.6	42.9	50.0	43.7	43.3	45.3	39.6	37.8	35.7
			020204										
		1A4c i	020300	0.4	1.0	1.2	0.8	0.7	1.2	1.9	1.8	1.7	2.3
			020302								0.0		
			020304							0.0	0.0		
	KEROSENE	1A2f i	030100										
			031500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			032000	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4a i	020100	0.6	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
		1A4b i	020200	4.4	0.7	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.1
		1A4c i	020300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NAPHTA	1A1a	010100										
	ORIMULSION	1A1a	010101						19.9	36.8	40.5	32.6	34.2
	LPG	1A1a	010100		0.0	0.0	0.0						
			010101										
			010102										
			010103										
			010200	0.0	0.0	0.0							
			010202										
			010203					0.0	0.0				0.0
		1A1b	010306			0.0		0.0	0.0	0.0	0.0		
		1A2a	030400	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
		1A2b	030500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2c	030600	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0
			030602							0.0	0.0	0.0	0.0
		1A2d	031100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2e	030900	0.3	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1
		1A2f i	030100										
			030700	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.4	0.4	0.4
			030800	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
			031000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			031300	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2
			031400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031500	0.5	0.6	0.7	0.6	0.5	0.5	0.5	0.5	0.6	0.4
		1A4a i	020100	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
			020105										0.0
		1A4b i	020200	0.7	0.7	0.6	0.9	0.8	0.7	0.8	0.6	0.7	0.7
		1A4c i	020300	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	REFINERY GAS	1A1a	010203							0.0	0.0		
		1A1b	010300	0.5	0.9	1.5	0.0						
			010304				2.1	2.4	2.3	2.7	2.3	2.5	2.7
			010306	13.5	13.5	13.2	13.2	14.0	18.5	18.7	14.5	12.7	13.1
		1A2f i	030100										
			032000	0.2	0.1	0.1	0.1			0.0	0.1	0.0	
GAS	NATURAL GAS	1A1a	010100										
			010101	4.0	4.4	3.3	4.4	6.4	7.8	9.5	12.0	17.5	17.3
			010102					2.0	2.9	4.1	8.1	9.3	6.5
			010103					0.0	0.1	0.1	0.1	0.1	0.1
			010104	2.5	3.9	5.7	7.5	7.6	8.2	15.2	17.7	21.5	23.7
			010105	0.7	1.3	2.2	4.2	8.6	16.8	21.9	23.5	26.4	26.6
			010200	10.0	11.8	11.1	10.9						
			010202					0.3	0.4	0.4	0.5	0.5	0.2
			010203					9.4	7.9	5.1		0.0	2.7
		1A1c	010504	9.5	9.7	11.1	11.2	12.3	12.9	15.2	19.9	22.0	24.0
		1A2a	030400	1.7	1.5	1.5	1.5	1.6	0.1	0.1			
			030402						1.6	1.6	1.9	1.9	2.1
		1A2b	030500	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
		1A2c	030600	1.0	1.3	1.5	1.2	1.3	1.0	0.8	1.1	1.6	2.0
			030602	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
			030604	0.5	0.6	0.7	0.7	0.8	0.9	1.3	1.3	1.2	1.3
		1A2d	031100	2.3	1.8	1.6	1.2	1.3	0.9	1.3	1.1	1.2	1.1
			031102						1.1	0.9	1.1	1.1	1.0
		1A2e	030900	8.1	9.2	9.5	11.2	12.7	14.0	12.2	13.4	12.2	11.8
			030902									0.0	0.0
			030904										
		1A2f i	030100	0.7	0.7	1.1	1.0						
			030102					0.7	0.4	0.3	0.2	0.3	0.5
			030103					0.8	0.8	1.1	1.0	1.1	0.9
			030104					0.1	0.6	2.1	3.0	4.8	6.1
			030105	0.0	0.0	0.0	0.0	0.0	0.2	0.9	1.0	1.2	1.2
			030106	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
			030700	4.2	4.2	4.1	4.5	5.0	5.9	5.2	5.6	5.7	6.4
			030800	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.7
			031000	1.2	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.0	1.3
			031200	0.2	0.2	0.3	0.4	0.5	0.7	0.7	0.7	0.7	0.6
			031300	1.4	2.0	2.2	2.5	2.8	2.9	3.5	3.2	3.2	3.8
			031400	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.2
			031500	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
			032000	1.1	1.2	1.2	1.5	1.6	1.7	1.9	2.0	2.1	2.3
		1A4a i	020100	6.3	6.8	7.1	8.6	7.3	8.4	11.2	7.6	3.0	5.3
			020103					0.0	0.0	0.0	0.0	0.2	0.0
			020104						0.0		0.0		
			020105	0.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.0	1.1
		1A4b i	020200	17.4	20.4	20.9	24.1	24.7	26.9	30.4	28.4	29.1	29.0
			020202					0.0	0.0	0.1	0.0	0.0	0.0
			020204		0.0	0.5	0.8	1.0	1.0	1.4	1.5	1.5	1.5
		1A4c i	020300	2.1	2.6	2.2	2.3	2.5	2.6	2.7	2.6	2.5	2.2
			020304	0.1	0.1	0.1	0.2	0.3	1.2	2.2	3.0	3.7	3.7
WASTE	WASTE	1A1a	010100	1.0	3.6	5.6	8.4						
			010101									1.3	1.3
			010102					5.1	4.4	6.3	7.7	8.1	14.5
			010103					4.1	5.3	6.0	5.6	4.7	1.1
			010104					0.6	0.9	1.9	1.9	1.6	1.5

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			010200	13.6	12.1	11.1	9.8						
			010202						3.3	4.6	4.6	4.6	
			010203					9.3	7.8	4.8	5.7	5.6	9.2
		1A2a	030400					0.0	0.0				
		1A2c	030600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		1A2d	031100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2e	030900	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0
			030902										
		1A2f i	030100										
			030102										
			030700	0.0	0.0	0.0	0.0	0.0	0.0			0.0	
			030800										
			031000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031200	0.0	0.0			0.0	0.0				
			031300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
			031400			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031600										
			032000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4a i	020100	0.9	1.0	1.1	1.1	1.2	1.3	1.2	1.2	0.7	1.5
			020103					0.0	0.0	0.0	0.0	0.0	0.0
	INDUSTR. WASTES	1A2f i	031600										
BIOMASS	WOOD	1A1a	010100			0.2	0.5						
			010101					0.0				0.3	
			010102					1.7	1.6	1.6	1.6	1.9	2.9
			010103					0.0	0.0	0.0	0.1	0.1	0.3
			010104						0.0				
			010200	3.2	3.6	4.1	3.8						
			010203					3.3	3.5	3.9	4.1	4.1	4.0
		1A2a	030400	0.0	0.0	0.0	0.0	0.0					
		1A2b	030500	0.0									
		1A2c	030600	0.0									
		1A2d	031100	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
			031102										
		1A2e	030900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
			030902										
		1A2f i	030100	1.1	1.1	1.1	1.1						
			030102									0.0	0.0
			030103					0.4	0.4	0.5	0.4	0.4	0.4
			030700	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030800										
			031000					0.0	0.0				0.0
			031200	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
			031300	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
			031400	3.2	3.0	3.0	3.0	3.0	3.0	2.7	2.8	2.9	2.9
			032000	1.4	1.4	1.5	1.5	1.3	1.1	1.2	1.2	1.2	0.9
		1A4a i	020100	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.6
			020105									0.0	0.0
		1A4b i	020200	9.0	10.4	10.7	11.9	11.6	11.8	12.7	12.6	11.1	11.6
			020202										
			020204										
		1A4c i	020300	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
			020303										
	STRAW	1A1a	010100	0.5	1.0	1.5	1.6						
			010101					0.1	0.1	0.4	0.7	1.0	1.3
			010102					0.6	1.1	1.5	1.3	1.3	1.3
			010103					0.7	1.0	1.4	1.5	1.5	1.3
			010104										
			010200	3.5	3.8	3.9	3.8						
			010203					3.9	4.0	4.2	3.9	3.9	3.9
		1A2f i	030103						0.0				
			030105									0.0	0.0

fuel_type	fuel_gr_abbr	nfr_id	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		1A4b i	020200	5.1	5.1	5.1	4.8	4.4	4.1	3.6	3.9	3.8	3.4
		1A4c i	020300	3.4	3.4	3.4	3.2	2.9	2.7	2.4	2.6	2.5	2.3
			020302					0.0	0.0	0.0	0.0	0.0	0.0
	BIO OIL	1A1a	010101										
			010102										
			010105										
			010200	0.7	0.7	0.7	0.8						
			010202										
			010203					0.2	0.3	0.1	0.0	0.0	0.0
		1A2f i	030103										
			030105										
		1A4a i	020105										
		1A4b i	020200										
		1A4c i	020304										
	BIOGAS	1A1a	010100	0.1	0.2	0.0	0.0						
			010101					0.0	0.0	0.0	0.0		
			010102					0.0		0.1	0.0	0.1	0.0
			010104					0.0	0.0	0.0			
			010105	0.1	0.2	0.3	0.5	0.5	0.6	0.6	0.8	1.0	1.1
			010200	0.0	0.0	0.1	0.1						
			010203					0.2	0.3	0.2	0.2	0.2	0.2
		1A2a	030400	0.0									
		1A2e	030900	0.0				0.0	0.1	0.1	0.1	0.1	0.0
			030902										
			030903										
		1A2f i	030100	0.3	0.3	0.4	0.4						
			030102										
			030103					0.0	0.0	0.0	0.0	0.0	0.0
			030105										
		1A4a i	020100					0.1	0.2	0.2	0.3	0.2	0.3
			020103						0.0	0.0	0.0	0.1	0.1
			020105	0.2	0.2	0.1	0.1	0.4	0.6	0.5	0.8	0.9	0.8
		1A4c i	020300					0.0	0.0	0.1	0.0	0.0	0.0
			020304					0.0	0.0	0.0	0.0	0.0	0.0
	BIO PROD GAS	1A1a	010105					0.1	0.0	0.0	0.0	0.0	0.0
		1A2f i	030105										
		1A4c i	020304								0.0	0.0	0.0

Continued

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SOLID	ANODE CARBON	1A2f i	032000										0.0
	COAL	1A1a	010100										
			010101	143.8	156.2	158.3	223.5	167.9	140.0	218.4	180.9	159.4	161.9
			010102	9.3	7.7	8.0	6.4	4.5	4.0	3.3	3.1	2.8	2.0
			010103										
			010104										0.0
			010105										
			010200										
			010202										
			010203	0.0	0.0	0.0	0.0	0.0	0.0		0.1	0.0	
		1A2c	030600	0.5	0.5	0.4	0.6	0.6	0.5	0.2			
		1A2d	031100										
			031102										
		1A2e	030900	1.5	1.7	1.1	0.4	0.7	0.4	0.5	0.5	0.0	
			030902	1.1	1.0	1.0	1.6	1.5	1.5	1.2	1.2	1.2	1.2
			030903							0.2	0.2	0.3	0.3
		1A2f i	030100										
			030102	0.1	0.1	0.1	0.1	0.0	0.0		0.1	0.0	0.0
			030103	0.4	0.4	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
			030106										
			030700	0.3	0.3		1.6	1.8	1.6	1.8	1.9	1.2	0.5
			030800	0.8	0.6	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.0
			031200										
			031300	0.0	0.0	0.0	0.0	0.0					
			031400	0.1			0.0	0.0					
			031600	5.7	4.5	4.3	3.4	3.8	3.9	4.3	4.0	3.5	1.1
			032000										0.1
		1A4a i	020100					0.0					
		1A4b i	020200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4c i	020300	1.1	1.2	0.9	1.2	1.4	1.8	2.0	2.1	1.8	0.4
			020304					0.0	0.0				0.0
	BROWN COAL BRI.	1A2f i	030100										
			030800										
		1A4a i	020100										
		1A4b i	020200	0.0	0.0	0.0	0.0					0.0	0.0
		1A4c i	020300										
	COKE OVEN COKE	1A2a	030400	0.0	0.0	0.0							
		1A2e	030900	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1		
			030902									0.1	0.1
			030903								0.0	0.0	0.1
		1A2f i	030100										
			030700	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
			030800	0.0									
			031200										
			031300				0.0	0.0			0.0	0.0	0.0
			031400										
			032000	0.9	0.9	0.8	0.7	0.8	0.7	0.8	1.0	0.9	0.6
		1A4b i	020200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIQUID	PETROLEUM COKE	1A1a	010100										
			010102					0.0	0.0				0.0
			010200										
		1A2a	030400										
		1A2c	030600										
		1A2d	031100										
		1A2e	030900										
		1A2f i	030100										
			030700	0.2	0.1	0.1	0.1	0.1					
			030800	0.0	0.1	0.1	0.1	0.1	0.2		0.0	0.0	
			031000										

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
			031300										
			031400										
			031600	6.5	7.7	7.5	7.7	8.2	7.8	8.5	9.1	6.8	5.9
			032000										
		1A4a i	020100	0.0	0.0	0.0	0.0		0.1				
		1A4b i	020200	0.0	0.0	0.0	0.0		0.1	0.0	0.0	0.1	
		1A4c i	020300	0.0	0.0	0.0	0.0						
	RESIDUAL OIL	1A1a	010100										
			010101	3.4	3.5	3.7	5.8	4.6	4.3	3.3	5.4	2.8	3.6
			010102	0.7	2.3	1.2	1.7	1.3	1.5	1.8	0.3	0.9	1.9
			010103	0.3	0.1	0.1	0.1	0.2	0.2	0.1	0.6	0.2	0.1
			010104		1.7	6.6	9.3	7.4	6.3	8.4	4.5	4.5	2.9
			010105	0.0	0.0	0.0	0.0						
			010200										
			010202					0.1	0.1	0.1			
			010203	1.1	1.0	1.0	0.6	0.2	0.4	0.4		0.1	0.1
		1A1b	010306	1.3	1.4	1.4	0.9	1.1	0.7	0.6	0.8	0.9	0.7
		1A2a	030400	0.0	0.0	0.0					0.0	0.0	0.0
		1A2b	030500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2c	030600	0.8	0.9	1.0	0.7	0.7	0.4	0.6	0.5		
		1A2d	031100	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	
			031102										
		1A2e	030900	4.7	4.3	4.9	3.2	2.9	1.7	3.0	1.6		
			030902	0.3	0.3	0.3	0.9	0.9	1.1	0.8	0.6	1.9	2.0
			030903				0.7	0.8	0.8	0.8	0.8	1.0	1.1
		1A2f i	030100										
			030102	0.6	0.6	0.5	0.6	0.4	0.5	0.7	0.4	0.2	
			030103	0.2	0.3	0.3	0.2	0.3	0.1	0.0			
			030104										
			030105		0.0	0.0	0.0	0.0	0.0	0.0		0.0	
			030700	0.5	0.5	0.6	0.2			0.2	0.1	0.4	
			030800	0.4	0.3	0.4	0.3	0.3	0.2	0.3	0.2	0.2	0.1
			031000	0.0	0.0	0.0					0.0	0.0	0.0
			031200	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0
			031300	0.1	0.1	0.1	0.1	0.1	0.4	0.6	0.2	0.0	
			031400	0.3	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.1	0.1
			031500	0.0	0.0	0.0							
			031600	0.9	0.5	0.6	0.6	0.8	0.7	1.0	1.1	0.5	0.2
			032000	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2		
		1A4a i	020100	0.3	0.2	0.5	0.2	0.1	0.1	0.3	0.1	0.1	0.0
			020103										
		1A4b i	020200	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0
		1A4c i	020300	1.8	1.6	1.4	0.9	0.7	0.8	0.9	0.6	0.3	0.1
			020302				0.0	0.0	0.0	0.0	0.0	0.0	0.0
			020304	0.0	0.0	0.0	0.0						
	GAS OIL	1A1a	010100										
			010101	0.1	0.1	0.1	1.0	0.2	0.2	0.5	0.5	0.9	2.3
			010102	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1
			010103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			010104	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
			010105	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
			010200										
			010202	0.5	0.9	0.2	0.4	0.5	0.2	0.2	0.2	0.3	0.4
			010203	0.6	0.5	0.4	1.0	0.6	0.5	0.4	0.4	0.7	1.0
		1A1b	010306				0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2a	030400	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		1A2b	030500	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		1A2c	030600	0.1	0.2	0.1	0.1	0.1	0.1	0.0			
			030602							0.0	0.0	0.0	0.0
			030604										0.0
		1A2d	031100	0.1	0.1	0.1	0.1	0.1	0.0	0.0			

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
			031102							0.0	0.0		
		1A2e	030900	0.5	0.7	0.6	0.5	0.5	0.4	0.1			
			030902				0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030904			0.0							
		1A2f i	030100						0.0	0.0	0.0	0.0	0.0
			030102							0.0	0.0	0.0	0.0
			030103	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
			030104	0.0		0.0			0.0	0.0	0.0	0.0	0.0
			030105	0.0	0.0							0.0	0.0
			030700	0.2	0.3	0.2	0.3	0.2	0.2	0.1			
			030800	0.3	0.5	0.4	0.5	0.4	0.3	0.1			
			031000	0.0	0.1	0.0	0.1	0.1	0.0	0.0			
			031200	0.1	0.1	0.1	0.1	0.1	0.1	0.0			
			031300	0.6	0.7	0.5	0.6	0.6	0.3	0.1			
			031400	0.1	0.1	0.1	0.1	0.1	0.0	0.0			
			031600							0.0	0.0	0.0	0.0
			032000	0.2	0.3	0.2	0.3	0.3	0.1	0.0	0.0	0.0	0.0
		1A4a i	020100	5.0	4.7	4.0	4.3	4.4	3.8	3.0	2.6	2.9	2.8
			020102										
			020103	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
			020105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4b i	020200	30.3	31.5	29.0	27.0	25.3	23.9	21.2	17.4	15.6	16.7
			020204									0.0	0.0
		1A4c i	020300	2.2	2.6	2.2	2.3	2.0	1.3	0.5			
			020302								0.0	0.0	0.0
			020304	0.0	0.0	0.0	0.0		0.0	0.0			0.0
	KEROSENE	1A2f i	030100										
			031500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			032000	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4a i	020100	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
		1A4b i	020200	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1
		1A4c i	020300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NAPHTA	1A1a	010100										
	ORIMULSION	1A1a	010101	34.1	30.2	23.8	1.9	0.0					
	LPG	1A1a	010100										
			010101							0.0		0.0	0.0
			010102									0.0	0.0
			010103										
			010200										
			010202						0.0	0.0	0.0		
			010203	0.0					0.0		0.0	0.0	0.0
		1A1b	010306										
		1A2a	030400	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2b	030500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2c	030600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030602	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2d	031100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2e	030900	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		1A2f i	030100										
			030700	0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
			030800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031300	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1
			031400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031500	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
		1A4a i	020100	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3
			020105						0.0	0.0	0.0	0.0	0.0
		1A4b i	020200	0.8	0.7	0.6	0.7	0.7	0.8	0.9	0.9	0.8	0.7
		1A4c i	020300	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	REFINERY GAS	1A1a	010203										

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		1A1b	010300										
			010304	2.4	2.4	2.5	2.7	2.4	2.0	2.2	2.3	1.8	1.9
			010306	13.2	13.3	12.7	13.9	13.4	13.4	13.9	13.6	12.9	13.5
		1A2f i	030100										
			032000										
GAS	NATURAL GAS	1A1a	010100										
			010101	18.4	18.2	16.5	17.9	17.3	17.2	19.0	13.9	10.9	13.4
			010102	6.5	6.4	5.5	3.9	3.3	3.0	2.6	0.9	3.8	2.7
			010103	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
			010104	22.9	24.9	30.0	29.8	32.0	27.3	33.5	26.2	27.9	24.6
			010105	25.5	27.9	27.6	26.7	26.9	24.0	21.5	17.1	18.3	15.4
			010200										
			010202	0.1	0.1	0.2	0.2	0.3	0.2	0.1	0.2	0.4	0.9
			010203	2.3	2.9	2.4	3.2	2.7	4.4	4.6	6.1	6.1	8.1
		1A1c	010504	25.4	24.8	26.6	26.6	27.4	28.1	28.7	28.5	28.1	26.6
		1A2a	030400	0.1	0.0	1.7	0.3	0.1	0.3	0.2	0.2	0.2	0.7
			030402	1.6	1.8		1.2	1.2	1.2	1.3	1.4	1.4	0.7
		1A2b	030500	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		1A2c	030600	1.8	2.4	1.8	2.2	2.0	2.4	2.1	2.0	1.6	0.3
			030602	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5
			030604	1.2	0.8	0.9	0.9	0.4	0.0				1.1
		1A2d	031100	1.0	1.4	0.9	1.6	1.3	1.6	1.5	1.6	1.7	1.5
			031102	1.1	1.1	1.2	1.0	1.0	1.0	1.0	0.2	0.1	0.1
		1A2e	030900	9.0	9.5	7.9	6.8	8.1	8.6	9.6	10.1	11.0	9.9
			030902		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030904	2.2	2.2	2.3	2.2	1.9	2.3	1.2	1.3	0.0	0.2
		1A2f i	030100						0.0	0.0	0.0	0.0	0.1
			030102	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.0
			030103	0.7	0.2	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.6
			030104	6.4	6.2	6.7	6.5	6.8	5.9	4.6	4.5	3.4	3.0
			030105	1.6	1.7	1.6	1.6	1.6	1.3	1.0	0.5	0.6	0.6
			030106	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
			030700	5.8	5.8	5.4	5.5	5.0	4.8	4.8	5.4	5.2	4.8
			030800	0.6	0.9	0.6	0.7	0.8	0.6	1.0	0.7	1.6	1.5
			031000	1.2	1.2	1.2	1.0	0.9	0.6	0.5	0.3	0.3	0.3
			031200	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.6	0.6	0.5
			031300	3.6	4.1	3.7	4.1	3.8	3.4	3.3	3.3	3.3	3.0
			031400	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
			031500	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.3	0.4
			032000	2.1	2.3	2.2	2.3	2.1	1.8	1.7	1.6	1.6	1.5
		1A4a i	020100	7.2	7.3	7.6	9.1	7.7	7.9	9.3	10.1	10.0	9.5
			020103	0.2	0.2	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0
			020104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
			020105	1.1	1.1	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8
		1A4b i	020200	27.6	29.3	28.1	30.0	29.9	29.5	28.6	26.6	26.5	26.8
			020202	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1
			020204	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.2
		1A4c i	020300	2.4	2.7	2.5	2.3	2.3	2.2	2.2	1.9	1.7	1.8
			020304	3.3	3.1	3.4	3.2	3.3	2.9	2.0	1.4	1.1	0.9
WASTE	WASTE	1A1a	010100										
			010101		0.2	0.9	0.1					0.0	0.0
			010102	12.1	13.0	13.9	14.1	16.6	19.6	19.9	20.3	21.0	20.8
			010103	9.0	9.0	9.2	9.1	9.1	8.8	9.6	9.4	9.6	8.8
			010104	2.2	2.5	2.6	3.0	2.9	2.6	3.1	3.3	3.3	3.2
			010200										
			010202										
			010203	6.4	6.6	6.6	7.4	6.5	4.3	3.8	4.7	5.0	4.0
		1A2a	030400										
		1A2c	030600	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A2d	031100	0.0			0.0		0.0	0.0	0.0	0.1	0.1
		1A2e	030900				0.0		0.0	0.0	0.0	0.0	0.1
			030902									0.0	

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		1A2f i	030100										
			030102				0.0	0.0	0.0	0.0	0.0	0.0	
			030700										
			030800						0.1	0.1	0.1	0.2	0.2
			031000	0.0							0.0	0.0	0.0
			031200										
			031300	0.0			0.0	0.1	0.0	0.0	0.0	0.0	0.0
			031400	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031600	0.5	1.4	1.9	1.5	2.0	2.0				
			032000	0.0			0.0		0.1	0.1		0.1	0.2
		1A4a i	020100	0.0			1.1	0.0					
			020103	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.0	0.1	0.1
	INDUSTR. WASTES	1A2f i	031600							1.5	1.6	2.0	1.7
BIOMASS	WOOD	1A1a	010100										
			010101		0.0	0.1	0.3	0.2	0.2	0.3	0.2	0.3	0.5
			010102	2.7	2.5	3.2	5.3	5.4	6.6	6.5	6.3	5.8	7.1
			010103	0.4	0.5	0.6	0.7	0.7	0.6	0.5	0.6	0.6	0.7
			010104			0.1	1.6	4.5	4.5	2.6	3.8	6.0	6.3
			010200										
			010203	3.9	4.5	5.0	5.6	6.2	6.5	7.0	7.1	7.9	8.6
		1A2a	030400				0.0	0.0					
		1A2b	030500										
		1A2c	030600										
		1A2d	031100	0.0	0.0	0.0	0.0	0.0	0.0				
			031102							0.0	1.1	1.2	1.2
		1A2e	030900	0.1	0.1	0.1	0.0	0.1	0.4	0.1	0.1	0.0	0.0
			030902										0.0
		1A2f i	030100						0.1	0.1	0.1	0.1	0.0
			030102	0.0	0.0					0.0	0.4	0.5	0.5
			030103	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.4	0.5
			030700	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030800								0.1	0.1	0.1
			031000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			031300	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2
			031400	3.0	3.1	2.5	1.8	1.7	2.0	2.6	2.7	3.7	3.6
			032000	1.2	1.3	0.7	1.6	1.6	1.1	1.4	0.7	1.2	1.2
		1A4a i	020100	0.8	0.7	0.7	0.7	0.7	0.8	1.0	1.0	1.1	1.0
			020105		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
		1A4b i	020200	14.6	17.5	18.1	20.9	22.3	26.4	29.4	35.5	34.5	34.3
			020202						0.0	0.0	0.0	0.0	0.0
			020204									0.0	0.0
		1A4c i	020300	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
			020303										
	STRAW	1A1a	010100										
			010101	1.1	1.6	2.6	3.2	3.7	3.3	3.7	3.6	2.4	2.8
			010102	1.3	1.3	1.2	1.3	2.1	2.0	1.7	1.9	1.7	1.9
			010103	0.7	2.1	1.9	2.1	2.1	2.1	2.1	2.1	2.1	2.2
			010104		0.1	1.2	1.7	1.9	2.4	2.5	2.5	0.8	1.5
			010200										
			010203	3.8	3.8	3.8	3.8	3.4	3.7	3.7	3.8	3.9	4.1
		1A2f i	030103										
			030105	0.0	0.0								
		1A4b i	020200	3.1	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
		1A4c i	020300	2.1	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
			020302	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BIO OIL	1A1a	010101				0.1				0.0	0.0	
			010102										
			010105					0.0			0.0	0.0	0.0
			010200										
			010202				0.0	0.0	0.0	0.0	0.0	0.4	0.2
			010203	0.0	0.2	0.1	0.3	0.6	0.7	1.1	1.1	1.4	1.4

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		1A2f i	030103			0.1							
			030105			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4a i	020105								0.0		
		1A4b i	020200								0.0	0.0	0.0
		1A4c i	020304	0.0	0.0	0.0							
	BIOGAS	1A1a	010100										
			010101										
			010102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			010104										
			010105	1.1	1.1	1.3	1.3	1.4	1.6	1.6	1.7	1.7	1.8
			010200										
			010203	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.2	0.1
		1A2a	030400										
		1A2e	030900	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
			030902	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1
			030903				0.1	0.1				0.0	0.1
		1A2f i	030100										
			030102				0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030103	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			030105		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		1A4a i	020100	0.3	0.4	0.4	0.3	0.4	0.4	0.5	0.4	0.4	0.3
			020103	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
			020105	0.9	0.8	0.8	0.8	0.8	0.8	0.6	0.6	0.5	0.6
		1A4c i	020300	0.1	0.1	0.1	0.1	0.2	0.1	0.3	0.3	0.4	0.4
			020304	0.1	0.1	0.2	0.4	0.5	0.6	0.5	0.5	0.5	0.6
	BIO PROD GAS	1A1a	010105	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3
		1A2f i	030105								0.0	0.0	0.0
		1A4c i	020304	0.0	0.0								

Continued

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
SOLID	ANODE CARBON	1A2f i	032000	0.0
	COAL	1A1a	010100	
			010101	155.9
			010102	1.7
			010103	
			010104	0.0
			010105	
			010200	
			010202	
			010203	
		1A2c	030600	
		1A2d	031100	
			031102	
		1A2e	030900	
			030902	1.0
			030903	0.2
		1A2f i	030100	
			030102	0.0
			030103	0.1
			030106	
			030700	0.5
			030800	0.0
			031200	
			031300	
			031400	
			031600	2.0
			032000	0.1
		1A4a i	020100	
		1A4b i	020200	0.0
		1A4c i	020300	0.9
			020304	

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
	BROWN COAL BRI.	1A2f i	030100	
			030800	
		1A4a i	020100	
		1A4b i	020200	0.0
		1A4c i	020300	
	COKE OVEN COKE	1A2a	030400	
		1A2e	030900	
			030902	0.0
			030903	0.1
		1A2f i	030100	
			030700	0.0
			030800	
			031200	
			031300	0.0
			031400	
			032000	0.6
		1A4b i	020200	0.0
LIQUID	PETROLEUM COKE	1A1a	010100	
			010102	0.0
			010200	
		1A2a	030400	
		1A2c	030600	
		1A2d	031100	
		1A2e	030900	
		1A2f i	030100	
			030700	
			030800	0.0
			031000	
			031300	
			031400	
			031600	5.1
			032000	
		1A4a i	020100	
		1A4b i	020200	0.0
		1A4c i	020300	
	RESIDUAL OIL	1A1a	010100	
			010101	4.9
			010102	0.2
			010103	0.1
			010104	0.2
			010105	
			010200	
			010202	0.0
			010203	0.2
		1A1b	010306	0.5
		1A2a	030400	0.0
		1A2b	030500	0.0
		1A2c	030600	0.4
		1A2d	031100	0.1
			031102	
		1A2e	030900	
			030902	1.9
			030903	1.0
		1A2f i	030100	
			030102	
			030103	
			030104	
			030105	
			030700	0.3
			030800	0.1

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
			031000	0.0
			031200	0.0
			031300	0.2
			031400	0.1
			031500	
			031600	0.3
			032000	
		1A4a i	020100	0.0
			020103	
		1A4b i	020200	0.0
		1A4c i	020300	0.6
			020302	0.0
			020304	0.0
	GAS OIL	1A1a	010100	
			010101	1.3
			010102	0.2
			010103	0.0
			010104	0.1
			010105	0.1
			010200	
			010202	1.0
			010203	1.3
		1A1b	010306	0.0
		1A2a	030400	
		1A2b	030500	
		1A2c	030600	
			030602	0.0
			030604	0.0
		1A2d	031100	
			031102	
		1A2e	030900	
			030902	0.0
			030904	
		1A2f i	030100	
			030102	0.0
			030103	0.0
			030104	0.0
			030105	0.0
			030700	
			030800	
			031000	
			031200	
			031300	
			031400	
			031600	0.0
			032000	0.0
		1A4a i	020100	2.5
			020102	
			020103	0.1
			020105	0.0
		1A4b i	020200	14.7
			020204	0.0
		1A4c i	020300	
			020302	0.0
			020304	
	KEROSENE	1A2f i	030100	
			031500	0.0
			032000	0.0
		1A4a i	020100	0.0
		1A4b i	020200	0.0
		1A4c i	020300	0.0

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
	NAPHTA	1A1a	010100	
	ORIMULSION	1A1a	010101	
	LPG	1A1a	010100	
			010101	0.0
			010102	0.1
			010103	0.0
			010200	
			010202	
			010203	0.0
		1A1b	010306	
		1A2a	030400	0.0
		1A2b	030500	0.0
		1A2c	030600	0.0
			030602	0.0
		1A2d	031100	0.0
		1A2e	030900	0.1
		1A2f i	030100	
			030700	0.1
			030800	0.0
			031000	0.0
			031200	0.0
			031300	0.1
			031400	0.0
			031500	0.1
		1A4a i	020100	0.2
			020105	0.0
		1A4b i	020200	0.8
		1A4c i	020300	0.0
	REFINERY GAS	1A1a	010203	
		1A1b	010300	
			010304	1.5
			010306	12.7
		1A2f i	030100	
			032000	
GAS	NATURAL GAS	1A1a	010100	
			010101	14.4
			010102	4.6
			010103	0.0
			010104	28.6
			010105	19.5
			010200	
			010202	1.2
			010203	8.8
		1A1c	010504	26.0
		1A2a	030400	0.3
			030402	1.2
		1A2b	030500	0.1
		1A2c	030600	0.6
			030602	0.6
			030604	1.0
		1A2d	031100	1.7
			031102	0.1
		1A2e	030900	9.5
			030902	0.1
			030904	1.5
		1A2f i	030100	0.1
			030102	0.0
			030103	0.5
			030104	3.9
			030105	0.7
			030106	0.1

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
			030700	5.2
			030800	1.6
			031000	0.3
			031200	0.6
			031300	3.3
			031400	0.3
			031500	0.4
			032000	1.6
		1A4a i	020100	11.8
			020103	0.1
			020104	
			020105	0.8
		1A4b i	020200	31.4
			020202	0.1
			020204	1.1
		1A4c i	020300	1.9
			020304	1.0
WASTE	WASTE	1A1a	010100	
			010101	
			010102	20.4
			010103	8.5
			010104	3.3
			010200	
			010202	
			010203	4.2
		1A2a	030400	
		1A2c	030600	0.0
		1A2d	031100	0.1
		1A2e	030900	0.1
			030902	
		1A2f i	030100	
			030102	
			030700	
			030800	0.1
			031000	0.0
			031200	
			031300	0.0
			031400	0.0
			031600	
			032000	
		1A4a i	020100	
			020103	0.1
	INDUSTR. WASTES	1A2f i	031600	1.4
BIO-MASS	WOOD	1A1a	010100	
			010101	3.3
			010102	9.3
			010103	1.1
			010104	11.3
			010200	
			010203	9.6
		1A2a	030400	
		1A2b	030500	
		1A2c	030600	
		1A2d	031100	
			031102	1.2
		1A2e	030900	0.0
			030902	0.0
		1A2f i	030100	0.0
			030102	0.6
			030103	0.4
			030700	0.0

fuel_type	fuel_gr_abbr	nfr_id	snap_id	2010
			030800	0.1
			031000	0.0
			031200	0.0
			031300	0.2
			031400	3.7
			032000	1.2
		1A4a i	020100	1.0
			020105	0.0
		1A4b i	020200	36.9
			020202	0.0
			020204	0.0
		1A4c i	020300	0.1
			020303	0.0
	STRAW	1A1a	010100	
			010101	5.5
			010102	3.9
			010103	2.4
			010104	2.0
			010200	
			010203	5.0
		1A2f i	030103	
			030105	
		1A4b i	020200	2.9
		1A4c i	020300	1.9
			020302	
	BIO OIL	1A1a	010101	
			010102	0.1
			010105	0.0
			010200	
			010202	0.1
			010203	1.7
		1A2f i	030103	
			030105	0.0
		1A4a i	020105	
		1A4b i	020200	0.0
		1A4c i	020304	
	BIOGAS	1A1a	010100	
			010101	0.0
			010102	0.0
			010104	
			010105	1.9
			010200	
			010203	0.1
		1A2a	030400	
		1A2e	030900	0.0
			030902	0.0
			030903	0.1
		1A2f i	030100	
			030102	0.0
			030103	0.0
			030105	0.0
		1A4a i	020100	0.4
			020103	0.1
			020105	0.5
		1A4c i	020300	0.4
			020304	0.6
	BIO PROD GAS	1A1a	010105	0.2
		1A2f i	030105	0.0
		1A4c i	020304	

Annex 3A-3 Default Lower Calorific Value (LCV) of fuels and fuel correspondence list

Table 3A-3.1 Time-series for calorific values of fuels (DEA 2011b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Crude Oil, Average	GJ pr tonne	42.40	42.40	42.40	42.70	42.70	42.70	42.70	43.00	43.00	43.00
Crude Oil, Golf	GJ pr tonne	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
Crude Oil, North Sea	GJ pr tonne	42.70	42.70	42.70	42.70	42.70	42.70	42.70	43.00	43.00	43.00
Refinery Feedstocks	GJ pr tonne	41.60	41.60	41.60	41.60	41.60	41.60	41.60	42.70	42.70	42.70
Refinery Gas	GJ pr tonne	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
LPG	GJ pr tonne	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Naphtha (LVN)	GJ pr tonne	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50
Motor Gasoline	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Aviation Gasoline	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
JP4	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Other Kerosene	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
JP1	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Gas/Diesel Oil	GJ pr tonne	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Fuel Oil	GJ pr tonne	40.40	40.40	40.40	40.40	40.40	40.40	40.70	40.65	40.65	40.65
Orimulsion	GJ pr tonne	27.60	27.60	27.60	27.60	27.60	28.13	28.02	27.72	27.84	27.58
Petroleum Coke	GJ pr tonne	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40
Waste Oil	GJ pr tonne	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
White Spirit	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Bitumen	GJ pr tonne	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80
Lubricants	GJ pr tonne	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
Natural Gas	GJ pr 1000 Nm^3	39.00	39.00	39.00	39.30	39.30	39.30	39.30	39.60	39.90	40.00
Town Gas	GJ pr 1000 m^3							17.00	17.00	17.00	17.00
Electricity Plant Coal	GJ pr tonne	25.30	25.40	25.80	25.20	24.50	24.50	24.70	24.96	25.00	25.00
Other Hard Coal	GJ pr tonne	26.10	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50
Coke	GJ pr tonne	31.80	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30
Brown Coal Briquettes	GJ pr tonne	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30
Straw	GJ pr tonne	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50
Wood Chips	GJ pr Cubic metre	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Wood Chips	GJ pr m^3	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30
Firewood, Hardwood	GJ pr m^3	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40
Firewood, Conifer	GJ pr tonne	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Wood Pellets	GJ pr tonne	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Wood Waste	GJ pr Cubic metre	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Wood Waste	GJ pr 1000 m^3	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Biogas	GJ pr tonne								23.00	23.00	23.00
Wastes	GJ pr tonne	8.20	8.20	9.00	9.40	9.40	10.00	10.50	10.50	10.50	10.50
Bioethanol	GJ pr tonne	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Liquid Biofuels	GJ pr tonne	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60
Bio Oil	GJ pr tonne	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Crude Oil, Average	GJ pr tonne	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
Crude Oil, Golf	GJ pr tonne	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
Crude Oil, North Sea	GJ pr tonne	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
Refinery Feedstocks	GJ pr tonne	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Refinery Gas	GJ pr tonne	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
LPG	GJ pr tonne	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Naphtha (LVN)	GJ pr tonne	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50
Motor Gasoline	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Aviation Gasoline	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
JP4	GJ pr tonne	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Other Kerosene	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
JP1	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Gas/Diesel Oil	GJ pr tonne	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Fuel Oil	GJ pr tonne	40.65	40.65	40.65	40.65	40.65	40.65	40.65	40.65	40.65	40.65
Orimulsion	GJ pr tonne	27.62	27.64	27.71	27.65	27.65	27.65	27.65	27.65	27.65	27.65
Petroleum Coke	GJ pr tonne	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40
Waste Oil	GJ pr tonne	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
White Spirit	GJ pr tonne	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Bitumen	GJ pr tonne	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80

Lubricants	GJ pr tonne	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
Natural Gas	GJ pr 1000 Nm^3	40.15	39.99	40.06	39.94	39.77	39.67	39.54	39.59	39.48	39.46
Town Gas	GJ pr 1000 m^3	17.01	16.88	17.39	16.88	17.58	17.51	17.20	17.14	15.50	21.29
Electricity Plant Coal	GJ pr tonne	24.80	24.90	25.15	24.73	24.60	24.40	24.80	24.40	24.30	24.60
Other Hard Coal	GJ pr tonne	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50	25.81	25.13
Coke	GJ pr tonne	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30
Brown Coal Briquettes	GJ pr tonne	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30
Straw	GJ pr tonne	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50
Wood Chips	GJ pr Cubic metre	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Wood Chips	GJ pr m^3	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30
Firewood, Hardwood	GJ pr m^3	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40
Firewood, Conifer	GJ pr tonne	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Wood Pellets	GJ pr tonne	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Wood Waste	GJ pr Cubic metre	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Wood Waste	GJ pr 1000 m^3	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Biogas	GJ pr tonne	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Wastes	GJ pr tonne	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50
Bioethanol	GJ pr tonne	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Liquid Biofuels	GJ pr tonne	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.50	37.50
Bio Oil	GJ pr tonne	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20

Continued		2010
Crude Oil, Average	GJ pr tonne	43.00
Crude Oil, Golf	GJ pr tonne	41.80
Crude Oil, North Sea	GJ pr tonne	43.00
Refinery Feedstocks	GJ pr tonne	42.70
Refinery Gas	GJ pr tonne	52.00
LPG	GJ pr tonne	46.00
Naphtha (LVN)	GJ pr tonne	44.50
Motor Gasoline	GJ pr tonne	43.80
Aviation Gasoline	GJ pr tonne	43.80
JP4	GJ pr tonne	43.80
Other Kerosene	GJ pr tonne	43.50
JP1	GJ pr tonne	43.50
Gas/Diesel Oil	GJ pr tonne	42.70
Fuel Oil	GJ pr tonne	40.65
Orimulsion	GJ pr tonne	27.65
Petroleum Coke	GJ pr tonne	31.40
Waste Oil	GJ pr tonne	41.90
White Spirit	GJ pr tonne	43.50
Bitumen	GJ pr tonne	39.80
Lubricants	GJ pr tonne	41.90
Natural Gas	GJ pr 1000 Nm3	39.46
Town Gas	GJ pr 1000 m3	21.35
Electricity Plant Coal	GJ pr tonne	24.44
Other Hard Coal	GJ pr tonne	24.44
Coke	GJ pr tonne	29.30
Brown Coal Briquettes	GJ pr tonne	18.30
Straw	GJ pr tonne	14.50
Wood Chips	GJ pr Cubic metre	2.80
Wood Chips	GJ pr m3	9.30
Firewood, Hardwood	GJ pr m3	10.40
Firewood, Conifer	GJ pr tonne	7.60
Wood Pellets	GJ pr tonne	17.50
Wood Waste	GJ pr Cubic metre	14.70
Wood Waste	GJ pr 1000 m3	3.20
Biogas	GJ pr tonne	23.00
Wastes	GJ pr tonne	10.50
Bioethanol	GJ pr tonne	26.70
Liquid Biofuels	GJ pr tonne	37.50
Bio Oil	GJ pr tonne	37.20

Table 3A-3.2 category correspondence list, DEA, DCE and Climate Convention reportings (CRF).

Danish Energy Agency	DCE Emission database	CRF fuel category
Other Hard Coal	Coal	Solid
Coke	Coke oven coke	Solid
Electricity Plant Coal	Coal	Solid
Brown Coal Briquettes	Brown coal briq.	Solid
-	Anode carbon	Solid
Orimulsion	Orimulsion	Liquid
Petroleum Coke	Petroleum coke	Liquid
Fuel Oil	Residual oil	Liquid
Waste Oil	Residual oil	Liquid
Gas/Diesel Oil	Gas oil	Liquid
Other Kerosene	Kerosene	Liquid
LPG	LPG	Liquid
Refinery Gas	Refinery gas	Liquid
Town Gas	Natural gas	Gas
Natural Gas	Natural gas	Gas
Straw	Straw	Biomass
Wood Waste	Wood and simil.	Biomass
Wood Pellets	Wood and simil.	Biomass
Wood Chips	Wood and simil.	Biomass
Firewood, Hardwood & Conifer	Wood and simil.	Biomass
Waste Combustion (biomass)	Municip. wastes	Biomass
Bio Oil	Bio oil	Biomass
Biogas	Biogas	Biomass
Biogas, other	Biogas	Biomass
Biogas, landfill	Biogas	Biomass
Biogas, sewage sludge	Biogas	Biomass
(Wood applied in gas engines)	Biomass producer gas	Biomass
Waste Combustion (fossil)	Fossil waste	Other fuel

Annex 3A-4 Emission factors

Table 3A-4.1 CO_2 emission factors 2010.

Fuel	Emission factor kg per GJ		Reference type	IPCC fuel category
	Biomass	Fossil fuel		
Coal, source category 1A1a Public electricity and heat production		93.6 [1)]	Country specific	Solid
Coal, Other source categories		94.6[3)]	IPCC 1997	Solid
Brown coal briquettes		94.6	IPCC 1997	Solid
Coke oven coke		108	IPCC 1997	Solid
Anodic carbon		108[1)]	IPCC 1997	Solid
Petroleum coke		92 [3)]	Country specific	Liquid
Residual oil, source category 1A1a Public electricity and heat production		79.2 [1)]	Country specific	Liquid
Residual oil, other source categories		77.4[3)]	IPCC 1997	Liquid
Gas oil		74 [1) 3)]	EEA 2007	Liquid
Kerosene		71.9	IPCC 1997	Liquid
Orimulsion		80 [2)]	Country specific	Liquid
LPG		63.1	IPCC 1997	Liquid
Refinery gas		57.134	Country specific	Liquid
Natural gas, off shore gas turbines		57.314	Country specific	Gas
Natural gas, other		56.74	Country specific	Gas
Waste	75.1 [3)4)]	+ 37[3)4)]	Country specific	Biomass and Other fuels
Straw	110		IPCC 1997	Biomass
Wood	110		IPCC 1997	Biomass
Bio oil	74		Country specific	Biomass
Biogas	83.6		Country specific	Biomass
Biomass producer gas	142.9[5)]		Country specific	Biomass

1) Plant specific data from EU ETS incorporated for individual plants.

2) Not applied in 2010. Orimulsion was applied in Denmark in 1995 – 2004.

3) Plant specific data from EU ETS incorporated for cement production.

4) The emission factor for waste is (37+75.1) kg CO_2 per GJ waste. The fuel consumption and the CO_2 emission have been disaggregated to the two IPCC fuel categories *Biomass* and *Other fuels* in CRF. The IEF[1] for CO_2, Other fuels is 82.22 kg CO_2 per GJ fossil waste.

5) Includes a high content of CO_2 in the gas.

For coal (1A1a), residual oil (1A1a), refinery gas, natural gas fuelled off shore gas turbines and other natural gas consumption time-series have been estimated. For all other fuels the same emission factor has been applied for 1990-2010.

[1] Not including cement production.

Table 3A-4.2 CO_2 emission factors, time-series.

Year	Coal, sector 1A1a, kg per GJ	Residual oil, sector 1A1a, kg per GJ	Refinery gas, kg per GJ	Natural gas, off shore gas turbines, kg per GJ	Natural gas, other, kg per GJ
1990	94	78.4	57.6	57.469	56.9
1991	94	78.4	57.6	57.469	56.9
1992	94	78.4	57.6	57.469	56.9
1993	94	78.4	57.6	57.469	56.9
1994	94	78.4	57.6	57.469	56.9
1995	94	78.4	57.6	57.469	56.9
1996	94	78.4	57.6	57.469	56.9
1997	94	78.4	57.6	57.469	56.9
1998	94	78.4	57.6	57.469	56.9
1999	94	78.4	57.6	57.469	56.9
2000	94	78.4	57.6	57.469	57.1
2001	94	78.4	57.6	57.469	57.25
2002	94	78.4	57.6	57.469	57.28
2003	94	78.4	57.6	57.469	57.19
2004	94	78.4	57.6	57.469	57.12
2005	94	78.4	57.6	57.469	56.96
2006	94.4	78.2	57.812	57.879	56.78
2007	94.3	78.1	57.848	57.784	56.78
2008	94	78.5	57.948	56.959	56.77
2009	93.6	78.9	56.814	57.254	56.69
2010	93.6	79.2	57.134	57.314	56.74

Table 3A-4.3 CH_4 emission factors and references 2010.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
SOLID	COAL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
				010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
				010104	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Pulverised Bituminous Combustion, Wet bottom.
		1A2 e-f	Industry - other	all	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
		1A4c i	Agriculture/ Forestry	020300	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.[1]
	BROWN COAL BRI.	1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
	COKE OVEN COKE	1A2 e-f	Industry	all	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, coal.
	ANODIC CARBON	1A2f i	Industry - other	032000	10	IPCC (1997), Tier 2, Table 1-19, Commercial coal boilers.
LIQUID	PETROLEUM COKE	1A1a	Commercial/ Institutional	020100	3	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.
		1A2f	Industry – other	all	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil.
		1A4b	Residential	020200	10	IPCC (1997), Tier 1, Table 1-7, Residential, oil.
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
				010102	1.3	Nielsen et al. (2010)
				010103	1.3	Nielsen et al. (2010)
				010104	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
				010202	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
				010203	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, Residual fuel oil.
		1A1b	Petroleum refining	010306	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
		1A2 a-f	Industry	all	1.3	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil.
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 2, Table 1-18, Residential, residual fuel oil.
		1A4c i	Agriculture/ Forestry	020300	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil[1].
				020302	1.4	IPCC (1997), Tier 2, Table 1-19, Commercial, residual fuel oil[1].
				020304	4	IPCC (1997), Tier 2, Table 1-15, Utility, Large diesel engines.
	GAS OIL	1A1a	Electricity and heat production	010101	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010103	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010104	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
				010105	24	Nielsen et al. (2010)
				010202	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010203	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
		1A1b	Petroleum refining	010306	3	IPCC (1997), Tier 1, Table 1-7, Energy industries, oil.
		1A2 c-f	Industry	Other	0.2	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil.
				Turbines	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil.
				Engines	24	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
				020103	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
				020105	24	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residential, distillate fuel oil.
				020204	24	Nielsen et al. (2010)
		1A4c	Agriculture/ Forestry	020302	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
	KEROSENE	1A2 f	Industry	all	0.2	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil.
		1A4a	Commercial/ Institutional	020100	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residential, distillate fuel oil.
		1A4c i	Agriculture/ Forestry	020300	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil[1].
	LPG	1A1a	Electricity and heat production	010101	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
				010102	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
				010103	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
				010203	3	IPCC (1997), Tier 1, Table 1-7, Energy Industries, oil.
		1A2 a-f	Industry	all	2	IPCC (1997), Tier 1, Table 1-7, Industry, oil
		1A4a	Commercial/ Institutional	020100	10	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
				020105	10	IPCC (1997), Tier 1, Table 1-7, Commercial, oil.
		1A4b i	Residential	020200	1.1	IPCC (1997), Tier 2, Table 1-18, Residiential propane/butane furnaces.
		1A4c i	Agriculture/ Forestry	020300	10	IPCC (1997), Tier 1, Table 1-7, Agriculture, oil.
	REFINERY GAS	1A1b	Petroleum refining	010304	1.7	Assumed equal to natural gas fuelled gas turbines. Nielsen et al. (2010)
				010306	1	Assumed equal to natural gas fuelled plants. IPCC (1997), Tier 1, Table 1-7, Natural gas
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010102	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010103	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010104	1.7	Nielsen et al. (2010)
				010105	481	Nielsen et al. (2010)
				010202	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
				010203	0.1	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, natural gas.
		1A1c	Other energy industries	010504	1.7	Nielsen et al. (2010)
		1A2 a-f	Industry	Other	1.4	IPCC (1997), Tier 2, Table 1-16, Industry, natural gas boilers.
				Gas turbines	1.7	Nielsen et al. (2010)
				Engines	481	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers.
				020103	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers.
				020105	481	Nielsen et al. (2010)
		1A4b i	Residential	020200	5	IPCC (1997), Tier 1, Table 1-7, Residential, natural gas.
				020202	5	IPCC (1997), Tier 1, Table 1-7, Residential, natural gas.
				020204	481	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	1.2	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers[1].
				020304	481	Nielsen et al. (2010)
WASTE	WASTE	1A1a	Electricity and heat production	010101	0.34	Nielsen et al. (2010)
				010102	0.34	Nielsen et al. (2010)
				010103	0.34	Nielsen et al. (2010)
				010203	0.34	Nielsen et al. (2010)
		1A2a-f	Industry	all	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
		1A4a	Commercial/ Institutional	020103	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
	INDUSTRIAL WASTE	1A2f	Industry	031600	30	IPCC (1997), Tier 1, Table 1-7, Industry, wastes.
BIOMASS	WOOD	1A1a	Electricity and heat production	010101	3.1	Nielsen et al. (2010)
				010102	3.1	Nielsen et al. (2010)
				010103	3.1	Nielsen et al. (2010)
				010104	3.1	Nielsen et al. (2010)
				010203	30	IPCC (1997), Tier 1, Table 1-7, Energy industries, wood.
		1A2 d-f	Industry	all	15	IPCC (1997), Tier 2, Table 1-16, Industry, wood stoker boilers.
		1A4a	Commercial/ Institutional	020100	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2].
				020105	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2].
		1A4b i	Residential	020200	114	DCE estimate based on technology distribution [3]
				020202	114	DCE estimate based on technology distribution [3]
				020204	114	DCE estimate based on technology distribution [3]
		1A4c i	Agriculture/ Forestry	020300	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2].
				020303	30	IPCC (1997), Tier 1, Table 1-7, Industry, wood[2].
	STRAW	1A1a	Electricity and heat production	010101	0.47	Nielsen et al. (2010)
				010102	0.47	Nielsen et al. (2010)
				010103	0.47	Nielsen et al. (2010)
				010104	0.47	Nielsen et al. (2010)
				010203	30	IPCC (1997), Tier 1, Table 1-7, Energy industries, other biomass
		1A4b i	Residential	020200	300	IPCC (1997), Tier 1, Table 1-7, Residential, other biomass.
		1A4c i	Agriculture/ Forestry	020300	300	IPCC (1997), Tier 1, Table 1-7, Agriculture, other biomass.
	BIO OIL	1A1a	Electricity and heat production	010102	0.9	IPCC (1997), Tier 2, Table 1-15, Utility Boiler, distillate fuel oil.
				010105	24	Nielsen et al. (2010) assumed same emission factor as for gas oil fuelled engines.
				010202	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
				010203	0.7	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil.
		1A2	Industry	030105	24	Nielsen et al. (2010) assumed same emission factor as for gas oil fuelled engines.
		1A4b i	Residential	020200	0.7	IPCC (1997), Tier 2, Table 1-18, Residentail, distillate fuel oil.
	BIOGAS	1A1a	Electricity and heat production	010101	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural gas. Assumed similar to natural gas (DCE assumption).
				010102	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural gas. Assumed similar to natural gas (DCE assumption).
				010105	434	Nielsen et al. (2010)
				010203	1	IPCC (1997), Tier 1, Table 1-7, Energy industries, natural

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
						gas. Assumed similar to natural gas (DCE assumption).
		1A2 e-f	Industry	Other	5	IPCC (1997), Tier 1, Table 1-7, Industry, natural gas. Assumed similar to natural gas (DCE assumption).
				Engines	434	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	5	IPCC (1997), Tier 1, Table 1-7, Commercial, natural gas. Assumed similar to natural gas (DCE assumption).
				020103	5	IPCC (1997), Tier 1, Table 1-7, Commercial, natural gas. Assumed similar to natural gas (DCE assumption).
				020105	434	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	5	IPCC (1997), Tier 1, Table 1-7, Agriculture, natural gas. Assumed similar to natural gas (DCE assumption).
				020304	434	Nielsen et al. (2010)
	BIO PROD GAS	1A1a	Electricity and heat production	010105	13	Nielsen et al. (2010)
		1A2	Industry	030105	13	Nielsen et al. (2010)

Assumed same emission factors as for commercial plants. Plant capacity and technology are similar for Danish plants.

Assumed same emission factor as for industrial plants. Plant capacity and technology is similar to industrial plants rather than to residential plants.

Aggregated emission factor based on the technology distribution in the sector (Nielsen et Hessberg 2011) and technology specific emission factors (EEA 2009; DEPA 2010).

In general, the same emission factors have been applied for 1990-2010. However, time-series have been estimated for both natural gas fuelled engines and biogas fuelled engines, residential wood combustion, natural gas fuelled gas turbines[2] and waste incineration plants[2].

Table 3A-4.4 CH_4 emission factors, time-series.

Year	Natural gas fuelled engines Emission factor, g per GJ	Biogas fuelled engines Emission factor, g per GJ	Residential wood combustion, g per GJ	Waste incineration g per GJ	Natural gas fuelled gas turbines, g per GJ
1990	266	239	198.0	0.59	1.5
1991	309	251	198.0	0.59	1.5
1992	359	264	198.0	0.59	1.5
1993	562	276	198.0	0.59	1.5
1994	623	289	198.0	0.59	1.5
1995	632	301	198.0	0.59	1.5
1996	616	305	198.0	0.59	1.5
1997	551	310	198.0	0.59	1.5
1998	542	314	198.0	0.59	1.5
1999	541	318	198.0	0.59	1.5
2000	537	323	198.0	0.59	1.5
2001	522	342	175.0	0.59	1.5
2002	508	360	165.1	0.59	1.6
2003	494	379	161.8	0.59	1.6
2004	479	397	158.2	0.51	1.7
2005	465	416	149.2	0.42	1.7
2006	473	434	138.8	0.34	1.7
2007	481	434	139.1	0.34	1.7
2008	481	434	130.7	0.34	1.7
2009	481	434	120.1	0.34	1.7
2010	481	434	114.0	0.34	1.7

[2] A minor emission source.

Table 3A-4.5 N_2O emission factors and references 2010.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
SOLID	COAL	1A1a	Electricity and heat production	010101	0.8	Elsam (2005)
				010102	0.8	Elsam (2005)
				010204	0.8	Elsam (2005)
		1A2 e-f	Industry	all	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
		1A4c i	Agriculture/ Forestry	020300	1.4	IPCC (1997), Tier 1, Table 1-8, Commercial, coal
	BROWN COAL BRI.	1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
	COKE OVEN COKE	1A2 e-f	Industry	all	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
		1A4b i	Residential	020200	1.4	IPCC (1997), Tier 1, Table 1-8, Residential, coal
	ANODIC CARBON	1A2f	Industry - other	032000	1.4	IPCC (1997), Tier 1, Table 1-8, Industry, coal
LIQUID	PETROLEUM COKE	1A2f	Industry – other	all	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
		1A4b	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential oil
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
				010102	5	Nielsen et al. (2010)
				010103	5	Nielsen et al. (2010)
				010104	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010105	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010202	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
				010203	0.3	IPCC (1997), Tier 2, Table 1-15, Utility, residual fuel oil
		1A1b	Petroleum refining	010306	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 a-f	Industry	all	5	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
				020302	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
				020304	0.3	IPCC (1997), Tier 2, Table 1-19, Commercial, fuel oil
	GAS OIL	1A1a	Electricity and heat production	010101	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010102	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010103	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010104	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010105	2.1	Nielsen et al. (2010)
				010202	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010203	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
		1A1b	Petroleum refining	010306	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 c-f	Industry	Other	0.4	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil boilers
				Turbines	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
				Engines	2.1	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
				020103	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
				020105	2.1	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
				020204	2.1	Nielsen et al. (2010)
		1A4c	Agriculture/ Forestry	020302	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
	KEROSENE	1A2	Industry	all	0.4	IPCC (1997), Tier 2, Table 1-16, Industry, distillate fuel oil boilers
		1A4a	Commercial/ Institutional	020100	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.4	IPCC (1997), Tier 2, Table 1-19, Commercial, distillate fuel oil[1)]
	LPG	1A1a	Electricity and heat production	010101	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010102	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
				010203	0.6	IPCC (1997), Tier 1, Table 1-8, Energy industries, oil
		1A2 a-f	Industry	all	0.6	IPCC (1997), Tier 1, Table 1-8, Industry, oil
		1A4a	Commercial/ Institutional	020100	0.6	IPCC (1997), Tier 1, Table 1-8, Commercial, oil
				020105	0.6	IPCC (1997), Tier 1, Table 1-8, Commercial, oil
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
		1A4c i	Agriculture/ Forestry	020300	0.6	IPCC (1997), Tier 1, Table 1-8, Agriculture, oil
	REFINERY GAS	1A1b	Petroleum refining	010304	1	Assumed equal to natural gas fuelled turbines. Based on Nielsen et al. (2010).
				010306	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010102	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010103	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010104	1	Nielsen et al. (2010)
				010105	0.58	Nielsen et al. (2010)
				010202	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010203	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
		1A1c	Other energy industries	010504	2.2	Nielsen & Illerup (2003)[2)]
		1A2 a-f	Industry	other	0.1	IPCC (1997), Tier 1, Table 1-8, Industry, natural gas

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g per GJ	Reference
				Gas turbines	1	Nielsen et al. (2010)
				Engines	0.58	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers
				020103	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers
				020105	0.58	Nielsen et al. (2010)
		1A4b i	Residential	020200	0.1	IPCC (1997), Tier 1, Table 1-8, Residential, natural gas
				020202	0.1	IPCC (1997), Tier 1, Table 1-8, Residential, natural gas
				020204	0.58	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	2.3	IPCC (1997), Tier 2, Table 1-19, Commercial, natural gas boilers[1)]
				020304	0.58	Nielsen et al. (2010)
WASTE	WASTE	1A1a	Electricity and heat production	010102	1.2	Nielsen et al. (2010)
				010103	1.2	Nielsen et al. (2010)
				010104	1.2	Nielsen et al. (2010)
				010203	1.2	Nielsen et al. (2010)
		1A2 c-f	Industry	all	4	IPCC (1997), Tier 1, Table 1-8, Industry, wastes
		1A4a	Commercial/ Institutional	020103	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wastes
	INDUSTR. WASTE	1A2f	Industry - other	031600	4	IPCC (1997), Tier 1, Table 1-8, Industry, wastes
BIOMASS	WOOD	1A1a	Electricity and heat production	010101	0.8	Nielsen et al. (2010)
				010102	0.8	Nielsen et al. (2010)
				010103	0.8	Nielsen et al. (2010)
				010104	0.8	Nielsen et al. (2010)
				010203	4	IPCC (1997), Tier 1, Table 1-8, Energy industries, wooc
		1A2 d-f	Industry	all	4	IPCC (1997), Tier 1, Table 1-8, Industry, wood
		1A4a	Commercial/ Institutional	020100	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wood
				020105	4	IPCC (1997), Tier 1, Table 1-8, Commercial, wood
		1A4b i	Residential	020200	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
				020202	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
				020204	4	IPCC (1997), Tier 1, Table 1-8, Residential, wood
		1A4c i	Agriculture/ Forestry	020300	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, wood
				020303	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, wood
	STRAW	1A1a	Electricity and heat production	010101	1.1	Nielsen et al. (2010)
				010102	1.1	Nielsen et al. (2010)
				010103	1.1	Nielsen et al. (2010)
				010104	1.1	Nielsen et al. (2010)
				010203	4	IPCC (1997), Tier 1, Table 1-8, Energy industries, other biomass
		1A4b i	Residential	020200	4	IPCC (1997), Tier 1, Table 1-8, Residential, other biomass
		1A4c i	Agriculture/ Forestry	020300	4	IPCC (1997), Tier 1, Table 1-8, Agriculture, other biomass
	BIO OIL	1A1a	Electricity and heat production	010102	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010105	2.1	Assumed equal to gas oil. Based on Nielsen et al. (2010)
				010202	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
				010203	0.4	IPCC (1997), Tier 2, Table 1-15, Utility, distillate fuel oil
		1A2	Industry	030105	2.1	Assumed equal to gas oil. Based on Nielsen et al. (2010)
		1A4b i	Residential	020200	0.6	IPCC (1997), Tier 1, Table 1-8, Residential, oil
	BIOGAS	1A1a	Electricity and heat production	010101	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010102	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
				010105	1.6	Nielsen et al. (2010)
				010203	0.1	IPCC (1997), Tier 1, Table 1-8, Energy industries, natural gas
		1A2 e-f	Industry	Other	0.1	IPCC (1997), Tier 1, Table 1-8, Industry, natural gas
				Engines	1.6	Nielsen et al. (2010)
		1A4a	Commercial/ Institutional	020100	0.1	IPCC (1997), Tier 1, Table 1-8, Commercial, natural gas
				020103	0.1	IPCC (1997), Tier 1, Table 1-8, Commercial, natural gas
				020105	1.6	Nielsen et al. (2010)
		1A4c i	Agriculture/ Forestry	020300	0.1	IPCC (1997), Tier 1, Table 1-8, Agriculture, natural gas
				020304	1.6	Nielsen et al. (2010)
	BIO PROD GAS	1A1a	Electricity and heat production	010105	2.7	Nielsen et al. (2010)
		1A2	Industry	030105	2.7	Nielsen et al. (2010)

In Denmark plants in Agriculture/Forestry are similar to Commercial plants.

Time-series have been estimated for natural gas fuelled gas turbines and refinery gas fuelled gas turbines. All other emission factors have been applied unchanged for 1990-2010.

Table 3A-4.6 N_2O emission factors, time-series.

Year	Natural gas fuelled gas turbines. Emission factor, g per GJ	Refinery gas fuelled gas turbines. Emission factor, g per GJ
1990	2.2	2.2
1991	2.2	2.2
1992	2.2	2.2
1993	2.2	2.2
1994	2.2	2.2
1995	2.2	2.2
1996	2.2	2.2
1997	2.2	2.2
1998	2.2	2.2
1999	2.2	2.2
2000	2.2	2.2
2001	2.0	2.0
2002	1.9	1.9
2003	1.7	1.7
2004	1.5	1.5
2005	1.4	1.4
2006	1.2	1.2
2007	1.0	1.0
2008	1.0	1.0
2009	1.0	1.0
2010	1.0	1.0

Table 3A-4.7 SO_2, NO_x, NMVOC and CO emission factors and references 2010.

					SO_2		NO_x		NM-VOC		CO	
Fuel type	Fuel	NFR	NFR_name	SNAP	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*
BIO-MASS	WOOD	1A1a	Electricity and heat production	010101	1.9	*12*	81	*12*	5.1	*12*	90	*12*
				010102	1.9	*12*	81	*12*	5.1	*12*	90	*12*
				010103	1.9	*12*	81	*12*	5.1	*12*	90	*12*
				010104	1.9	*12*	81	*12*	5.1	*12*	90	*12*
				010203	25	*22, 21*	90	*22, 21, 4*	7.3	*13*	240	*4*
		1A2d	Pulp paper and print	031102	25	*22, 21*	90	*22, 21, 4*	10	*13*	240	*4*
		1A2e	Food processing, beverages and tobacco	030900	25	*22, 21*	90	*22, 21, 4*	10	*13*	240	*4*
				030902	25	*22, 21*	90	*22, 21, 4*	10	*13*	240	*4*
		1A2f	Industry- Other	(all)	25	*22, 21*	90	*22, 21, 4*	10	*13*	240	*4*
		1A4a	Commercial/ Institutional	020100	25	*22, 21*	90	*22, 21, 4*	146	*13*	240	*4*
				020105	25	*22, 21*	90	*22, 21, 4*	146	*13*	240	*4*
		1A4b i	Residential	020200	25	*22, 21*	120	*22*	358.5	*39*	3188	*39*
				020202	25	*22, 21*	120	*22*	358.5	*39*	3188	*39*
				020204	25	*22, 21*	120	*22*	358.5	*39*	3188	*39*
		1A4c i	Agriculture/ Forestry	020300	25	*22, 21*	90	*22, 21, 4*	146	*13*	240	*4*
				020303	25	*22, 21*	90	*22, 21, 4*	146	*13*	240	*4*
	STRAW	1A1a	Electricity and heat production	010101	49	*12*	125	*12*	0.78	*12*	67	*12*
				010102	49	*12*	125	*12*	0.78	*12*	67	*12*
				010103	49	*12*	125	*12*	0.78	*12*	67	*12*
				010104	49	*12*	125	*12*	0.78	*12*	67	*12*
				010203	130	*5*	90	*4, 28*	7.3	*13*	325	*4, 5*
		1A4b i	Residential	020200	130	*5*	90	*4, 28*	400	*13*	4000	*1, 6, 7*
		1A4c i	Agriculture/ Forestry	020300	130	*5*	90	*4, 28*	146	*13*	4000	*1, 6, 7*
	BIO OIL	1A1a	Electricity and heat production	010102	1	*37*	249	*15*	0.8	*13*	15	*15*
				010105	1	*37*	700	*15*	37	*13*	15	*15*
				010202	1	*37*	65	*15*	0.8	*13*	15	*15*
				010203	1	*37*	65	*15*	0.8	*13*	15	*15*
		1A2f	Industry-Other	030105	1	*37*	700	*15*	37	*13*	100	*15*
		1A4b i	Residential	020200	1	*37*	65	*15*	15	*13*	100	*15*
	BIOGAS	1A1a	Electricity and heat production	010101	25	*26*	28	*4*	2	*16*	36	*4*
				010102	25	*26*	28	*4*	2	*16*	36	*4*
				010105	19.2	*31*	202	*12*	10	*12*	310	*12*
				010203	25	*26*	28	*4*	2	*16*	36	*4*
		1A2e	Food processing, beverages and tobacco	030900	25	*26*	28	*4*	2	*16*	36	*4*
				030902	25	*26*	59	*4*	2	*16*	36	*4*
				030903	25	*26*	59	*4*	2	*16*	36	*4*
		1A2f	Industry- Other	030102	25	*26*	59	*4*	2	*16*	36	*4*
				030103	25	*26*	28	*4*	2	*16*	36	*4*
				030105	19.2	*31*	202	*12*	10	*12*	310	*12*
		1A4a	Commercial/ Institutional	020100	25	*26*	28	*4*	2	*16*	36	*4*
				020103	25	*26*	28	*4*	2	*16*	36	*4*
				020105	19.2	*31*	202	*12*	10	*12*	310	*12*
		1A4c i	Agriculture/ Forestry	020300	25	*26*	28	*4*	2	*16*	36	*4*
				020304	19.2	*31*	202	*12*	10	*12*	310	*12*
	BIO PROD GAS	1A1a	Electricity and heat production	010105	1.9	*12*	173	*12*	2	*12*	586	*12*
		1A2f	Industry-Other	030105	1.9	*12*	173	*12*	2	*12*	586	*12*
WASTE	WASTE	1A1a	Electricity and heat production	010102	8.3	*12*	102	*12*	0.56	*12*	3.9	*12*
				010103	8.3	*12*	102	*12*	0.56	*12*	3.9	*12*
				010104	8.3	*12*	102	*12*	0.56	*12*	3.9	*12*
				010203	15	*34*	164	*9*	2	*13*	10	*9*
		1A2c	Chemicals	030600	15	*34*	164	*9*	2	*13*	10	*9*
		1A2d	Pulp, paper and print	031100	15	*34*	164	*9*	2	*13*	10	*9*
		1A2e	Food processing, beverages and tobacco	030900	15	*34*	164	*9*	2	*13*	10	*9*
		1A2f	Industry - Other	(all)	15	*34*	164	*9*	2	*13*	10	*9*
		1A4a	Commercial/ Institutional	020103	15	*34*	164	*9*	2	*13*	10	*9*
	INDISTRIAL WASTE	1A2f	Industry - Other	031600	15	*34*	164	*9*	2	*13*	10	*9*
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.3	*17*	55	*41*	2	*14*	15	*3*
				010102	0.3	*17*	55	*41*	2	*14*	15	*3*
				010103	0.3	*17*	42	*9*	2	*14*	28	*4*
				010104	0.3	*17*	48	*12*	1.6	*12*	4.8	*12*
				010105	0.3	*17*	135	*12*	92	*12*	58	*12*

					SO_2		NO_x		NM-VOC		CO	
Fuel type	Fuel	NFR	NFR_name	SNAP	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*
				010202	0.3	*17*	42	*36*	2	*14*	28	*4*
				010203	0.3	*17*	42	*36*	2	*14*	28	*4*
		1A1c	Other energy industries	010504	0.3	*17*	250	*1, 8, 32*	1.6	*12*	4.8	*12*
		1A2a	Iron and steel	030400	0.3	*17*	42	*36*	2	*14*	28	*4*
				030402	0.3	*17*	42	*36*	2	*14*	28	*4*
		1A2b	Non-ferrous metals	030500	0.3	*17*	42	*36*	2	*14*	28	*4*
		1A2c	Chemicals	030600	0.3	*17*	42	*36*	2	*14*	28	*4*
				030602	0.3	*17*	42	*36*	2	*14*	28	*4*
				030604	0.3	*17*	48	*12*	1.6	*12*	4.8	*12*
		1A2d	Pulp, paper and print	031100	0.3	*17*	42	*36*	2	*14*	28	*4*
				031102	0.3	*17*	42	*36*	2	*14*	28	*4*
		1A2e	Food processing, beverages and tobacco	030900	0.3	*17*	42	*36*	2	*14*	28	*4*
				030902	0.3	*17*	42	*36*	2	*14*	28	*4*
				030904	0.3	*17*	48	*12*	1.6	*12*	4.8	*12*
		1A2f	Industry - Other	030104	0.3	*17*	48	*12*	1.6	*12*	4.8	*12*
				030105	0.3	*17*	135	*12*	92	*12*	58	*12*
				(other)	0.3	*17*	42	*36*	2	*14*	28	*4*
		1A4a	Commercial/ Institutional	020100	0.3	*17*	30	*1,4,11*	2	*14*	28	*4*
				020103	0.3	*17*	30	*1,4,11*	2	*14*	28	*4*
				020105	0.3	*17*	135	*12*	92	*12*	58	*12*
		1A4b i	Residential	020200	0.3	*17*	30	*1,4,11*	4	*11*	20	*11*
				020202	0.3	*17*	30	*1,4,11*	4	*11*	20	*11*
				020204	0.3	*17*	135	*12*	92	*12*	58	*12*
		1A4c i	Agriculture/ Forestry	020300	0.3	*17*	30	*1,4,11*	2	*14*	28	*4*
				020304	0.3	*17*	135	*12*	92	*12*	58	*12*
LIQUID	PETROLEUM COKE	1A1a	Electricity and heat production	010102	605	*20*	95	*38*	10	*38*	61	*38*
		1A2f	Industry - Other	(all)	605	*20*	95	*38*	10	*38*	61	*38*
		1A4b	Residential	020200	605	*20*	50	*1*	484	*13*	1000	*1*
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	218	*18*	138	*18*	2.3	*13*	15	*3*
				010102	218	*18*	138	*18*	0.8	*12*	2.8	*12*
				010103	218	*18*	138	*18*	0.8	*12*	2.8	*12*
				010104	218	*18*	138	*18*	2.3	*13*	15	*3*
				010202	344	*25,10, 24*	142	*4*	2.3	*13*	30	*1*
				010203	344	*25,10, 24*	142	*4*	2.3	*13*	30	*1*
		1A1b	Petroleum refining	010306	537	*33*	142	*4*	2.3	*13*	30	*1*
		1A2a	Iron and steel	030400	344	*25,10, 24*	130	*28*	0.8	*12*	2.8	*12*
		1A2b	Non-ferrous metals	030500	344	*25,10, 24*	130	*28*	0.8	*12*	2.8	*12*
		1A2c	Chemicals	030600	344	*25,10, 24*	130	*28*	0.8	*12*	2.8	*12*
		1A2d	Pulp, paper and print	031100	344	*25,10, 24*	130	*28*	0.8	*12*	2.8	*12*
		1A2e	Food processing, beverages and tobacco	030902	344	*25,10, 24*	136	*12*	0.8	*12*	2.8	*12*
				030903	344	*25,10, 24*	136	*12*	0.8	*12*	2.8	*12*
		1A2f	Industry - other	(all)	344	*25,10, 24*	130	*28*	0.8	*12*	2.8	*12*
		1A4a	Commercial/ Institutional	020100	344	*25,10, 24*	142	*4*	5	*13*	30	*1*
		1A4b i	Residential	020200	344	*25,10, 24*	142	*4*	15	*13*	30	*1*
		1A4c i	Agriculture/ Forestry	020300	344	*25,10, 24*	142	*4*	5	*13*	30	*1*
				020302	344	*25,10, 24*	142	*4*	5	*13*	30	*1*
				020304	344	*25,10, 24*	130	*28*	10	*13*	100	*13*
	GAS OIL	1A1a	Electricity and heat production	010101	23	*27*	249	*18*	0.8	*13*	15	*3*
				010102	23	*27*	249	*18*	0.8	*13*	15	*3*
				010103	23	*27*	65	*28*	0.8	*13*	15	*3*
				010104	23	*27*	350	*9*	0.2	*13*	15	*3*
				010105	23	*27*	942	*12*	37	*13*	130	*12*
				010202	23	*27*	65	*28*	0.8	*13*	30	*1*
				010203	23	*27*	65	*28*	0.8	*13*	30	*1*
		1A1b	Petroleum refining	010306	23	*27*	65	*28*	0.8	*13*	30	*1*
		1A2c	Chemicals	030602	23	*27*	65	*28*	5	*13*	30	*1*
				030604	23	*27*	65	*28*	0.2	*13*	15	*3*
		1A2e	Food processing, beverages and tobacco	030902	23	*27*	65	*28*	5	*13*	30	*1*
		1A2f	Industry - other	030105	23	*27*	942	*12*	37	*13*	130	*12*
				(other)	23	*27*	65	*28*	10	*13*	30	*1*
		1A4a	Commercial/ Institutional	020100	23	*27*	52	*4*	5	*13*	30	*1*
				020103	23	*27*	52	*4*	5	*13*	30	*1*
				020105	23	*27*	942	*12*	37	*13*	130	*12*

					SO_2		NO_x		NM-VOC		CO	
Fuel type	Fuel	NFR	NFR_name	SNAP	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*	g/GJ	*Ref.*
		1A4b i	Residential	020200	23	*27*	52	*4*	15	*13*	43	*1*
				020204	23	*27*	942	*12*	37	*13*	130	*12*
		1A4c	Agriculture/Forestry	020302	23	*27*	52	*4*	5	*13*	30	*1*
	KEROSENE	1A2f	Industry - other	031500	5	*30*	50	*1*	10	*13*	20	*1*
				032000	5	*30*	50	*1*	10	*13*	20	*1*
		1A4a	Commercial/ Institutional	020100	5	*30*	50	*1*	5	*13*	20	*1*
		1A4b i	Residential	020200	5	*30*	50	*1*	15	*13*	20	*1*
		1A4c i	Agriculture/ Forestry	020300	5	*30*	50	*1*	5	*13*	20	*1*
	LPG	1A1a	Electricity and heat production	010101	0.13	*23*	96	*32*	0.8	*13*	25	*1*
				010102	0.13	*23*	96	*32*	0.8	*13*	25	*1*
				010103	0.13	*23*	96	*32*	0.8	*13*	25	*1*
				010203	0.13	*23*	96	*32*	0.8	*13*	25	*1*
		1A2a	Iron and steel	030400	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A2b	Non-ferrous metals	030500	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A2c	Chemicals	030600	0.13	*23*	96	*32*	5	*13*	25	*1*
				030602	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A2d	Pulp, paper and print	031100	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A2e	Food processing, beverages and tobacco	030900	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A2f	Industry - other	(all)	0.13	*23*	96	*32*	5	*13*	25	*1*
		1A4a	Commercial/ Institutional	020100	0.13	*23*	71	*32*	5	*13*	25	*1*
				020105	0.13	*23*	71	*32*	5	*13*	25	*1*
		1A4b i	Residential	020200	0.13	*23*	47	*32*	10	*13*	25	*1*
		1A4c i	Agriculture/ Forestry	020300	0.13	*23*	71	*32*	5	*13*	25	*1*
	REFINERY GAS	1A1b	Petroleum refining	010304	1	*2*	170	*9*	1.4	*35*	6.2	*35*
				010306	1	*2*	80	*40*	1.4	*35*	6.2	*35*
SOLID	ANODE CARBON	1A2f	Industry - other	032000	574	*29*	95	*29*	10	*29*	10	*29*
	COAL	1A1a	Electricity and heat production	010101	10	*18*	30	*18*	1.2	*13*	10	*3*
				010102	10	*18*	30	*18*	1.2	*13*	10	*3*
				010104	10	*18*	30	*18*	1.2	*13*	10	*3*
		1A2e	Food processing, beverages and tobacco	030902 030903	574	*19*	95	*4*	10	*13*	10	*3*
		1A2f	Industry - other	(all)	574	*19*	95	*4*	10	*13*	10	*3*
		1A4b i	Residential	020200	574	*19*	95	*4*	484	*13*	2000	*32*
		1A4c i	Agriculture/ Forestry	020300	574	*19*	95	*4*	88.8	*13*	931	*13*
	BROWN COAL BRI.	1A4b i	Residential	020200	574	*19*	95	*4*	484	*13*	2000	*29*
	COKE OVEN COKE	1A2e	Food processing, beverages and tobacco	030902 030903	574	*19*	95	*4*	10	*13*	10	*29*
		1A2f	Industry - other	(all)	574	*19*	95	*4*	10	*13*	10	*29*
		1A4b i	Residential	020200	574	*19*	95	*4*	484	*13*	2000	*29*

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33. NERI calculation based on plant specific data 2003.
34. NERI calculation based on plant specific data for MSW incineration, district heating plants, 2009.
35. Same emission factor as for natural gas fuelled gas turbines is assumed.
36. Wit, J. d & Andersen, S. D. 2003. Emissioner fra større gasfyrede kedler, Dansk Gasteknisk Center 2003. The emission factor have been assumed to be the average value of the stated interval (NERI assumption).
37. Folkecenter for Vedvarende Energi, 2000. http://www.folkecenter.dk/plant-oil/emission/emission_rapsolie.pdf.
38. Unknown – the emission factor will be updated according to EEA (2009).
39. Aggregated emission factor based on the technology distribution in the sector and guidebook (EEA 2009) emission factors. Technology distribution based on Nielsen & Hessberg (2011).
40. NERI calculation based on plant specific data.
41. DEPA (2003): Miljøministeriets Bekendtgørelse 808 af 25/09/2003, Bekendtgørelse om begrænsning af visse luftforurenende emissioner fra store fyringsanlæg. Danish legislation. Available at: https://www.retsinformation.dk/Forms/R0710.aspx?id=12697 (25-01-2012)

Table 3A-4.8 SO_2, NO_x, NMVOC and CO emission factors time-series, g per GJ.

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	230	234	239	243	248	252	256	260	265	269
			1A2f i	Industry-Other	030105										
			1A4a i	Commercial/Institutional plants	020105	230	234	239	243	248	252	256	260	265	269
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304					248	252	256	260	265	269
		STRAW	1A1a	Electricity and heat production	010200	600	554	508	463						
					010203					417	371	325	325	325	325
			1A4b i	Residential plants	020200	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
					020302					325	325	325	325	325	325
		WOOD	1A1a	Electricity and heat production	010200	400	373	347	320						
					010203					293	267	240	240	240	240
			1A2a	Iron and steel	030400	400	373	347	320	293					
			1A2d	Pulp, Paper and Print	031100	400	373	347	320	293	267	240	240	240	240
			1A2e	Food processing, beverages and tobacco	030900	400	373	347	320	293	267	240	240	240	240
			1A2f i	Industry-Other	030100	400	373	347	320						
					030103					293	267	240	240	240	240
					030700	400	373	347	320	293	267	240	240	240	240
					031000					293	267				240
					031200	400	373	347		293	267	240	240	240	240
					031300	400	373	347	320	293	267	240	240	240	240
					031400	400	373	347	320	293	267	240	240	240	240
					032000	400	373	347	320	293	267	240	240	240	240
			1A4a i	Commercial/Institutional plants	020100	400	373	347	320	293	267	240	240	240	240
			1A4b i	Residential plants	020200	4428.7	4428.7	4428.7	4428.7	4428.7	4428.7	4428.7	4428.7	4428.7	4428.7
					020202										
					020204										
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	400	373	347	320	293	267	240	240	240	240
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
					010105	189	211	212	227	226	222	221	182	182	182
			1A1c	Manufacture of solid fuels and other energy industries	010504	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
			1A2c	Chemicals	030604	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
			1A2e	Food processing, beverages and tobacco	030904										
			1A2f i	Industry-Other	030104					6.2	6.2	6.2	6.2	6.2	6.2
					030105	189	211	212	227	226	222	221	182	182	182
			1A4a i	Commercial/Institutional plants	020104						6.2		6.2		
					020105	189	211	212	227	226	222	221	182	182	182

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			1A4b i	Residential plants	020204		211	212	227	226	222	221	182	182	182
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	189	211	212	227	226	222	221	182	182	182
	WASTE	WASTE	1A1a	Electricity and heat production	010102					7.4	7.4	7.4	7.4	7.4	7.4
					010103					7.4	7.4	7.4	7.4	7.4	7.4
					010104					7.4	7.4	7.4	7.4	7.4	7.4
					010200	100	85	70	55						
					010203					40	25	10	10	10	10
			1A2a	Iron and steel	030400					40	25				
			1A2c	Chemicals	030600	100	85	70	55	40	25	10	10	10	
			1A2d	Pulp, Paper and Print	031100	100	85	70	55	40	25	10	10	10	10
			1A2e	Food processing, beverages and tobacco	030900	100	85	70	55	40	25	10		10	10
			1A2f i	Industry-Other	030700	100	85	70	55	40	25			10	
					031000	100	85	70	55	40	25	10	10	10	10
					031200	100	85			40	25				
					031300	100	85	70	55	40	25	10	10	10	
					031400			70	55	40	25	10	10	10	10
					032000	100	85	70	55	40	25	10	10	10	10
			1A4a i	Commercial/Institutional plants	020100	100	85	70	55	40	25	10	10	10	10
					020103					40	25	10	10	10	10
NMVOC	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	14	14	14	14	14	14	14	14	14	14
			1A2f i	Industry-Other	030105										
			1A4a i	Commercial/Institutional plants	020105	14	14	14	14	14	14	14	14	14	14
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304					14	14	14	14	14	14
		STRAW	1A4b i	Residential plants	020200	925	872.5	820	767	715	663	610	558	505	453
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020302					10	10	10	10	10	10
		WOOD	1A2a	Iron and steel	030400	146	132	119	105	92					
			1A2d	Pulp, Paper and Print	031100	146	132	119	105	92	78	64	51	37	24
			1A2e	Food processing, beverages and tobacco	030900	146	132	119	105	92	78	64	51	37	24
			1A2f i	Industry-Other	030100	146	132	119	105						
					030103					92	78	64	51	37	24
					030700	146	132	119	105	92	78	64	51	37	24
					031000					92	78				24
					031200	146	132	119		92	78	64	51	37	24
					031300	146	132	119	105	92	78	64	51	37	24
					031400	146	132	119	105	92	78	64	51	37	24
					032000	146	132	119	105	92	78	64	51	37	24
			1A4b i	Residential plants	020200	572.5	572.5	572.5	572.5	572.5	572.5	572.5	572.5	572.5	572.5
					020202										
					020204										

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
					010105	60	69	81	127	140	142	138	124	122	122
			1A1c	Manufacture of solid fuels and other energy industries	010504	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
			1A2c	Chemicals	030604	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
			1A2e	Food processing, beverages and tobacco	030904										
			1A2f i	Industry-Other	030104					1.4	1.4	1.4	1.4	1.4	1.4
					030105	60	69	81	127	140	142	138	124	122	122
			1A4a i	Commercial/Institutional plants	020104						1.4		1.4		
					020105	60	69	81	127	140	142	138	124	122	122
			1A4b i	Residential plants	020204		69	81	127	140	142	138	124	122	122
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	60	69	81	127	140	142	138	124	122	122
	LIQUID	RESIDUAL OIL	1A4c i	Agriculture/Forestry/Fishing, Stationary	020304									5	5
	WASTE	WASTE	1A1a	Electricity and heat production	010102					0.98	0.98	0.98	0.98	0.98	0.98
					010103					0.98	0.98	0.98	0.98	0.98	0.98
					010104					0.98	0.98	0.98	0.98	0.98	0.98
NOX	BIOMASS	BIO OIL	1A1a	Electricity and heat production	010200	100	95	90	85						
					010203					80	75	70	65	65	65
		BIOGAS	1A1a	Electricity and heat production	010105	711	696	681	665	650	635	616	597	578	559
			1A2f i	Industry-Other	030105										
			1A4a i	Commercial/Institutional plants	020105	711	696	681	665	650	635	616	597	578	559
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304					650	635	616	597	578	559
		WOOD	1A1a	Electricity and heat production	010203					130	130	130	130	130	90
			1A2a	Iron and steel	030400	130	130	130	130	130					
			1A2d	Pulp, Paper and Print	031100	130	130	130	130	130	130	130	130	130	90
			1A2e	Food processing, beverages and tobacco	030900	130	130	130	130	130	130	130	130	130	90
			1A2f i	Industry-Other	030100	130	130	130	130						
					030102									130	90
					030103					130	130	130	130	130	90
					030700	130	130	130	130	130	130	130	130	130	90
					031000					130	130				90
					031200	130	130	130		130	130	130	130	130	90
					031300	130	130	130	130	130	130	130	130	130	90
					031400	130	130	130	130	130	130	130	130	130	90
					032000	130	130	130	130	130	130	130	130	130	90
			1A4a i	Commercial/Institutional plants	020100	130	130	130	130	130	130	130	130	130	90
					020105									130	90
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	130	130	130	130	130	130	130	130	130	90

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010101					115	115		115		
					010102					115	115			115	115
					010104	161	157	153	149	145	141	138	134	131	127
					010105	276	241	235	214	199	194	193	170	167	167
			1A2c	Chemicals	030604	161	157	153	149	145	141	138	134	131	127
			1A2f i	Industry-Other	030104					145	141	138	134	131	127
					030105	276	241	235	214	199	194	193	170	167	167
			1A4a i	Commercial/Institutional plants	020104						141		134		
					020105	276	241	235	214	199	194	193	170	167	167
			1A4b i	Residential plants	020204		241	235	214	199	194	193	170	167	167
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	276	241	235	214	199	194	193	170	167	167
	LIQUID	GAS OIL	1A1a	Electricity and heat production	010103						75	65	65	65	65
					010105					1247	1196	1145	1094	1044	993
					010200	100	95	90	85						
					010202					80	75	70	65	65	65
					010203					80	75	70	65	65	65
			1A1b	Petroleum refining	010306		95	90	85	80	75	70	65		
			1A2a	Iron and steel	030400	100	95	90	85	80	75	70	65	65	65
			1A2b	Non-ferrous metals	030500	100	95	90	85	80	75	70	65	65	65
			1A2c	Chemicals	030600	100	95	90	85	80	75	70	65	65	65
			1A2d	Pulp, Paper and Print	031100	100	95	90	85	80	75	70	65	65	65
			1A2e	Food processing, beverages and tobacco	030900	100	95	90	85	80	75	70	65	65	65
			1A2f i	Industry-Other	030102					75	75	70	65	65	65
					030103					80	75	70	65	65	65
					030105					1247				1247	1247
					030700	100	95	90	85	80	75	70	65	65	65
					030800	100	95	90	85	80	75	70	65	65	65
					031000	100	95	90	85	80	75	70	65	65	65
					031200	100	95	90	85	80	75	70	65	65	65
					031300	100	95	90	85	80	75	70	65	65	65
					031400	100	95	90	85	80	75	70	65	65	65
					032000	100	95	90	85	80	75	70	65	65	65
			1A4a i	Commercial/Institutional plants	020105					1247	1196	1145	1094	1044	993
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304							1145	1094		
		ORIMULSION	1A1a	Electricity and heat production	010101						138	139	138	138	
		PETROLEUM COKE	1A1a	Electricity and heat production	010102					200	200				
			1A2f i	Industry-Other	030700	200						200	200	200	200

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					030800	200	200	200	200	200	200				200
					031600	200	200	200	200	200	200	200	200	200	200
		REFINERY GAS	1A1b	Petroleum refining	010306	100	100	100	100	80	80	80	80	80	80
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	342	384	294	289						
					010101						239	250	200	177	152
					010102	342	384	294	289	267	239	250	200	177	152
					010103					267	239	250	200	177	152
					010104					267	239	250	200	177	152
					010105					267	239	250	200	177	152
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304									142	142
	SOLID	BROWN COAL BRI.	1A4b i	Residential plants	020200	200	200	200	200	200	200	200	200	200	200
		COAL	1A1a	Electricity and heat production	010100	342	384	294	289						
					010101	342	384	294	289	267	239	250	200	177	152
					010102	342	384	294	289	267	239	250	200	177	152
					010103					267	239	250			
					010104					267	239	250	200		
					010203					200	200	200	200	200	200
			1A2c	Chemicals	030600	200	200	200	200	200	200	200	200	200	200
			1A2e	Food processing, beverages and tobacco	030900	200	200	200	200	200	200	200	200	200	200
					030902						200	200	200	200	200
			1A2f i	Industry-Other	030102					200	200	200	200	200	200
					030103					200	200	200	200	200	200
					030700	200			200	200	200	200	200	200	200
					030800	200	200	200	200	200	200	200	200	200	200
					031300	200	200	200	200	200	200	200	200	200	
					031600	200	200	200	200	200	200	200	200	200	200
					032000				200						
			1A4a i	Commercial/Institutional plants	020100	200	200	200	200	200	200	200	200	200	
			1A4b i	Residential plants	020200	200	200	200	200	200	200	200	200	200	200
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	200	200	200	200	200	200	200	200	200	200
		COKE OVEN COKE	1A2a	Iron and steel	030400	200	200								200
			1A2e	Food processing, beverages and tobacco	030900	200	200	200	200	200	200	200	200	200	200
			1A2f i	Industry-Other	030700	200	200	200	200	200	200	200	200	200	200
					030800	200								200	200
					031300	200	200	200	200	200	200	200	200	200	
					032000	200	200	200	200		200	200	200	200	200

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			1A4b i	Residential plants	020200	200	200	200	200	200	200	200	200	200	200
	WASTE	WASTE	1A1a	Electricity and heat production	010102					134	134	134	134	134	129
					010103					134	134	134	134	134	129
					010104					134	134	134	134	134	129
SO2	LIQUID	GAS OIL	1A1a	Electricity and heat production	010101					94	23	23	23	23	23
					010102					94	23	23	23	23	23
					010104		94	94	94	94	23	23	23	23	23
					010105					94	23	23	23	23	23
					010202					94	23	23	23	23	23
					010203					94	23	23	23	23	23
			1A1b	Petroleum refining	010306		94	94	94	94	23	23	23		
			1A2a	Iron and steel	030400	94	94	94	94	94	23	23	23	23	23
			1A2b	Non-ferrous metals	030500	94	94	94	94	94	23	23	23	23	23
			1A2c	Chemicals	030600	94	94	94	94	94	23	23	23	23	23
			1A2d	Pulp, Paper and Print	031100	94	94	94	94	94	23	23	23	23	23
			1A2e	Food processing, beverages and tobacco	030900	94	94	94	94	94	23	23	23	23	23
			1A2f i	Industry-Other	030102					94	23	23	23	23	23
					030103					94	23	23	23	23	23
					030105					94				23	23
					030700	94	94	94	94	94	23	23	23	23	23
					030800	94	94	94	94	94	23	23	23	23	23
					031000	94	94	94	94	94	23	23	23	23	23
					031200	94	94	94	94	94	23	23	23	23	23
					031300	94	94	94	94	94	23	23	23	23	23
					031400	94	94	94	94	94	23	23	23	23	23
					032000	94	94	94	94	94	23	23	23	23	23
			1A4a i	Commercial/Institutional plants	020100	94	94	94	94	94	23	23	23	23	23
					020102					94		23		23	
					020103					94		23	23	23	23
					020105					94	23	23	23	23	23
			1A4b i	Residential plants	020200	94	94	94	94	94	23	23	23	23	23
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	94	94	94	94	94	23	23	23	23	23
		ORIMULSION	1A1a	Electricity and heat production	010101						149	147	149	149	
		PETROLEUM COKE	1A1a	Electricity and heat production	010102					787	787				
			1A2f i	Industry-Other	030700	787						787	787	787	787
					030800	787	787	787	787	787	787				787
					031600	787	787	787	787	787	787	787	787	787	787

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			1A4a i	Commercial/Institutional plants	020100	787	787	787	787	787	787	787	787	787	787
			1A4b i	Residential plants	020200	787	787	787	787	787	787	787	787	787	787
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	787	787	787	787		787	787	787	787	787
		REFINERY GAS	1A1b	Petroleum refining	010306	1	1	1	1	61	1	1	1	1	1
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	446	470	490	475						
					010101						351	408	344	369	369
					010102	446	470	490	475	543	351	408	344	369	369
					010103					543	351	408	344	369	369
					010104					543	351	408	344	369	369
					010105					543	351	408	344	369	369
					010202					495	495	495	344	344	344
					010203					495	495	495	344	344	344
			1A1b	Petroleum refining	010306	798	798	798	798	537	537	537	537	537	537
			1A2a	Iron and steel	030400	495	495	495	495	495	495	495	344	344	344
			1A2b	Non-ferrous metals	030500	495	495	495	495	495	495	495	344	344	344
			1A2c	Chemicals	030600	495	495	495	495	495	495	495	344	344	344
			1A2d	Pulp, Paper and Print	031100	495	495	495	495	495	495	495	344	344	344
			1A2e	Food processing, beverages and tobacco	030900	495	495	495	495	495	495	495	344	344	344
					030902						495	495	344	344	344
			1A2f i	Industry-Other	030102					495	495	495	344	344	344
					030103					495	495	495	344	344	344
					030700	495	495	495	495	495	495	495	344		344
					030800	495	495	495	495	495	495	495	344	344	344
					031000	495	495	495	495	495	495	495	344	344	344
					031200	495	495	495	495	495	495	495		344	344
					031300	495	495	495	495	495	495	495	344	344	344
					031400	495	495	495	495	495	495	495	344	344	344
					031500	495	495	495	495	495	495	495	344	344	344
					031600	495	495	495	495	495	495	495	344	344	344
					032000	495	495	495	495	495	495	495	344	344	344
			1A4a i	Commercial/Institutional plants	020100	495	495	495	495	495	495	495	344	344	344
			1A4b i	Residential plants	020200	495	495	495	495	495	495	495	344	344	344
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	495	495	495	495	495	495	495	344	344	344
	SOLID	COAL	1A1a	Electricity and heat production	010100	506	571	454	386						
					010101	506	571	454	386	343	312	420	215	263	193
					010102	506	571	454	386	343	312	420	215	263	193
					010103					343	312	420			
					010104					343	312	420	215		

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	WASTE	INDUSTR. WASTES	1A2f i	Industry-Other	031600										
		WASTE	1A1a	Electricity and heat production	010100	138	116	95	73						
					010102					52	30	29	28	26	25
					010103					52	30	29	28	26	25
					010104					52	30	29	28	26	25
					010200	138	131	124	117						
					010203					110	103	95	88	81	74
			1A2a	Iron and steel	030400					110	103				
			1A2c	Chemicals	030600	138	131	124	117	110	103	95	88	81	
			1A2d	Pulp, Paper and Print	031100	138	131	124	117	110	103	95	88	81	74
			1A2e	Food processing, beverages and tobacco	030900	138	131	124	117	110	103	95		81	74
			1A2f i	Industry-Other	030102										
					030700	138	131	124	117	110	103			81	
					030800										
					031000	138	131	124	117	110	103	95	88	81	74
					031200	138	131			110	103				
					031300	138	131	124	117	110	103	95	88	81	
					031400			124	117	110	103	95	88	81	74
					031600										
					032000	138	131	124	117	110	103	95	88	81	74
			1A4a i	Commercial/Institutional plants	020100	138	131	124	117	110	103	95	88	81	74
					020103					110	103	95	88	81	74

Continued

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	273	279	285	292	298	304	310	310	310	310
			1A2f i	Industry-Other	030105		279	285	292	298	304	310	310	310	310
			1A4a i	Commercial/Institutional plants	020105	273	279	285	292	298	304	310	310	310	310
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	273	279	285	292	298	304	310	310	310	310
		STRAW	1A1a	Electricity and heat production	010200										
					010203	325	325	325	325	325	325	325	325	325	325
			1A4b i	Residential plants	020200	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
					020302	325	325	325	325	325	325	4000	325	4000	4000
		WOOD	1A1a	Electricity and heat production	010200										
					010203	240	240	240	240	240	240	240	240	240	240
			1A2a	Iron and steel	030400				240	240					
			1A2d	Pulp, Paper and Print	031100	240	240	240	240	240	240				
			1A2e	Food processing, beverages and tobacco	030900	240	240	240	240	240	240	240	240	240	240

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
			1A2f i	Industry-Other	030100						240	240	240	240	240
					030103	240	240	240	240	240	240	240	240	240	240
					030700	240	240	240	240	240	240	240	240	240	240
					031000	240	240	240	240	240	240	240	240	240	240
					031200	240	240	240	240	240	240	240	240	240	240
					031300	240	240	240	240	240	240	240	240	240	240
					031400	240	240	240	240	240	240	240	240	240	240
					032000	240	240	240	240	240	240	240	240	240	240
			1A4a i	Commercial/Institutional plants	020100	240	240	240	240	240	240	240	240	240	240
			1A4b i	Residential plants	020200	4428.7	4027.3	3887.1	3880.5	3866.9	3734.9	3554.2	3643.8	3498.1	3292.7
					020202						3734.9	3554.2	3643.8	3498.1	3292.7
					020204									3498.1	3292.7
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	240	240	240	240	240	240	240	240	240	240
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8	4.8
					010105	183	163	142	122	101	81	70	58	58	58
			1A1c	Manufacture of solid fuels and other energy industries	010504	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8	4.8
			1A2c	Chemicals	030604	6.2	6.2	6.2	6.2	6.2	6.2				4.8
			1A2e	Food processing, beverages and tobacco	030904	28	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8	4.8
			1A2f i	Industry-Other	030104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8	4.8
					030105	183	163	142	122	101	81	70	58	58	58
			1A4a i	Commercial/Institutional plants	020104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8		
					020105	183	163	142	122	101	81	70	58	58	58
			1A4b i	Residential plants	020204	183	163	142	122	101	81	70	58	58	58
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	183	163	142	122	101	81	70	58	58	58
	WASTE	WASTE	1A1a	Electricity and heat production	010102	8	8	8	8	6.6	5.3	3.9	3.9	3.9	3.9
					010103	8	8	8	8	6.6	5.3	3.9	3.9	3.9	3.9
					010104	8			8			3.9			
					010200										
					010203	10	10	10	10	10	10	10	10	10	10
			1A2a	Iron and steel	030400										
			1A2c	Chemicals	030600	10			10	10	10	10	10	10	10
			1A2d	Pulp, Paper and Print	031100	10			10		10	10	10	10	10
			1A2e	Food processing, beverages and tobacco	030900				10		10	10	10	10	10
			1A2f i	Industry-Other	030700										
					031000	10							10	10	10
					031200										
					031300	10			10	10	10	10	10	10	10

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
					031400	10			10	10	10	10	10	10	10
					032000	10			10		10	10		10	10
			1A4a i	Commercial/Institutional plants	020100	10			10	10					
					020103	10	10	10	10	10	10	10	10	10	10
NMVOC	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	14	13	13	12	11	10	10	10	10	10
			1A2f i	Industry-Other	030105		13	13	12	11	10	10	10	10	10
			1A4a i	Commercial/Institutional plants	020105	14	13	13	12	11	10	10	10	10	10
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	14	13	13	12	11	10	10	10	10	10
		STRAW	1A4b i	Residential plants	020200	400	400	400	400	400	400	400	400	400	400
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020302	10	10	10	10	10	10	146	10	146	146
		WOOD	1A2a	Iron and steel	030400				10	10					
			1A2d	Pulp, Paper and Print	031100	10	10	10	10	10	10				
			1A2e	Food processing, beverages and tobacco	030900	10	10	10	10	10	10	10	10	10	10
			1A2f i	Industry-Other	030100						10	10	10	10	10
					030103	10	10	10	10	10	10	10	10	10	10
					030700	10	10	10	10	10	10	10	10	10	10
					031000	10	10	10	10	10	10	10	10	10	10
					031200	10	10	10	10	10	10	10	10	10	10
					031300	10	10	10	10	10	10	10	10	10	10
					031400	10	10	10	10	10	10	10	10	10	10
					032000	10	10	10	10	10	10	10	10	10	10
			1A4b i	Residential plants	020200	572.5	510.0	484.7	477.9	470.1	446.6	415.9	421.9	401.3	373.4
					020202						446.6	415.9	421.9	401.3	373.4
					020204									401.3	373.4
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
					010105	121	114	108	101	95	88	90	92	92	92
			1A1c	Manufacture of solid fuels and other energy industries	010504	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
			1A2c	Chemicals	030604	1.4	1.4	1.5	1.5	1.6	1.6				1.6
			1A2e	Food processing, beverages and tobacco	030904	2	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
			1A2f i	Industry-Other	030104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
					030105	121	114	108	101	95	88	90	92	92	92
			1A4a i	Commercial/Institutional plants	020104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6		
					020105	121	114	108	101	95	88	90	92	92	92
			1A4b i	Residential plants	020204	121	114	108	101	95	88	90	92	92	92
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	121	114	108	101	95	88	90	92	92	92
	LIQUID	RESIDUAL OIL	1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	5	5	5	5						

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	WASTE	WASTE	1A1a	Electricity and heat production	010102	0.98	0.98	0.98	0.98	0.84	0.7	0.56	0.56	0.56	0.56
					010103	0.98	0.98	0.98	0.98	0.84	0.7	0.56	0.56	0.56	0.56
					010104	0.98			0.98			0.56			
NO_X	BIOMASS	BIO OIL	1A1a	Electricity and heat production	010200										
					010203	65	65	65	65	65	65	65	65	65	65
		BIOGAS	1A1a	Electricity and heat production	010105	540	484	427	371	315	259	202	202	202	202
			1A2f i	Industry-Other	030105		484	427	371	315	259	202	202	202	202
			1A4a i	Commercial/Institutional plants	020105	540	484	427	371	315	259	202	202	202	202
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	540	484	427	371	315	259	202	202	202	202
		WOOD	1A1a	Electricity and heat production	010203	90	90	90	90	90	90	90	90	90	90
			1A2a	Iron and steel	030400				90	90					
			1A2d	Pulp, Paper and Print	031100	90	90	90	90	90	90				
			1A2e	Food processing, beverages and tobacco	030900	90	90	90	90	90	90	90	90	90	90
			1A2f i	Industry-Other	030100						90	90	90	90	90
					030102	90	90					90	90	90	90
					030103	90	90	90	90	90	90	90	90	90	90
					030700	90	90	90	90	90	90	90	90	90	90
					031000	90	90	90	90	90	90	90	90	90	90
					031200	90	90	90	90	90	90	90	90	90	90
					031300	90	90	90	90	90	90	90	90	90	90
					031400	90	90	90	90	90	90	90	90	90	90
					032000	90	90	90	90	90	90	90	90	90	90
			1A4a i	Commercial/Institutional plants	020100	90	90	90	90	90	90	90	90	90	90
					020105		90	90		90	90	90	90	90	90
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	90	90	90	90	90	90	90	90	90	90
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	115	115	115	115	97	97	97	97	55	55
					010102	115	115	115	115	97	97	97	97	55	55
					010104	124	119	113	108	103	98	73	48	48	48
					010105	168	163	158	153	148	143	139	135	135	135
			1A2c	Chemicals	030604	124	119	113	108	103	98				48
			1A2f i	Industry-Other	030104	124	119	113	108	103	98	73	48	48	48
					030105	168	163	158	153	148	143	139	135	135	135
			1A4a i	Commercial/Institutional plants	020104	124	119	113	108	103	98	73	48		
					020105	168	163	158	153	148	143	139	135	135	135
			1A4b i	Residential plants	020204	168	163	158	153	148	143	139	135	135	135
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	168	163	158	153	148	143	139	135	135	135
	LIQUID	GAS OIL	1A1a	Electricity and heat production	010103		65	65	65	65	65	65	65	65	65
					010105	942	942	942	942	942	942	942	942	942	942

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
					010200										
					010202	65	65	65	65	65	65	65	65	65	65
					010203	65	65	65	65	65	65	65	65	65	65
			1A1b	Petroleum refining	010306				65	65	65	65	65	65	65
			1A2a	Iron and steel	030400	65	65	65	65	65	65	65			
			1A2b	Non-ferrous metals	030500	65	65	65	65	65	65	65			
			1A2c	Chemicals	030600	65	65	65	65	65	65	65			
			1A2d	Pulp, Paper and Print	031100	65	65	65	65	65	65	65			
			1A2e	Food processing, beverages and tobacco	030900	65	65	65	65	65	65	65			
			1A2f i	Industry-Other	030102							65	65	65	65
					030103	65	65	65	65	65	65	65	65	65	
					030105	942	942							942	942
					030700	65	65	65	65	65	65	65			
					030800	65	65	65	65	65	65	65			
					031000	65	65	65	65	65	65	65			
					031200	65	65	65	65	65	65	65			
					031300	65	65	65	65	65	65	65			
					031400	65	65	65	65	65	65	65			
					032000	65	65	65	65	65	65	65	65	65	65
			1A4a i	Commercial/Institutional plants	020105	942	942	942	942	942	942	942	942	942	942
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	942	942	942	942		942	942			942
		ORIMUL-SION	1A1a	Electricity and heat production	010101		88	86	86	86					
		PETROLEUM COKE	1A1a	Electricity and heat production	010102										
			1A2f i	Industry-Other	030700	95	95	95	95	95					
					030800	95	95	95	95	95	95		95	95	
					031600	95	95	95	95	95	95	95	95	95	95
		REFINERY GAS	1A1b	Petroleum refining	010306	80	80	80	80	80	80	80	80	80	80
		RESIDUAL OIL	1A1a	Electricity and heat production	010100										
					010101	129	122	130	144	131	127	109	98	138	138
					010102	129	122	130	144	131	127	109	98	138	138
					010103	129	122	130	144	131				138	138
					010104		122	130	144	131	127	109	98	138	138
					010105	129	122	130	144						
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	142	142	142	142						
	SOLID	BROWN COAL BRI.	1A4b i	Residential plants	020200	95	95	95	95					95	95

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		COAL	1A1a	Electricity and heat production	010100										
					010101	129	122	130	144	131	127	109	98	59	39
					010102	129	122	130	144	131	127	109	98	59	39
					010103										
					010104										
					010203	95	95	95	95	95	95		95	95	
			1A2c	Chemicals	030600	95	95	95	95	95	95	95			
			1A2e	Food processing, beverages and tobacco	030900	95	95	95	95	95	95	95	95	95	
					030902	95	95	95	95	95	95	95	95	95	95
			1A2f i	Industry-Other	030102	95	95	95	95	95	95		95	95	95
					030103	95	95	95	95	95	95	95	95	95	95
					030700	95	95		95	95	95	95	95	95	95
					030800	95	95	95	95	95	95	95	95	95	95
					031300	95	95	95	95	95					
					031600	95	95	95	95	95	95	95	95	95	95
					032000										95
			1A4a i	Commercial/Institutional plants	020100					95					
			1A4b i	Residential plants	020200	95	95	95	95	95	95	95	95	95	95
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	95	95	95	95	95	95	95	95	95	95
		COKE OVEN COKE	1A2a	Iron and steel	030400	95	95	95							
			1A2e	Food processing, beverages and tobacco	030900	95	95	95	95	95	95	95	95		
			1A2f i	Industry-Other	030700	95	95	95	95	95	95	95	95	95	95
					030800	95									
					031300				95	95			95	95	95
					032000	95	95	95	95	95	95	95	95	95	95
			1A4b i	Residential plants	020200	95	95	95	95	95	95	95	95	95	95
	WASTE	WASTE	1A1a	Electricity and heat production	010102	124	124	124	124	117	110	102	102	102	102
					010103	124	124	124	124	117	110	102	102	102	102
					010104	124			124			102			
SO_2	LIQUID	GAS OIL	1A1a	Electricity and heat production	010101	23	23	23	23	23	23	23	23	23	23
					010102	23	23	23	23	23	23	23	23	23	23
					010104	23	23	23	23	23	23	23	23	23	23
					010105	23	23	23	23	23	23	23	23	23	23
					010202	23	23	23	23	23	23	23	23	23	23
					010203	23	23	23	23	23	23	23	23	23	23
			1A1b	Petroleum refining	010306				23	23	23	23	23	23	23
			1A2a	Iron and steel	030400	23	23	23	23	23	23	23			
			1A2b	Non-ferrous metals	030500	23	23	23	23	23	23	23			

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
			1A2c	Chemicals	030600	23	23	23	23	23	23	23			
			1A2d	Pulp, Paper and Print	031100	23	23	23	23	23	23	23			
			1A2e	Food processing, beverages and tobacco	030900	23	23	23	23	23	23	23			
			1A2f i	Industry-Other	030102							23	23	23	23
					030103	23	23	23	23	23	23	23	23	23	
					030105	23	23							23	23
					030700	23	23	23	23	23	23	23			
					030800	23	23	23	23	23	23	23			
					031000	23	23	23	23	23	23	23			
					031200	23	23	23	23	23	23	23			
					031300	23	23	23	23	23	23	23			
					031400	23	23	23	23	23	23	23			
					032000	23	23	23	23	23	23	23	23	23	23
			1A4a i	Commercial/Institutional plants	020100	23	23	23	23	23	23	23	23	23	23
					020102										
					020103	23	23	23	23	23	23	23	23	23	23
					020105	23	23	23	23	23	23	23	23	23	23
			1A4b i	Residential plants	020200	23	23	23	23	23	23	23	23	23	23
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	23	23	23	23	23	23	23			
		ORIMUL-SION	1A1a	Electricity and heat production	010101		12	12	12	12					
		PETROLEUM COKE	1A1a	Electricity and heat production	010102										
			1A2f i	Industry-Other	030700	787	605	605	605	605					
					030800	787	605	605	605	605	605		605	605	
					031600	787	605	605	605	605	605	605	605	605	605
			1A4a i	Commercial/Institutional plants	020100	787	605	605	605		605				
			1A4b i	Residential plants	020200	787	605	605	605		605	605	605	605	
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	787	605	605	605						
		REFINERY GAS	1A1b	Petroleum refining	010306	1	1	1	1	1	1	1	1	1	1
		RESIDUAL OIL	1A1a	Electricity and heat production	010100										
					010101	403	315	290	334	349	283	308	206	218	218
					010102	403	315	290	334	349	283	308	206	218	218
					010103	403	315	290	334	349				218	218
					010104		315	290	334	349	283	308	206	218	218
					010105	403	315	290	334						
					010202					344	344	344			
					010203	344	344	344	344	344	344	344		344	344

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
			1A1b	Petroleum refining	010306	537	537	537	537	537	537	537	537	537	537
			1A2a	Iron and steel	030400	344	344	344					344	344	344
			1A2b	Non-ferrous metals	030500	344	344	344	344	344	344	344	344	344	344
			1A2c	Chemicals	030600	344	344	344	344	344	344	344	344		
			1A2d	Pulp, Paper and Print	031100	344	344	344	344	344	344	344	344	344	
			1A2e	Food processing, beverages and tobacco	030900	344	344	344	344	344	344	344	344		
					030902	344	344	344	344	344	344	344	344	344	344
			1A2f i	Industry-Other	030102	344	344	344	344	344	344	344	344	344	
					030103	344	344	344	344	344	344	344			
					030700	344	344	344	344			344	344	344	
					030800	344	344	344	344	344	344	344	344	344	344
					031000	344	344	344					344	344	344
					031200	344	344	344			344	344	344	344	344
					031300	344	344	344	344	344	344	344	344	344	
					031400	344	344	344	344	344	344	344	344	344	344
					031500	344	344	344							
					031600	344	344	344	344	344	344	344	344	344	344
					032000	344	344	344	344	344	344	344	344		
			1A4a i	Commercial/Institutional plants	020100	344	344	344	344	344	344	344	344	344	344
			1A4b i	Residential plants	020200	344	344	344	344	344	344	344	344	344	344
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	344	344	344	344	344	344	344	344	344	344
	SOLID	COAL	1A1a	Electricity and heat production	010100										
					010101	64	47	45	61	42	41	37	40	26	14
					010102	64	47	45	61	42	41	37	40	26	14
					010103										
					010104										
	WASTE	INDUSTR. WASTES	1A2f i	Industry-Other	031600							22	15	15	15
		WASTE	1A1a	Electricity and heat production	010100										
					010102	24	24	24	24	19	14	8.3	8.3	8.3	8.3
					010103	24	24	24	24	19	14	8.3	8.3	8.3	8.3
					010104	24			24			8.3			
					010200										
					010203	67	60	52	45	37	30	22	15	15	15
			1A2a	Iron and steel	030400										
			1A2c	Chemicals	030600	67			45	37	30	22	15	15	15
			1A2d	Pulp, Paper and Print	031100	67			45		30	22	15	15	15
			1A2e	Food processing, beverages and tobacco	030900				45		30	22	15	15	15
			1A2f i	Industry-Other	030102				45	37	30	22	15	15	

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
					030700										
					030800						30	22	15	15	15
					031000	67							15	15	15
					031200										
					031300	67			45	37	30	22	15	15	15
					031400	67			45	37	30	22	15	15	15
					031600	67	60	52	45	37	30				
					032000	67			45		30	22		15	15
			1A4a i	Commercial/Institutional plants	020100	67			45	37					
					020103	67	60	52	45	37	30	22	15	15	15

Continued

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
CO	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	310
			1A2f i	Industry-Other	030105	310
			1A4a i	Commercial/Institutional plants	020105	310
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	310
		STRAW	1A1a	Electricity and heat production	010200	
					010203	325
			1A4b i	Residential plants	020200	4000
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	4000
					020302	
		WOOD	1A1a	Electricity and heat production	010200	
					010203	240
			1A2a	Iron and steel	030400	
			1A2d	Pulp, Paper and Print	031100	
			1A2e	Food processing, beverages and tobacco	030900	240
			1A2f i	Industry-Other	030100	240
					030103	240
					030700	240
					031000	240
					031200	240
					031300	240
					031400	240
					032000	240
			1A4a i	Commercial/Institutional plants	020100	240
			1A4b i	Residential plants	020200	3188.2
					020202	3188.2
					020204	3188.2
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	240

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	4.8
					010105	58
			1A1c	Manufacture of solid fuels and other energy industries	010504	4.8
			1A2c	Chemicals	030604	4.8
			1A2e	Food processing, beverages and tobacco	030904	4.8
			1A2f i	Industry-Other	030104	4.8
					030105	58
			1A4a i	Commercial/Institutional plants	020104	
					020105	58
			1A4b i	Residential plants	020204	58
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	58
	WASTE	WASTE	1A1a	Electricity and heat production	010102	3.9
					010103	3.9
					010104	3.9
					010200	
					010203	10
			1A2a	Iron and steel	030400	
			1A2c	Chemicals	030600	10
			1A2d	Pulp, Paper and Print	031100	10
			1A2e	Food processing, beverages and tobacco	030900	10
			1A2f i	Industry-Other	030700	
					031000	10
					031200	
					031300	10
					031400	10
					032000	
			1A4a i	Commercial/Institutional plants	020100	
					020103	10
NMVOC	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	10
			1A2f i	Industry-Other	030105	10
			1A4a i	Commercial/Institutional plants	020105	10
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	10
		STRAW	1A4b i	Residential plants	020200	400
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020302	
		WOOD	1A2a	Iron and steel	030400	
			1A2d	Pulp, Paper and Print	031100	
			1A2e	Food processing, beverages and tobacco	030900	10

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
			1A2f i	Industry-Other	030100	10
					030103	10
					030700	10
					031000	10
					031200	10
					031300	10
					031400	10
					032000	10
			1A4b i	Residential plants	020200	358.5
					020202	358.5
					020204	358.5
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	1.6
					010105	92
			1A1c	Manufacture of solid fuels and other energy industries	010504	1.6
			1A2c	Chemicals	030604	1.6
			1A2e	Food processing, beverages and tobacco	030904	1.6
			1A2f i	Industry-Other	030104	1.6
					030105	92
			1A4a i	Commercial/Institutional plants	020104	
					020105	92
			1A4b i	Residential plants	020204	92
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	92
	LIQUID	RESIDUAL OIL	1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	10
	WASTE	WASTE	1A1a	Electricity and heat production	010102	0.56
					010103	0.56
					010104	0.56
NO_X	BIOMASS	BIO OIL	1A1a	Electricity and heat production	010200	
					010203	65
		BIOGAS	1A1a	Electricity and heat production	010105	202
			1A2f i	Industry-Other	030105	202
			1A4a i	Commercial/Institutional plants	020105	202
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	202
		WOOD	1A1a	Electricity and heat production	010203	90
			1A2a	Iron and steel	030400	
			1A2d	Pulp, Paper and Print	031100	
			1A2e	Food processing, beverages and tobacco	030900	90

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
			1A2f i	Industry-Other	030100	90
					030102	90
					030103	90
					030700	90
					031000	90
					031200	90
					031300	90
					031400	90
					032000	90
			1A4a i	Commercial/Institutional plants	020100	90
					020105	90
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	90
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	55
					010102	55
					010104	48
					010105	135
			1A2c	Chemicals	030604	48
			1A2f i	Industry-Other	030104	48
					030105	135
			1A4a i	Commercial/Institutional plants	020104	
					020105	135
			1A4b i	Residential plants	020204	135
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	135
	LIQUID	GAS OIL	1A1a	Electricity and heat production	010103	65
					010105	942
					010200	
					010202	65
					010203	65
			1A1b	Petroleum refining	010306	65
			1A2a	Iron and steel	030400	
			1A2b	Non-ferrous metals	030500	
			1A2c	Chemicals	030600	
			1A2d	Pulp, Paper and Print	031100	
			1A2e	Food processing, beverages and tobacco	030900	
			1A2f i	Industry-Other	030102	65
					030103	65
					030105	942
					030700	

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
					030800	
					031000	
					031200	
					031300	
					031400	
					032000	65
			1A4a i	Commercial/Institutional plants	020105	942
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	
		ORIMUL-SION	1A1a	Electricity and heat production	010101	
		PETROLEUM COKE	1A1a	Electricity and heat production	010102	95
			1A2f i	Industry-Other	030700	
					030800	95
					031600	95
		REFINERY GAS	1A1b	Petroleum refining	010306	80
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	
					010101	138
					010102	138
					010103	138
					010104	138
					010105	
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020304	130
	SOLID	BROWN COAL BRI.	1A4b i	Residential plants	020200	95
		COAL	1A1a	Electricity and heat production	010100	
					010101	30
					010102	30
					010103	
					010104	30
					010203	
			1A2c	Chemicals	030600	
			1A2e	Food processing, beverages and tobacco	030900	
					030902	95
			1A2f i	Industry-Other	030102	95
					030103	95
					030700	95
					030800	95

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
					031300	
					031600	95
					032000	95
			1A4a i	Commercial/Institutional plants	020100	
			1A4b i	Residential plants	020200	95
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	95
		COKE OVEN COKE	1A2a	Iron and steel	030400	
			1A2e	Food processing, beverages and tobacco	030900	
			1A2f i	Industry-Other	030700	95
					030800	
					031300	95
					032000	95
			1A4b i	Residential plants	020200	95
	WASTE	WASTE	1A1a	Electricity and heat production	010102	102
					010103	102
					010104	102
SO_2	LIQUID	GAS OIL	1A1a	Electricity and heat production	010101	23
					010102	23
					010104	23
					010105	23
					010202	23
					010203	23
			1A1b	Petroleum refining	010306	23
			1A2a	Iron and steel	030400	
			1A2b	Non-ferrous metals	030500	
			1A2c	Chemicals	030600	
			1A2d	Pulp, Paper and Print	031100	
			1A2e	Food processing, beverages and tobacco	030900	
			1A2f i	Industry-Other	030102	23
					030103	23
					030105	23
					030700	
					030800	
					031000	
					031200	
					031300	
					031400	

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
					032000	23
			1A4a i	Commercial/Institutional plants	020100	23
					020102	
					020103	23
					020105	23
			1A4b i	Residential plants	020200	23
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	
		ORIMUL-SION	1A1a	Electricity and heat production	010101	
		PETROLEUM COKE	1A1a	Electricity and heat production	010102	605
			1A2f i	Industry-Other	030700	
					030800	605
					031600	605
			1A4a i	Commercial/Institutional plants	020100	
			1A4b i	Residential plants	020200	605
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	
		REFINERY GAS	1A1b	Petroleum refining	010306	1
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	
					010101	218
					010102	218
					010103	218
					010104	218
					010105	
					010202	344
					010203	344
			1A1b	Petroleum refining	010306	537
			1A2a	Iron and steel	030400	344
			1A2b	Non-ferrous metals	030500	344
			1A2c	Chemicals	030600	344
			1A2d	Pulp, Paper and Print	031100	344
			1A2e	Food processing, beverages and tobacco	030900	
					030902	344
			1A2f i	Industry-Other	030102	
					030103	
					030700	344
					030800	344
					031000	344

pollutant	fuel_gr	fuel	nfr_id	nfr_name	snap	2010
					031200	344
					031300	344
					031400	344
					031500	
					031600	344
					032000	
			1A4a i	Commercial/Institutional plants	020100	344
			1A4b i	Residential plants	020200	344
			1A4c i	Agriculture/Forestry/Fishing, Stationary	020300	344
	SOLID	COAL	1A1a	Electricity and heat production	010100	
					010101	10
					010102	10
					010103	
					010104	10
	WASTE	INDUSTR. WASTES	1A2f i	Industry-Other	031600	15
		WASTE	1A1a	Electricity and heat production	010100	
					010102	8.3
					010103	8.3
					010104	8.3
					010200	
					010203	15
			1A2a	Iron and steel	030400	
			1A2c	Chemicals	030600	15
			1A2d	Pulp, Paper and Print	031100	15
			1A2e	Food processing, beverages and tobacco	030900	15
			1A2f i	Industry-Other	030102	
					030700	
					030800	15
					031000	15
					031200	
					031300	15
					031400	15
					031600	
					032000	
			1A4a i	Commercial/Institutional plants	020100	
					020103	15

Annex 3A-5 Large point sources

Table 3A-5.1 Large point sources, fuel consumption in 2010 (1A1, 1A2 and 1A4).

nfr_id	lps_id	lps_name	fuel_id	fuel_gr_abbr	Fuel consumption, TJ
1A1a	001	Amagervaerket	102A	COAL	14626
1A1a	001	Amagervaerket	111A	WOOD	2921
1A1a	001	Amagervaerket	117A	STRAW	1905
1A1a	001	Amagervaerket	203A	RESIDUAL OIL	704
1A1a	002	Svanemoellevaerket	204A	GAS OIL	15
1A1a	002	Svanemoellevaerket	301A	NATURAL GAS	2765
1A1a	003	H.C.Oerstedsvaerket	203A	RESIDUAL OIL	12
1A1a	003	H.C.Oerstedsvaerket	204A	GAS OIL	351
1A1a	003	H.C.Oerstedsvaerket	301A	NATURAL GAS	6626
1A1a	004	Kyndbyvaerket	204A	GAS OIL	1131
1A1a	005	Masnedoevaerket	111A	WOOD	89
1A1a	005	Masnedoevaerket	117A	STRAW	563
1A1a	005	Masnedoevaerket	204A	GAS OIL	23
1A1a	007	Stigsnaesvaerket	203A	RESIDUAL OIL	1943
1A1a	007	Stigsnaesvaerket	204A	GAS OIL	17
1A1a	008	Asnaesvaerket	102A	COAL	19883
1A1a	008	Asnaesvaerket	203A	RESIDUAL OIL	648
1A1a	008	Asnaesvaerket	204A	GAS OIL	37
1A1a	010	Avedoerevaerket	102A	COAL	11049
1A1a	010	Avedoerevaerket	111A	WOOD	11204
1A1a	010	Avedoerevaerket	117A	STRAW	1976
1A1a	010	Avedoerevaerket	203A	RESIDUAL OIL	832
1A1a	010	Avedoerevaerket	204A	GAS OIL	6
1A1a	010	Avedoerevaerket	301A	NATURAL GAS	9099
1A1a	011	Fynsvaerket	102A	COAL	21149
1A1a	011	Fynsvaerket	117A	STRAW	2775
1A1a	011	Fynsvaerket	203A	RESIDUAL OIL	193
1A1a	011	Fynsvaerket	309A	BIOGAS	24
1A1a	012	Studstrupvaerket	102A	COAL	25689
1A1a	012	Studstrupvaerket	117A	STRAW	1792
1A1a	012	Studstrupvaerket	203A	RESIDUAL OIL	525
1A1a	012	Studstrupvaerket	204A	GAS OIL	8
1A1a	014	Nordjyllandsvaerket	102A	COAL	28784
1A1a	014	Nordjyllandsvaerket	203A	RESIDUAL OIL	150
1A1a	014	Nordjyllandsvaerket	204A	GAS OIL	0
1A1a	014	Nordjyllandsvaerket	303A	LPG	1
1A1a	018	Skaerbaekvaerket	204A	GAS OIL	16
1A1a	018	Skaerbaekvaerket	301A	NATURAL GAS	13532
1A1a	019	Enstedvaerket	102A	COAL	20773
1A1a	019	Enstedvaerket	111A	WOOD	412
1A1a	019	Enstedvaerket	117A	STRAW	1839
1A1a	019	Enstedvaerket	203A	RESIDUAL OIL	126
1A1a	019	Enstedvaerket	204A	GAS OIL	14
1A1a	019	Enstedvaerket	303A	LPG	0
1A1a	020	Esbjergvaerket	102A	COAL	13943
1A1a	020	Esbjergvaerket	203A	RESIDUAL OIL	208
1A1a	020	Esbjergvaerket	303A	LPG	0
1A1a	022	Oestkraft	102A	COAL	697
1A1a	022	Oestkraft	111A	WOOD	105
1A1a	022	Oestkraft	203A	RESIDUAL OIL	193
1A1a	022	Oestkraft	204A	GAS OIL	20
1A1a	022	Oestkraft	303A	LPG	0
1A1a	025	Horsens Kraftvarmevaerk	114A	WASTE	1006
1A1a	025	Horsens Kraftvarmevaerk	301A	NATURAL GAS	967
1A1a	026	Herningvaerket	111A	WOOD	3699
1A1a	026	Herningvaerket	203A	RESIDUAL OIL	6
1A1a	026	Herningvaerket	204A	GAS OIL	0
1A1a	026	Herningvaerket	215A	BIO OIL	3
1A1a	026	Herningvaerket	301A	NATURAL GAS	779

Continued					
1A1a	026	Herningvaerket	303A	LPG	0
1A1a	027	I/S Vestforbraending	114A	WASTE	5693
1A1a	027	I/S Vestforbraending	204A	GAS OIL	11
1A1a	027	I/S Vestforbraending	301A	NATURAL GAS	26
1A1a	028	Amagerforbraending	111A	WOOD	9
1A1a	028	Amagerforbraending	114A	WASTE	4243
1A1a	028	Amagerforbraending	303A	LPG	66
1A1a	029	Energi Randers Produktion	102A	COAL	442
1A1a	029	Energi Randers Produktion	110A	PETROLEUM COKE	4
1A1a	029	Energi Randers Produktion	111A	WOOD	2988
1A1a	029	Energi Randers Produktion	204A	GAS OIL	75
1A1a	029	Energi Randers Produktion	215A	BIO OIL	55
1A1a	029	Energi Randers Produktion	309A	BIOGAS	8
1A1a	030	Grenaa Kraftvarmevaerk	102A	COAL	565
1A1a	030	Grenaa Kraftvarmevaerk	111A	WOOD	69
1A1a	030	Grenaa Kraftvarmevaerk	117A	STRAW	651
1A1a	030	Grenaa Kraftvarmevaerk	203A	RESIDUAL OIL	26
1A1a	030	Grenaa Kraftvarmevaerk	204A	GAS OIL	4
1A1a	030	Grenaa Kraftvarmevaerk	303A	LPG	0
1A1a	031	Hilleroed Kraftvarmevaerk	301A	NATURAL GAS	2843
1A1a	032	Helsingoer Kraftvarmevaerk	301A	NATURAL GAS	1903
1A1a	036	Kolding Forbraendingsanlaeg TAS	111A	WOOD	231
1A1a	036	Kolding Forbraendingsanlaeg TAS	114A	WASTE	1111
1A1a	036	Kolding Forbraendingsanlaeg TAS	117A	STRAW	6
1A1a	037	Maabjergvaerket	111A	WOOD	600
1A1a	037	Maabjergvaerket	114A	WASTE	1575
1A1a	037	Maabjergvaerket	117A	STRAW	439
1A1a	037	Maabjergvaerket	301A	NATURAL GAS	105
1A1a	038	Soenderborg Kraftvarmevaerk	111A	WOOD	44
1A1a	038	Soenderborg Kraftvarmevaerk	114A	WASTE	708
1A1a	038	Soenderborg Kraftvarmevaerk	301A	NATURAL GAS	869
1A1a	039	I/S Kara Affaldsforbraendingsanlaeg	111A	WOOD	341
1A1a	039	I/S Kara Affaldsforbraendingsanlaeg	114A	WASTE	1826
1A1a	039	I/S Kara Affaldsforbraendingsanlaeg	301A	NATURAL GAS	17
1A1a	040	Viborg Kraftvarme	301A	NATURAL GAS	2380
1A1a	042	I/S Nordforbraending	111A	WOOD	601
1A1a	042	I/S Nordforbraending	114A	WASTE	1072
1A1a	046	Affaldscenter aarhus - Forbraendsanlaegget	114A	WASTE	2485
1A1a	047	I/S Reno Nord	114A	WASTE	1664
1A1a	047	I/S Reno Nord	204A	GAS OIL	6
1A1a	048	Silkeborg Kraftvarmevaerk	204A	GAS OIL	0
1A1a	048	Silkeborg Kraftvarmevaerk	301A	NATURAL GAS	3756
1A1a	050	AffaldPlus+, Naestved Forbraendingsanlaeg	114A	WASTE	1201
1A1a	051	AVV Forbraendingsanlaeg	111A	WOOD	129
1A1a	051	AVV Forbraendingsanlaeg	114A	WASTE	716
1A1a	051	AVV Forbraendingsanlaeg	117A	STRAW	34
1A1a	051	AVV Forbraendingsanlaeg	203A	RESIDUAL OIL	3
1A1a	051	AVV Forbraendingsanlaeg	204A	GAS OIL	2
1A1a	052	Affaldsforbraendingsanlaeg I/S REFA	114A	WASTE	1166
1A1a	053	Svendborg Kraftvarmevaerk	111A	WOOD	33
1A1a	053	Svendborg Kraftvarmevaerk	114A	WASTE	467
1A1a	053	Svendborg Kraftvarmevaerk	301A	NATURAL GAS	4
1A1a	054	Kommunekemi	114A	WASTE	1589
1A1a	054	Kommunekemi	203A	RESIDUAL OIL	130
1A1a	054	Kommunekemi	204A	GAS OIL	40
1A1a	055	I/S Faelles Forbraending	114A	WASTE	328
1A1a	058	I/S Reno Syd	111A	WOOD	48
1A1a	058	I/S Reno Syd	114A	WASTE	639
1A1a	058	I/S Reno Syd	117A	STRAW	7
1A1a	058	I/S Reno Syd	204A	GAS OIL	4
1A1a	059	I/S Kraftvarmevaerk Thisted	111A	WOOD	32
1A1a	059	I/S Kraftvarmevaerk Thisted	114A	WASTE	485

Continued					
1A1a	059	I/S Kraftvarmevaerk Thisted	117A	STRAW	47
1A1a	060	Knudmosevaerket	111A	WOOD	3
1A1a	060	Knudmosevaerket	114A	WASTE	241
1A1a	060	Knudmosevaerket	301A	NATURAL GAS	16
1A1a	061	Affaldplus+, Slagelse Forbr. and DONG Slagelse KVV	114A	WASTE	622
1A1a	061	Affaldplus+, Slagelse Forbr. and DONG Slagelse KVV	117A	STRAW	453
1A1a	065	Haderslev Kraftvarmevaerk	111A	WOOD	40
1A1a	065	Haderslev Kraftvarmevaerk	114A	WASTE	535
1A1a	065	Haderslev Kraftvarmevaerk	117A	STRAW	3
1A1a	065	Haderslev Kraftvarmevaerk	301A	NATURAL GAS	7
1A1a	066	Frederikshavn Affaldskraftvarmevaerk	111A	WOOD	23
1A1a	066	Frederikshavn Affaldskraftvarmevaerk	114A	WASTE	361
1A1a	066	Frederikshavn Affaldskraftvarmevaerk	204A	GAS OIL	2
1A1a	067	Vejen Kraftvarmevaerk	114A	WASTE	296
1A1a	068	Bofa I/S	114A	WASTE	204
1A1a	069	DTU	301A	NATURAL GAS	1105
1A1a	070	AffaldPlus+, Naestved Kraftvarmevaerk	301A	NATURAL GAS	245
1A1a	072	Hjoerring Varmeforsyning	111A	WOOD	464
1A1a	072	Hjoerring Varmeforsyning	301A	NATURAL GAS	119
1A1a	085	L90 Affaldsforbraending	114A	WASTE	2413
1A1a	085	L90 Affaldsforbraending	204A	GAS OIL	6
1A1a	086	Hammel Fjernvarmeselskab	111A	WOOD	21
1A1a	086	Hammel Fjernvarmeselskab	114A	WASTE	308
1A1a	086	Hammel Fjernvarmeselskab	215A	BIO OIL	25
1A1a	087	Koege Kraftvarmevaerk	111A	WOOD	1364
1A1a	087	Koege Kraftvarmevaerk	203A	RESIDUAL OIL	4
1A1a	087	Koege Kraftvarmevaerk	204A	GAS OIL	0
1A1a	088	Skagen Forbraending	111A	WOOD	25
1A1a	088	Skagen Forbraending	114A	WASTE	102
1A1a	090	Odense Kraftvarmevaerk	111A	WOOD	168
1A1a	090	Odense Kraftvarmevaerk	114A	WASTE	2478
1A1a	090	Odense Kraftvarmevaerk	117A	STRAW	2
1A1a	090	Odense Kraftvarmevaerk	204A	GAS OIL	43
1A1a	091	Centralkommunernes Transmissionsselskab F_berg	204A	GAS OIL	411
1A1a	092	Frederikshavn Kraftvarmevaerk	301A	NATURAL GAS	507
1A1a	093	Fjernvarme Fyn, Centrum Varmecentral	301A	NATURAL GAS	102
1A1a	094	Special Waste System	114A	WASTE	48
1A1a	095	Grenaa Forbraending	114A	WASTE	243
1A1b	009	Statoil Raffinaderi	204A	GAS OIL	3
1A1b	009	Statoil Raffinaderi	308A	REFINERY GAS	8432
1A1b	017	Shell Raffinaderi	203A	RESIDUAL OIL	454
1A1b	017	Shell Raffinaderi	308A	REFINERY GAS	5832
1A1c	024	Nybro Gasbehandlingsanlaeg	301A	NATURAL GAS	295
1A2a	033	DanSteel	301A	NATURAL GAS	1223
1A2c	081	Haldor Topsoee	204A	GAS OIL	0
1A2c	081	Haldor Topsoee	301A	NATURAL GAS	556
1A2c	081	Haldor Topsoee	303A	LPG	0
1A2c	084	Cheminova	204A	GAS OIL	2
1A2c	084	Cheminova	301A	NATURAL GAS	997
1A2d	034	Dalum Papir	111A	WOOD	1187
1A2d	034	Dalum Papir	301A	NATURAL GAS	76
1A2e	023	Danisco Grindsted	102A	COAL	420
1A2e	023	Danisco Grindsted	111A	WOOD	4
1A2e	023	Danisco Grindsted	204A	GAS OIL	10
1A2e	023	Danisco Grindsted	301A	NATURAL GAS	51
1A2e	071	Maricogen	301A	NATURAL GAS	1453
1A2e	082	Nordic Sugar Nakskov	102A	COAL	615
1A2e	082	Nordic Sugar Nakskov	107A	COKE OVEN COKE	28
1A2e	082	Nordic Sugar Nakskov	203A	RESIDUAL OIL	608
1A2e	082	Nordic Sugar Nakskov	204A	GAS OIL	4
1A2e	082	Nordic Sugar Nakskov	309A	BIOGAS	40
1A2e	083	Nordic Sugar Nykoebing	102A	COAL	203

Continued					
1A2e	083	Nordic Sugar Nykoebing	107A	COKE OVEN COKE	52
1A2e	083	Nordic Sugar Nykoebing	203A	RESIDUAL OIL	965
1A2e	083	Nordic Sugar Nykoebing	309A	BIOGAS	53
1A2e	089	AarhusKarlshamn Denmark A/S	111A	WOOD	35
1A2e	089	AarhusKarlshamn Denmark A/S	203A	RESIDUAL OIL	1262
1A2f i	045	Aalborg Portland	102A	COAL	2019
1A2f i	045	Aalborg Portland	110A	PETROLEUM COKE	5115
1A2f i	045	Aalborg Portland	115A	INDUSTR. WASTES	1355
1A2f i	045	Aalborg Portland	121A	FOSSIL WASTE	1355
1A2f i	045	Aalborg Portland	203A	RESIDUAL OIL	337
1A2f i	045	Aalborg Portland	204A	GAS OIL	5
1A2f i	076	Rockwool A/S Vamdrup	101A	ANODE CARBON	46
1A2f i	076	Rockwool A/S Vamdrup	102A	COAL	87
1A2f i	076	Rockwool A/S Vamdrup	107A	COKE OVEN COKE	181
1A2f i	076	Rockwool A/S Vamdrup	204A	GAS OIL	1
1A2f i	076	Rockwool A/S Vamdrup	301A	NATURAL GAS	134
1A2f i	077	Rockwool A/S Doense	101A	ANODE CARBON	0
1A2f i	077	Rockwool A/S Doense	107A	COKE OVEN COKE	380
1A2f i	077	Rockwool A/S Doense	204A	GAS OIL	0
1A2f i	077	Rockwool A/S Doense	301A	NATURAL GAS	95
1A2f i	078	Ardagh Glass Holmegaard A/S	204A	GAS OIL	0
1A2f i	078	Ardagh Glass Holmegaard A/S	301A	NATURAL GAS	839
1A2f i	080	Saint-Gobain Isover A/S	301A	NATURAL GAS	104
1A4a i	049	Rensningsanlaegget Lynetten	114A	WASTE	75
1A4a i	049	Rensningsanlaegget Lynetten	204A	GAS OIL	19
1A4a i	049	Rensningsanlaegget Lynetten	309A	BIOGAS	104
Total					324599

Table 3A-5.2 Large point sources, plant specific emissions (IPCC 1A1, 1A2 and 1A4)[1].

nfr_id	lps_id	lps_name	SO_2	NO_x	NMVOC	CO
1A1a	001	Amagervaerket	x	x		
1A1a	002	Svanemoellevaerket		x		
1A1a	003	H.C.Oerstedsvaerket	x	x		
1A1a	004	Kyndbyvaerket	x	x		
1A1a	005	Masnedoevaerket	x	x		
1A1a	007	Stigsnaesvaerket	x	x		
1A1a	008	Asnaesvaerket	x	x		
1A1a	010	Avedoerevaerket	x	x		
1A1a	011	Fynsvaerket	x	x		
1A1a	012	Studstrupvaerket	x	x		
1A1a	014	Nordjyllandsvaerket	x	x		
1A1a	015	Aalborgvaerket				
1A1a	018	Skaerbaekvaerket	x	x		
1A1a	019	Enstedvaerket	x	x		
1A1a	020	Esbjergvaerket	x	x		
1A1a	022	Oestkraft	x	x		
1A1a	025	Horsens Kraftvarmevaerk	x	x		
1A1a	026	Herningvaerket	x	x		x
1A1a	027	I/S Vestforbraending	x	x		
1A1a	028	Amagerforbraending	x	x		x
1A1a	029	Energi Randers Produktion	x	x		
1A1a	030	Grenaa Kraftvarmevaerk	x	x		x
1A1a	031	Hilleroed Kraftvarmevaerk		x		
1A1a	032	Helsingoer Kraftvarmevaerk		x		
1A1a	036	Kolding Forbraendingsanlaeg TAS	x	x	x	x
1A1a	037	Maabjergvaerket	x	x		
1A1a	038	Soenderborg Kraftvarmevaerk	x	x	x	x
1A1a	039	I/S Kara Affaldsforbraendingsanlaeg	x			x
1A1a	040	Viborg Kraftvarme		x		
1A1a	042	I/S Nordforbraending	x	x		x
1A1a	046	Affaldscenter aarhus - Forbraendsanlaegget	x	x	x	
1A1a	047	I/S Reno Nord	x	x		x
1A1a	048	Silkeborg Kraftvarmevaerk		x		
1A1a	050	AffaldPlus+, Naestved Forbraendingsanlaeg	x	x	x	x
1A1a	051	AVV Forbraendingsanlaeg	x	x	x	x
1A1a	052	Affaldsforbraendingsanlaeg I/S REFA	x	x		x
1A1a	053	Svendborg Kraftvarmevaerk	x	x	x	x
1A1a	054	Kommunekemi	x	x		x
1A1a	055	I/S Faelles Forbraending	x	x	x	x
1A1a	058	I/S Reno Syd	x	x		x
1A1a	059	I/S Kraftvarmevaerk Thisted	x	x	x	x
1A1a	060	Knudmosevaerket	x	x		
1A1a	061	Affaldplus+, Slagelse Forbr. and DONG Slagelse KVV	x	x	x	x
1A1a	062	VEGA (Vestforbraending Taastrup)				
1A1a	063	Hadsund Bys Fjernvarmevaerk				
1A1a	064	Aars Fjernvarmeforsyning				
1A1a	065	Haderslev Kraftvarmevaerk	x	x		x
1A1a	066	Frederikshavn Affaldskraftvarmevaerk	x	x		x
1A1a	067	Vejen Kraftvarmevaerk	x	x		
1A1a	068	Bofa I/S	x	x		x
1A1a	069	DTU		x		
1A1a	070	AffaldPlus+, Naestved Kraftvarmevaerk		x		x
1A1a	072	Hjoerring Varmeforsyning		x		x

Continued						
1A1a	085	L90 Affaldsforbraending	x	x		x
1A1a	086	Hammel Fjernvarmeselskab	x	x		x
1A1a	087	Koege Kraftvarmevaerk	x	x		
1A1a	088	Skagen Forbraending	x	x	x	
1A1a	090	Odense Kraftvarmevaerk	x	x		x
1A1a	091	Centralkommunernes Transmissionsselskab F_berg	x	x		
1A1a	092	Frederikshavn Kraftvarmevaerk	x	x		
1A1a	094	Special Waste System	x	x	x	x
1A1b	009	Statoil Raffinaderi	x	x		
1A1b	017	Shell Raffinaderi	x	x		
1A1c	024	Nybro Gasbehandlingsanlaeg		x		
1A2a	033	DanSteel		x		
1A2c	081	Haldor Topsoee				
1A2c	084	Cheminova		x		
1A2d	034	Dalum Papir		x		
1A2e	023	Danisco Grindsted	x	x		
1A2e	035	Danisco Sugar Assens				
1A2e	071	Maricogen		x		
1A2e	082	Nordic Sugar Nakskov	x			
1A2e	083	Nordic Sugar Nykoebing	x			
1A2e	089	AarhusKarlshamn Denmark A/S	x	x		
1A2f i	045	Aalborg Portland	x	x		x
1A2f i	076	Rockwool A/S Vamdrup	x	x		
1A2f i	077	Rockwool A/S Doense	x	x		
1A2f i	078	Ardagh Glass Holmegaard A/S		x		x
1A2f i	080	Saint-Gobain Isover A/S		x		
1A4a i	049	Rensningsanlaegget Lynetten	x	x	x	x
Grand Total			5178	17908	1.1	1551
Share of total emission from stationary combustion, %			51%	44%	0.01%	1.00%

1) Emissions of the pollutants marked with “x” are plant specific. Emission of other pollutants is estimated based on emission factors. The total shown *in this table* only includes plant specific data.

Annex 3A-6 Adjustment of CO_2 emission

Table 3A-6.1 Adjustment of CO_2 emission (ref. DEA, 2011b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Actual Degree Days	Degree days	2857	3284	3022	3434	3148	3297	3837	3236	3217	3056
Normal Degree Days	Degree days	3379	3380	3 359	3 365	3 366	3 378	3 395	3 389	3 375	3 339
Net electricity import	PJ	25	-7	13	4	-17	-3	-55	-26	-16	-8
Actual CO_2 emission	1 000 000 tonnes	37.6	47.3	41.5	43.7	47.2	43.9	57.0	47.2	43.4	40.1
Adjusted CO_2 emission	1 000 000 tonnes	43.9	45.7	44.4	44.7	43.4	43.3	44.0	41.3	39.7	38.2
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Actual Degree Days	Degree days	2902	3279	3011	3150	3113	3068	2908	2807	2853	3061
Normal Degree Days	Degree days	3 304	3 289	3 273	3 271	3 261	3 224	3 188	3 136	3 120	3 127
Net electricity import	PJ	2	-2	-7	-31	-10	5	-25	-3	5.2	1.2
Actual CO_2 emission	1 000 000 tonnes	36.2	37.8	37.4	42.1	36.1	32.4	40.0	34.5	31.7	30.9
Adjusted CO_2 emission	1 000 000 tonnes	36.9	37.4	35.8	35.3	33.9	33.5	34.4	33.8	32.9	31.2

Continued		2010
Actual Degree Days	Degree days	3742
Normal Degree Days	Degree days	3 171
Net electricity import	PJ	-4.1
Actual CO2 emission	1 000 000 tonnes	31.2
Adjusted CO2 emission	1 000 000 tonnes	30.3

Annex 3A-7 Uncertainty estimates

Table 3A-7.1 Uncertainty estimation, tier 1.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncer-tainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	23834	15224	0.9	0.5	1.030	0.493	-0.124	0.401	-0.062	0.511	0.515
Stationary Combustion, BKB	CO_2	11	3	3.0	5	5.831	0.000	-0.000	0.000	-0.001	0.000	0.001
Stationary Combustion, Coke	CO_2	138	84	1.9	5	5.340	0.014	-0.001	0.002	-0.004	0.006	0.007
Stationary Combustion, Fosssil waste	CO_2	573	1410	5.0	10	11.180	0.496	0.025	0.037	0.245	0.263	0.359
Stationary Combustion, Petroleum coke	CO_2	410	477	5.0	5	7.068	0.106	0.004	0.013	0.018	0.089	0.091
Stationary Combustion, Residual oil	CO_2	2440	880	1.0	2	2.224	0.062	-0.031	0.023	-0.061	0.032	0.069
Stationary Combustion, Gas oil	CO_2	4547	1577	2.4	4	4.688	0.233	-0.059	0.042	-0.235	0.144	0.276
Stationary Combustion, Kerosene	CO_2	366	4	2.8	5	5.706	0.001	-0.008	0.000	-0.040	0.000	0.040
Stationary Combustion, LPG	CO_2	164	89	2.2	5	5.477	0.015	-0.001	0.002	-0.006	0.007	0.010
Stationary Combustion, Refinery gas	CO_2	816	817	1.0	2	2.236	0.057	0.004	0.022	0.007	0.030	0.031
Stationary Combustion, Natural gas	CO_2	4335	10607	1.0	0	1.100	0.367	0.184	0.280	0.073	0.405	0.412
Stationary Combustion, SOLID, CH_4	CH_4	13	4	1.0	100	100.005	0.014	-0.000	0.000	-0.017	0.000	0.017
Stationary Combustion, LIQUID, CH_4	CH_4	3	1	1.1	100	100.007	0.004	-0.000	0.000	-0.003	0.000	0.003
Stationary Combustion, GAS, CH_4	CH_4	3	7	1.0	100	100.005	0.021	0.000	0.000	0.011	0.000	0.011
Natural gas fuelled engines, GAS, CH_4	CH_4	5	234	1.0	2	2.236	0.016	0.006	0.006	0.012	0.009	0.015
Stationary Combustion, WASTE, CH_4	CH_4	1	1	5.0	100	100.125	0.004	0.000	0.000	0.002	0.000	0.002
Stationary Combustion, BIOMASS, CH_4	CH_4	97	133	12.8	100	100.822	0.421	0.001	0.004	0.136	0.064	0.150
Biogas fuelled engines, BIOMASS, CH_4	CH_4	1	28	3.8	10	10.703	0.009	0.001	0.001	0.007	0.004	0.008
Stationary Combustion, SOLID, N_2O	N_2O	68	42	1.0	400	400.001	0.523	-0.000	0.001	-0.164	0.001	0.164
Stationary Combustion, LIQUID, N_2O	N_2O	43	14	1.1	1000	1000.001	0.432	-0.001	0.000	-0.584	0.001	0.584
Stationary Combustion, GAS, N_2O	N_2O	16	36	1.0	750	750.001	0.842	0.001	0.001	0.434	0.001	0.434
Stationary Combustion, WASTE, N_2O	N_2O	7	16	5.0	400	400.031	0.197	0.000	0.000	0.107	0.003	0.107
Stationary Combustion, BIOMASS, N_2O	N_2O	38	93	12.6	400	400.198	1.175	0.002	0.002	0.649	0.044	0.651
Total		37928.266	31780.168				3.464					1.670
Total uncertainties			Overall uncertainty i the year (%):				1.861				Trend uncertainty (%):	1.292

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncer-tainty	Uncertainty in trend in national emissions introduced by activity data uncer-tainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO_2	Gg CO_2	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	23834	15224	0.9	0.5	1.030	0.503	-0.119	0.405	-0.060	0.515	0.518
Stationary Combustion, BKB	CO_2	11	3	3.0	5	5.831	0.000	-0.000	0.000	-0.001	0.000	0.001
Stationary Combustion, Coke	CO_2	138	84	1.9	5	5.340	0.014	-0.001	0.002	-0.004	0.006	0.007
Stationary Combustion, Fosssil waste	CO_2	573	1410	5.0	10	11.180	0.506	0.025	0.037	0.248	0.265	0.363
Stationary Combustion, Petroleum coke	CO_2	410	477	5.0	5	7.068	0.108	0.004	0.013	0.018	0.090	0.091
Stationary Combustion, Residual oil	CO_2	2440	880	1.0	2	2.224	0.063	-0.030	0.023	-0.061	0.032	0.069
Stationary Combustion, Gas oil	CO_2	4547	1577	2.4	4	4.688	0.237	-0.058	0.042	-0.232	0.145	0.274
Stationary Combustion, Kerosene	CO_2	366	4	2.8	5	5.706	0.001	-0.008	0.000	-0.040	0.000	0.040
Stationary Combustion, LPG	CO_2	164	89	2.2	5	5.477	0.016	-0.001	0.002	-0.006	0.007	0.010
Stationary Combustion, Refinery gas	CO_2	816	817	1.0	2	2.236	0.059	0.004	0.022	0.007	0.031	0.032
Stationary Combustion, Natural gas	CO_2	4335	10607	1.0	0	1.100	0.374	0.186	0.282	0.074	0.408	0.415
Total	CO_2	37634	31172				0.724					0.664
Total uncertainties						Overall uncertainty i the year (%):	0.851				Trend uncertainty (%):	0.815

PCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncer-tainty	Uncertainty in trend in national emissions introduced by activity data uncer-tainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg CH_4	Mg CH_4	%	%	%	%	%	%	%	%	%
Stationary Combustion, SOLID, CH_4	CH_4	613	208	1.0	100	100.005	1.070	-0.314	0.036	-31.352	0.049	31.352
Stationary Combustion, LIQUID, CH_4	CH_4	133	62	1.1	100	100.007	0.318	-0.065	0.011	-6.496	0.017	6.496
Stationary Combustion, GAS, CH_4	CH_4	149	320	1.0	100	100.005	1.649	-0.030	0.055	-3.016	0.078	3.017
Natural gas fuelled engines, GAS, CH_4	CH_4	221	11138	1.0	2	2.236	1.282	1.781	1.907	3.562	2.697	4.468
Stationary Combustion, WASTE, CH_4	CH_4	37	65	5.0	100	100.125	0.336	-0.010	0.011	-0.983	0.079	0.986
Stationary Combustion, BIOMASS, CH_4	CH_4	4616	6323	12.8	100	100.822	32.809	-1.536	1.083	-153.583	19.674	154.838
Biogas fuelled engines, BIOMASS, CH_4	CH_4	70	1316	3.8	10	10.703	0.725	0.185	0.225	1.852	1.216	2.215
Total	CH_4	5839	19432				1082.659					25034.759
Total uncertainties				Overall uncertainty i the year (%):			32.904				Trend uncertainty (%):	158.224

PCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg N_2O	Mg N_2O	%	%	%	%	%	%	%	%	%
Stationary Combustion, SOLID, N_2O	N_2O	220	134	1.0	400	400.001	83.140	-0.219	0.242	-87.414	0.331	87.415
Stationary Combustion, LIQUID, N_2O	N_2O	138	44	1.1	1000	1000.001	68.619	-0.210	0.080	-209.662	0.129	209.662
Stationary Combustion, GAS, N_2O	N_2O	53	115	1.0	750	750.001	133.754	0.097	0.208	72.375	0.293	72.376
Stationary Combustion, WASTE, N_2O	N_2O	21	51	5.0	400	400.031	31.385	0.047	0.091	18.677	0.646	18.689
Stationary Combustion, BIOMASS, N_2O	N_2O	122	301	12.6	400	400.198	186.788	0.286	0.543	114.261	9.667	114.669
Total	N_2O	554	645				65385.460					70335.989
Total uncertainties				Overall uncertainty i the year (%):			255.706				Trend uncertainty (%):	265.209

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertarinty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg SO_2	Mg SO_2	%	%	%	%	%	%	%	%	%
01	SO_2	127249	3941	2	10	10.198	3.983	-0.028	0.025	-0.279	0.072	0.288
02	SO_2	11485	2801	2	20	20.100	5.579	0.013	0.018	0.265	0.051	0.270
03	SO_2	16155	3349	2	10	10.198	3.385	0.015	0.022	0.148	0.061	0.160
Total	SO_2	154888	10091				58.445					0.181
Total uncertainties						Overall uncertainty i the year (%):	7.645				Trend uncertainty (%):	0.426

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg NOx	Mg NOx	%	%	%	%	%	%	%	%	%
01	NOx	94790	26707	2	20	20.100	13.218	-0.057	0.232	-1.147	0.655	1.320
02	NOx	7451	8138	2	50	50.040	10.027	0.048	0.071	2.389	0.200	2.397
03	NOx	13109	5768	2	20	20.100	2.855	0.010	0.050	0.200	0.141	0.245
Total	NOx	115350	40613				283.391					7.550
Total uncertainties						Overall uncertainty i the year (%):	16.834				Trend uncertainty (%):	2.748

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg NMVOC	Mg NMVOC	%	%	%	%	%	%	%	%	%
01	NMVOC	496	2445	2	50	50.040	6.667	0.128	0.175	6.422	0.496	6.441
02	NMVOC	12361	15607	2	50	50.040	42.552	-0.046	1.118	-2.301	3.163	3.912
03	NMVOC	1100	301	2	50	50.040	0.821	-0.082	0.022	-4.099	0.061	4.100
Total	NMVOC	13957	18354				1855.774					73.598
Total uncertainties				Overall uncertainty i the year (%):			43.079			Trend uncertainty (%):		8.579

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg CO	Mg CO	%	%	%	%	%	%	%	%	%
01	CO	8105	11484	2	20	20.100	1.482	0.015	0.086	0.304	0.243	0.389
02	CO	120675	140427	2	50	50.040	45.123	-0.003	1.052	-0.133	2.976	2.979
03	CO	4704	3817	2	20	20.100	0.493	-0.013	0.029	-0.250	0.081	0.263
Total	CO	133484	155728				2038.560					9.092
Total uncertainties				Overall uncertainty i the year (%):			45.150			Trend uncertainty (%):		3.015

Table 3A-7.2 Uncertainty estimation for GHG 2010, tier 2.

Category	Parameter	Below 2.5%	Above 97.5%	Difference	Below 2.5%	Above 97.5%	Difference	Median	Below 2.5%	Above 97.5%	Difference
all	all							31917.7	31524.6	32548.7	1024.0
1A1+1A2+1A4 St.comb, N_2O	all							292.9	78.4	881.2	802.8
1A1+1A2+1A4 St.comb, CO_2	all							31173.9	30918.0	31437.5	519.5
1A1+1A2+1A4 St.comb, CH_4	all							408.5	328.2	603.2	275.0
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, BIOMASS, N_2O	97.49	124.56	27.08	0.07	5.58	5.51	84.99	7.92	618.47	610.56
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, GAS, N_2O	184.86	188.50	3.64	0.01	2.18	2.18	32.51	1.45	407.16	405.71
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Coal, CO_2	161.12	164.02	2.90	93.20	94.12	0.92	15223.59	15073.72	15382.49	308.77
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Fossil waste, CO_2	16.27	17.95	1.68	74.78	90.90	16.12	1409.06	1262.45	1569.22	306.78
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, SOLID, N_2O	161.73	164.88	3.15	0.02	1.73	1.71	38.21	3.12	283.34	280.22
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, BIOMASS, CH_4	94.17	121.39	27.22	0.49	3.06	2.57	131.75	51.97	328.20	276.23
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Natural gas, CO_2	184.82	188.57	3.75	56.60	57.05	0.45	10608.25	10491.50	10724.44	232.94
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, LIQUID, N_2O	52.75	53.95	1.19	0.01	3.67	3.66	12.40	0.39	195.60	195.21
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Gas oil, CO_2	20.80	21.83	1.03	71.15	76.99	5.85	1577.35	1505.56	1651.67	146.11
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, WASTE, N_2O	36.25	39.98	3.74	0.03	2.81	2.78	14.44	1.23	106.80	105.57
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Refinery gas, CO_2	14.12	14.40	0.27	54.54	60.15	5.60	816.14	777.49	858.80	81.32
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Petroleum coke, CO_2	4.88	5.38	0.50	88.72	97.91	9.20	477.26	445.75	511.81	66.06
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Residual oil, CO_2	11.09	11.30	0.21	77.05	80.17	3.12	879.80	860.77	899.45	38.67
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, GAS, CH_4	161.92	165.15	3.23	0.02	0.11	0.09	6.74	2.64	17.48	14.83
1A1+1A2+1A4 St.comb, CH_4	Natural gas fuelled engines, GAS, CH_4	22.93	23.38	0.45	9.91	10.30	0.39	233.88	228.89	239.15	10.27
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, LPG, CO_2	1.38	1.44	0.06	60.12	66.22	6.10	88.88	84.17	93.74	9.57
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, SOLID, CH_4	161.78	164.84	3.06	0.01	0.07	0.06	4.31	1.70	10.81	9.11
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Coke, CO_2	0.71	0.74	0.03	110.47	121.97	11.50	84.13	79.78	88.66	8.88
1A1+1A2+1A4 St.comb, CH_4	Biogas fuelled engines, BIOMASS, CH_4	2.92	3.15	0.23	8.25	10.03	1.78	27.65	24.88	30.71	5.83
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, WASTE, CH_4	36.20	39.99	3.79	0.01	0.09	0.08	1.37	0.54	3.43	2.89
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, LIQUID, CH_4	52.75	53.95	1.19	0.01	0.06	0.05	1.30	0.51	3.33	2.81
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Kerosene, CO_2	0.05	0.06	0.00	68.48	75.47	6.99	3.89	3.67	4.11	0.44
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, BKB, CO_2	0.03	0.03	0.00	90.05	99.34	9.29	2.58	2.44	2.73	0.29

Annex 3A-8 Emission inventory 2010 based on SNAP sectors

Table 3A-8.1 Emission inventory 2010 based on SNAP sectors.

SNAP	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2 [1)] [Gg]	N_2O [Mg]
1	3940.66	26707.39	2445.28	11010.49	11483.63	32517.29	344.67
101	2613.4	16136.21	2251.23	10507.63	6951.29	27202.24	249.7
10100	0	0	0	0	0	0	0
10101	1668.1	5998.1	249.57	160.31	2539.69	16872.81	136.91
10102	646.93	3549.91	66.44	40.43	1032.19	4198.76	39.32
10103	166.96	1157.64	9.29	7.7	225.56	1357.77	14.44
10104	87.52	2303.68	106.2	86.37	1293.08	3468.34	43.91
10105	43.9	3126.88	1819.73	10212.82	1860.77	1304.55	15.13
102	1050.38	2538.06	131.39	441.88	4305	2969.46	65.85
10200	0	0	0	0	0	0	0
10201	0	0	0	0	0	0	0
10202	33.74	113.49	3.37	1.09	65.85	150.22	0.55
10203	1016.64	2424.57	128.02	440.79	4239.16	2819.24	65.3
10204	0	0	0	0	0	0	0
10205	0	0	0	0	0	0	0
103	269.08	1543.53	21.02	16.73	102.41	854.05	3.09
10300	0	0	0	0	0	0	0
10301	0	0	0	0	0	0	0
10302	0	0	0	0	0	0	0
10303	0	0	0	0	0	0	0
10304	1.7	255.8	2.15	2.61	9.51	89.34	1.53
10305	0	0	0	0	0	0	0
10306	267.38	1287.73	18.88	14.13	92.9	764.71	1.55
104	0	0	0	0	0	0	0
10400	0	0	0	0	0	0	0
10401	0	0	0	0	0	0	0
10402	0	0	0	0	0	0	0
10403	0	0	0	0	0	0	0
10404	0	0	0	0	0	0	0
10405	0	0	0	0	0	0	0
10406	0	0	0	0	0	0	0
10407	0	0	0	0	0	0	0
105	7.81	6489.59	41.64	44.25	124.93	1491.54	26.03
10500	0	0	0	0	0	0	0
10501	0	0	0	0	0	0	0
10502	0	0	0	0	0	0	0
10503	0	0	0	0	0	0	0

SNAP	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2 [1)] [Gg]	N_2O [Mg]
10504	7.81	6489.59	41.64	44.25	124.93	1491.54	26.03
10505	0	0	0	0	0	0	0
10506	0	0	0	0	0	0	0
2	2800.92	8137.99	15607.22	7797.91	140427.3	9122.51	222.15
201	122.94	836.56	262.08	661.67	903.9	1132.95	34.12
20100	108.08	608.19	182.98	50.07	665.52	1017.47	32.34
20101	0	0	0	0	0	0	0
20102	0	0	0	0	0	0	0
20103	4.55	12.67	0.46	2.9	30.56	26.56	0.48
20104	0	0	0	0	0	0	0
20105	10.3	215.7	78.63	608.7	207.82	88.92	1.3
20106	0	0	0	0	0	0	0
202	1665.65	6614.61	14859.91	5796.23	130609.1	7375.77	172.36
20200	1664.71	6437.29	14753.03	5248.43	130528.2	7302.48	171.64
20201	0	0	0	0	0	0	0
20202	0.11	4.03	1.57	0.95	12.06	7.27	0.02
20203	0	0	0	0	0	0	0
20204	0.83	173.29	105.31	546.85	68.88	66.02	0.7
20205	0	0	0	0	0	0	0
203	1012.34	686.82	485.23	1340	8914.32	613.78	15.67
20300	997.63	426.72	387.99	594.82	8663.82	505.03	14.1
20301	0	0	0	0	0	0	0
20302	2.07	0.92	0.04	0.01	0.22	0.57	0
20303	0.01	0.04	0.07	0.01	0.11	0.05	0
20304	12.64	259.15	97.14	745.16	250.17	108.14	1.57
20305	0	0	0	0	0	0	0
3	3349.03	5768.07	341.92	623.7	3829.78	4313.12	78.16
301	129.16	427.02	84.01	370.45	335.25	436.05	8.76
30100	0.81	5.88	0.46	0.58	9.61	7.57	0.13
30101	0	0	0	0	0	0	0
30102	35.92	55.29	5.99	8.73	133.93	67.05	2.26
30103	90.54	76.08	6.9	8.85	122.83	94.32	2
30104	1.17	187.5	6.25	6.64	18.75	221.61	3.91
30105	0.7	99.39	64.28	345.56	48.22	41.62	0.44
30106	0.02	2.87	0.14	0.1	1.91	3.88	0.01
304	3.1	124.91	3.12	2.18	43.33	88.44	0.2
30400	2.73	15.01	0.68	0.47	9.09	19.06	0.07
30401	0	0	0	0	0	0	0
30402	0.37	109.9	2.45	1.71	34.24	69.38	0.12
30403	0	0	0	0	0	0	0
30404	0	0	0	0	0	0	0

SNAP	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2 [1)] [Gg]	N_2O [Mg]
30405	0	0	0	0	0	0	0
30406	0	0	0	0	0	0	0
305	8.03	7.93	0.25	0.19	3.34	8.43	0.13
30500	8.03	7.93	0.25	0.19	3.34	8.43	0.13
30501	0	0	0	0	0	0	0
30502	0	0	0	0	0	0	0
30503	0	0	0	0	0	0	0
30504	0	0	0	0	0	0	0
30505	0	0	0	0	0	0	0
30506	0	0	0	0	0	0	0
306	123.9	230.83	4.22	4.23	38.22	151.51	2.97
30600	123.73	74.13	1.51	1.75	17.82	63.21	1.91
30601	0	0	0	0	0	0	0
30602	0.17	23.4	1.11	0.78	15.58	31.58	0.06
30603	0	0	0	0	0	0	0
30604	0	133.3	1.6	1.7	4.82	56.72	1
30605	0	0	0	0	0	0	0
30606	0	0	0	0	0	0	0
307	391.82	314.57	16.15	13.2	161.19	373.66	2.97
30700	391.82	314.57	16.15	13.2	161.19	373.66	2.97
30701	0	0	0	0	0	0	0
30702	0	0	0	0	0	0	0
30703	0	0	0	0	0	0	0
30704	0	0	0	0	0	0	0
30705	0	0	0	0	0	0	0
30706	0	0	0	0	0	0	0
308	83.13	124.25	5.1	8.76	71.15	134.36	1.94
30800	83.13	124.25	5.1	8.76	71.15	134.36	1.94
30801	0	0	0	0	0	0	0
30802	0	0	0	0	0	0	0
30803	0	0	0	0	0	0	0
30804	0	0	0	0	0	0	0
30805	0	0	0	0	0	0	0
30806	0	0	0	0	0	0	0
309	991.95	1060.84	33.66	36.28	312.69	999.6	18.94
30900	4.92	417.8	19.54	15.82	270.11	554.18	1.29
30901	0	0	0	0	0	0	0
30902	729.6	403.13	8.37	13.92	28.43	258.99	11.01
30903	257	156.98	3.43	4.07	7.17	103.98	5.19
30904	0.44	82.93	2.33	2.47	6.98	82.45	1.45
30905	0	0	0	0	0	0	0

SNAP	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2 [1)] [Gg]	N_2O [Mg]
30906	0	0	0	0	0	0	0
310	2.72	15.13	0.68	0.5	9.41	19.51	0.08
31000	2.72	15.13	0.68	0.5	9.41	19.51	0.08
31001	0	0	0	0	0	0	0
31002	0	0	0	0	0	0	0
31003	0	0	0	0	0	0	0
31004	0	0	0	0	0	0	0
31005	0	0	0	0	0	0	0
31006	0	0	0	0	0	0	0
311	65.81	228.54	15.71	22.14	335.99	246.73	5.67
31100	36.11	95.54	3.69	4.23	48.97	111.85	0.91
31101	0	0	0	0	0	0	0
31102	29.7	133	12.02	17.91	287.02	134.88	4.76
31103	0	0	0	0	0	0	0
31104	0	0	0	0	0	0	0
31105	0	0	0	0	0	0	0
31106	0	0	0	0	0	0	0
312	3.74	25.46	1.21	0.91	17.45	33.13	0.14
31200	3.74	25.46	1.21	0.91	17.45	33.13	0.14
31201	0	0	0	0	0	0	0
31202	0	0	0	0	0	0	0
31203	0	0	0	0	0	0	0
31204	0	0	0	0	0	0	0
31205	0	0	0	0	0	0	0
31206	0	0	0	0	0	0	0
313	60.86	188.37	9.43	9.16	150.95	229.79	2.17
31300	60.86	188.37	9.43	9.16	150.95	229.79	2.17
31301	0	0	0	0	0	0	0
31302	0	0	0	0	0	0	0
31303	0	0	0	0	0	0	0
31304	0	0	0	0	0	0	0
31305	0	0	0	0	0	0	0
31306	0	0	0	0	0	0	0
314	117.48	357.67	37.5	56.21	890.95	431.12	15.16
31400	117.48	357.67	37.5	56.21	890.95	431.12	15.16
31401	0	0	0	0	0	0	0
31402	0	0	0	0	0	0	0
31403	0	0	0	0	0	0	0
31404	0	0	0	0	0	0	0
31405	0	0	0	0	0	0	0
31406	0	0	0	0	0	0	0

SNAP	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2[1)] [Gg]	N_2O [Mg]
315	0.13	25.43	1.26	0.73	13.28	28.11	0.1
31500	0.13	25.43	1.26	0.73	13.28	28.11	0.1
31501	0	0	0	0	0	0	0
31502	0	0	0	0	0	0	0
31503	0	0	0	0	0	0	0
31504	0	0	0	0	0	0	0
31505	0	0	0	0	0	0	0
31506	0	0	0	0	0	0	0
316	680	2153	74.37	71.53	1113	829.85	13
31600	680	2153	74.37	71.53	1113	829.85	13
31601	0	0	0	0	0	0	0
31602	0	0	0	0	0	0	0
31603	0	0	0	0	0	0	0
31604	0	0	0	0	0	0	0
31605	0	0	0	0	0	0	0
31606	0	0	0	0	0	0	0
320	687.2	484.14	14.59	27.22	320.97	302.85	5.94
32000	687.2	484.14	14.59	27.22	320.97	302.85	5.94
32001	0	0	0	0	0	0	0
32002	0	0	0	0	0	0	0
32003	0	0	0	0	0	0	0
32004	0	0	0	0	0	0	0
32005	0	0	0	0	0	0	0
32006	0	0	0	0	0	0	0

[1)] Including CO_2 emission from biomass

Annex 3A-9 Description of the Danish energy statistics

This description of the Danish energy statistics has been prepared by Denmark's National Environmental Research Institute (NERI) in cooperation with the Danish Energy Agency (DEA) as background information to the Danish National Inventory Report (NIR).

The Danish energy statistics system

DEA is responsible for the Danish energy balance. Main contributors to the energy statistics outside DEA are Statistics Denmark and Danish Energy Association (before Association of Danish Energy Companies). The statistics is performed using an integrated statistical system building on an Access database and Excel spreadsheets.

The DEA follows the recommendations of the International Energy Agency as well as Eurostat.

The national energy statistics is updated annually and all revisions are immediately included in the published statistics, which can be found on the DEA homepage[3]. It is an easy task to check for breaks in a series because the statistics is 100% time-series oriented.

The national energy statistics does not include Greenland and Faroe Islands.

For historical reasons, DEA receive monthly information from the Danish oil companies regarding Danish deliveries of oil products to Greenland and Faroe Islands. However, the monthly (MOS) and annual (AOS) reporting of oil statistics to Eurostat and IEA exclude Greenland and Faroe Islands. For all other energy products, the Danish figures are also excluding Greenland and Faroe Islands.

Reporting to the Danish Energy Agency

The Danish Energy Agency receives monthly statistics for the following fuel groups:

- Crude oil and oil products.
  - Monthly data from 46 oil companies, the main purpose is monitoring oil stocks according to the oil preparedness system.
- Natural gas.
  - Fuel/flare from platforms in the North Sea.
  - Natural gas balance from the regulator Energinet.dk (National monopoly).
- Coal and coke.
  - Power plants (94 %).
  - Industry companies (4 %).
  - Coal and coke traders (2 %).
- Electricity.
  - Monthly reporting by e-mail from the regulator Energinet.dk (National monopoly).
    - The statistics covers:
    - Production by type of producer.
    - Own use of electricity.

[3] http://www.ens.dk/EN-US/INFO/FACTSANDFIGURES/ENERGY_STATISTICS_AND_INDICATORS/ANNUAL%20STATISTICS/Sider/Forside.aspx

    - Import and export by country.
    - Domestic supply (consumption + distribution loss).
- Town gas (quarterly) from two town gas producers.
- The large central power plants also report monthly consumption of biomass.

Annual data includes renewable energy including waste. The DEA conducts a biannual survey on wood pellets and wood fuel. Statistics Denmark conducts biannual surveys on the energy consumption in the service and industrial sectors. Statistics Denmark prepares annual surveys on forest (wood fuel) & straw.

Other annual data sources include:

- DEA.
    - Survey on production of electricity and heat and fuels used.
    - Survey on end use of oil.
    - Survey on end use of natural gas.
    - Survey on end use of coal and coke.
- DCE, Aarhus University.
    - Energy consumption for domestic air transport.
- Danish Energy Association (Association of Danish Energy companies).
    - Survey on electricity consumption.
- Ministry of Taxation.
    - Border trade.
- Centre for Biomass Technology.
    - Annual estimates of final consumption of straw and wood chips.

Annual revisions

In general, DEA follows the same procedures as in the Danish national account. This means that normally only figures for the last two years are revised.

Aggregating the energy statistics on SNAP level

The sectors used in the official energy statistics have been mapped to SNAP categories, used in the Danish emission database. DCE aggregates the official energy statistics to SNAP level based on a source correspondence table.

In cooperation between DEA and DCE, a fuel correspondence table has been developed mapping the fuels used by the DEA in the official energy statistics with the fuel codes used in the Danish national emission database. The fuel correspondence table between fuel categories used by the DEA, DCE and IPCC is presented in Annex 2A-3.

The mapping between the energy statistics and the SNAP and fuel codes used by DCE can be seen in the table below.

Table 105 Correspondence between the Danish national energy statistics and the SNAP nomenclature (only stationary combustion part shown).

Unit: TJ	Enduse		Transformation	
	SNAP	Fuel	SNAP	Fuel
Energy Sector				
Extraction and Gasification				
- Extraction				
- - Natural Gas	010504	301A		
- Gasification				
- - Biogas, Landfill				
- - Biogas, Other				
- - Electricity				
Refineries				
- Used for Refining				
- - Crude Oil				
- - Refinery Feedstocks				
- - Electricity				
- - District Heating				
- Own Use				
- - Refinery Gas	010306	308A		
- - LPG	010306	303A		
- - Gas-/Diesel Oil	010306	204A		
- - Fuel Oil	010306	203A		
- Net Production				
- - Refinery Gas				
- - LPG				
- - Naphtha (LVN)				
- - Aviation Gasoline				
- - Motor Gasoline				
- - JP4				
- - Other Kerosene				
- - JP1				
- - Gas-/Diesel Oil				
- - Fuel Oil				
- - Petroleum Coke				
- - White Spirit				
- - Lubricants				
- - Bitumen				
Distribution				
- Electricity Used in Distribution				
- - Elelctricity Distribution				
- - District Heating Distribution				
- - Gas Distribution				
Transformation Sector				
Large-scale Power Units				
- Fuels Used for Power Production				
- - Gas-/Diesel Oil			010100	204A
- - Fuel Oil			010100	203A
- - Electricity Plant Coal			010100	102A
- - Straw			010100	117A
- Own Use				
- - Electricity				
- Gross Production				
- - Electricity				
Large-Scale CHP Units				
- Fuels Used for Power Production				
- - Refinery Gas			010300	308A
- - LPG			010100	303A
- - Naphtha (LVN)			010100	210A
- - Gas-/Diesel Oil			010100	204A
- - Fuel Oil			010100	203A
- - Petroleum Coke			010100	110A
- - Orimulsion			010100	225A
- - Natural Gas			010100	301A
- - Electricity Plant Coal			010100	102A
- - Straw			010100	117A
- - Wood Chips			010100	111A
- - Wood Pellets			010100	111A
- - Wood Waste			010100	111A
- - Biogas, Landfill			010100	309A
- - Biogas, Sludge			010100	309A
- - Biogas, Others			010100	309A
- - Waste, Non-renewable			010100	114A
- - Wastes, Renewable			010100	114A
- Fuels Used for Heat Production				

Continued			
- - Refinery Gas		010300	308A
- - LPG		010100	303A
- - Naphtha (LVN)		010100	210A
- - Gas-/Diesel Oil		010100	204A
- - Fuel Oil		010100	203A
- - Petroleum Coke		010100	110A
- - Orimulsion		010100	225A
- - Natural Gas		010100	301A
- - Electricity Plant Coal		010100	102A
- - Straw		010100	117A
- - Wood Chips		010100	111A
- - Wood Pellets		010100	111A
- - Wood Waste		010100	111A
- - Biogas, Landfill		010100	309A
- - Biogas, Sludge		010100	309A
- - Biogas, Other		010100	309A
- - Wastes, Non-renewable		010100	114A
- - Wastes, Renewable		010100	114A
- Own Use			
- - Electricity			
- - District Heating			
- Production			
- - Electricity, Gross			
- - District Heating, Net			
Small-Scale CHP Units			
- Fuels Used for Power Production			
- - Gas-/Diesel Oil		010100	204A
- - Fuel Oil		010100	203A
- - Natural Gas		010100	301A
- - Hard Coal		010100	102A
- - Straw		010100	117A
- - Wood Chips		010100	111A
- - Wood Pellets		010100	111A
- - Wood Waste		010100	111A
- - Biogas, Landfill		010100	309A
- - Biogas, Sludge		010100	309A
- - Biogas, Other		010100	309A
- - Waste, Non-renewable		010100	114A
- - Wastes, Renewable		010100	114A
- Fuels Used for Heat Production			
- - Gas-/Diesel Oil		010100	204A
- - Fuel Oil		010100	203A
- - Natural Gas		010100	301A
- - Coal		010100	102A
- - Straw		010100	117A
- - Wood Chips		010100	111A
- - Wood Pellets		010100	111A
- - Wood Waste		010100	111A
- - Biogas, Landfill		010100	309A
- - Biogas, Sludge		010100	309A
- - Biogas, Other		010100	309A
- - Wastes, Non-renewable		010100	114A
- - Wastes, Renewable		010100	114A
- Own Use			
- - Electricity			
- - District Heating			
- Production			
- - Electricity, Gross			
- - District Heating, Net			
Wind Turbines			
- Used for Power Production			
- - Wind Power			
- Gross Production			
- - Electricity			
Hydro Power Units			
- Used for Power Production			
- - Hydro Power			
- Gross Production			
- - Electricity			
District Heating Units			
- Fuels Used for Heat Production			
- - Refinery Gas		010300	308A
- - LPG		010200	303A
- - Gas-/Diesel Oil		010200	204A
- - Fuel Oil		010200	203A

Continued			
- - Waste Oil		010200	203A
- - Petroleum Coke		010200	110A
- - Natural Gas		010200	301A
- - Electricity Plant Coal		010200	102A
- - Coal		010200	102A
- - Solar Energy			
- - Geothermal Energy			
- - Straw		010200	117A
- - Wood Chips		010200	111A
- - Wood Pellets		010200	111A
- - Wood Waste		010200	111A
- - Biogas, Landfill		010200	309A
- - Biogas, Sludge		010200	309A
- - Biogas, Other		010200	309A
- - Wastes, Non-renewable		010200	114A
- - Wastes, Renewable		010200	114A
- - Fish Oil		010200	215A
- - Electricity for Heat Pumps			
- Own Use			
- - District Heating			
- Net Production			
- - District Heating			
Autoproducers, Electricity Only			
- Fuels Used for Power Production			
- - Natural Gas		030100	301A
- - Solar Energy			
- - Biogas, Landfill		030100	309A
- - Biogas, Sewage Sludge		030100	309A
- - Biogas, Other		030100	309A
- Gross Production			
- - Electricity			
Autoproducers, CHP Units			
- Fuels Used for Power Production			
- - Refinery Gas		010300	308A
- - Gas-/Diesel Oil		030100	204A
- - Fuel Oil		030100	203A
- - Waste Oil		030100	203A
- - Natural Gas		030100	301A
- - Coal		030100	102A
- - Straw		030100	117A
- - Wood Chips		030100	111A
- - Wood Pellets		030100	111A
- - Wood Waste		030100	111A
- - Biogas, Landfill		030100	309A
- - Biogas, Sludge		030100	309A
- - Biogas, Other		030100	309A
- - Fish Oil		030100	215A
- - Wastes, Non-renewable		010100	114A
- - Wastes, Renewable		010100	114A
- Fuels Used for Heat Production		030100	114A
- - Refinery Gas		010300	308A
- - Gas-/Diesel Oil		030100	204A
- - Fuel Oil		030100	203A
- - Waste Oil		030100	203A
- - Natural Gas		030100	301A
- - Coal		030100	102A
- - Wood Chips		030100	111A
- - Wood Waste		030100	111A
- - Biogas, Landfill		030100	309A
- - Biogas, Sludge		030100	309A
- - Biogas, Other		030100	309A
- - Wastes, Non-renewable		010100	114A
- - Wastes, Renewable		010100	114A
- Production			
- - Electricity, Gross			
- - District Heating, Net			
Autoproducers, Heat Only			
- Fuels Used for Heat Production			
- - Gas-/Diesel Oil		030100	204A
- - Fuel Oil		030100	203A
- - Waste Oil		030100	203A
- - Natural Gas		030100	301A
- - Straw		030100	117A
- - Wood Chips		030100	111A
- - Wood Chips		030100	111A

Continued				
- - Wood Waste			030100	111A
- - Biogas, Landfill			030100	309A
- - Biogas, Sludge			030100	309A
- - Biogas, Other			030100	309A
- - Wastes, Non-renewable			010200	114A
- - Wastes, Renewable			010200	114A
- - Heat Pumps				
- Net Production				
- - District Heating				
Gas Works Gas Units	030106	301A		
- Fuels Used for Production of District Heating				
- - Refinery Gas				
- - LPG				
- - Naphtha (LVN)				
- - Gas-/Diesel Oil				
- - Natural Gas				
- - Hard Coal				
- Production				
- - Gas Works Gas				
- - Coke				
Distribution Losses				
- Distribution Losses etc.				
- - Natural Gas				
- - Electricity				
- - District Heating				
- - Gas Works Gas				
Consumption Sector				
- Non-energy Use				
- - White Spirit				
- - Lubricants				
- - Bitumen				
Transport				
Military Transport				
- Aviation Gasoline				
- Motor Gasoline				
- JP4				
- JP1				
- Gas-/Diesel Oil				
Road				
- LPG				
- Motor Gasoline				
- Other Kerosene	020200	206A		
- Gas-/Diesel Oil				
- Fuel Oil				
- Bioethanol				
- Biodielsel				
Rail				
- Motor Gasoline				
- Other Kerosene				
- Gas-/Diesel Oil				
- Electricity				
Domestic Sea Transport				
- LPG	Transport			
- Other Kerosene	Transport			
- Gas-/Diesel Oil	Transport			
- Fuel Oil	Transport			
Domestic Aviation				
- LPG	Transport			
- Aviation Gasoline	Transport			
- Motor Gasoline	Transport			
- Other Kerosene	020100	206A		
- JP1	Transport			
International Aviation				
- Aviation Gasoline	Transport			
- JP1	Transport			
Agriculture and Foresty				
- LPG	Transport			
- Motor Gasoline	Transport			
- Other Kerosene	020300	206A		
- Gas-/Diesel Oil	Transport			
- Fuel Oil	020300	203A		
- Petroleum Coke	020300	110A		
- Natural Gas	020300	301A		
- Coal	020300	102A		

Continued		
- Brown Coal Briquettes	020300 106A	
- Straw	020300 117A	
- Wood Chips	020300 111A	
- Wood Waste	020300 111A	
- Biogas, Other	020300 309A	
- Heat Pumps		
- Electricity		
Horticulture		
- LPG	Transport	
- Motor Gasoline	Transport	
- Gas-/Diesel Oil	Transport	
- Fuel Oil	020300 203A	
- Petroleum Coke	020300 110A	
- Natural Gas	020300 301A	
- Coal	020300 102A	
- Wood Waste	020300 111A	
- Electricity		
- District Heating		
Fishing		
- LPG	Transport	
- Motor Gasoline	Transport	
- Other Kerosene	Transport	
- Gas-/Diesel Oil	Transport	
- Fuel Oil	Transport	
Manufacturing Industry		
- Refinery Gas	030100 308A	
- LPG	Transport	
- Naphtha (LVN)	Transport	
- Motor Gasoline	Transport	
- Other Kerosene	030100 206A	
- Gas-/Diesel Oil	Transport	
- Fuel Oil	030100 203A	
- Waste Oil	030100 203A	
- Petroleum Coke	030100 110A	
- Natural Gas	030100 301A	
- Coal	030100 102A	
- Coke	030100 107A	
- Brown Coal Briquettes	030100 106A	
- Wood Pellets	030100 111A	
- Wood Waste	030100 111A	
- Biogas, Landfill	030100 111A	
- Biogas, Sludge	030100 309A	
- Biogas, Other	030100 309A	
- Wastes, Non-renewable	030100 114A	
- Wastes, Renewable	030100 114A	
- Heat Pumps		
- Electricity		
- District Heating		
- Gas Works Gas	030100 301A	
Construction		
- LPG	031500 303A	
- Motor Gasoline	Transport	
- Other Kerosene	031500 206A	
- Gas-/Diesel Oil	Transport	
- Fuel Oil	031500 203A	
- Natural Gas	031500 301A	
- Electricity		
Wholesale		
- LPG	020100 303A	
- Motor Gasoline	020100 206A	
- Other Kerosene	020100 204A	
- Gas-/Diesel Oil	020100 203A	
- Petroleum Coke	020100 110A	
- Natural Gas	020100 301A	
- Wood Waste	020100 111A	
- Electricity		
- District Heating		
Retail Trade		
- LPG	020100 303A	
- Other Kerosene	020100 206A	
- Gas-/Diesel Oil	020100 204A	
- Fuel Oil	020100 203A	
- Petroleum Coke	020100 110A	
- Natural Gas	020100 301A	
- Electricity		

Continued			
- District Heating			
Private Service			
- LPG	020100	303A	
- Other Kerosene	020100	206A	
- Gas-/Diesel Oil	020100	204A	
- Fuel Oil	020100	203A	
- Waste Oil	020100	203A	
- Petroleum Coke	020100	110A	
- Natural Gas	020100	301A	
- Wood Chips	020100	111A	
- Wood Waste	020100	111A	
- Biogas, Landfill	020100	309A	
- Biogas, Sludge	020100	309A	
- Biogas, Other	020100	309A	
- Wastes, Non-renewable	020100	114A	
- Wastes, Renewable	020100	114A	
- Electricity			
- District Heating			
- Gas Works Gas	020100	301A	
Public Service			
- LPG	020100	303A	
- Other Kerosene	020100	206A	
- Gas-/Diesel Oil	020100	204A	
- Fuel Oil	020100	203A	
- Petroleum Coke	020100	110A	
- Natural Gas	020100	301A	
- Coal	020100	102A	
- Brown Coal Briquettes	020100	106A	
- Solar Energy			
- Wood Chips	020100	111A	
- Wood Pellets	020100	111A	
- Electricity			
- District Heating			
- Gas Works Gas	020100	301A	
Single Family Houses			
- LPG	020200	303A	
- Motor Gasoline	Transport		
- Other Kerosene	020200	206A	
- Gas-/Diesel Oil	020200	204A	
- Fuel Oil	020200	203A	
- Petroleum Coke	020200	110A	
- Natural Gas	020200	301A	
- Coal	020200	102A	
- Coke	020200	107A	
- Brown Coal Briquettes	020200	106A	
- Solar Energy			
- Straw	020200	117A	
- Firewood	020200	111A	
- Wood Chips	020200	111A	
- Wood Pellets	020200	111A	
- Biodiesel	020200	215A	
- Heat Pumps			
- Electricity			
- District Heating			
- Gas Works Gas	020200	301A	
Multi-family Houses			
- LPG	020200	303A	
- Other Kerosene	020200	206A	
- Gas-/Diesel Oil	020200	204A	
- Fuel Oil	020200	203A	
- Petroleum Coke	020200	110A	
- Natural Gas	020200	301A	
- Coal	020200	102A	
- Coke	020200	107A	
- Brown Coal Briquettes	020200	106A	
- Solar Energy			
- Electricity			
- District Heating			
- Gas Works Gas	020200	301A	

Annex 3A-10 EU ETS data for coal

EU ETS data are available for the years 2006-2010. Corresponding values for lower calorific value (LCV) and implied emission factor (IEF) for CO_2 for 2006-2009 are shown in Figure 3A-10.1. The IEF factors include the oxidation factors.

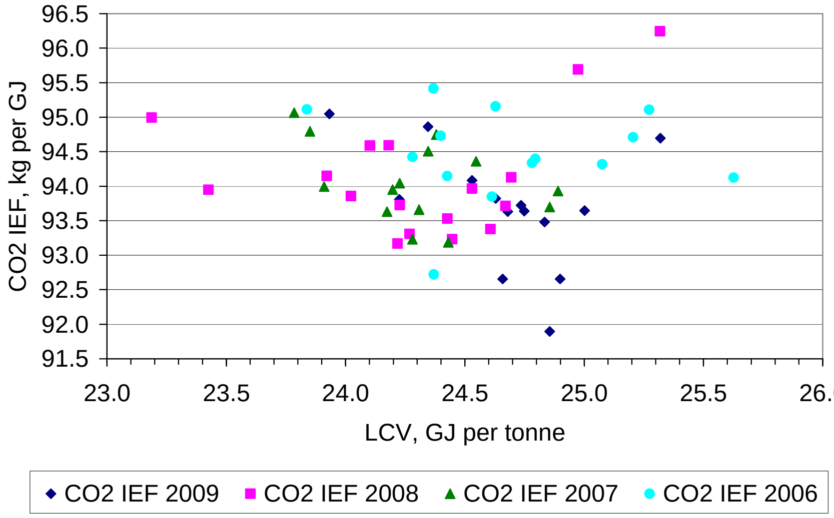

Figure 3A-10.1 EU ETS data for LCV and CO_2 IEF (including oxidation factor) for coal. Data for the years 2006-2009.

Annex 3B - Transport

List of content

Annex 3B-1: Fleet data 1985-2010 for road transport (No. vehicles)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	75564	16627	13368	10706	8571	7246	6992	6618	6159	5646	5194
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	404441	179963	156167	134583	102209	66638	55669	43359	30440	19722	12950
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	97500	87416	63723	53008	61799	45282	38690	30726	21910	14275	8539
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	152241	318622	330062	307289	254029	235152	221928	204914	179982	150784	119474
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		165103	178393	209260	261580	258381	253651	249450	243072	232062	220895
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			28375	60724	96923	141546	180780	219477	218990	216002	214711
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									39547	74071	107025
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	90872	28856	23474	19524	15744	13167	12527	11642	10624	9570	8659
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	344505	171158	152919	137410	110812	76213	63961	50125	35583	23605	15800
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	87587	74393	54644	44813	52998	40866	35395	28785	21181	14516	9144
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	210664	276842	281144	261222	218176	205239	196225	184150	165329	142253	115689
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		221807	211098	215194	242499	240697	238039	236139	232642	225250	217019
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			51521	101611	148509	235536	319571	414973	413070	407030	404816
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									105322	217501	303709
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	3246	1388	1186	1033	897	911	945	971	986	987	989
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	3113	3661	3581	3373	3096	2800	2589	2352	2039	1657	1381
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	1078	564	531	687	859	865	865	846	773	702	599
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	4087	2263	2037	1700	1575	1659	1801	1950	2055	2081	2018
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		4323	3630	3161	2668	2810	3052	3331	3638	3874	4089
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			1263	2350	3350	5384	7888	10682	11000	11250	11334
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									3980	8667	14011
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	69406	71018	70198	69500	68720	65169	62762	59117	54631	50590	48238
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			979	2163	3799	6613	9919	13122	13689	14318	15305
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									3064	8535	18568
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	14055	14871	13888	13012	12136	11757	11413	10708	10043	9269	8435
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			1017	1988	3035	4323	5638	7401	7600	7595	7716

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Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									2079	5072	9087
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014											
Passenger Cars	LPG cars	Conventional	0	1990	1136	1163	1166	1173	1184	734	495	310	171	96	56
Passenger Cars	LPG cars	Euro I	1991	1996				1	4	4	3	1	1	1	3
Passenger Cars	LPG cars	Euro II	1997	2000											
Passenger Cars	LPG cars	Euro III	2001	2005											
Passenger Cars	LPG cars	Euro IV	2006	2010											
Passenger Cars	2-Stroke	Conventional	0	9999	4823	5417	4804	4308	3747	3029	2443	1824	1248	761	400
Passenger Cars	Electric cars	Conventional	0	9999	130	133	133	134	136	155	163	187	230	292	298
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	34172	44442	45625	46865	48934	49865	46712	42710	37987	34274	30224
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							3773	7509	12025	17550	17352
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											5272
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	113019	146986	150898	154999	161842	169142	160228	148520	133718	120795	105967
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998							16899	35370	56836	76717	75753
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001											24555
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015											
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	684	889	913	938	979	632	462	295	196	125	90
Light Duty Vehicles	LPG <3,5t	Euro I	1995	1998										1	1
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001											
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006											
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Electric <3,5t	Conventional	0	9999	3	4	4	4	4	3	2	2	1	1	1
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	621	530	510	497	503	455	412	365	326	336	318
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	8686	7049	6675	6430	6419	6194	5738	5137	4646	4156	3518
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996					66	376	711	976	973	967	906
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001								89	521	1236	1782
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	7266	5897	5584	5379	5375	5316	5373	5207	4854	4491	4116
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996					51	298	671	968	1002	1081	1102
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001								94	429	798	1200

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Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	4984	4519	4461	4388	4454	3991	3248	2731	2360	1984	1623
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996					37	156	234	285	283	286	289
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001								21	126	216	262
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	5171	4689	4628	4552	4601	4348	4047	3669	3316	2924	2537
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996					58	334	708	1001	1007	985	963
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001								98	535	937	1371
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	4307	5179	5237	5326	5315	5031	4565	4059	3536	3067	2596
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996					67	469	1003	1452	1442	1400	1322
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001								152	748	1330	1898
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	7	8	8	9	9	7	6	6	6	6	6
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996							0	1	1	1	1
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001								0	1	2	3
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	271	326	329	335	327	326	329	321	300	262	231
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996					11	62	152	239	246	252	253
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001								28	147	289	455
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT >32t	Conventional	0	1993	0	0	0	0	0	0	1	0	0	1	1
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996							0	1	1	1	1
Heavy Duty Vehicles	Diesel RT >32t	Euro II	1997	2001								0	1	0	0
Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009											

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Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	5617	5132	5080	5011	5065	4783	4448	4025	3645	3208	2772
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996					63	356	759	1069	1076	1051	1028
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001								104	570	1000	1467
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	8359	10252	10740	11202	11174	10480	8917	7262	5877	4730	3842
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996					204	1616	3609	4958	4683	4110	3555
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001								495	2223	4240	5939
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	1672	2083	2242	2382	2379	2398	2257	2045	1799	1469	1240
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996					49	333	888	1316	1327	1314	1305
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001								143	778	1564	2540
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro I	1994	1996								1	1	1	1
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001										1	1
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT >60t	Euro V	2010	2013											
Buses	Gasoline Urban Buses	Conventional	0	9999	8	8	9	11	14	11	11	16	17	17	15
Buses	Diesel Urban Buses <15t	Conventional	0	1993	347	352	433	488	639	558	494	411	335	281	250
Buses	Diesel Urban Buses <15t	Euro I	1994	1996						49	81	122	130	132	124
Buses	Diesel Urban Buses <15t	Euro II	1997	2001									103	295	438
Buses	Diesel Urban Buses <15t	Euro III	2002	2006											
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009											
Buses	Diesel Urban Buses <15t	Euro V	2010	2013											
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	2083	2109	2597	2928	3833	3475	3205	2861	2691	2353	2012
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996						397	632	985	989	891	891
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001									183	568	817
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006											
Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009											
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013											
Buses	Diesel Urban Buses >18t	Conventional	0	1993	5	5	6	7	9	8	6	7	6	3	2
Buses	Diesel Urban Buses >18t	Euro I	1994	1996						1	1	3	3	3	2

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Buses	Diesel Urban Buses >18t	Euro II	1997	2001										6	20
Buses	Diesel Urban Buses >18t	Euro III	2002	2006											
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009											
Buses	Diesel Urban Buses >18t	Euro V	2010	2013											
Buses	Gasoline Coaches	Conventional	0	9999	931	942	1161	1309	1508	1762	1775	1786	1791	1808	1810
Buses	Diesel Coaches <15t	Conventional	0	1993	3710	3756	4627	5215	6010	5926	5739	5506	5208	4941	4629
Buses	Diesel Coaches <15t	Euro I	1994	1996						420	682	1113	1103	1091	1056
Buses	Diesel Coaches <15t	Euro II	1997	2001									370	695	1039
Buses	Diesel Coaches <15t	Euro III	2002	2006											
Buses	Diesel Coaches <15t	Euro IV	2007	2009											
Buses	Diesel Coaches <15t	Euro V	2010	2013											
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	804	814	1003	1131	1303	1389	1393	1342	1253	1241	1184
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996						35	89	153	162	163	159
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001									44	77	119
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006											
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009											
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013											
Buses	Diesel Coaches >18t	Conventional	0	1993	122	123	152	171	197	210	221	211	193	193	206
Buses	Diesel Coaches >18t	Euro I	1994	1996						20	42	78	84	82	81
Buses	Diesel Coaches >18t	Euro II	1997	2001									25	54	99
Buses	Diesel Coaches >18t	Euro III	2002	2006											
Buses	Diesel Coaches >18t	Euro IV	2007	2009											
Buses	Diesel Coaches >18t	Euro V	2010	2013											
Mopeds	<50 cm^3	Conventional	0	1999	151000	120000	118000	113000	109000	105000	114167	123333	132500	141667	150833
Mopeds	<50 cm^3	Euro I	2000	2003											
Mopeds	<50 cm^3	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	6209	6617	6804	6904	7111	7406	7672	8214	8980	9598	10385
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	7037	7499	7712	7824	8059	8394	8695	9310	10177	10878	11769
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006											
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999											
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	19352	20622	21207	21516	22162	23083	23911	25602	27986	29914	32365
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003											
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999											
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	8796	9374	9639	9780	10074	10492	10869	11637	12721	13597	14712
Motorcycles	4-stroke >750 cm^3	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm^3	Euro II	2004	2006											

Continued

Motorcycles	4-stroke >750 cm³	Euro III	2007	9999

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	4994	4949	4963	5045	5223	5417	5720	6082	6467	6725	6926
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	9402	7791	6441	5527	4770	4352	4074	4103	4094	4147	4114
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	5582	4146	3061	2228	1672	1270	1027	857	728	634	570
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	95486	78149	62695	47507	35638	25239	18617	13047	9408	6534	4744
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	203911	188827	166452	145685	119764	96438	73966	56842	40817	29940	20925
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	212883	211037	207661	203273	197813	189161	177736	161965	144902	127481	107674
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	132974	131683	130255	129818	128942	127649	126013	122908	119230	116047	111745
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		20508	43702	64814	94621	136765	135422	134549	133140	132632	131095
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							46184	87915	132696	172453	231452
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	8291	8215	8200	8321	8638	9068	9589	10256	10936	11399	11659
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	11566	9555	7938	6866	5944	5373	5149	5260	5419	5580	5670
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	6258	4775	3690	2780	2170	1670	1386	1183	1020	895	801
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	94495	78552	64108	49671	37838	27501	20744	15212	11502	8468	6409
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	203364	190772	171667	153308	129613	107638	85474	67960	51210	39584	29267
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	402938	402008	397847	391775	383212	370014	348949	317429	286209	256600	220109
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	363267	359633	355644	355739	352843	349396	344681	334040	320023	310538	298463
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		51628	107387	148845	196878	250957	248647	251018	247684	246743	243808
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							55169	101832	129710	145251	160859
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	1024	1079	1128	1237	1391	1600	2060	2628	3224	3589	3776
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	1181	1034	936	859	830	841	1031	1314	1735	2009	2238
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	520	479	444	399	369	318	311	330	319	297	271
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	1904	1798	1696	1572	1431	1299	1182	1129	1031	935	835
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	4161	4188	4196	4099	3992	3847	3772	3641	3404	3151	2818
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	11470	11572	11776	11983	12425	12702	13039	13204	12844	12336	11594
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	18867	18776	18757	18984	19326	19848	20510	21171	20918	20652	20096
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		4628	9892	14692	21393	29899	30850	32713	33204	33810	33934
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							7690	14232	17902	19391	21351
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	46384	44480	41523	38006	34340	30089	26006	22027	17996	14360	10988
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	16471	17245	18106	19220	20895	21616	21549	20568	19152	17776	15909
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	30074	30082	30026	30342	30592	30774	31125	33912	32640	32025	31709
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		12723	30100	46644	70013	100191	102310	119573	119892	121697	123348
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							32073	82104	114599	127116	135759
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014							3564	15517	48853	84084	145874
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	7728	7120	6345	5723	5039	4460	3895	3402	2906	2515	2094

Continued															
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	7698	7640	7463	7353	7287	7147	6943	6586	6016	5573	5022
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	13139	13250	13151	13303	13569	13890	13944	14951	14421	14008	13616
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		3892	8650	12988	18896	25773	26255	31305	31519	32057	32304
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							6437	15561	18440	20382	22310
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014							715	2819	5822	9752	14524
Passenger Cars	LPG cars	Conventional	0	1990	30	24	17	11	10	10	10	7	8	7	6
Passenger Cars	LPG cars	Euro I	1991	1996	2	2	3	2	4	4	3	2	2	2	3
Passenger Cars	LPG cars	Euro II	1997	2000			1	2	1	1	1			1	1
Passenger Cars	LPG cars	Euro III	2001	2005								1	2	4	3
Passenger Cars	LPG cars	Euro IV	2006	2010										1	1
Passenger Cars	2-Stroke	Conventional	0	9999	300	200	150	100	50						
Passenger Cars	Electric cars	Conventional	0	9999	322	301	280	250	211	183	183	188	191	273	348
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	27140	23832	21083	18787	16405	14063	11895	9932	7990	6333	4955
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	17103	16862	16703	16454	16011	15464	14728	13331	12214	11199	10027
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	9655	14319	14153	14012	13791	13616	13420	10302	9608	8984	8074
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			3784	8014	13934	20623	26271	18997	18312	17579	15860
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011								3184	3811	4024	4055
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	94102	80466	67925	56940	46624	37412	29736	24088	18849	14736	11426
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998	74373	72684	71182	69081	66775	63284	58501	52343	46832	41793	36667
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001	49951	74831	73532	72069	70326	68384	65625	55257	49899	45253	40307
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006			27192	54236	92157	139815	191430	165441	156158	147666	134874
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011								37658	53994	59145	62080
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015							2831	11914	20867	26410	34043
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	60	36	27	21	14	10	9	7	5	4	4
Light Duty Vehicles	LPG <3,5t	Euro I	1995	1998	1	1									
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001	1				1	3	3	2	2	3	3
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006							5	7	7	8	8
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011								1	3	4	3
Light Duty Vehicles	Electric <3,5t	Conventional	0	9999	1								1	7	4
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	307	295	291	283	268	287	296	328	324	340	343
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	3011	2552	2088	1709	1430	1244	1075	937	793	653	540
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996	834	769	715	656	594	492	437	360	290	234	189
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001	2136	2254	2161	2078	2003	1901	1722	1504	1250	1062	898
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006		166	460	755	1049	1437	1677	1662	1576	1448	1311
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009							53	364	758	911	931
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013								2	5	27	191
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	3782	3406	3069	2766	2503	2241	2077	1899	1682	1418	1251
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996	1099	1070	1040	985	948	885	827	747	666	544	475

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Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001	1575	1783	1840	1884	1858	1838	1706	1587	1357	1207	1085
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006		155	443	713	1061	1501	1936	1996	1908	1784	1640
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009		2	2	2	2	3	93	427	823	890	940
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013				1	1	1	2	42	180	345	535
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	1368	1094	896	734	612	500	435	367	295	224	191
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996	278	274	248	203	174	152	138	113	99	85	68
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001	298	312	291	285	278	273	267	239	200	157	137
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006		10	32	46	58	82	99	108	107	103	95
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009					1	1	2	25	49	63	65
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013									8	11	33
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	2143	1897	1382	1158	1003	884	895	724	531	427	351
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996	905	983	787	701	638	562	574	461	334	246	207
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001	1642	1926	1653	1586	1587	1564	1711	1454	1081	855	735
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006		194	389	665	919	1245	1740	1655	1464	1326	1208
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009		4	4	6	7	14	101	457	697	747	762
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013						3	21	106	255	414	562
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	2097	1769	1231	984	797	655	623	463	306	217	163
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996	1204	1206	935	815	728	643	654	515	361	271	212
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001	2179	2589	2176	2053	1970	1846	1969	1668	1245	986	829
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006		197	487	803	1143	1583	2273	2160	1903	1747	1598
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009		3	3	3	3	26	126	593	907	985	1000
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013						7	24	124	292	490	678
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	4	4	4	4	4	4	4	4	3	2	2
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996	1	2	1	1	1	0	1	1	1	0	1
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001	3	3	2	2	2	2	2	2	1	1	1
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006				0	2	2	3	3	3	3	3
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009								3	3	1	2
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013								1	1	1	1
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	185	139	93	70	50	42	36	22	12	9	6
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996	239	241	190	157	134	114	95	68	41	27	22
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001	618	792	670	641	637	639	702	590	442	332	283
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006		82	193	341	509	747	1189	1157	1025	932	884
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009			0	1	1	21	86	400	606	661	672
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013							10	69	157	254	338
Heavy Duty Vehicles	Diesel RT >32t	Conventional	0	1993	2	2	1	2	2	2	1	1	1		
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996	0	1	1	1	1	1	1	1	1	1	1
Heavy Duty Vehicles	Diesel RT >32t	Euro II	1997	2001	1	1	0								
Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006		1	1	2	1	2	3	3	3	3	3

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Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009								1	1	1	0
Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013										1	1
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	2481	1887	1804	1515	1250	1033	756	655	548	442	365
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996	1025	954	1006	898	781	648	475	407	337	248	208
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001	1862	1872	2119	2035	1942	1802	1407	1275	1084	857	739
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006		188	497	852	1123	1432	1434	1454	1468	1329	1212
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009		3	6	8	8	15	83	402	701	751	770
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013						3	17	93	256	415	563
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	3173	2250	1980	1585	1255	973	705	576	453	328	254
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996	2884	2100	1834	1472	1214	979	713	596	466	346	278
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001	7098	7055	6586	5636	4638	3653	2744	2272	1777	1349	1128
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006		1009	2342	3625	4439	5378	5558	4873	4142	3372	2837
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009		4	7	6	10	76	213	992	1630	1718	1744
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013		1	1	1		27	151	672	1159	1543	1979
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	1029	708	549	388	287	219	170	123	94	67	61
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996	1215	1060	967	781	616	482	352	286	177	115	97
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001	3548	4062	4016	3731	3293	2841	2248	1798	1240	837	676
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006		552	1706	3011	4472	6217	7584	7031	5987	4774	4004
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009		1	5	6	6	82	328	2117	3548	3677	3808
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013		1	2	2	2	1	68	722	1421	1894	2648
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro I	1994	1996	1	1	1	1	1	1					
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001	1	1	1	1	1	1	1	1	1	1	1
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009								1	1	1	1
Heavy Duty Vehicles	Diesel TT/AT >60t	Euro V	2010	2013									1	3	
Buses	Gasoline Urban Buses	Conventional	0	9999	11	9	7	1	2	2	2	4	7	9	9
Buses	Diesel Urban Buses <15t	Conventional	0	1993	200	183	154	123	101	80	68	56	49	33	25
Buses	Diesel Urban Buses <15t	Euro I	1994	1996	118	118	96	106	88	84	75	57	53	28	16
Buses	Diesel Urban Buses <15t	Euro II	1997	2001	525	542	553	569	535	545	494	427	367	221	117
Buses	Diesel Urban Buses <15t	Euro III	2002	2006			56	155	248	378	461	438	433	416	363
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009								119	261	433	425
Buses	Diesel Urban Buses <15t	Euro V	2010	2013											165
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	1701	1506	1175	1030	880	758	621	538	451	329	276
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996	845	810	749	691	620	561	476	399	338	296	253
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001	1049	1165	1156	1136	1066	1061	1032	1002	919	851	744
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006			288	456	596	733	991	992	989	962	969
Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009								107	327	624	628
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013											217
Buses	Diesel Urban Buses >18t	Conventional	0	1993	37	47	45	25	24	23	16	7	6	5	2

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Buses	Diesel Urban Buses >18t	Euro I	1994	1996	28	44	52	51	42	44	44	23	6	4	2
Buses	Diesel Urban Buses >18t	Euro II	1997	2001	106	220	225	224	218	217	215	213	161	147	142
Buses	Diesel Urban Buses >18t	Euro III	2002	2006			135	228	337	388	448	439	414	398	389
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009								124	247	338	340
Buses	Diesel Urban Buses >18t	Euro V	2010	2013											97
Buses	Gasoline Coaches	Conventional	0	9999	1796	1788	1763	1722	1663	1586	1521	1422	1306	1186	1052
Buses	Diesel Coaches <15t	Conventional	0	1993	4340	3989	3649	3360	3029	2726	2438	2162	1928	1661	1439
Buses	Diesel Coaches <15t	Euro I	1994	1996	1079	1053	1031	982	956	920	873	814	732	664	614
Buses	Diesel Coaches <15t	Euro II	1997	2001	1347	1658	1694	1740	1908	2023	2144	2144	2078	2010	1914
Buses	Diesel Coaches <15t	Euro III	2002	2006			253	482	751	1052	1351	1423	1439	1463	1454
Buses	Diesel Coaches <15t	Euro IV	2007	2009								227	478	790	822
Buses	Diesel Coaches <15t	Euro V	2010	2013											204
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	1133	1061	1013	957	914	847	758	682	598	520	463
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996	148	161	173	176	176	184	177	177	176	184	179
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001	173	208	221	220	230	240	238	236	226	245	258
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006			19	46	61	71	90	81	99	106	107
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009								11	38	69	66
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013											41
Buses	Diesel Coaches >18t	Conventional	0	1993	192	177	157	142	138	121	92	77	56	49	38
Buses	Diesel Coaches >18t	Euro I	1994	1996	78	76	79	74	70	65	60	56	49	46	36
Buses	Diesel Coaches >18t	Euro II	1997	2001	145	190	196	201	192	192	202	199	173	164	156
Buses	Diesel Coaches >18t	Euro III	2002	2006			32	92	152	230	293	302	312	321	322
Buses	Diesel Coaches >18t	Euro IV	2007	2009								55	114	180	194
Buses	Diesel Coaches >18t	Euro V	2010	2013											39
Mopeds	<50 cm³	Conventional	0	1999	143607	136249	128209	120305	112262	103829	94855	86621	78814	71067	63633
Mopeds	<50 cm³	Euro I	2000	2003	16393	28751	42791	48695	46069	43455	40746	37826	35231	32572	30009
Mopeds	<50 cm³	Euro II	2004	9999					10669	21715	33399	44553	50954	56361	59358
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	11054	11367	11582	11850	12326	13158	14241	15400	15790	15474	14877
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	11909	12331	12662	13098	13716	14486	15411	16311	16873	17111	17168
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	619	1074	1568	2088	2087	2144	2240	2373	2462	2488	2497
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006					694	1791	3236	3221	3196	3132	3067
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999								1798	3021	3649	4045
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	32749	33910	34821	36019	37720	39837	42380	44855	46402	47054	47213
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	1703	2953	4311	5742	5739	5897	6159	6527	6769	6843	6868
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006					1910	4925	8898	8857	8788	8614	8435
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999								4945	8307	10034	11123
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	14886	15414	15828	16372	17146	18108	19264	20388	21092	21388	21461
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	774	1342	1960	2610	2609	2681	2800	2967	3077	3110	3122

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Motorcycles	4-stroke >750 cm³	Euro II	2004	2006					868	2239	4045	4026	3995	3915	3834
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999								2248	3776	4561	5056

Annex 3B-2: Mileage data 1985-2010 for road transport (km)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	6898	5036	5020	4943	4673	4504	4045	3621	3335	3050	2744
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	11952	9124	9315	9465	9104	8935	8056	7246	6688	6086	5464
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	15828	12187	12126	11958	11339	11098	10021	9034	8382	7701	7030
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	18153	15198	15457	15563	14954	14699	13299	12029	11221	10402	9502
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		19297	21313	20826	19613	19184	17328	15634	14538	13432	12228
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			13079	20210	22114	22138	22063	21152	21962	20228	18379
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									13663	19661	20283
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	8160	6115	6116	6100	5825	5614	5036	4501	4137	3778	3392
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	14463	10969	11159	11343	10885	10701	9655	8692	8036	7327	6590
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	19291	14852	14777	14614	13831	13540	12229	11031	10238	9411	8586
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	21834	18592	18837	18953	18207	17880	16173	14625	13636	12624	11513
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		23244	26518	25834	24228	23698	21402	19308	17952	16579	15090
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			16047	24225	26429	26559	26647	25578	27351	25181	22862
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									16672	23262	25144
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	9805	7331	7272	7165	6780	6612	5940	5318	4900	4488	4043
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	16733	12955	13258	13416	13025	12726	11473	10336	9561	8813	7985
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	24142	18422	18247	18037	17270	16905	15279	13773	12797	11791	10705
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	27306	23829	23741	23384	22167	21704	19580	17656	16427	15159	13795
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		28853	33993	32962	30950	30306	27330	24598	22851	21104	19203
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			20240	30057	32754	33711	32616	31675	33844	31105	28213
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									20657	28412	29771
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	32155	38541	39573	37387	36179	37017	34100	31914	30123	27778	25630
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			65391	84050	77145	67118	62343	60019	60341	50849	44321
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									40538	50785	48691
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	46264	53249	53444	45968	41172	40970	37093	34359	32040	29482	27287

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Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			73922	98829	96065	97027	90763	83591	82535	63238	51172
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									63924	84599	77084
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014											
Passenger Cars	LPG cars	Conventional	0	1990	19437	20317	21540	22701	23076	22930	20921	19064	17909	16523	15301
Passenger Cars	LPG cars	Euro I	1991	1996				50845	46204	44966	44030	39027	36223	33377	34870
Passenger Cars	LPG cars	Euro II	1997	2000											
Passenger Cars	LPG cars	Euro III	2001	2005											
Passenger Cars	LPG cars	Euro IV	2006	2010											
Passenger Cars	2-Stroke	Conventional	0	9999	17823	15382	15347	15187	14504	14198	12814	11547	10718	9875	8972
Passenger Cars	Electric cars	Conventional	0	9999	11658	12344	13110	13845	14116	17157	16281	14919	14394	13460	13737
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	17881	16906	17319	17990	18103	18964	18746	17579	16799	16095	15204
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							14993	20931	21758	21886	24249
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											14121
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	29031	31758	31868	30545	29838	30783	30397	28749	27220	25447	23936
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998							23800	33458	35423	36060	38876
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001											22770
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015											
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	16914	15982	16371	17004	17110	17029	15916	15322	14658	13958	13040
Light Duty Vehicles	LPG <3,5t	Euro I	1995	1998										18592	34023
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001											
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006											
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Electric <3,5t	Conventional	0	9999	8346	7895	8089	8402	8456	8708	6937	6318	8434	7850	7183
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	21156	19192	20660	21163	19525	18688	18802	17867	16851	15925	16000
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	31577	30571	33054	29490	24866	24174	25842	23826	22069	20712	18897
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996					20754	23816	33598	35053	37440	34688	31372
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001								22262	24890	29087	32264
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	35381	34158	36921	32934	27760	27083	29125	26789	24841	23413	21356

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Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996					23771	27223	36875	39999	43102	39923	36017
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001								25498	29613	36054	36597
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	28543	31445	34106	32527	27693	30447	30623	25147	23906	23653	25610
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996					22369	30180	41679	37797	40184	39158	41670
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001								23450	26721	36760	46467
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	47566	52415	56851	54218	46211	51455	52070	42803	40823	40463	43512
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996					36330	47626	61552	59731	66448	64783	68835
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001								38086	44241	58918	69595
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	75373	83146	78512	83072	79757	79515	77648	75508	67041	66058	58006
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996					60796	69440	88873	100795	105755	102894	89413
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001								64908	71163	92551	90591
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	73707	81339	76954	81334	77957	81279	79781	80178	69911	67861	58458
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996							112697	87402	109362	105438	91468
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001								65722	79051	81209	92406
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	81567	90014	85161	90008	87117	89994	87174	84244	74920	74454	65581
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996					61934	72773	87231	99988	107395	104246	90473
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001								65722	71485	91030	88752
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel RT >32t	Conventional	0	1993	59804	65997	62439	65992	63253	60159	80838	54865	47831	77251	67015
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996							64455	98396	111670	108396	87291

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Heavy Duty Vehicles	Diesel RT >32t	Euro II	1997	2001								65722	79429	111234	59026
Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	51513	57170	62045	59093	50993	56747	57319	47507	45573	45055	48204
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996					39923	52387	67789	65871	73373	71695	76046
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001								41921	48779	65145	76850
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	82664	88351	84555	81135	82070	85575	79845	80836	75719	71864	65188
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996					57281	67012	78849	97650	112854	103407	97109
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001								62509	76667	89662	97570
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	107012	111733	108316	98187	101912	106526	94437	94229	91732	82757	77559
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996					74677	87663	95089	116300	134272	119004	110151
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001								75360	88695	102707	106992
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013											
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro I	1994	1996								134176	132165	114243	108634
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001										69882	132901
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel TT/AT >60t	Euro V	2010	2013											
Buses	Gasoline Urban Buses	Conventional	0	9999	28119	27614	22913	21004	16584	24890	22570	18774	20954	20270	17859
Buses	Diesel Urban Buses <15t	Conventional	0	1993	178201	202121	164267	138931	106475	115554	106869	101303	95018	91205	81174
Buses	Diesel Urban Buses <15t	Euro I	1994	1996						91234	135731	138230	151691	142301	125821
Buses	Diesel Urban Buses <15t	Euro II	1997	2001									86798	114360	128118
Buses	Diesel Urban Buses <15t	Euro III	2002	2006											
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009											
Buses	Diesel Urban Buses <15t	Euro V	2010	2013											
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	169795	192827	156723	132557	101596	110825	102563	98901	91958	87443	79633
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996						91234	136323	133072	151602	142559	125315
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001									86798	111710	128861
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006											

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Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009											
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013											
Buses	Diesel Urban Buses >18t	Conventional	0	1993	216968	246398	200264	169384	129821	143068	126078	115033	113550	93849	72821
Buses	Diesel Urban Buses >18t	Euro I	1994	1996						91234	165134	110540	155508	145293	133337
Buses	Diesel Urban Buses >18t	Euro II	1997	2001										86734	102849
Buses	Diesel Urban Buses >18t	Euro III	2002	2006											
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009											
Buses	Diesel Urban Buses >18t	Euro V	2010	2013											
Buses	Gasoline Coaches	Conventional	0	9999	16996	17254	14369	13229	12238	13298	16452	18269	17679	16981	15951
Buses	Diesel Coaches <15t	Conventional	0	1993	31790	37351	30471	25888	23251	24530	28493	32603	31547	29819	28288
Buses	Diesel Coaches <15t	Euro I	1994	1996						17395	32539	38186	45895	42610	39640
Buses	Diesel Coaches <15t	Euro II	1997	2001									26168	37700	39613
Buses	Diesel Coaches <15t	Euro III	2002	2006											
Buses	Diesel Coaches <15t	Euro IV	2007	2009											
Buses	Diesel Coaches <15t	Euro V	2010	2013											
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	42777	50286	41025	34855	31305	29375	34809	40314	39123	36987	35313
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996						28616	48203	63296	75783	70278	65473
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001									43049	64008	64928
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006											
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009											
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013											
Buses	Diesel Coaches >18t	Conventional	0	1993	91765	107883	88016	74780	67164	65632	75927	87500	83935	79067	73524
Buses	Diesel Coaches >18t	Euro I	1994	1996						45525	76764	98544	121168	112452	104770
Buses	Diesel Coaches >18t	Euro II	1997	2001									68486	94315	98009
Buses	Diesel Coaches >18t	Euro III	2002	2006											
Buses	Diesel Coaches >18t	Euro IV	2007	2009											
Buses	Diesel Coaches >18t	Euro V	2010	2013											
Mopeds	<50 cm^3	Conventional	0	1999	2331	2210	2309	2427	2494	2546	2495	2460	2484	2506	2135
Mopeds	<50 cm^3	Euro I	2000	2003											
Mopeds	<50 cm^3	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	8367	8199	8195	8650	8890	9054	8763	8246	7858	7626	7137
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	8367	8199	8195	8650	8890	9054	8763	8246	7858	7626	7137
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006											
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999											
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	8367	8199	8195	8650	8890	9054	8763	8246	7858	7626	7137
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003											

Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999											
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	8367	8199	8195	8650	8890	9054	8763	8246	7858	7626	7137
Motorcycles	4-stroke >750 cm^3	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm^3	Euro II	2004	2006											
Motorcycles	4-stroke >750 cm^3	Euro III	2007	9999											

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	2505	2305	2204	2088	1971	1772	1616	1500	1379	1250	1137
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	4954	4539	4285	4015	3730	3308	2964	2684	2436	2190	1973
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	6464	5985	5714	5433	5116	4608	4184	3868	3558	3228	2931
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	8791	8276	7956	7570	7185	6502	5970	5336	4973	4502	4085
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	11295	10582	10205	9735	9273	8408	7725	7060	6565	5977	5454
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	16912	15695	15053	14304	13521	12188	11134	10323	9558	8732	7985
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	20496	21281	20393	19345	18266	16390	14905	13874	12745	11556	10509
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		12643	18141	20266	20046	18959	20866	19458	17859	16182	14709
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							12372	17930	18560	18493	17259
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	3091	2837	2712	2568	2426	2182	1990	1854	1707	1548	1408
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	5990	5480	5181	4858	4519	3996	3571	3249	2934	2636	2378
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	7899	7291	6969	6626	6243	5615	5097	4736	4346	3944	3580
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	10639	9913	9522	9039	8553	7692	7021	6408	5916	5349	4855
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	13929	12963	12492	11909	11321	10230	9357	8643	7979	7248	6593
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	21034	19511	18705	17763	16783	15114	13796	12787	11817	10773	9837
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	25394	25961	24869	23586	22269	19993	18188	16891	15537	14090	12816
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		15494	22341	25376	25267	23985	24945	23191	21352	19368	17618
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							15158	22119	24021	23625	22009
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	3676	3373	3238	3080	2927	2654	2450	2307	2134	1939	1764
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	7339	6776	6463	6099	5743	5056	4411	3944	3525	3157	2861
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	9872	9096	8714	8280	7800	6989	6337	5887	5390	4889	4448
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	12704	11696	11216	10646	10058	9023	8190	7625	6983	6321	5747
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	17707	16301	15650	14876	14075	12654	11523	10748	9875	8962	8175
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	25933	23894	22857	21662	20462	18382	16728	15538	14279	12952	11785
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	30442	32640	31249	29623	27964	25097	22811	21136	19454	17640	16039
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		19170	27446	30525	30428	29248	31201	28857	26552	24099	21928
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							18725	27438	29806	29543	27488
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	22745	21289	19979	19914	19320	17886	16591	11394	11186	9990	9422

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Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	38263	33888	31038	30250	28739	25920	23508	17942	16697	14747	13789
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	47378	50015	44648	42796	40183	35485	31475	26529	24198	21258	19846
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		28653	37698	43030	42443	39538	41367	36182	32578	28596	26678
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							24865	32533	35294	35054	33605
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014							24865	28908	28253	30916	30228
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	24140	20380	18827	18424	17539	15546	13812	12463	10891	9522	8868
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	43038	35677	32263	30994	28943	25285	22279	20287	17587	15365	14268
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	69425	67770	53118	46099	41563	35872	31358	27287	24305	21246	19781
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		45589	61667	66611	61080	54224	52262	39979	34245	29581	27345
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							35790	47348	50916	44411	38914
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014							35790	41659	45556	45700	45128
Passenger Cars	LPG cars	Conventional	0	1990	14846	13717	12218	10556	9806	8692	7851	6109	5267	4621	3768
Passenger Cars	LPG cars	Euro I	1991	1996	28759	26291	23458	22787	22494	19728	16926	14750	13368	12005	11073
Passenger Cars	LPG cars	Euro II	1997	2000			43768	37006	40514	39833	39231			20077	18543
Passenger Cars	LPG cars	Euro III	2001	2005								20002	27043	26386	24238
Passenger Cars	LPG cars	Euro IV	2006	2010										17582	31815
Passenger Cars	2-Stroke	Conventional	0	9999	8247	7570	7258	6886	6501						
Passenger Cars	Electric cars	Conventional	0	9999	13340	13406	13072	12352	11223	10054	9349	6755	7594	7696	8924
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	14616	13566	13032	12507	11751	10376	9288	9578	8081	7680	7422
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	22825	20675	19530	18492	17255	15127	13526	14008	12007	11636	11621
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	20896	21150	24338	23019	21451	18778	16781	17351	14859	14372	14339
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			13917	19847	20585	19958	19628	23201	19882	19214	19179
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011								13912	21825	22626	22850
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	21822	19569	18352	18091	17336	15668	14061	13973	12283	11368	11287
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998	34817	30590	28287	27538	26176	23485	21082	20958	18449	17088	17041
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001	31033	31438	35527	34559	32821	29387	26367	26186	23046	21303	21244
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006			20258	30170	31499	30733	29954	35281	31113	28771	28717
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011								20870	31321	33151	34025
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015							19651	24679	28916	31296	31989
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	12711	11299	10423	9277	7618	6008	5864	5408	4221	4122	4000
Light Duty Vehicles	LPG <3,5t	Euro I	1995	1998	32025	27762									
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001	18316				27349	23470	22276	21885	20179	18381	17836
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006							22965	27145	25718	24751	24426
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011								16378	25518	29713	29154
Light Duty Vehicles	Electric <3,5t	Conventional	0	9999	6761								8923	8622	10534
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	15471	16386	17426	16472	15933	14390	15767	17431	16055	14867	15235
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	17998	19427	17832	17427	17356	13770	12326	11299	9527	7503	7335

Continued

Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996	29567	31641	28972	28313	28171	22483	20536	19157	16533	13396	13498
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001	33621	38852	37231	36385	36178	28983	26510	24630	21322	17270	17427
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006		23999	30457	37037	40438	33904	33864	33957	29442	23883	24144
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009							21495	24072	27799	28066	31249
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013								21330	26509	20103	20500
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	20385	21977	20204	19835	19740	15661	14103	12881	10762	8522	8199
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996	34028	36267	33253	32312	32138	25565	23309	21638	18652	15249	15270
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001	38039	43965	42648	41760	41691	33322	30444	28296	24580	20104	20096
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006		27938	35690	43799	45881	38559	37944	38831	34004	27959	28122
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009		27347	50073	43000	42745	31082	25152	29235	32789	33756	35450
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013				42615	42362	33706	27678	25018	27054	28476	32060
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	19428	19932	18403	17977	17596	16328	14851	13724	11802	9451	9655
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996	31236	31904	29199	28575	27842	25897	23692	21822	18862	15220	15387
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001	36467	39369	36463	35771	34936	32685	30039	27915	24400	19565	19935
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006		24773	31764	38763	39702	38256	39574	39863	34739	28046	28613
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009					43062	40064	30462	26732	32423	32216	37073
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013									23342	32517	27743
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	32862	33635	30971	30536	29809	27892	25357	23336	20040	15985	16119
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996	51549	52457	48183	47430	46367	43139	39394	36454	31410	25315	25739
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001	57665	64423	61815	60780	59420	55441	50761	47189	40825	32993	33611
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006		41358	53911	61347	66642	65459	64274	65746	57079	46091	47215
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009		39875	62922	64039	71783	56467	46090	48277	57189	55784	59133
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013						42569	47256	47763	50168	48542	55490
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	54320	48744	45352	44778	43238	39974	36392	33774	28941	23205	23132
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996	82609	73422	67978	67079	64314	59362	54134	50451	43464	35271	35456
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001	92771	89979	86706	85646	82303	76040	69477	64932	56155	45672	46012
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006		57240	72653	88121	92122	89652	88352	92512	80247	65446	66214
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009		55991	96623	101964	91312	61937	68990	66793	78889	77283	81664
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013						58803	73185	66845	70129	66931	75787
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	56076	49143	46523	44877	42931	39707	35968	33382	28908	22389	23889
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996	84127	72631	67577	66326	62299	62261	56064	52032	44700	38083	37994
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001	100442	89831	83181	81643	78782	73085	65810	60681	54484	42466	48097
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006				58837	73291	99846	100664	93424	80261	65257	69630
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009								57095	87698	82535	88489
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013								57095	98102	79762	85108
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	61225	54790	50623	49375	47758	44506	40728	37044	32070	25640	28165
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996	83315	74284	69375	68365	65209	60404	54354	50250	43011	35164	37770

Continued

Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001	88982	90606	90550	89296	85683	79627	72049	67121	58005	47481	50916
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006		56936	74759	87145	91990	89917	86613	93909	81853	66906	71585
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009			56049	75899	110131	62495	71635	66913	79090	77509	87209
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013							57521	64027	70613	67878	82098
Heavy Duty Vehicles	Diesel RT >32t	Conventional	0	1993	62601	58944	54842	33182	31817	29603	24520	22757	19550		
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996	77588	70375	70188	68889	65902	61136	55051	51092	43893	35688	40635
Heavy Duty Vehicles	Diesel RT >32t	Euro II	1997	2001	74901	101905	97999								
Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006		56325	104812	91020	96425	82252	77789	76167	69980	71115	75882
Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009								57095	98102	79762	52060
Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013										79762	63863
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	36076	34714	31912	31679	31465	29326	27630	25994	23311	17470	19092
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996	56115	53711	49296	48918	48698	45272	42683	40442	36612	27930	30900
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001	62828	66074	63335	62750	62418	58145	54696	52002	47267	36175	40350
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006		42316	55119	63223	69921	68620	69299	72567	66101	50517	56565
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009		40799	64332	65996	75262	59079	49746	53335	66363	61232	71317
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013						44538	50839	52517	58052	53295	66437
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	59837	51470	47377	47198	46345	42965	41598	39893	36626	28318	31436
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996	88793	77589	71212	70815	69287	64202	62048	59312	54020	41602	46677
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001	97141	96740	93155	93303	91674	84982	83403	79107	71782	55184	61440
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006		64475	81407	95848	102774	101252	112344	120094	110384	85386	94695
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009		58478	89659	111095	86241	72927	83389	82946	106080	98463	114013
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013		60693	112110	112129		66899	85541	88563	107392	97527	116118
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	73942	77821	71029	68073	63925	57917	54553	50254	42285	36771	33357
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996	103698	109404	100120	96430	91138	83280	78475	73799	62772	57395	54418
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001	110324	134290	131843	127772	121151	111339	104759	97068	81876	74135	69609
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006		85450	105378	123178	128215	126280	131263	140652	121314	111852	105841
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009		83955	97398	140287	147386	85879	98969	94782	114344	129025	128962
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013		83955	118025	153422	145858	129694	86281	92355	110209	119657	120157
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro I	1994	1996	102248	112188	102762	99064	94180	86654					
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001	125089	137250	125719	121194	115219	106012	101625	95118	81958	75984	72075
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009								87082	150067	139129	131971
Heavy Duty Vehicles	Diesel TT/AT >60t	Euro V	2010	2013									80250	102649	
Buses	Gasoline Urban Buses	Conventional	0	9999	15801	15469	15262	14610	12816	17679	17823	33299	30963	34224	30311
Buses	Diesel Urban Buses <15t	Conventional	0	1993	73704	69555	65973	63516	60209	55726	50795	47221	44449	39163	36136
Buses	Diesel Urban Buses <15t	Euro I	1994	1996	113375	105491	98660	94825	90297	82525	76773	73252	66207	59119	55131
Buses	Diesel Urban Buses <15t	Euro II	1997	2001	126818	125943	122778	118677	113321	103362	96682	92361	83241	75928	72292
Buses	Diesel Urban Buses <15t	Euro III	2002	2006			77218	104396	123458	120207	122546	133140	120242	106697	100328

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Buses	Diesel Urban Buses <15t	Euro IV	2007	2009								80502	106873	111220	131333
Buses	Diesel Urban Buses <15t	Euro V	2010	2013											74487
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	72610	68150	64917	62950	60082	55042	52409	50205	46021	41624	39883
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996	112238	103891	96819	92706	88492	80900	75874	72615	65528	58620	55334
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001	123334	124475	125185	120556	115115	104997	98202	94098	85460	76384	72149
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006			77218	123225	129727	124894	117172	131589	119314	106491	100100
Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009								80502	100595	106405	133010
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013											74487
Buses	Diesel Urban Buses >18t	Conventional	0	1993	85502	80053	75911	73414	69467	64654	60909	56380	53371	43923	40378
Buses	Diesel Urban Buses >18t	Euro I	1994	1996	109194	102039	97540	93824	89504	81849	76464	74727	62198	55090	50827
Buses	Diesel Urban Buses >18t	Euro II	1997	2001	97862	113068	136013	130814	124514	113816	106091	101716	91824	82521	77396
Buses	Diesel Urban Buses >18t	Euro III	2002	2006			77218	120043	124379	129423	123893	128295	116682	104390	98193
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009								80502	112083	118033	129601
Buses	Diesel Urban Buses >18t	Euro V	2010	2013											74487
Buses	Gasoline Coaches	Conventional	0	9999	15331	14610	14368	13776	13279	12518	11817	11340	10805	9917	9239
Buses	Diesel Coaches <15t	Conventional	0	1993	25816	24981	24029	24070	23909	22168	20561	19793	17929	15846	15032
Buses	Diesel Coaches <15t	Euro I	1994	1996	35800	34011	32350	32035	31604	29178	26916	25823	23414	20740	19736
Buses	Diesel Coaches <15t	Euro II	1997	2001	39702	40077	41985	41416	40778	37702	34880	33573	30504	27047	25740
Buses	Diesel Coaches <15t	Euro III	2002	2006			25866	40567	44023	44313	43678	46855	42426	37560	35755
Buses	Diesel Coaches <15t	Euro IV	2007	2009								28605	38702	39423	46768
Buses	Diesel Coaches <15t	Euro V	2010	2013											26662
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	32808	31527	30668	30759	30634	28915	27028	26295	24133	21777	20969
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996	59248	56132	53179	52678	51874	47871	43982	42185	38089	33805	32103
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001	63867	66866	69171	68608	67457	61924	56923	54622	49646	43951	41971
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006			42553	61143	77824	75987	72217	75315	67838	59795	56739
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009								47058	58106	63988	77970
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013											43862
Buses	Diesel Coaches >18t	Conventional	0	1993	67418	64351	61817	61719	61578	56880	52648	51019	46690	40889	39438
Buses	Diesel Coaches >18t	Euro I	1994	1996	94564	89990	86004	84786	83217	76411	70956	67835	61629	54514	51947
Buses	Diesel Coaches >18t	Euro II	1997	2001	101528	103472	113133	112138	110603	101413	92833	88694	80654	71976	68493
Buses	Diesel Coaches >18t	Euro III	2002	2006			67697	93888	114101	114157	116516	123137	111570	98836	94266
Buses	Diesel Coaches >18t	Euro IV	2007	2009								74865	105169	109410	121458
Buses	Diesel Coaches >18t	Euro V	2010	2013											69779
Mopeds	<50 cm^3	Conventional	0	1999	1939	1528	1550	1551	1523	1500	1497	1503	1514	1498	1485
Mopeds	<50 cm^3	Euro I	2000	2003	1939	1528	1550	1551	1523	1500	1497	1503	1514	1498	1485
Mopeds	<50 cm^3	Euro II	2004	9999					1523	1500	1497	1503	1514	1498	1485
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973

Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006					5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999								4426	4250	3971	3973
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006					5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999								4426	4250	3971	3973
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke >750 cm^3	Euro I	2000	2003	6945	6567	6354	6017	5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke >750 cm^3	Euro II	2004	2006					5540	5076	4722	4426	4250	3971	3973
Motorcycles	4-stroke >750 cm^3	Euro III	2007	9999								4426	4250	3971	3973

Annex 3B-3: EU directive emission limits for road transportation vehicles

Private cars and light duty vehicles I (<1305 kg).

G prkm		EURO 1	EURO 2	EURO 3[1]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	2.72	2.2	2.3	1.0	1.0	1.0
	Diesel	2.72	1.0	0.64	0.5	0.5	0.5
HC	Gasoline	-	-	0.20	0.10	0.1	0.1
NMHC	Gasoline	-	-	-	-	0.068	0.068
NO_x	Gasoline	-	-	0.15	0.08	0.06	0.06
	Diesel	-	-	0.5	0.25	0.18	0.08
HC+NO_x	Gasoline	0.97	0.5	-	-		-
	Diesel	0.97	0.7/0.9[2]	0.56	0.30	0.23	0.17
Particulates	Diesel	0.14	0.08/0.10[2]	0.05	0.025	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	15	15	15
HC	Gasoline	-	-	-	1.8	1.8	1.8
Evaporation							
HC[3]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements.

[2] Less stringent emission limits for direct injection diesel engines.

[3] Unit: g/test.

Light duty vehicles II (1305-1760 kg)

G pr km		EURO 1	EURO 2	EURO 3[1]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	5.17	4.0	4.17	1.81	1.81	1.81
	Diesel	5.17	1.25	0.80	0.63	0.63	0.63
HC	Gasoline	-	-	0.25	0.13	0.13	0.13
NMHC	Gasoline	-	-	-	-	0.9	0.9
NO_x	Gasoline	-	-	0.18	0.10	0.75	0.75
	Diesel	-	-	0.65	0.33	0.235	0.105
HC+NO_x	Gasoline	1.4	0.6	-	-	-	-
	Diesel	1.4	1.0/1.3[2]	0.72	0.39	0.295	0.195
Particulates	Gasoline					0.005	0.005
	Diesel	0.19	0.12/0.14[2]	0.07	0.04	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	24	24	24
HC	Gasoline	-	-		2.7	2.7	2.7
Evaporation							
HC[3]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements.

[2] Less stringent emission limits for direct injection diesel engines.

[3] Unit: g/test.

Light duty vehicles III (>1760 kg).

G pr km		EURO 1	EURO 2	EURO 3[1]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	6.9	5.0	5.22	2.27	2.27	2.27
	Diesel	6.9	1.5	0.95	0.74	0.74	0.74
HC	Gasoline	-	-	0.29	0.16	0.16	0.16
NMHC	Gasoline					0.108	0.108
NO_x	Gasoline	-	-	0.21	0.11	0.082	0.082
	Diesel	-	-	0.78	0.39	0.28	0.125
$HC+NO_x$	Gasoline	1.7	0.7	-	-	-	-
	Diesel	1.7	1.2/1.6[2]	0.86	0.46	0.35	0.215
Particulates	Gasoline					0.005	0.005
	Diesel	0.25	0.17/0.20[2]	0.10	0.06	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	30	30	30
HC	Gasoline	-	-	-	3.2	3.2	3.2
Evaporation							
HC[3]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2] Less stringent emission limits for direct injection diesel engines

[3] Unit: g/test

Heavy duty diesel vehicles.

(g pr kWh)		EURO I	EURO II	EURO III	EURO IV	EURO V	EURO VI	EEV[2]
	Test[1]	1993	1996	2001	2006	2009	2014	2000
CO	ECE/ESC	4.5	4.0	2.1	1.5	1.5	1.5	1.5
	ETC	-	-	(5.45)	4.0	4.0	4.0	3.0
HC	ECE/ESC	1.1	1.1	0.66	0.46	0.46	0.13	0.25
	ETC	-	-	(0.78)	0.55	0.55	0.16	0.40
NO_x	ECE/ESC	8.0	7.0	5.0	3.5	2.0	0.4	2.0
	ETC	-	-	(5.0)	3.5	2.0	0.4	2.0
Particulates[3]	ECE/ESC	0.36/0.61	0.15/0.25	0.10/0.13	0.02	0.02	0.01	0.02
	ETC	-	-	(0.16/0.21)	0.03	0.03	0.01	0.02
	ELR	-	-	0.8	0.5	0.5		0.15
NH_3	ECE/ESC						10 (ppm)	
	ETC						10 (ppm)	

[1] Test procedure: Euro 1 og Euro 2: ECE (stationary)
Euro 3: ESC (stationary) + ELR (load response)
Euro 4, Euro 5 og EEV: ESC (stationary) + ETC (transient) + ELR (load response)

[2] EEV: Emission limits for extra environmental friendly vehicles, used as a basis for economical incitaments (gas fueled vehicles).

[3] For Euro 1, Euro 2 og Euro 3 less stringent emission limits apply for small engines:

Euro 1: <85 kW
Euro 2: <0,7 l
Euro 3: <0,75 l

Annex 3B-4: Basis emission factors (g pr km)

Sector	Subsector	Tech 2	FYear	LYear	FCu	FCr	FCh	COu	COr	COh	PMu	PMr	PMh	NOxu	NOxr	NOxh
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	67,499	55,000	62,743	27,505	19,333	15,520	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	58,240	44,460	48,600	18,966	14,480	18,620	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	53,248	45,170	51,200	15,859	8,200	8,260	0,063	0,044	0,041	1,619	2,102	2,909
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	53,248	45,170	51,200	16,752	8,793	7,620	0,042	0,029	0,029	1,680	2,253	3,276
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	51,420	43,440	47,700	9,087	4,956	4,292	0,030	0,020	0,020	1,691	2,089	2,662
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	47,399	41,954	46,055	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	46,486	39,509	44,016	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	48,687	42,255	45,323	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	50,038	44,193	48,285	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	79,277	67,000	76,386	27,505	19,333	15,520	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	67,779	51,090	60,300	18,966	14,480	18,620	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	61,731	50,686	59,680	15,859	8,200	8,260	0,063	0,044	0,041	1,831	2,377	3,283
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	61,731	50,686	59,680	16,752	8,793	7,620	0,042	0,029	0,029	1,917	2,580	3,472
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	61,652	49,112	52,052	9,087	4,956	4,292	0,030	0,020	0,020	2,122	2,757	3,524
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	57,521	48,522	51,518	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	56,324	47,687	48,786	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	58,259	49,897	53,092	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	60,486	52,793	55,293	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	96,536	80,000	88,267	27,505	19,333	15,520	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	73,798	57,090	66,300	18,966	14,480	18,620	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	75,270	63,260	70,700	15,859	8,200	8,260	0,063	0,044	0,041	2,066	2,675	3,680
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	75,270	63,260	70,700	16,752	8,793	7,620	0,042	0,029	0,029	2,806	3,441	4,604
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	71,055	58,080	69,900	9,087	4,956	4,292	0,030	0,020	0,020	2,293	2,750	3,687
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	74,616	61,902	65,020	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	76,837	65,226	66,732	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	70,798	57,424	56,826	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	86,099	67,877	65,859	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,520	0,433	0,528
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	47,836	42,807	48,388	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	50,442	44,117	48,779	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	48,920	43,427	45,585	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	48,920	43,427	45,585	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014	48,920	43,427	45,585	0,083	0,034	0,021	0,006	0,005	0,005	0,388	0,305	0,415

Continued

Passenger Cars	Diesel >2,0 l	Conventional	0	1990	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,824	0,723	0,861
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	65,267	58,299	64,360	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	65,267	58,299	64,360	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	65,267	58,299	64,360	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	65,267	58,299	64,360	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014	65,267	58,299	64,360	0,083	0,034	0,021	0,006	0,005	0,005	0,388	0,305	0,415
Passenger Cars	LPG cars	Conventional	0	1990	59,000	45,000	54,000	2,043	2,373	9,723	0,040	0,030	0,025	2,203	2,584	2,861
Passenger Cars	LPG cars	Euro I	1991	1996	49,145	45,155	54,125	1,310	1,445	3,560	0,040	0,030	0,025	0,340	0,283	0,298
Passenger Cars	LPG cars	Euro II	1997	2000	49,145	45,155	54,125	0,891	0,982	2,421	0,040	0,030	0,025	0,122	0,102	0,107
Passenger Cars	LPG cars	Euro III	2001	2005	49,145	45,155	54,125	0,733	0,809	1,993	0,040	0,030	0,025	0,082	0,068	0,071
Passenger Cars	LPG cars	Euro IV	2006	2010	49,145	45,155	54,125	0,445	0,491	1,210	0,040	0,030	0,025	0,044	0,037	0,039
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	82,270	59,883	56,470	14,925	6,075	7,389	0,040	0,040	0,040	2,671	3,118	3,387
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	96,450	70,388	66,450	4,187	0,862	1,087	0,003	0,002	0,002	0,427	0,400	0,429
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	96,450	70,388	66,450	2,554	0,526	0,663	0,003	0,002	0,002	0,145	0,136	0,146
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	96,450	70,388	66,450	2,177	0,448	0,565	0,001	0,001	0,001	0,090	0,084	0,090
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	96,450	70,388	66,450	1,172	0,241	0,304	0,001	0,001	0,001	0,043	0,040	0,043
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	76,718	65,934	72,142	1,124	1,009	1,060	0,285	0,303	0,322	1,673	0,843	0,834
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006	68,860	58,185	63,660	0,322	0,269	0,347	0,047	0,044	0,061	0,740	0,634	0,664
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011	68,860	58,185	63,660	0,255	0,213	0,275	0,024	0,023	0,032	0,319	0,273	0,286
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015	68,860	58,185	63,660	0,255	0,213	0,275	0,003	0,003	0,004	0,228	0,195	0,204
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	88,500	67,500	81,000	3,064	3,559	14,584	0,060	0,045	0,038	3,305	3,876	4,291
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001	73,718	67,733	81,188	1,336	1,474	3,631	0,060	0,045	0,038	0,183	0,153	0,161
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006	73,718	67,733	81,188	1,100	1,214	2,990	0,060	0,045	0,038	0,122	0,102	0,107
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011	73,718	67,733	81,188	0,668	0,737	1,815	0,060	0,045	0,038	0,066	0,055	0,058
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	225,000	150,000	165,000	70,000	55,000	55,000	0,400	0,400	0,400	4,500	7,500	7,500
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	125,002	110,985	112,984	2,060	1,509	1,351	0,321	0,240	0,216	4,211	4,104	4,476
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996	100,036	91,682	104,222	0,668	0,501	0,546	0,126	0,095	0,090	2,939	2,938	3,316
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001	94,988	88,592	101,003	0,534	0,466	0,461	0,059	0,053	0,061	3,223	3,118	3,414
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006	101,379	92,883	105,924	0,660	0,481	0,452	0,067	0,048	0,041	2,499	2,300	2,498
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009	98,559	92,910	106,610	0,342	0,270	0,258	0,015	0,013	0,014	1,707	1,645	1,801
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013	99,641	93,536	106,995	0,344	0,270	0,259	0,015	0,013	0,014	1,012	0,972	1,062
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	183,253	153,117	150,068	2,358	1,698	1,525	0,330	0,236	0,207	7,928	7,236	7,499
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996	155,870	135,518	136,666	1,086	0,817	0,766	0,201	0,144	0,131	4,729	4,306	4,464
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001	148,625	131,263	133,537	0,868	0,727	0,717	0,094	0,080	0,093	5,152	4,593	4,682

Continued																
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006	157,573	137,771	138,996	1,084	0,771	0,733	0,104	0,073	0,063	3,997	3,536	3,485
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009	151,450	136,152	138,554	0,553	0,418	0,369	0,023	0,019	0,019	2,728	2,512	2,488
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013	153,617	137,425	139,289	0,560	0,421	0,374	0,023	0,019	0,019	1,647	1,483	1,468
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	198,513	163,310	159,212	2,546	1,876	1,693	0,351	0,254	0,233	8,826	7,718	7,748
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996	170,171	144,307	143,334	1,200	0,918	0,866	0,218	0,159	0,147	5,321	4,638	4,638
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001	163,223	140,030	139,590	0,985	0,820	0,804	0,103	0,087	0,103	5,815	4,975	4,889
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006	172,146	146,082	144,611	1,176	0,873	0,835	0,109	0,078	0,071	4,745	3,881	3,702
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009	163,114	142,925	143,274	0,599	0,448	0,410	0,024	0,020	0,020	3,208	2,754	2,620
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013	165,111	144,096	144,035	0,606	0,452	0,413	0,025	0,020	0,020	1,909	1,634	1,552
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	261,662	205,735	193,152	3,512	2,514	2,221	0,483	0,341	0,298	11,287	9,455	9,120
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996	212,834	172,142	164,411	1,612	1,206	1,117	0,298	0,209	0,181	6,721	5,601	5,385
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001	204,313	167,263	160,324	1,267	1,025	1,002	0,129	0,105	0,122	7,473	6,118	5,804
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006	215,351	173,802	164,914	1,601	1,150	1,096	0,153	0,106	0,090	6,139	4,859	4,431
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009	201,093	168,074	161,976	0,829	0,602	0,523	0,031	0,024	0,023	4,079	3,400	3,171
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013	205,393	169,743	162,354	0,869	0,625	0,536	0,032	0,025	0,023	2,460	2,028	1,883
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	315,898	243,280	222,355	2,558	1,885	1,712	0,482	0,353	0,319	12,251	9,862	9,114
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996	269,815	211,940	195,827	2,068	1,563	1,437	0,383	0,264	0,231	8,634	6,952	6,468
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001	261,049	207,213	191,812	1,620	1,285	1,399	0,172	0,137	0,157	9,465	7,549	6,947
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006	272,733	213,630	195,690	2,025	1,487	1,403	0,189	0,130	0,113	7,649	6,024	5,545
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009	257,598	207,458	192,565	1,003	0,728	0,628	0,041	0,031	0,028	5,146	4,223	3,967
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013	260,560	209,253	193,919	1,015	0,735	0,634	0,041	0,031	0,028	3,062	2,508	2,353
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	333,975	257,930	233,499	2,703	1,987	1,810	0,512	0,375	0,336	12,868	10,379	9,526
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996	286,465	225,388	206,076	2,162	1,647	1,535	0,398	0,281	0,244	9,122	7,308	6,742
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001	276,892	220,156	201,909	1,682	1,346	1,457	0,185	0,148	0,167	9,876	7,848	7,164
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006	289,328	227,449	206,788	2,121	1,582	1,481	0,201	0,141	0,118	7,733	6,089	5,633
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009	277,178	222,906	203,989	1,044	0,752	0,640	0,044	0,033	0,029	5,258	4,284	4,029
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013	280,496	224,942	205,435	1,056	0,760	0,647	0,044	0,033	0,029	3,127	2,544	2,388
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	369,813	292,229	265,715	2,928	2,149	2,047	0,567	0,415	0,376	14,515	11,942	11,008
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996	324,707	259,936	238,178	2,377	1,862	1,795	0,436	0,314	0,281	10,453	8,509	7,843
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001	313,359	251,467	240,101	1,930	1,574	1,563	0,211	0,172	0,195	11,232	9,043	8,280
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006	327,617	262,877	239,852	2,325	1,732	1,685	0,214	0,153	0,135	8,883	7,017	6,445
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009	316,735	259,706	237,679	1,145	0,834	0,714	0,049	0,038	0,034	5,978	5,101	4,533
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013	320,475	262,095	239,548	1,159	0,844	0,722	0,049	0,038	0,034	3,554	3,030	2,690
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996	328,394	256,124	232,416	2,482	1,894	1,795	0,453	0,317	0,286	10,614	8,446	7,666
Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006	330,977	257,873	232,502	2,398	1,789	1,725	0,219	0,153	0,135	9,225	7,224	6,550
Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009	316,444	252,503	229,586	1,151	0,839	0,723	0,049	0,037	0,033	6,270	5,071	4,708

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Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013	319,806	254,559	231,118	1,166	0,847	0,729	0,049	0,037	0,033	3,735	3,012	2,790
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	332,114	254,391	227,288	2,560	1,899	1,804	0,488	0,361	0,339	13,305	10,460	9,286
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996	297,033	229,431	205,352	2,173	1,665	1,602	0,380	0,277	0,261	9,509	7,408	6,570
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001	280,137	219,605	203,132	1,746	1,372	1,500	0,191	0,152	0,174	10,046	7,771	6,867
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006	294,936	228,574	203,723	2,067	1,559	1,515	0,184	0,132	0,120	8,110	6,154	5,397
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009	283,202	224,159	200,624	0,990	0,709	0,618	0,043	0,031	0,028	5,531	4,329	3,837
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013	286,144	226,034	202,156	1,002	0,717	0,625	0,043	0,032	0,028	3,297	2,575	2,277
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	385,216	290,623	255,748	3,006	2,216	2,091	0,579	0,419	0,384	15,378	11,908	10,419
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996	338,164	257,767	227,915	2,561	1,946	1,861	0,464	0,324	0,293	10,891	8,408	7,387
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001	329,707	253,289	223,868	2,056	1,607	1,775	0,227	0,177	0,201	11,695	8,978	7,885
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006	341,490	259,512	227,377	2,453	1,826	1,775	0,223	0,155	0,136	9,414	7,197	6,354
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009	327,133	254,126	224,236	1,157	0,830	0,704	0,050	0,036	0,032	6,398	5,061	4,523
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013	330,656	256,284	225,882	1,168	0,837	0,715	0,050	0,037	0,032	3,814	3,008	2,681
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	427,609	323,566	283,490	3,242	2,400	2,283	0,622	0,462	0,425	17,311	13,363	11,617
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996	376,029	287,195	252,542	2,823	2,135	2,079	0,500	0,358	0,333	12,142	9,377	8,189
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001	364,063	281,631	253,871	2,313	1,826	1,823	0,257	0,201	0,227	12,955	9,936	8,683
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006	380,024	289,287	252,570	2,675	1,999	1,959	0,240	0,170	0,146	10,432	7,969	6,995
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009	367,275	285,007	249,788	1,241	0,894	0,759	0,054	0,040	0,035	7,035	5,657	4,952
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013	371,248	287,356	251,512	1,256	0,902	0,765	0,055	0,040	0,035	4,187	3,365	2,944
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001	439,443	338,240	299,997	2,783	2,192	2,191	0,317	0,246	0,275	15,566	11,836	10,222
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009	440,973	342,585	300,013	1,445	1,038	0,878	0,064	0,047	0,041	8,477	6,746	5,764
Buses	Gasoline Urban Buses	Conventional	0	9999	225,000	150,000	165,000	70,000	55,000	55,000	0,400	0,400	0,400	4,500	7,500	7,500
Buses	Diesel Urban Buses <15t	Conventional	0	1993	265,880	211,064	197,424	4,479	3,144	2,830	0,729	0,490	0,413	9,347	7,678	7,133
Buses	Diesel Urban Buses <15t	Euro I	1994	1996	214,880	174,564	162,024	1,568	1,120	0,981	0,261	0,199	0,178	6,945	5,531	4,861
Buses	Diesel Urban Buses <15t	Euro II	1997	2001	207,395	170,373	158,652	1,391	0,958	0,806	0,129	0,107	0,103	7,552	5,971	5,224
Buses	Diesel Urban Buses <15t	Euro III	2002	2006	219,770	179,899	167,027	1,509	1,028	0,926	0,130	0,100	0,093	6,425	4,515	3,631
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009	204,146	174,431	172,127	0,800	0,542	0,422	0,032	0,025	0,022	4,076	3,101	2,593
Buses	Diesel Urban Buses <15t	Euro V	2010	2013	207,620	176,864	174,491	0,813	0,551	0,430	0,032	0,025	0,023	2,432	1,845	1,545
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	338,177	261,819	230,080	4,720	3,242	2,606	0,656	0,439	0,351	15,108	12,139	10,803
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996	288,515	228,326	202,771	2,204	1,612	1,330	0,359	0,258	0,226	9,289	7,392	6,426
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001	279,657	224,821	202,070	1,892	1,310	1,120	0,179	0,146	0,137	9,989	7,828	6,822
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006	293,115	235,088	211,025	2,070	1,382	1,257	0,174	0,132	0,115	8,427	6,044	4,919
Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009	276,404	230,306	217,637	1,045	0,709	0,556	0,044	0,033	0,028	5,452	4,181	3,521
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013	280,396	232,974	220,038	1,057	0,716	0,563	0,044	0,033	0,029	3,250	2,486	2,089
Buses	Diesel Urban Buses >18t	Conventional	0	1993	424,462	330,433	285,157	6,145	4,310	3,420	0,833	0,575	0,455	19,310	15,492	13,433
Buses	Diesel Urban Buses >18t	Euro I	1994	1996	369,176	292,254	253,780	2,882	2,132	1,965	0,451	0,336	0,311	11,840	9,361	8,043

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Buses	Diesel Urban Buses >18t	Euro II	1997	2001	358,097	288,482	265,154	2,541	1,716	1,467	0,241	0,194	0,178	12,472	9,751	8,334
Buses	Diesel Urban Buses >18t	Euro III	2002	2006	373,469	299,269	262,705	2,691	1,778	1,703	0,209	0,151	0,142	10,561	7,685	6,305
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009	359,379	300,406	272,408	1,287	0,869	0,664	0,054	0,039	0,032	7,106	5,505	4,635
Buses	Diesel Urban Buses >18t	Euro V	2010	2013	363,797	303,565	275,335	1,297	0,877	0,671	0,054	0,039	0,033	4,234	3,275	2,755
Buses	Gasoline Coaches	Conventional	0	9999	225,000	150,000	165,000	70,000	55,000	55,000	0,400	0,400	0,400	4,500	7,500	7,500
Buses	Diesel Coaches <15t	Conventional	0	1993	306,332	225,195	199,049	2,712	1,738	1,372	0,490	0,328	0,269	11,324	8,822	8,156
Buses	Diesel Coaches <15t	Euro I	1994	1996	280,973	207,851	184,178	2,199	1,466	1,186	0,395	0,260	0,209	8,768	6,699	6,147
Buses	Diesel Coaches <15t	Euro II	1997	2001	279,483	208,488	184,973	1,775	1,203	1,092	0,186	0,137	0,120	10,033	7,549	6,840
Buses	Diesel Coaches <15t	Euro III	2002	2006	303,872	224,218	197,656	2,308	1,464	1,283	0,223	0,145	0,115	8,591	6,046	5,368
Buses	Diesel Coaches <15t	Euro IV	2007	2009	290,989	221,962	197,681	1,241	0,813	0,689	0,048	0,034	0,030	5,666	4,225	3,842
Buses	Diesel Coaches <15t	Euro V	2010	2013	298,215	226,393	200,893	1,288	0,842	0,696	0,049	0,034	0,030	3,434	2,544	2,291
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	306,332	225,195	199,049	2,712	1,738	1,372	0,490	0,328	0,269	11,324	8,822	8,156
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996	280,973	207,851	184,178	2,199	1,466	1,186	0,395	0,260	0,209	8,768	6,699	6,147
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001	279,483	208,488	184,973	1,775	1,203	1,092	0,186	0,137	0,120	10,033	7,549	6,840
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006	303,872	224,218	197,656	2,308	1,464	1,283	0,223	0,145	0,115	8,591	6,046	5,368
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009	290,989	221,962	197,681	1,241	0,813	0,689	0,048	0,034	0,030	5,666	4,225	3,842
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013	298,215	226,393	200,893	1,288	0,842	0,696	0,049	0,034	0,030	3,434	2,544	2,291
Buses	Diesel Coaches >18t	Conventional	0	1993	371,932	272,817	240,539	3,104	2,042	1,732	0,572	0,388	0,331	14,084	10,772	9,735
Buses	Diesel Coaches >18t	Euro I	1994	1996	329,598	243,565	215,080	2,511	1,722	1,458	0,452	0,302	0,246	10,737	8,049	7,206
Buses	Diesel Coaches >18t	Euro II	1997	2001	323,939	241,571	213,608	2,031	1,395	1,290	0,214	0,161	0,143	11,883	8,817	7,837
Buses	Diesel Coaches >18t	Euro III	2002	2006	335,657	242,331	211,644	2,557	1,669	1,439	0,242	0,156	0,126	9,681	6,781	5,889
Buses	Diesel Coaches >18t	Euro IV	2007	2009	319,737	238,136	211,184	1,328	0,875	0,742	0,052	0,036	0,032	6,428	4,728	4,226
Buses	Diesel Coaches >18t	Euro V	2010	2013	328,400	243,537	215,269	1,363	0,896	0,758	0,053	0,037	0,032	3,881	2,845	2,536
Mopeds	<50 cm^3	Conventional	0	1999	25,000	25,000	0,000	13,800	13,800	0,000	0,188	0,188	0,000	0,020	0,020	0,000
Mopeds	<50 cm^3	Euro I	2000	2003	15,000	15,000	0,000	5,600	5,600	0,000	0,076	0,076	0,000	0,020	0,020	0,000
Mopeds	<50 cm^3	Euro II	2004	9999	12,080	12,080	0,000	1,300	1,300	0,000	0,038	0,038	0,000	0,260	0,260	0,000
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	27,115	28,317	39,640	15,605	19,285	28,470	0,200	0,200	0,200	0,029	0,030	0,035
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	24,800	27,499	36,055	15,258	17,209	24,960	0,020	0,020	0,020	0,237	0,428	0,655
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	27,015	30,386	40,330	10,391	14,456	24,910	0,020	0,020	0,020	0,304	0,424	0,567
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006	22,260	25,160	33,756	3,708	5,765	9,135	0,005	0,005	0,005	0,323	0,447	0,598
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999	19,262	20,359	25,932	2,060	3,201	5,092	0,005	0,005	0,005	0,253	0,382	0,612
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	26,648	23,766	26,620	20,461	19,486	22,990	0,020	0,020	0,020	0,196	0,300	0,548
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003	37,374	35,472	41,400	10,599	9,003	10,460	0,020	0,020	0,020	0,258	0,400	0,610
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006	34,197	33,450	41,276	2,230	2,436	6,092	0,005	0,005	0,005	0,257	0,390	0,577
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999	30,983	30,719	38,129	1,228	1,345	3,357	0,005	0,005	0,005	0,076	0,132	0,265
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	35,731	35,542	43,748	20,461	19,486	22,990	0,020	0,020	0,020	0,019	0,030	0,086

Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	43,101	41,041	47,500	10,599	9,003	10,460	0,020	0,020	0,020	0,125	0,178	0,392
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006	42,110	38,004	41,895	2,230	2,436	6,092	0,005	0,005	0,005	0,143	0,244	0,459
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999	40,343	37,470	43,083	1,228	1,345	3,357	0,005	0,005	0,005	0,104	0,200	0,484

Sector	Subsector	Tech 2	FYear	LYear	CH_4u	CH_4r	CH_4h	N_2Ou	N_2Or	N_2Oh	NH_3u	NH_3r	NH_3h	VOCu	VOCr	VOCh
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,030	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,030	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,030	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,053	0,031	0,026
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,034	0,021	0,015
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,018	0,011	0,009

Continued

Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,080	0,046	0,034
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,098	0,058	0,038
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,011	0,006	0,006
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,011	0,006	0,006
Passenger Cars	LPG cars	Conventional	0	1990	0,080	0,035	0,025	0,000	0,000	0,000	0,000	0,000	0,000	1,082	0,667	0,490
Passenger Cars	LPG cars	Euro I	1991	1996	0,080	0,035	0,025	0,021	0,013	0,008	0,000	0,000	0,000	0,239	0,071	0,083
Passenger Cars	LPG cars	Euro II	1997	2000	0,019	0,008	0,006	0,013	0,003	0,002	0,000	0,000	0,000	0,050	0,015	0,017
Passenger Cars	LPG cars	Euro III	2001	2005	0,013	0,006	0,004	0,005	0,002	0,001	0,000	0,000	0,000	0,036	0,011	0,012
Passenger Cars	LPG cars	Euro IV	2006	2010	0,004	0,002	0,001	0,005	0,002	0,001	0,000	0,000	0,000	0,007	0,002	0,002
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	0,150	0,040	0,025	0,010	0,007	0,007	0,002	0,002	0,002	1,877	0,729	0,446
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	0,026	0,016	0,014	0,034	0,020	0,010	0,070	0,132	0,074	0,220	0,109	0,078
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	0,017	0,013	0,011	0,023	0,013	0,008	0,163	0,149	0,084	0,053	0,026	0,019
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	0,003	0,002	0,004	0,007	0,001	0,001	0,002	0,030	0,065	0,031	0,015	0,011
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	0,002	0,002	0,000	0,001	0,000	0,000	0,002	0,029	0,065	0,013	0,007	0,005
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,081	0,065	0,063
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,030	0,024	0,023
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,030	0,024	0,023
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	0,120	0,053	0,038	0,000	0,000	0,000	0,000	0,000	0,000	1,623	1,000	0,735
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001	0,029	0,013	0,009	0,020	0,005	0,003	0,000	0,000	0,000	0,075	0,022	0,026
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006	0,019	0,008	0,006	0,008	0,003	0,002	0,000	0,000	0,000	0,054	0,016	0,019
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011	0,006	0,003	0,002	0,008	0,003	0,002	0,000	0,000	0,000	0,011	0,003	0,004
Heavy Duty Vehicles	Gasoline >3,5t	Conventional	0	9999	0,140	0,110	0,070	0,006	0,006	0,006	0,002	0,002	0,002	7,000	5,500	3,500
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Conventional	0	1993	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,298	0,789	0,576
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro I	1994	1996	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,253	0,167	0,130
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro II	1997	2001	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,171	0,111	0,086
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro III	2002	2006	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,162	0,102	0,077
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,022	0,017	0,017
Heavy Duty Vehicles	Diesel RT 3,5 - 7,5t	Euro V	2010	2013	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,022	0,017	0,017
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Conventional	0	1993	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,957	0,589	0,449

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Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro I	1994	1996	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,389	0,258	0,208
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro II	1997	2001	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,263	0,172	0,137
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro III	2002	2006	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,252	0,157	0,120
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro IV	2007	2009	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,035	0,025	0,022
Heavy Duty Vehicles	Diesel RT 7,5 - 12t	Euro V	2010	2013	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,035	0,026	0,022
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Conventional	0	1993	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,012	0,646	0,509
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro I	1994	1996	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,429	0,279	0,229
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro II	1997	2001	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,281	0,186	0,150
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro III	2002	2006	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,260	0,168	0,134
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro IV	2007	2009	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,034	0,025	0,024
Heavy Duty Vehicles	Diesel RT 12 - 14 t	Euro V	2010	2013	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,034	0,025	0,024
Heavy Duty Vehicles	Diesel RT 14 - 20t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,510	0,971	0,768
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,606	0,403	0,325
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,409	0,267	0,213
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,378	0,243	0,196
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,046	0,032	0,028
Heavy Duty Vehicles	Diesel RT 14 - 20t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,047	0,033	0,029
Heavy Duty Vehicles	Diesel RT 20 - 26t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,819	0,517	0,406
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,728	0,476	0,380
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,489	0,314	0,248
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,453	0,287	0,225
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,059	0,040	0,035
Heavy Duty Vehicles	Diesel RT 20 - 26t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,059	0,041	0,035
Heavy Duty Vehicles	Diesel RT 26 - 28t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,842	0,541	0,430
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,736	0,488	0,394
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,499	0,327	0,262
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,467	0,304	0,243
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,064	0,045	0,037
Heavy Duty Vehicles	Diesel RT 26 - 28t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,065	0,045	0,037
Heavy Duty Vehicles	Diesel RT 28 - 32t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,874	0,560	0,444
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,778	0,518	0,419
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,523	0,344	0,276
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,491	0,317	0,252
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,070	0,051	0,043
Heavy Duty Vehicles	Diesel RT 28 - 32t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,071	0,051	0,043
Heavy Duty Vehicles	Diesel RT >32t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,812	0,527	0,419

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Heavy Duty Vehicles	Diesel RT >32t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,496	0,316	0,249
Heavy Duty Vehicles	Diesel RT >32t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,070	0,048	0,041
Heavy Duty Vehicles	Diesel RT >32t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,070	0,049	0,041
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,736	0,476	0,380
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,678	0,450	0,363
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,450	0,296	0,238
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,415	0,269	0,215
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,059	0,041	0,036
Heavy Duty Vehicles	Diesel TT/AT 28 - 34t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,060	0,042	0,036
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,877	0,555	0,438
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,805	0,524	0,420
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,538	0,343	0,270
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,494	0,312	0,244
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,071	0,048	0,041
Heavy Duty Vehicles	Diesel TT/AT 34 - 40t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,072	0,049	0,041
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,901	0,570	0,450
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,844	0,546	0,433
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,558	0,358	0,282
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,510	0,323	0,253
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,077	0,053	0,045
Heavy Duty Vehicles	Diesel TT/AT 40 - 50t	Euro V	2010	2013	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,078	0,053	0,045
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,626	0,406	0,323
Heavy Duty Vehicles	Diesel TT/AT 50 - 60t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,090	0,063	0,053
Buses	Gasoline Urban Buses	Conventional	0	9999	0,140	0,110	0,070	0,006	0,006	0,006	0,002	0,002	0,002	7,000	5,500	3,500
Buses	Diesel Urban Buses <15t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	2,628	1,738	1,490
Buses	Diesel Urban Buses <15t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,507	0,364	0,312
Buses	Diesel Urban Buses <15t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,350	0,245	0,209
Buses	Diesel Urban Buses <15t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,318	0,220	0,199
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,043	0,034	0,032
Buses	Diesel Urban Buses <15t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,044	0,034	0,033
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,602	0,977	0,762
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,659	0,431	0,351
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,451	0,296	0,248
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,416	0,269	0,232
Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,061	0,045	0,040
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,061	0,046	0,040

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Buses	Diesel Urban Buses >18t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,666	1,018	0,791
Buses	Diesel Urban Buses >18t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,720	0,477	0,386
Buses	Diesel Urban Buses >18t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,491	0,332	0,263
Buses	Diesel Urban Buses >18t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,446	0,291	0,241
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,074	0,055	0,047
Buses	Diesel Urban Buses >18t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,075	0,056	0,048
Buses	Gasoline Coaches	Conventional	0	9999	0,140	0,110	0,070	0,006	0,006	0,006	0,002	0,002	0,002	7,000	5,500	3,500
Buses	Diesel Coaches <15t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,907	0,533	0,393
Buses	Diesel Coaches <15t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,830	0,516	0,397
Buses	Diesel Coaches <15t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,586	0,359	0,272
Buses	Diesel Coaches <15t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,577	0,351	0,271
Buses	Diesel Coaches <15t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,072	0,048	0,039
Buses	Diesel Coaches <15t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,074	0,049	0,039
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,907	0,533	0,393
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,830	0,516	0,397
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,586	0,359	0,272
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,577	0,351	0,271
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,072	0,048	0,039
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,074	0,049	0,039
Buses	Diesel Coaches >18t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,013	0,623	0,482
Buses	Diesel Coaches >18t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,915	0,581	0,457
Buses	Diesel Coaches >18t	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,630	0,392	0,305
Buses	Diesel Coaches >18t	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,608	0,371	0,286
Buses	Diesel Coaches >18t	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,076	0,050	0,042
Buses	Diesel Coaches >18t	Euro V	2010	2013	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,078	0,051	0,042
Mopeds	<50 cm^3	Conventional	0	1999	0,219	0,219	0,000	0,001	0,001	0,001	0,001	0,001	0,001	13,910	13,910	0,000
Mopeds	<50 cm^3	Euro I	2000	2003	0,044	0,044	0,000	0,001	0,001	0,001	0,001	0,001	0,001	2,730	2,730	0,000
Mopeds	<50 cm^3	Euro II	2004	9999	0,024	0,024	0,000	0,001	0,001	0,001	0,001	0,001	0,001	1,560	1,560	0,000
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	0,150	0,150	0,150	0,002	0,002	0,002	0,002	0,002	0,002	8,393	7,078	9,800
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	0,128	0,104	0,138
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	0,142	0,144	0,132	0,002	0,002	0,002	0,002	0,002	0,002	1,242	0,866	0,976
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006	0,136	0,092	0,092	0,002	0,002	0,002	0,002	0,002	0,002	1,042	0,843	0,965
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999	0,082	0,032	0,028	0,002	0,002	0,002	0,002	0,002	0,002	0,456	0,441	0,511
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	0,545	0,487	0,361
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003	0,148	0,174	0,156	0,002	0,002	0,002	0,002	0,002	0,002	2,390	1,522	1,079
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006	0,156	0,120	0,122	0,002	0,002	0,002	0,002	0,002	0,002	1,326	0,925	0,828

Continued																
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999	0,094	0,042	0,036	0,002	0,002	0,002	0,002	0,002	0,002	0,598	0,499	0,615
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	0,392	0,337	0,556
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	0,092	0,092	0,154	0,002	0,002	0,002	0,002	0,002	0,002	2,495	1,643	1,554
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006	0,084	0,062	0,102	0,002	0,002	0,002	0,002	0,002	0,002	1,088	0,674	0,656
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999	0,050	0,022	0,030	0,002	0,002	0,002	0,002	0,002	0,002	0,384	0,309	0,416

Annex 3B-5: Reduction factors

Sector	Subsector	Tech 2	FYear	LYear	FCuR	FCrR	FChR	COuR	COrR	COhR	PMuR	PMrR	PMhR	NOxuR	NOxrR	NOxhR	VOCuR	VOCrR	VOChR
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	1,93	5,83	4,43	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	-2,72	-0,72	1,59	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	-5,57	-5,34	-4,84	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	2,08	1,72	5,30	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	-1,28	-2,83	-3,05	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	-5,15	-8,80	-7,33	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	-2,98	-5,37	-2,63	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	5,12	7,23	12,60	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	-15,39	-9,65	-1,29	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	-5,45	-3,06	-0,81	18,08	48,77	83,05	17,92	36,92	53,22	-7,94	1,18	-0,20	34,81	33,43	41,61
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	-2,27	-1,45	5,79	76,38	81,12	94,30	48,53	51,90	58,32	-18,71	-18,46	-12,98	65,94	63,35	66,25
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	-2,27	-1,45	5,79	80,09	84,22	89,72	49,02	60,57	75,83	10,60	24,53	13,19	27,61	44,26	51,85
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014	-2,27	-1,45	5,79	80,09	84,22	89,72	89,80	92,11	95,17	35,63	45,66	37,49	27,61	44,26	51,85

Continued																			
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	0,00	0,00	0,00	18,08	48,77	83,05	17,92	36,92	53,22	-7,94	1,18	-0,20	-22,14	-25,38	-11,51
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	0,00	0,00	0,00	76,38	81,12	94,30	48,53	51,90	58,32	-18,71	-18,46	-12,98	52,23	62,67	63,93
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	0,00	0,00	0,00	80,09	84,22	89,72	49,02	60,57	75,83	10,60	24,53	13,19	86,39	86,10	83,20
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014	0,00	0,00	0,00	80,09	84,22	89,72	89,80	92,11	95,17	35,63	45,66	37,49	86,39	86,10	83,20
Passenger Cars	LPG cars	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	LPG cars	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	LPG cars	Euro II	1997	2000	0,00	0,00	0,00	32,00	32,00	32,00	0,00	0,00	0,00	64,00	64,00	64,00	79,00	79,00	79,00
Passenger Cars	LPG cars	Euro III	2001	2005	0,00	0,00	0,00	44,00	44,00	44,00	0,00	0,00	0,00	76,00	76,00	76,00	85,00	85,00	85,00
Passenger Cars	LPG cars	Euro IV	2006	2010	0,00	0,00	0,00	66,00	66,00	66,00	0,00	0,00	0,00	87,00	87,00	87,00	97,00	97,00	97,00
Passenger Cars	Electric cars	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	0,00	0,00	0,00	39,00	39,00	39,00	0,00	0,00	0,00	66,00	66,00	66,00	76,00	76,00	76,00
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	0,00	0,00	0,00	48,00	48,00	48,00	60,25	54,57	37,37	79,00	79,00	79,00	86,00	86,00	86,00
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	0,00	0,00	0,00	72,00	72,00	72,00	60,25	54,57	37,37	90,00	90,00	90,00	94,00	94,00	94,00
Light Duty Vehicles	Diesel <3,5t	Conventional	0	1994	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5t	Euro I	1995	1998	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5t	Euro II	1999	2001	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5t	Euro III	2002	2006	0,00	0,00	0,00	18,00	18,00	18,00	33,00	33,00	33,00	35,00	35,00	35,00	38,00	38,00	38,00
Light Duty Vehicles	Diesel <3,5t	Euro IV	2007	2011	0,00	0,00	0,00	35,00	35,00	35,00	65,00	65,00	65,00	72,00	72,00	72,00	77,00	77,00	77,00
Light Duty Vehicles	Diesel <3,5t	Euro V	2012	2015	0,00	0,00	0,00	35,00	35,00	35,00	95,63	95,63	95,63	80,00	80,00	80,00	77,00	77,00	77,00
Light Duty Vehicles	LPG <3,5t	Conventional	0	1994	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	LPG <3,5t	Euro II	1999	2001	0,00	0,00	0,00	32,00	32,00	32,00	0,00	0,00	0,00	64,00	64,00	64,00	79,00	79,00	79,00
Light Duty Vehicles	LPG <3,5t	Euro III	2002	2006	0,00	0,00	0,00	44,00	44,00	44,00	0,00	0,00	0,00	76,00	76,00	76,00	85,00	85,00	85,00
Light Duty Vehicles	LPG <3,5t	Euro IV	2007	2011	0,00	0,00	0,00	66,00	66,00	66,00	0,00	0,00	0,00	87,00	87,00	87,00	97,00	97,00	97,00
Light Duty Vehicles	Electric <3,5t	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Gasoline >3,5t	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Euro I	1994	1996	19,97	17,39	7,76	67,55	66,82	59,55	60,69	60,33	58,47	30,21	28,42	25,92	80,53	78,89	77,38
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Euro II	1997	2001	24,01	20,18	10,60	74,08	69,13	65,86	81,61	77,85	71,87	23,47	24,02	23,73	86,86	85,98	85,16
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Euro III	2002	2006	18,90	16,31	6,25	67,98	68,13	66,52	79,28	80,07	80,84	40,66	43,96	44,20	87,56	87,06	86,71
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Euro IV	2007	2009	21,15	16,29	5,64	83,37	82,11	80,91	95,44	94,65	93,58	59,45	59,91	59,77	98,28	97,79	97,11
Heavy Duty Veh.	Diesel RT 3,5 - 7,5t	Euro V	2010	2013	20,29	15,72	5,30	83,30	82,11	80,82	95,45	94,62	93,60	75,97	76,32	76,28	98,27	97,79	97,13
Heavy Duty Veh.	Diesel RT 7,5 - 12t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

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Heavy Duty Veh.	Diesel RT 7,5 - 12t	Euro I	1994	1996	14,94	11,49	8,93	53,96	51,87	49,75	39,18	39,03	36,52	40,35	40,49	40,47	59,34	56,17	53,69
Heavy Duty Veh.	Diesel RT 7,5 - 12t	Euro II	1997	2001	18,90	14,27	11,02	63,18	57,16	53,02	71,53	66,12	55,10	35,02	36,53	37,57	72,55	70,85	69,48
Heavy Duty Veh.	Diesel RT 7,5 - 12t	Euro III	2002	2006	14,01	10,02	7,38	54,03	54,57	51,94	68,40	69,00	69,32	49,58	51,13	53,53	73,67	73,28	73,21
Heavy Duty Veh.	Diesel RT 7,5 - 12t	Euro IV	2007	2009	17,35	11,08	7,67	76,57	75,39	75,78	93,10	92,09	90,79	65,60	65,29	66,82	96,38	95,67	95,13
Heavy Duty Veh.	Diesel RT 7,5 - 12t	Euro V	2010	2013	16,17	10,25	7,18	76,27	75,18	75,47	93,04	92,07	90,83	79,22	79,51	80,43	96,34	95,66	95,14
Heavy Duty Veh.	Diesel RT 12 - 14 t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 12 - 14 t	Euro I	1994	1996	14,28	11,64	9,97	52,86	51,03	48,87	37,82	37,42	37,06	39,71	39,91	40,14	57,63	56,88	54,97
Heavy Duty Veh.	Diesel RT 12 - 14 t	Euro II	1997	2001	17,78	14,26	12,32	61,29	56,29	52,49	70,72	65,68	55,94	34,11	35,54	36,90	72,19	71,22	70,63
Heavy Duty Veh.	Diesel RT 12 - 14 t	Euro III	2002	2006	13,28	10,55	9,17	53,81	53,44	50,67	68,93	69,17	69,39	46,23	49,71	52,23	74,33	74,00	73,71
Heavy Duty Veh.	Diesel RT 12 - 14 t	Euro IV	2007	2009	17,83	12,48	10,01	76,48	76,13	75,80	93,03	92,25	91,58	63,65	64,32	66,18	96,64	96,09	95,32
Heavy Duty Veh.	Diesel RT 12 - 14 t	Euro V	2010	2013	16,83	11,77	9,53	76,18	75,91	75,63	92,99	92,24	91,61	78,37	78,82	79,97	96,61	96,08	95,34
Heavy Duty Veh.	Diesel RT 14 - 20t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 14 - 20t	Euro I	1994	1996	18,66	16,33	14,88	54,10	52,05	49,69	38,29	38,82	39,43	40,46	40,76	40,96	59,89	58,50	57,65
Heavy Duty Veh.	Diesel RT 14 - 20t	Euro II	1997	2001	21,92	18,70	17,00	63,94	59,22	54,89	73,27	69,36	59,06	33,79	35,29	36,36	72,92	72,50	72,28
Heavy Duty Veh.	Diesel RT 14 - 20t	Euro III	2002	2006	17,70	15,52	14,62	54,42	54,24	50,66	68,29	69,01	69,76	45,61	48,61	51,42	74,94	75,03	74,44
Heavy Duty Veh.	Diesel RT 14 - 20t	Euro IV	2007	2009	23,15	18,31	16,14	76,40	76,04	76,43	93,48	92,87	92,25	63,86	64,05	65,23	96,97	96,70	96,31
Heavy Duty Veh.	Diesel RT 14 - 20t	Euro V	2010	2013	21,50	17,49	15,95	75,25	75,14	75,86	93,36	92,81	92,21	78,21	78,55	79,35	96,86	96,61	96,25
Heavy Duty Veh.	Diesel RT 20 - 26t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 20 - 26t	Euro I	1994	1996	14,59	12,88	11,93	19,16	17,09	16,07	20,49	25,29	27,75	29,52	29,51	29,03	11,17	8,06	6,45
Heavy Duty Veh.	Diesel RT 20 - 26t	Euro II	1997	2001	17,36	14,83	13,74	36,69	31,82	18,28	64,44	61,13	50,94	22,74	23,45	23,78	40,30	39,31	39,01
Heavy Duty Veh.	Diesel RT 20 - 26t	Euro III	2002	2006	13,66	12,19	11,99	20,84	21,10	18,05	60,89	63,32	64,58	37,56	38,91	39,16	44,75	44,58	44,64
Heavy Duty Veh.	Diesel RT 20 - 26t	Euro IV	2007	2009	18,46	14,72	13,40	60,80	61,35	63,31	91,59	91,35	91,18	58,00	57,18	56,47	92,84	92,20	91,51
Heavy Duty Veh.	Diesel RT 20 - 26t	Euro V	2010	2013	17,52	13,99	12,79	60,33	61,00	62,95	91,54	91,32	91,17	75,01	74,57	74,18	92,77	92,15	91,47
Heavy Duty Veh.	Diesel RT 26 - 28t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 26 - 28t	Euro I	1994	1996	14,23	12,62	11,74	20,03	17,07	15,21	22,33	25,06	27,38	29,11	29,59	29,23	12,60	9,85	8,38
Heavy Duty Veh.	Diesel RT 26 - 28t	Euro II	1997	2001	17,09	14,65	13,53	37,76	32,22	19,50	63,87	60,48	50,30	23,25	24,39	24,79	40,81	39,59	39,01
Heavy Duty Veh.	Diesel RT 26 - 28t	Euro III	2002	2006	13,37	11,82	11,44	21,52	20,38	18,17	60,68	62,36	64,94	39,91	41,33	40,87	44,52	43,89	43,54
Heavy Duty Veh.	Diesel RT 26 - 28t	Euro IV	2007	2009	17,01	13,58	12,64	61,39	62,14	64,62	91,49	91,19	91,37	59,14	58,72	57,71	92,39	91,72	91,36
Heavy Duty Veh.	Diesel RT 26 - 28t	Euro V	2010	2013	16,01	12,79	12,02	60,92	61,74	64,28	91,43	91,15	91,35	75,70	75,49	74,93	92,31	91,66	91,32
Heavy Duty Veh.	Diesel RT 28 - 32t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel RT 28 - 32t	Euro I	1994	1996	12,20	11,05	10,36	18,82	13,37	12,31	23,04	24,44	25,14	27,98	28,75	28,76	10,90	7,44	5,56
Heavy Duty Veh.	Diesel RT 28 - 32t	Euro II	1997	2001	15,27	13,95	9,64	34,08	26,77	23,67	62,75	58,53	48,13	22,62	24,28	24,79	40,10	38,55	37,82
Heavy Duty Veh.	Diesel RT 28 - 32t	Euro III	2002	2006	11,41	10,04	9,73	20,60	19,39	17,71	62,16	63,07	64,05	38,80	41,24	41,46	43,86	43,33	43,19
Heavy Duty Veh.	Diesel RT 28 - 32t	Euro IV	2007	2009	14,35	11,13	10,55	60,90	61,17	65,11	91,34	90,97	90,96	58,81	57,29	58,82	91,98	90,92	90,30
Heavy Duty Veh.	Diesel RT 28 - 32t	Euro V	2010	2013	13,34	10,31	9,85	60,41	60,74	64,74	91,27	90,91	90,93	75,51	74,62	75,57	91,91	90,86	90,25
Heavy Duty Veh.	Diesel RT >32t	Euro I	1994	1996	12,62	11,53	10,93	16,13	13,50	12,48	20,12	23,79	25,25	28,73	28,95	28,74	8,76	5,59	4,01

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Heavy Duty Veh.	Diesel RT >32t	Euro III	2002	2006	11,93	10,92	10,90	18,97	18,29	15,90	61,41	63,24	64,69	38,06	39,23	39,11	44,27	43,43	42,99
Heavy Duty Veh.	Diesel RT >32t	Euro IV	2007	2009	15,80	12,78	12,01	61,10	61,71	64,74	91,36	91,17	91,27	57,90	57,34	56,23	92,18	91,31	90,51
Heavy Duty Veh.	Diesel RT >32t	Euro V	2010	2013	14,90	12,07	11,43	60,60	61,33	64,46	91,29	91,12	91,26	74,92	74,66	74,06	92,09	91,27	90,50
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Euro I	1994	1996	10,56	9,81	9,65	15,13	12,34	11,18	22,12	23,23	22,95	28,53	29,18	29,25	7,82	5,31	4,45
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Euro II	1997	2001	15,65	13,67	10,63	31,82	27,73	16,83	60,81	57,94	48,69	24,49	25,71	26,04	38,86	37,80	37,36
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Euro III	2002	2006	11,19	10,15	10,37	19,25	17,89	15,99	62,26	63,46	64,44	39,05	41,17	41,88	43,54	43,44	43,48
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Euro IV	2007	2009	14,73	11,88	11,73	61,31	62,64	65,74	91,27	91,29	91,77	58,43	58,62	58,68	91,95	91,29	90,55
Heavy Duty Veh.	Diesel TT/AT 28 - 34t	Euro V	2010	2013	13,84	11,15	11,06	60,85	62,25	65,37	91,19	91,23	91,73	75,22	75,38	75,48	91,88	91,23	90,51
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Euro I	1994	1996	12,21	11,31	10,88	14,79	12,18	10,98	19,78	22,63	23,62	29,18	29,40	29,10	8,18	5,48	4,19
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Euro II	1997	2001	14,41	12,85	12,47	31,60	27,45	15,10	60,77	57,68	47,54	23,95	24,61	24,32	38,67	38,17	38,36
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Euro III	2002	2006	11,35	10,70	11,09	18,41	17,61	15,12	61,53	63,00	64,68	38,79	39,57	39,01	43,62	43,84	44,36
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Euro IV	2007	2009	15,08	12,56	12,32	61,51	62,53	66,34	91,40	91,31	91,63	58,39	57,50	56,59	91,92	91,32	90,66
Heavy Duty Veh.	Diesel TT/AT 34 - 40t	Euro V	2010	2013	14,16	11,82	11,68	61,16	62,20	65,81	91,32	91,25	91,60	75,20	74,74	74,26	91,84	91,26	90,62
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Euro I	1994	1996	12,06	11,24	10,92	12,93	11,05	8,95	19,65	22,36	21,85	29,86	29,82	29,51	6,26	4,20	3,76
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Euro II	1997	2001	14,86	12,96	10,45	28,66	23,92	20,16	58,75	56,55	46,55	25,17	25,64	25,26	38,00	37,21	37,26
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Euro III	2002	2006	11,13	10,59	10,91	17,51	16,69	14,19	61,42	63,23	65,66	39,74	40,37	39,79	43,37	43,37	43,77
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Euro IV	2007	2009	14,11	11,92	11,89	61,73	62,77	66,78	91,26	91,37	91,76	59,36	57,67	57,38	91,47	90,74	89,97
Heavy Duty Veh.	Diesel TT/AT 40 - 50t	Euro V	2010	2013	13,18	11,19	11,28	61,26	62,40	66,49	91,17	91,30	91,72	75,82	74,82	74,66	91,38	90,68	89,95
Heavy Duty Veh.	Diesel TT/AT 50 - 60t	Euro II	1997	2001	15,12	13,22	11,08	27,35	21,99	18,67	57,33	55,25	45,19	26,42	26,84	26,77	38,07	36,01	34,82
Heavy Duty Veh.	Diesel TT/AT 50 - 60t	Euro IV	2007	2009	14,82	12,10	11,08	62,26	63,07	67,40	91,40	91,54	91,89	59,93	58,30	58,71	91,05	90,11	89,38
Buses	Gasoline Urban Buses	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Urban Buses <15t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Urban Buses <15t	Euro I	1994	1996	19,18	17,29	17,93	64,98	64,38	65,34	64,18	59,36	56,81	25,70	27,96	31,85	80,69	79,04	79,08
Buses	Diesel Urban Buses <15t	Euro II	1997	2001	22,00	19,28	19,64	68,95	69,53	71,53	82,28	78,21	74,97	19,20	22,23	26,76	86,68	85,91	86,00
Buses	Diesel Urban Buses <15t	Euro III	2002	2006	17,34	14,77	15,40	66,31	67,30	67,27	82,14	79,67	77,43	31,27	41,19	49,10	87,89	87,33	86,64
Buses	Diesel Urban Buses <15t	Euro IV	2007	2009	23,22	17,36	12,81	82,13	82,75	85,07	95,64	94,92	94,57	56,39	59,61	63,64	98,36	98,06	97,83
Buses	Diesel Urban Buses <15t	Euro V	2010	2013	21,91	16,20	11,62	81,85	82,49	84,81	95,57	94,91	94,51	73,98	75,97	78,34	98,34	98,04	97,80
Buses	Diesel Urban Buses 15 - 18t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Urban Buses 15 - 18t	Euro I	1994	1996	14,69	12,79	11,87	53,30	50,29	48,97	45,25	41,27	35,52	38,51	39,11	40,52	58,83	55,91	53,90
Buses	Diesel Urban Buses 15 - 18t	Euro II	1997	2001	17,30	14,13	12,17	59,92	59,59	57,00	72,71	66,78	60,84	33,88	35,52	36,86	71,87	69,67	67,40
Buses	Diesel Urban Buses 15 - 18t	Euro III	2002	2006	13,33	10,21	8,28	56,14	57,37	51,77	73,49	70,02	67,33	44,22	50,21	54,47	74,05	72,45	69,52

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Buses	Diesel Urban Buses 15 - 18t	Euro IV	2007	2009	18,27	12,04	5,41	77,87	78,14	78,66	93,34	92,51	91,91	63,91	65,56	67,41	96,21	95,37	94,76
Buses	Diesel Urban Buses 15 - 18t	Euro V	2010	2013	17,09	11,02	4,36	77,61	77,91	78,39	93,29	92,44	91,82	78,49	79,52	80,66	96,18	95,33	94,71
Buses	Diesel Urban Buses >18t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Urban Buses >18t	Euro I	1994	1996	13,02	11,55	11,00	53,10	50,54	42,55	45,84	41,58	31,51	38,69	39,58	40,12	56,81	53,19	51,17
Buses	Diesel Urban Buses >18t	Euro II	1997	2001	15,64	12,70	7,01	58,65	60,18	57,11	71,05	66,18	60,82	35,41	37,06	37,96	70,55	67,39	66,73
Buses	Diesel Urban Buses >18t	Euro III	2002	2006	12,01	9,43	7,87	56,20	58,74	50,21	74,88	73,79	68,82	45,31	50,39	53,06	73,26	71,41	69,52
Buses	Diesel Urban Buses >18t	Euro IV	2007	2009	15,33	9,09	4,47	79,06	79,83	80,58	93,56	93,24	92,92	63,20	64,47	65,49	95,53	94,57	94,05
Buses	Diesel Urban Buses >18t	Euro V	2010	2013	14,29	8,13	3,44	78,89	79,66	80,38	93,49	93,15	92,82	78,07	78,86	79,49	95,49	94,52	93,98
Buses	Gasoline Coaches	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Coaches <15t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Coaches <15t	Euro I	1994	1996	8,28	7,70	7,47	18,93	15,68	13,60	19,31	20,59	22,44	22,57	24,07	24,64	8,47	3,14	-1,19
Buses	Diesel Coaches <15t	Euro II	1997	2001	8,76	7,42	7,07	34,56	30,80	20,45	62,13	58,30	55,34	11,40	14,43	16,14	35,38	32,63	30,64
Buses	Diesel Coaches <15t	Euro III	2002	2006	0,80	0,43	0,70	14,91	15,75	6,50	54,54	55,87	57,10	24,13	31,47	34,19	36,41	34,05	30,99
Buses	Diesel Coaches <15t	Euro IV	2007	2009	5,01	1,44	0,69	54,25	53,24	49,77	90,25	89,66	88,99	49,96	52,11	52,89	92,04	91,07	90,12
Buses	Diesel Coaches <15t	Euro V	2010	2013	2,65	-0,53	-0,93	52,50	51,58	49,26	90,05	89,49	88,84	69,67	71,16	71,91	91,83	90,88	89,96
Buses	Diesel Coaches 15 - 18t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Coaches 15 - 18t	Euro I	1994	1996	8,28	7,70	7,47	18,93	15,68	13,60	19,31	20,59	22,44	22,57	24,07	24,64	8,47	3,14	-1,19
Buses	Diesel Coaches 15 - 18t	Euro II	1997	2001	8,76	7,42	7,07	34,56	30,80	20,45	62,13	58,30	55,34	11,40	14,43	16,14	35,38	32,63	30,64
Buses	Diesel Coaches 15 - 18t	Euro III	2002	2006	0,80	0,43	0,70	14,91	15,75	6,50	54,54	55,87	57,10	24,13	31,47	34,19	36,41	34,05	30,99
Buses	Diesel Coaches 15 - 18t	Euro IV	2007	2009	5,01	1,44	0,69	54,25	53,24	49,77	90,25	89,66	88,99	49,96	52,11	52,89	92,04	91,07	90,12
Buses	Diesel Coaches 15 - 18t	Euro V	2010	2013	2,65	-0,53	-0,93	52,50	51,58	49,26	90,05	89,49	88,84	69,67	71,16	71,91	91,83	90,88	89,96
Buses	Diesel Coaches >18t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Diesel Coaches >18t	Euro I	1994	1996	11,38	10,72	10,58	19,11	15,65	15,87	21,00	21,97	25,46	23,77	25,28	25,99	9,71	6,78	5,13
Buses	Diesel Coaches >18t	Euro II	1997	2001	12,90	11,45	11,20	34,56	31,66	25,53	62,65	58,54	56,71	15,63	18,15	19,50	37,83	37,12	36,81
Buses	Diesel Coaches >18t	Euro III	2002	2006	9,75	11,17	12,01	17,62	18,24	16,92	57,74	59,71	61,98	31,26	37,05	39,51	39,99	40,51	40,69
Buses	Diesel Coaches >18t	Euro IV	2007	2009	14,03	12,71	12,20	57,22	57,13	57,19	90,88	90,59	90,41	54,36	56,11	56,59	92,52	91,99	91,37
Buses	Diesel Coaches >18t	Euro V	2010	2013	11,70	10,73	10,51	56,10	56,11	56,24	90,69	90,43	90,28	72,44	73,59	73,96	92,33	91,84	91,19
Mopeds	<50 cm^3	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mopeds	<50 cm^3	Euro I	2000	2003	40,00	40,00	0,00	59,42	59,42	0,00	59,84	59,84	0,00	0,00	0,00	0,00	80,37	80,37	0,00
Mopeds	<50 cm^3	Euro II	2004	9999	51,68	51,68	0,00	90,58	90,58	0,00	80,00	80,00	0,00	-1200,00	-1200,00	0,00	88,79	88,79	0,00
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	8,20	9,50	10,60	0,00	0,00	0,00	0,00	0,00	0,00	22,10	-0,90	-15,50	89,70	88,00	85,90
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	0,00	0,00	0,00	31,90	16,00	0,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006	17,60	17,20	16,30	75,70	66,50	63,40	75,00	75,00	75,00	-6,10	-5,40	-5,50	16,10	2,60	1,10
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999	28,70	33,00	35,70	86,50	81,40	79,60	75,00	75,00	75,00	16,90	9,90	-7,90	63,30	49,10	47,60

Continued

Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	28,70	33,00	35,70	0,00	0,00	0,00	0,00	0,00	0,00	24,10	24,90	10,10	77,20	68,00	66,50
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	0,00	0,00	0,00	48,20	53,80	54,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006	8,50	5,70	0,30	89,10	87,50	73,50	75,00	75,00	75,00	0,20	2,50	5,40	44,50	39,20	23,30
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999	17,10	13,40	7,90	94,00	93,10	85,40	75,00	75,00	75,00	70,40	67,00	56,50	75,00	67,20	43,00
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	17,10	13,40	7,90	0,00	0,00	0,00	0,00	0,00	0,00	85,00	83,20	78,10	84,30	79,50	64,20
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	0,00	0,00	0,00	48,20	53,80	54,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006	2,30	7,40	11,80	89,10	87,50	73,50	75,00	75,00	75,00	-14,20	-37,30	-17,00	56,40	59,00	57,80
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999	6,40	8,70	9,30	94,00	93,10	85,40	75,00	75,00	75,00	16,90	-12,40	-23,50	84,60	81,20	73,20

Annex 3B-6: Deterioration factors

Sector	Subsector	Tech 2	FYear	LYear	COU	COR	COH	NOxU	NOxR	NOxH	VOCU	VOCR	VOCH
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	2,456763636	2,5358	2,5358	2,0508818	1,888	1,888	1,8627364	1,5974	1,5974
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	2,456763636	2,5358	2,5358	2,0508818	1,888	1,888	1,8627364	1,5974	1,5974
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	1,417018479	1,144042107	1,144042107	1	1	1	1,1679608	1	1
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	1,080190658	1,030184039	1,030184039	1	1	1	1,032483	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	1,848646364	1,76984	1,76984	2,0508818	1,888	1,888	1,8916591	1,7868	1,7868
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	1,848646364	1,76984	1,76984	2,0508818	1,888	1,888	1,8916591	1,7868	1,7868
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	1,184210095	1	1	1,2745755	1	1	1	1	1
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	1,082566466	1	1	1,1228334	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	1,446653636	1,19748	1,19748	2,0508818	1,888	1,888	1,6774609	1,45388	1,45388
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	1,446653636	1,19748	1,19748	2,0508818	1,888	1,888	1,6774609	1,45388	1,45388
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	1,198355499	1	1	1,295693	1	1	1	1	1
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	1,114643111	1	1	1,1707201	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel <2,0 l	Euro V	2011	2014	1	1	1	1	1	1	1	1	1

Continued

Passenger Cars	Diesel >2,0 l	Conventional	0	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	1	1	1	1	1	1	1	1	1
Passenger Cars	Diesel >2,0 l	Euro V	2011	2014	1	1	1	1	1	1	1	1	1
Passenger Cars	LPG cars	Conventional	0	1990	1	1	1	1	1	1	1	1	1
Passenger Cars	LPG cars	Euro I	1991	1996	1	1	1	1	1	1	1	1	1
Passenger Cars	LPG cars	Euro II	1997	2000	1	1	1	1	1	1	1	1	1
Passenger Cars	LPG cars	Euro III	2001	2005	1	1	1	1	1	1	1	1	1
Passenger Cars	LPG cars	Euro IV	2006	2010	1	1	1	1	1	1	1	1	1
Passenger Cars	Electric cars	Conventional	0	9999	1	1	1	1	1	1	1	1	1
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	1	1	1	1	1	1	1	1	1
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	2,456763636	2,5358	2,5358	2,0508818	1,888	1,888	1,8627364	1,5974	1,5974
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	2,456763636	2,5358	2,5358	2,0508818	1,888	1,888	1,8627364	1,5974	1,5974
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	1,148767586	1	1	1,221664	1	1	1	1	1
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	1,0721928	1	1	1,1073467	1	1	1	1	1

Annex 3B-7: Fuel consumption factors (MJ/km) and emission factors (g/km)

Sector	ForecastYear	FCu (MJ)	FCr (MJ)	FCh (MJ)	CO_2u	CO_2r	CO_2h	CH_4u	CH_4r	CH_4h	N_2Ou	N_2Or	N_2Oh	SO_2u	SO_2r	SO_2h	NO_xu	NO_xr	NO_xh
Passenger Cars	1985	3,388	2,108	2,435	248	154	178	0,147	0,027	0,024	0,009	0,006	0,006	0,086	0,052	0,063	1,884	2,175	2,682
Passenger Cars	1986	3,335	2,095	2,415	244	153	177	0,146	0,027	0,024	0,009	0,006	0,006	0,057	0,034	0,042	1,853	2,163	2,722
Passenger Cars	1987	3,313	2,083	2,390	242	152	175	0,147	0,027	0,024	0,009	0,006	0,006	0,056	0,034	0,041	1,851	2,172	2,772
Passenger Cars	1988	3,237	2,074	2,370	237	152	173	0,145	0,027	0,024	0,009	0,006	0,006	0,055	0,034	0,041	1,833	2,183	2,814
Passenger Cars	1989	3,199	2,066	2,353	234	151	172	0,144	0,027	0,024	0,009	0,006	0,006	0,040	0,025	0,030	1,821	2,184	2,835
Passenger Cars	1990	3,180	2,059	2,338	232	151	171	0,144	0,027	0,024	0,009	0,006	0,006	0,040	0,025	0,030	1,821	2,190	2,853
Passenger Cars	1991	3,192	2,055	2,323	233	150	170	0,141	0,026	0,023	0,009	0,006	0,006	0,040	0,025	0,029	1,773	2,106	2,749
Passenger Cars	1992	3,149	2,051	2,305	230	150	169	0,131	0,026	0,022	0,010	0,006	0,006	0,026	0,017	0,020	1,666	1,949	2,551
Passenger Cars	1993	3,152	2,044	2,282	230	149	167	0,124	0,025	0,022	0,011	0,006	0,005	0,014	0,009	0,010	1,585	1,804	2,366
Passenger Cars	1994	3,110	2,043	2,268	227	149	166	0,112	0,023	0,020	0,011	0,006	0,005	0,014	0,009	0,010	1,459	1,616	2,138
Passenger Cars	1995	3,108	2,044	2,258	227	149	165	0,102	0,022	0,019	0,012	0,007	0,005	0,014	0,009	0,010	1,356	1,443	1,924
Passenger Cars	1996	3,132	2,047	2,251	229	150	165	0,093	0,021	0,018	0,013	0,007	0,005	0,014	0,009	0,010	1,273	1,291	1,738
Passenger Cars	1997	3,082	2,048	2,238	225	150	164	0,083	0,020	0,017	0,013	0,007	0,005	0,013	0,009	0,010	1,170	1,144	1,551
Passenger Cars	1998	3,077	2,049	2,222	225	150	162	0,075	0,019	0,016	0,013	0,007	0,005	0,013	0,009	0,010	1,072	1,002	1,362
Passenger Cars	1999	3,055	2,049	2,209	223	150	162	0,068	0,017	0,015	0,013	0,006	0,004	0,010	0,007	0,008	0,985	0,879	1,196
Passenger Cars	2000	3,037	2,050	2,202	222	150	161	0,063	0,016	0,014	0,013	0,006	0,004	0,007	0,005	0,005	0,924	0,791	1,074
Passenger Cars	2001	3,063	2,052	2,200	224	150	161	0,058	0,015	0,013	0,012	0,006	0,004	0,007	0,005	0,005	0,885	0,733	0,990
Passenger Cars	2002	3,037	2,057	2,200	222	150	161	0,052	0,014	0,012	0,012	0,006	0,004	0,007	0,005	0,005	0,832	0,672	0,900
Passenger Cars	2003	3,042	2,060	2,200	223	151	161	0,047	0,012	0,011	0,012	0,005	0,003	0,007	0,005	0,005	0,783	0,612	0,813
Passenger Cars	2004	2,993	2,062	2,200	219	151	161	0,041	0,011	0,010	0,011	0,005	0,003	0,007	0,005	0,005	0,726	0,554	0,729
Passenger Cars	2005	3,020	2,064	2,198	221	151	161	0,037	0,010	0,009	0,011	0,005	0,003	0,001	0,001	0,001	0,678	0,497	0,646
Passenger Cars	2006	3,001	2,067	2,198	219	151	161	0,032	0,008	0,008	0,010	0,004	0,003	0,001	0,001	0,001	0,619	0,441	0,568
Passenger Cars	2007	2,981	2,073	2,201	218	152	161	0,026	0,007	0,006	0,010	0,004	0,003	0,001	0,001	0,001	0,567	0,392	0,503
Passenger Cars	2008	2,976	2,065	2,191	218	151	160	0,023	0,006	0,005	0,009	0,003	0,003	0,001	0,001	0,001	0,529	0,356	0,456
Passenger Cars	2009	2,945	2,053	2,176	215	150	159	0,020	0,005	0,004	0,009	0,003	0,002	0,001	0,001	0,001	0,499	0,330	0,421
Passenger Cars	2010	2,955	2,033	2,155	214	148	156	0,017	0,004	0,004	0,009	0,003	0,002	0,001	0,001	0,001	0,480	0,310	0,394
Light Duty Vehicles	1985	4,021	2,786	2,987	297	206	221	0,049	0,017	0,011	0,002	0,001	0,001	0,771	0,555	0,607	2,072	1,208	1,244
Light Duty Vehicles	1986	4,001	2,788	2,993	295	206	221	0,048	0,016	0,011	0,001	0,001	0,001	0,467	0,337	0,369	2,054	1,186	1,220
Light Duty Vehicles	1987	4,013	2,788	2,993	296	206	221	0,048	0,016	0,011	0,001	0,001	0,001	0,468	0,337	0,368	2,061	1,187	1,221
Light Duty Vehicles	1988	3,958	2,788	2,993	292	206	221	0,048	0,016	0,011	0,001	0,001	0,001	0,462	0,337	0,369	2,026	1,185	1,218
Light Duty Vehicles	1989	3,935	2,789	2,997	290	206	221	0,047	0,016	0,010	0,001	0,001	0,001	0,310	0,227	0,248	2,008	1,170	1,201
Light Duty Vehicles	1990	3,930	2,790	2,998	290	206	221	0,046	0,016	0,010	0,001	0,001	0,001	0,310	0,227	0,249	2,004	1,165	1,196
Light Duty Vehicles	1991	3,968	2,789	2,997	293	206	221	0,047	0,016	0,010	0,001	0,001	0,001	0,312	0,227	0,248	2,028	1,171	1,202

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Light Duty Vehicles	1992	3,956	2,787	2,991	292	206	221	0,048	0,016	0,011	0,002	0,001	0,001	0,200	0,146	0,160	2,025	1,194	1,228
Light Duty Vehicles	1993	3,995	2,786	2,989	295	206	221	0,049	0,016	0,011	0,002	0,001	0,001	0,078	0,056	0,062	2,050	1,203	1,238
Light Duty Vehicles	1994	3,970	2,786	2,988	293	206	221	0,049	0,016	0,011	0,002	0,001	0,001	0,078	0,057	0,062	2,034	1,197	1,232
Light Duty Vehicles	1995	3,964	2,770	2,971	293	205	219	0,046	0,016	0,010	0,002	0,001	0,001	0,078	0,056	0,062	1,980	1,170	1,205
Light Duty Vehicles	1996	3,964	2,738	2,938	293	202	217	0,042	0,015	0,009	0,002	0,002	0,002	0,078	0,056	0,061	1,889	1,125	1,160
Light Duty Vehicles	1997	3,879	2,706	2,904	286	200	214	0,038	0,014	0,008	0,003	0,002	0,002	0,077	0,055	0,060	1,755	1,087	1,124
Light Duty Vehicles	1998	3,856	2,680	2,874	285	198	212	0,034	0,013	0,008	0,004	0,003	0,003	0,076	0,055	0,060	1,663	1,058	1,097
Light Duty Vehicles	1999	3,816	2,656	2,847	282	196	210	0,031	0,012	0,007	0,004	0,004	0,003	0,042	0,030	0,033	1,572	1,029	1,070
Light Duty Vehicles	2000	3,784	2,636	2,824	279	195	209	0,027	0,011	0,006	0,005	0,004	0,004	0,009	0,006	0,007	1,497	1,010	1,052
Light Duty Vehicles	2001	3,800	2,619	2,805	281	193	207	0,024	0,010	0,006	0,006	0,005	0,004	0,009	0,006	0,007	1,453	0,992	1,035
Light Duty Vehicles	2002	3,757	2,604	2,789	277	192	206	0,021	0,008	0,005	0,007	0,005	0,005	0,009	0,006	0,007	1,357	0,951	0,994
Light Duty Vehicles	2003	3,747	2,589	2,776	277	191	205	0,018	0,007	0,004	0,008	0,005	0,004	0,009	0,006	0,006	1,265	0,894	0,935
Light Duty Vehicles	2004	3,681	2,576	2,765	272	190	204	0,015	0,006	0,003	0,009	0,005	0,004	0,009	0,006	0,006	1,150	0,836	0,876
Light Duty Vehicles	2005	3,701	2,564	2,755	273	189	204	0,013	0,004	0,003	0,010	0,005	0,004	0,002	0,001	0,001	1,075	0,780	0,817
Light Duty Vehicles	2006	3,671	2,554	2,748	271	189	203	0,010	0,003	0,002	0,011	0,005	0,004	0,002	0,001	0,001	0,996	0,732	0,767
Light Duty Vehicles	2007	3,635	2,543	2,743	268	188	203	0,009	0,003	0,002	0,011	0,004	0,004	0,002	0,001	0,001	0,912	0,676	0,708
Light Duty Vehicles	2008	3,641	2,536	2,739	269	187	202	0,007	0,002	0,001	0,011	0,004	0,004	0,002	0,001	0,001	0,825	0,608	0,637
Light Duty Vehicles	2009	3,635	2,534	2,737	268	187	202	0,006	0,002	0,001	0,012	0,004	0,004	0,002	0,001	0,001	0,772	0,570	0,598
Light Duty Vehicles	2010	3,684	2,530	2,735	272	187	202	0,006	0,002	0,001	0,012	0,004	0,004	0,002	0,001	0,001	0,747	0,541	0,567
Heavy Duty Vehicles	1985	12,721	9,865	8,986	941	730	665	0,150	0,064	0,056	0,030	0,030	0,030	2,967	2,302	2,095	11,955	9,685	8,925
Heavy Duty Vehicles	1986	12,852	9,956	9,058	951	737	670	0,151	0,065	0,057	0,030	0,030	0,030	1,799	1,395	1,268	12,076	9,765	8,983
Heavy Duty Vehicles	1987	12,933	10,012	9,102	957	741	673	0,152	0,066	0,057	0,030	0,030	0,030	1,811	1,403	1,274	12,149	9,813	9,017
Heavy Duty Vehicles	1988	13,094	10,123	9,190	969	749	680	0,154	0,067	0,058	0,030	0,030	0,030	1,834	1,418	1,287	12,303	9,918	9,093
Heavy Duty Vehicles	1989	13,150	10,162	9,221	973	752	682	0,154	0,067	0,058	0,030	0,030	0,030	1,228	0,950	0,861	12,357	9,953	9,119
Heavy Duty Vehicles	1990	13,432	10,358	9,374	994	766	694	0,156	0,068	0,060	0,030	0,030	0,030	1,255	0,968	0,876	12,613	10,123	9,239
Heavy Duty Vehicles	1991	13,400	10,336	9,356	992	765	692	0,156	0,068	0,060	0,030	0,030	0,030	1,252	0,966	0,874	12,593	10,111	9,230
Heavy Duty Vehicles	1992	13,566	10,450	9,448	1004	773	699	0,158	0,069	0,060	0,030	0,030	0,030	0,824	0,635	0,574	12,739	10,209	9,302
Heavy Duty Vehicles	1993	13,802	10,613	9,575	1021	785	708	0,160	0,070	0,061	0,030	0,030	0,030	0,322	0,248	0,224	12,925	10,327	9,377
Heavy Duty Vehicles	1994	13,781	10,600	9,558	1020	784	707	0,160	0,071	0,062	0,030	0,030	0,030	0,322	0,248	0,223	12,739	10,163	9,218
Heavy Duty Vehicles	1995	13,450	10,372	9,370	995	768	693	0,160	0,071	0,062	0,030	0,030	0,030	0,314	0,243	0,219	12,096	9,661	8,780
Heavy Duty Vehicles	1996	13,452	10,377	9,362	995	768	693	0,160	0,072	0,063	0,030	0,030	0,030	0,315	0,243	0,219	11,728	9,334	8,456
Heavy Duty Vehicles	1997	13,311	10,288	9,287	985	761	687	0,155	0,071	0,063	0,030	0,030	0,030	0,311	0,241	0,217	11,395	9,045	8,180
Heavy Duty Vehicles	1998	13,072	10,134	9,171	967	750	679	0,146	0,070	0,062	0,030	0,030	0,030	0,306	0,237	0,215	11,111	8,805	7,961
Heavy Duty Vehicles	1999	12,941	10,054	9,113	958	744	674	0,138	0,069	0,062	0,030	0,030	0,030	0,167	0,129	0,117	10,937	8,644	7,803
Heavy Duty Vehicles	2000	12,950	10,073	9,135	958	745	676	0,131	0,068	0,061	0,030	0,030	0,030	0,030	0,024	0,021	10,892	8,585	7,731
Heavy Duty Vehicles	2001	12,817	9,993	9,082	948	739	672	0,123	0,067	0,061	0,030	0,030	0,030	0,030	0,023	0,021	10,613	8,361	7,534

Continued

Heavy Duty Vehicles	2002	12,997	10,114	9,163	962	748	678	0,118	0,067	0,060	0,030	0,030	0,030	0,030	0,024	0,021	10,441	8,195	7,363
Heavy Duty Vehicles	2003	13,099	10,180	9,198	969	753	681	0,113	0,067	0,060	0,030	0,030	0,030	0,031	0,024	0,022	10,150	7,948	7,134
Heavy Duty Vehicles	2004	13,149	10,211	9,208	973	756	681	0,109	0,067	0,060	0,030	0,030	0,030	0,031	0,024	0,022	9,865	7,715	6,924
Heavy Duty Vehicles	2005	13,366	10,359	9,310	989	767	689	0,106	0,068	0,060	0,030	0,030	0,030	0,006	0,005	0,004	9,688	7,554	6,766
Heavy Duty Vehicles	2006	13,450	10,420	9,348	995	771	692	0,101	0,067	0,059	0,030	0,030	0,030	0,006	0,005	0,004	9,409	7,319	6,551
Heavy Duty Vehicles	2007	13,531	10,493	9,394	1001	776	695	0,088	0,060	0,052	0,030	0,030	0,030	0,006	0,005	0,004	8,933	6,886	6,127
Heavy Duty Vehicles	2008	13,532	10,516	9,401	1001	778	696	0,069	0,048	0,041	0,030	0,030	0,030	0,006	0,005	0,004	8,271	6,274	5,527
Heavy Duty Vehicles	2009	13,563	10,556	9,428	1002	780	697	0,056	0,039	0,034	0,030	0,030	0,030	0,006	0,005	0,004	7,803	5,810	5,061
Heavy Duty Vehicles	2010	13,479	10,504	9,381	997	777	694	0,048	0,034	0,029	0,030	0,030	0,030	0,006	0,005	0,004	7,482	5,430	4,666
Buses	1985	13,770	10,397	9,025	1019	769	667	0,174	0,081	0,070	0,030	0,029	0,029	3,180	2,389	2,035	13,534	10,591	9,165
Buses	1986	13,773	10,401	9,027	1019	769	668	0,174	0,081	0,070	0,030	0,029	0,029	1,910	1,436	1,224	13,540	10,591	9,165
Buses	1987	13,777	10,408	9,033	1019	770	668	0,174	0,081	0,070	0,030	0,029	0,029	1,911	1,437	1,225	13,552	10,604	9,176
Buses	1988	13,783	10,419	9,044	1020	771	669	0,174	0,081	0,070	0,030	0,029	0,029	1,913	1,440	1,228	13,573	10,626	9,195
Buses	1989	13,786	10,422	9,046	1020	771	669	0,174	0,081	0,070	0,030	0,029	0,029	1,276	0,961	0,820	13,577	10,626	9,195
Buses	1990	13,776	10,404	9,028	1019	770	668	0,174	0,081	0,070	0,030	0,029	0,029	1,275	0,959	0,818	13,543	10,588	9,162
Buses	1991	13,774	10,401	9,026	1019	770	668	0,174	0,081	0,070	0,030	0,029	0,029	1,275	0,958	0,818	13,539	10,585	9,159
Buses	1992	13,768	10,391	9,019	1019	769	667	0,174	0,081	0,070	0,030	0,029	0,029	0,827	0,621	0,530	13,524	10,576	9,152
Buses	1993	13,760	10,379	9,008	1018	768	666	0,174	0,081	0,070	0,030	0,029	0,029	0,318	0,239	0,204	13,501	10,555	9,134
Buses	1994	13,619	10,281	8,939	1008	761	661	0,174	0,081	0,070	0,029	0,029	0,029	0,314	0,236	0,201	13,131	10,290	8,933
Buses	1995	13,391	10,095	8,804	991	747	651	0,174	0,081	0,070	0,029	0,029	0,029	0,308	0,231	0,197	12,505	9,806	8,569
Buses	1996	13,206	9,951	8,700	977	736	643	0,174	0,081	0,070	0,029	0,029	0,029	0,303	0,227	0,194	11,987	9,406	8,271
Buses	1997	13,021	9,845	8,628	963	728	638	0,171	0,080	0,069	0,029	0,029	0,029	0,299	0,225	0,193	11,626	9,136	8,063
Buses	1998	12,739	9,697	8,546	942	717	632	0,163	0,077	0,067	0,029	0,029	0,029	0,292	0,221	0,191	11,254	8,872	7,885
Buses	1999	12,483	9,566	8,477	924	708	627	0,156	0,074	0,064	0,029	0,029	0,029	0,158	0,120	0,105	10,885	8,610	7,709
Buses	2000	12,379	9,519	8,448	916	704	625	0,150	0,071	0,062	0,029	0,029	0,029	0,029	0,022	0,020	10,689	8,458	7,588
Buses	2001	12,368	9,525	8,450	915	705	625	0,146	0,069	0,061	0,029	0,029	0,029	0,029	0,022	0,020	10,601	8,374	7,510
Buses	2002	12,370	9,543	8,461	915	706	626	0,141	0,067	0,059	0,029	0,029	0,029	0,029	0,022	0,020	10,355	8,155	7,329
Buses	2003	12,383	9,575	8,484	916	708	627	0,135	0,064	0,057	0,029	0,029	0,029	0,029	0,022	0,020	10,088	7,896	7,104
Buses	2004	12,421	9,605	8,500	919	711	629	0,131	0,062	0,055	0,030	0,029	0,029	0,029	0,022	0,020	9,895	7,691	6,916
Buses	2005	12,406	9,610	8,506	918	711	629	0,127	0,060	0,053	0,030	0,029	0,029	0,006	0,004	0,004	9,697	7,490	6,726
Buses	2006	12,417	9,631	8,521	919	712	630	0,123	0,058	0,052	0,030	0,029	0,029	0,006	0,005	0,004	9,518	7,303	6,546
Buses	2007	12,432	9,669	8,558	920	715	633	0,115	0,054	0,048	0,030	0,029	0,029	0,006	0,005	0,004	9,240	7,066	6,333
Buses	2008	12,374	9,679	8,591	915	716	635	0,101	0,048	0,044	0,030	0,030	0,029	0,006	0,005	0,004	8,748	6,704	6,032
Buses	2009	12,338	9,709	8,642	912	717	638	0,086	0,042	0,038	0,030	0,030	0,029	0,006	0,005	0,004	8,233	6,324	5,714
Buses	2010	12,292	9,723	8,673	909	719	641	0,073	0,036	0,033	0,030	0,030	0,030	0,006	0,005	0,004	7,853	5,952	5,379
Mopeds	1985	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	

Continued																			
Mopeds	1986	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1987	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1988	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1989	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1990	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1991	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1992	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1993	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1994	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1995	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1996	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1997	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1998	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1999	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	2000	1,050	1,050		77	77		0,201	0,201		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2001	1,019	1,019		74	74		0,188	0,188		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2002	0,985	0,985		72	72		0,175	0,175		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2003	0,969	0,969		71	71		0,169	0,169		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2004	0,940	0,940		69	69		0,159	0,159		0,001	0,001		0,002	0,002		0,035	0,035	
Mopeds	2005	0,910	0,910		66	66		0,149	0,149		0,001	0,001		0,000	0,000		0,051	0,051	
Mopeds	2006	0,876	0,876		64	64		0,138	0,138		0,001	0,001		0,000	0,000		0,067	0,067	
Mopeds	2007	0,848	0,848		62	62		0,128	0,128		0,001	0,001		0,000	0,000		0,083	0,083	
Mopeds	2008	0,827	0,827		60	60		0,121	0,121		0,001	0,001		0,000	0,000		0,094	0,094	
Mopeds	2009	0,806	0,806		59	59		0,115	0,115		0,001	0,001		0,000	0,000		0,105	0,105	
Mopeds	2010	0,790	0,790		57	57		0,109	0,109		0,001	0,001		0,000	0,000		0,113	0,113	
Motorcycles	1985	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1986	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1987	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1988	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1989	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1990	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1991	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1992	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1993	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1994	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1995	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391

Continued

Motorcycles	1996	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1997	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1998	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	1999	1,241	1,208	1,481	91	88	108	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,003	0,140	0,224	0,391
Motorcycles	2000	1,256	1,224	1,499	92	89	109	0,190	0,190	0,190	0,002	0,002	0,002	0,003	0,003	0,003	0,143	0,228	0,395
Motorcycles	2001	1,266	1,233	1,509	92	90	110	0,188	0,189	0,189	0,002	0,002	0,002	0,003	0,003	0,003	0,146	0,231	0,400
Motorcycles	2002	1,276	1,243	1,519	93	91	111	0,187	0,188	0,188	0,002	0,002	0,002	0,003	0,003	0,003	0,148	0,235	0,404
Motorcycles	2003	1,285	1,251	1,528	94	91	112	0,185	0,187	0,187	0,002	0,002	0,002	0,003	0,003	0,003	0,151	0,238	0,409
Motorcycles	2004	1,290	1,257	1,534	94	92	112	0,184	0,184	0,185	0,002	0,002	0,002	0,003	0,003	0,004	0,154	0,243	0,413
Motorcycles	2005	1,299	1,265	1,545	95	92	113	0,181	0,180	0,181	0,002	0,002	0,002	0,001	0,001	0,001	0,158	0,248	0,419
Motorcycles	2006	1,306	1,273	1,554	95	93	113	0,179	0,175	0,177	0,002	0,002	0,002	0,001	0,001	0,001	0,162	0,254	0,426
Motorcycles	2007	1,310	1,277	1,559	95	93	113	0,172	0,166	0,168	0,002	0,002	0,002	0,001	0,001	0,001	0,158	0,249	0,421
Motorcycles	2008	1,311	1,278	1,560	95	93	114	0,169	0,161	0,163	0,002	0,002	0,002	0,001	0,001	0,001	0,157	0,247	0,420
Motorcycles	2009	1,312	1,279	1,560	95	93	114	0,167	0,159	0,160	0,002	0,002	0,002	0,001	0,001	0,001	0,156	0,246	0,420
Motorcycles	2010	1,312	1,279	1,560	94	92	112	0,166	0,158	0,159	0,002	0,002	0,002	0,001	0,001	0,001	0,156	0,246	0,421

Sector	ForecastYear	NMVOCu (exh)	NMVOCr (exh)	NMVOCh (exh)	NMVOCu (tot)	NMVOCr (tot)	NMVOCh (tot)	COu	COr	COh	NH3u	NH3r	NH3h	TSPu	TSPr	TSPh
Passenger Cars	1985	3,237	1,047	0,923	5,341	1,421	0,977	39,399	10,545	11,644	0,002	0,002	0,002	0,096	0,050	0,053
Passenger Cars	1986	3,137	1,013	0,892	5,246	1,387	0,946	36,856	9,698	10,490	0,002	0,002	0,002	0,095	0,049	0,052
Passenger Cars	1987	3,112	0,983	0,859	5,208	1,354	0,912	35,289	8,909	9,428	0,002	0,002	0,002	0,093	0,047	0,051
Passenger Cars	1988	2,877	0,956	0,829	5,057	1,340	0,884	31,432	8,287	8,533	0,002	0,002	0,002	0,086	0,045	0,049
Passenger Cars	1989	2,753	0,929	0,800	4,957	1,316	0,855	29,276	7,750	7,764	0,002	0,002	0,002	0,084	0,044	0,048
Passenger Cars	1990	2,688	0,910	0,778	4,889	1,294	0,832	28,035	7,363	7,236	0,002	0,002	0,002	0,082	0,043	0,047
Passenger Cars	1991	2,697	0,863	0,735	4,768	1,224	0,786	27,914	6,886	6,695	0,004	0,007	0,005	0,079	0,040	0,044
Passenger Cars	1992	2,507	0,793	0,673	4,445	1,129	0,720	25,422	6,287	6,116	0,008	0,017	0,010	0,070	0,036	0,040
Passenger Cars	1993	2,463	0,720	0,607	4,175	1,016	0,648	24,342	5,577	5,416	0,011	0,026	0,015	0,065	0,033	0,037
Passenger Cars	1994	2,231	0,634	0,533	3,779	0,900	0,570	21,489	4,893	4,733	0,016	0,038	0,022	0,058	0,029	0,034
Passenger Cars	1995	2,131	0,559	0,471	3,470	0,789	0,502	20,275	4,402	4,317	0,021	0,050	0,028	0,053	0,026	0,030
Passenger Cars	1996	2,112	0,493	0,415	3,233	0,685	0,442	19,894	3,971	3,958	0,025	0,060	0,034	0,049	0,023	0,027
Passenger Cars	1997	1,839	0,427	0,360	2,829	0,597	0,384	17,032	3,528	3,578	0,032	0,072	0,040	0,041	0,020	0,024
Passenger Cars	1998	1,682	0,364	0,307	2,481	0,500	0,325	15,581	3,077	3,174	0,041	0,082	0,046	0,035	0,017	0,021
Passenger Cars	1999	1,462	0,308	0,259	2,143	0,424	0,275	13,417	2,680	2,822	0,048	0,090	0,051	0,032	0,016	0,019
Passenger Cars	2000	1,332	0,268	0,226	1,781	0,344	0,236	12,210	2,403	2,580	0,054	0,095	0,054	0,029	0,014	0,018
Passenger Cars	2001	1,294	0,240	0,202	1,679	0,305	0,211	12,013	2,222	2,437	0,054	0,095	0,055	0,029	0,014	0,017
Passenger Cars	2002	1,135	0,210	0,178	1,471	0,266	0,186	10,635	2,037	2,291	0,052	0,090	0,055	0,026	0,013	0,016
Passenger Cars	2003	1,046	0,180	0,154	1,320	0,226	0,160	9,969	1,833	2,113	0,048	0,085	0,055	0,025	0,012	0,016

Continued

Passenger Cars	2004	0,871	0,152	0,131	1,097	0,190	0,136	8,385	1,634	1,934	0,045	0,080	0,054	0,023	0,012	0,016
Passenger Cars	2005	0,834	0,125	0,109	1,024	0,157	0,113	8,367	1,433	1,745	0,041	0,074	0,054	0,023	0,012	0,016
Passenger Cars	2006	0,709	0,101	0,090	0,864	0,127	0,093	7,218	1,235	1,542	0,036	0,067	0,052	0,022	0,011	0,015
Passenger Cars	2007	0,589	0,080	0,072	0,704	0,099	0,074	6,009	1,018	1,300	0,031	0,059	0,049	0,021	0,011	0,014
Passenger Cars	2008	0,533	0,066	0,060	0,622	0,080	0,061	5,492	0,864	1,125	0,026	0,052	0,047	0,022	0,011	0,014
Passenger Cars	2009	0,470	0,055	0,051	0,547	0,068	0,053	4,862	0,753	0,998	0,023	0,047	0,045	0,021	0,010	0,013
Passenger Cars	2010	0,444	0,046	0,043	0,504	0,056	0,044	4,633	0,640	0,862	0,020	0,042	0,042	0,022	0,010	0,012
Light Duty Vehicles	1985	0,758	0,189	0,146	1,073	0,241	0,156	7,118	1,810	2,091	0,001	0,001	0,001	0,487	0,261	0,277
Light Duty Vehicles	1986	0,716	0,184	0,143	1,016	0,232	0,153	6,697	1,763	2,031	0,001	0,001	0,001	0,482	0,264	0,279
Light Duty Vehicles	1987	0,727	0,184	0,143	1,025	0,232	0,153	6,791	1,765	2,033	0,001	0,001	0,001	0,489	0,264	0,279
Light Duty Vehicles	1988	0,678	0,183	0,143	0,988	0,234	0,153	6,361	1,760	2,027	0,001	0,001	0,001	0,451	0,264	0,280
Light Duty Vehicles	1989	0,642	0,179	0,141	0,944	0,228	0,150	6,018	1,727	1,984	0,001	0,001	0,001	0,441	0,266	0,282
Light Duty Vehicles	1990	0,633	0,178	0,140	0,930	0,226	0,149	5,927	1,716	1,971	0,001	0,001	0,001	0,439	0,266	0,282
Light Duty Vehicles	1991	0,669	0,180	0,141	0,967	0,227	0,150	6,251	1,729	1,987	0,001	0,001	0,001	0,462	0,266	0,281
Light Duty Vehicles	1992	0,684	0,186	0,144	1,008	0,238	0,154	6,437	1,780	2,053	0,001	0,001	0,001	0,444	0,263	0,279
Light Duty Vehicles	1993	0,726	0,188	0,145	1,046	0,239	0,155	6,828	1,800	2,078	0,001	0,001	0,001	0,465	0,262	0,277
Light Duty Vehicles	1994	0,701	0,186	0,144	1,031	0,239	0,154	6,617	1,791	2,055	0,001	0,001	0,001	0,451	0,262	0,278
Light Duty Vehicles	1995	0,683	0,179	0,140	0,986	0,227	0,149	6,392	1,679	1,925	0,002	0,002	0,002	0,437	0,248	0,264
Light Duty Vehicles	1996	0,659	0,165	0,132	0,907	0,204	0,140	6,055	1,478	1,699	0,002	0,004	0,003	0,415	0,220	0,237
Light Duty Vehicles	1997	0,576	0,153	0,126	0,793	0,187	0,132	5,230	1,295	1,496	0,003	0,006	0,004	0,341	0,193	0,210
Light Duty Vehicles	1998	0,549	0,144	0,121	0,727	0,172	0,126	4,977	1,152	1,340	0,004	0,008	0,005	0,300	0,168	0,186
Light Duty Vehicles	1999	0,500	0,135	0,116	0,651	0,159	0,120	4,482	1,017	1,194	0,005	0,010	0,006	0,257	0,146	0,165
Light Duty Vehicles	2000	0,465	0,129	0,112	0,566	0,145	0,115	4,187	0,919	1,090	0,007	0,012	0,007	0,222	0,127	0,146
Light Duty Vehicles	2001	0,459	0,124	0,108	0,542	0,137	0,111	4,091	0,830	0,993	0,008	0,014	0,008	0,208	0,111	0,131
Light Duty Vehicles	2002	0,409	0,116	0,103	0,481	0,127	0,105	3,681	0,749	0,906	0,008	0,014	0,009	0,175	0,097	0,117
Light Duty Vehicles	2003	0,375	0,107	0,095	0,432	0,115	0,097	3,369	0,667	0,813	0,007	0,012	0,008	0,158	0,085	0,104
Light Duty Vehicles	2004	0,312	0,097	0,088	0,357	0,104	0,089	2,812	0,586	0,721	0,006	0,011	0,008	0,129	0,074	0,092
Light Duty Vehicles	2005	0,293	0,089	0,081	0,329	0,094	0,082	2,620	0,509	0,631	0,005	0,010	0,008	0,121	0,064	0,082
Light Duty Vehicles	2006	0,257	0,082	0,075	0,285	0,086	0,076	2,252	0,448	0,561	0,005	0,008	0,007	0,107	0,057	0,074
Light Duty Vehicles	2007	0,227	0,074	0,069	0,249	0,078	0,069	1,924	0,410	0,515	0,004	0,007	0,007	0,096	0,051	0,067
Light Duty Vehicles	2008	0,206	0,066	0,061	0,223	0,069	0,062	1,725	0,370	0,468	0,003	0,006	0,006	0,088	0,045	0,060
Light Duty Vehicles	2009	0,191	0,062	0,057	0,205	0,064	0,058	1,633	0,352	0,445	0,003	0,006	0,006	0,081	0,041	0,055
Light Duty Vehicles	2010	0,194	0,058	0,054	0,206	0,060	0,055	1,623	0,335	0,425	0,003	0,006	0,006	0,083	0,039	0,052
Heavy Duty Vehicles	1985	0,865	0,581	0,442	0,865	0,581	0,442	3,120	2,307	2,152	0,003	0,003	0,003	0,479	0,349	0,318
Heavy Duty Vehicles	1986	0,855	0,575	0,438	0,855	0,575	0,438	3,088	2,282	2,127	0,003	0,003	0,003	0,482	0,352	0,320
Heavy Duty Vehicles	1987	0,851	0,572	0,436	0,851	0,572	0,436	3,085	2,279	2,125	0,003	0,003	0,003	0,484	0,353	0,321
Heavy Duty Vehicles	1988	0,843	0,567	0,433	0,843	0,567	0,433	3,079	2,275	2,120	0,003	0,003	0,003	0,488	0,356	0,324

Continued																
Heavy Duty Vehicles	1989	0,839	0,564	0,431	0,839	0,564	0,431	3,061	2,260	2,106	0,003	0,003	0,003	0,490	0,357	0,325
Heavy Duty Vehicles	1990	0,825	0,556	0,425	0,825	0,556	0,425	3,056	2,257	2,104	0,003	0,003	0,003	0,497	0,362	0,330
Heavy Duty Vehicles	1991	0,829	0,558	0,427	0,829	0,558	0,427	3,063	2,262	2,109	0,003	0,003	0,003	0,496	0,362	0,330
Heavy Duty Vehicles	1992	0,821	0,553	0,424	0,821	0,553	0,424	3,078	2,274	2,122	0,003	0,003	0,003	0,500	0,365	0,332
Heavy Duty Vehicles	1993	0,808	0,545	0,418	0,808	0,545	0,418	3,080	2,277	2,127	0,003	0,003	0,003	0,505	0,368	0,336
Heavy Duty Vehicles	1994	0,788	0,534	0,410	0,788	0,534	0,410	2,999	2,218	2,074	0,003	0,003	0,003	0,500	0,363	0,331
Heavy Duty Vehicles	1995	0,762	0,519	0,399	0,762	0,519	0,399	2,883	2,139	2,003	0,003	0,003	0,003	0,481	0,349	0,317
Heavy Duty Vehicles	1996	0,719	0,492	0,380	0,719	0,492	0,380	2,768	2,063	1,943	0,003	0,003	0,003	0,466	0,336	0,307
Heavy Duty Vehicles	1997	0,671	0,459	0,354	0,671	0,459	0,354	2,628	1,971	1,879	0,003	0,003	0,003	0,431	0,312	0,289
Heavy Duty Vehicles	1998	0,617	0,421	0,323	0,617	0,421	0,323	2,482	1,876	1,818	0,003	0,003	0,003	0,385	0,281	0,266
Heavy Duty Vehicles	1999	0,570	0,387	0,297	0,570	0,387	0,297	2,361	1,798	1,770	0,003	0,003	0,003	0,345	0,255	0,247
Heavy Duty Vehicles	2000	0,533	0,360	0,275	0,533	0,360	0,275	2,280	1,748	1,744	0,003	0,003	0,003	0,317	0,236	0,235
Heavy Duty Vehicles	2001	0,499	0,334	0,254	0,499	0,334	0,254	2,209	1,701	1,705	0,003	0,003	0,003	0,286	0,214	0,217
Heavy Duty Vehicles	2002	0,475	0,315	0,239	0,475	0,315	0,239	2,225	1,711	1,715	0,003	0,003	0,003	0,270	0,202	0,204
Heavy Duty Vehicles	2003	0,453	0,296	0,225	0,453	0,296	0,225	2,228	1,706	1,703	0,003	0,003	0,003	0,256	0,190	0,189
Heavy Duty Vehicles	2004	0,435	0,282	0,214	0,435	0,282	0,214	2,231	1,701	1,691	0,003	0,003	0,003	0,242	0,179	0,175
Heavy Duty Vehicles	2005	0,420	0,269	0,204	0,420	0,269	0,204	2,265	1,719	1,701	0,003	0,003	0,003	0,234	0,171	0,164
Heavy Duty Vehicles	2006	0,403	0,255	0,194	0,403	0,255	0,194	2,277	1,720	1,692	0,003	0,003	0,003	0,223	0,162	0,152
Heavy Duty Vehicles	2007	0,358	0,226	0,172	0,358	0,226	0,172	2,211	1,666	1,619	0,003	0,003	0,003	0,199	0,144	0,133
Heavy Duty Vehicles	2008	0,291	0,184	0,141	0,291	0,184	0,141	2,068	1,554	1,482	0,003	0,003	0,003	0,163	0,118	0,108
Heavy Duty Vehicles	2009	0,245	0,156	0,119	0,245	0,156	0,119	2,003	1,505	1,412	0,003	0,003	0,003	0,140	0,101	0,092
Heavy Duty Vehicles	2010	0,214	0,136	0,105	0,214	0,136	0,105	1,971	1,483	1,375	0,003	0,003	0,003	0,117	0,084	0,077
Buses	1985	1,517	0,973	0,696	1,517	0,973	0,696	5,571	4,331	4,505	0,003	0,003	0,003	0,629	0,411	0,320
Buses	1986	1,509	0,963	0,686	1,509	0,963	0,686	5,493	4,235	4,351	0,003	0,003	0,003	0,629	0,410	0,320
Buses	1987	1,511	0,964	0,688	1,511	0,964	0,688	5,482	4,224	4,340	0,003	0,003	0,003	0,629	0,411	0,320
Buses	1988	1,512	0,965	0,689	1,512	0,965	0,689	5,453	4,191	4,295	0,003	0,003	0,003	0,630	0,412	0,321
Buses	1989	1,506	0,958	0,682	1,506	0,958	0,682	5,398	4,124	4,187	0,003	0,003	0,003	0,630	0,412	0,320
Buses	1990	1,501	0,954	0,676	1,501	0,954	0,676	5,416	4,140	4,200	0,003	0,003	0,003	0,629	0,410	0,319
Buses	1991	1,503	0,956	0,679	1,503	0,956	0,679	5,441	4,169	4,245	0,003	0,003	0,003	0,628	0,410	0,319
Buses	1992	1,510	0,966	0,688	1,510	0,966	0,688	5,537	4,286	4,427	0,003	0,003	0,003	0,628	0,410	0,319
Buses	1993	1,512	0,969	0,690	1,512	0,969	0,690	5,594	4,352	4,522	0,003	0,003	0,003	0,627	0,409	0,319
Buses	1994	1,455	0,954	0,692	1,455	0,954	0,692	5,657	4,536	4,894	0,003	0,003	0,003	0,604	0,397	0,313
Buses	1995	1,349	0,907	0,662	1,349	0,907	0,662	5,659	4,649	5,091	0,003	0,003	0,003	0,568	0,376	0,300
Buses	1996	1,247	0,853	0,625	1,247	0,853	0,625	5,529	4,577	4,992	0,003	0,003	0,003	0,537	0,359	0,289
Buses	1997	1,152	0,801	0,595	1,152	0,801	0,595	5,261	4,385	4,810	0,003	0,003	0,003	0,503	0,340	0,277
Buses	1998	1,049	0,747	0,565	1,049	0,747	0,565	4,968	4,192	4,668	0,003	0,003	0,003	0,455	0,314	0,261
Buses	1999	0,943	0,688	0,530	0,943	0,688	0,530	4,631	3,949	4,453	0,003	0,003	0,003	0,409	0,288	0,245

Continued																
Buses	2000	0,867	0,647	0,507	0,867	0,647	0,507	4,433	3,819	4,359	0,003	0,003	0,003	0,375	0,269	0,232
Buses	2001	0,813	0,614	0,485	0,813	0,614	0,485	4,244	3,656	4,183	0,003	0,003	0,003	0,335	0,245	0,217
Buses	2002	0,748	0,577	0,463	0,748	0,577	0,463	4,077	3,529	4,070	0,003	0,003	0,003	0,308	0,230	0,206
Buses	2003	0,683	0,532	0,433	0,683	0,532	0,433	3,810	3,273	3,773	0,003	0,003	0,003	0,272	0,206	0,189
Buses	2004	0,639	0,500	0,408	0,639	0,500	0,408	3,642	3,091	3,524	0,003	0,003	0,003	0,257	0,196	0,180
Buses	2005	0,597	0,469	0,386	0,597	0,469	0,386	3,469	2,918	3,312	0,003	0,003	0,003	0,233	0,180	0,167
Buses	2006	0,560	0,442	0,367	0,560	0,442	0,367	3,322	2,769	3,132	0,003	0,003	0,003	0,221	0,171	0,159
Buses	2007	0,515	0,408	0,340	0,515	0,408	0,340	3,125	2,579	2,896	0,003	0,003	0,003	0,204	0,159	0,148
Buses	2008	0,459	0,368	0,311	0,459	0,368	0,311	2,909	2,402	2,703	0,003	0,003	0,003	0,181	0,141	0,132
Buses	2009	0,394	0,320	0,274	0,394	0,320	0,274	2,645	2,174	2,438	0,003	0,003	0,003	0,156	0,123	0,117
Buses	2010	0,337	0,275	0,239	0,337	0,275	0,239	2,456	1,973	2,165	0,003	0,003	0,003	0,135	0,106	0,100
Mopeds	1985	13,691	13,691		14,110	13,838		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1986	13,691	13,691		14,118	13,841		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1987	13,691	13,691		14,115	13,840		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1988	13,691	13,691		14,144	13,850		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1989	13,691	13,691		14,161	13,856		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1990	13,691	13,691		14,151	13,853		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1991	13,691	13,691		14,131	13,846		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1992	13,691	13,691		14,135	13,847		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1993	13,691	13,691		14,106	13,837		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1994	13,691	13,691		14,124	13,843		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1995	13,691	13,691		14,125	13,844		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1996	13,691	13,691		14,108	13,838		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1997	13,691	13,691		14,131	13,846		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1998	13,691	13,691		14,111	13,839		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1999	13,691	13,691		14,157	13,855		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	2000	12,563	12,563		12,948	12,699		12,960	12,960		0,001	0,001		0,176	0,176	
Mopeds	2001	11,773	11,773		12,193	11,921		12,371	12,371		0,001	0,001		0,168	0,168	
Mopeds	2002	10,937	10,937		11,368	11,089		11,748	11,748		0,001	0,001		0,160	0,160	
Mopeds	2003	10,520	10,520		10,948	10,671		11,437	11,437		0,001	0,001		0,156	0,156	
Mopeds	2004	9,924	9,924		10,353	10,075		10,776	10,776		0,001	0,001		0,148	0,148	
Mopeds	2005	9,299	9,299		9,766	9,464		10,085	10,085		0,001	0,001		0,140	0,140	
Mopeds	2006	8,636	8,636		9,119	8,806		9,353	9,353		0,001	0,001		0,131	0,131	
Mopeds	2007	8,023	8,023		8,496	8,190		8,669	8,669		0,001	0,001		0,123	0,123	
Mopeds	2008	7,588	7,588		8,047	7,749		8,189	8,189		0,001	0,001		0,118	0,118	
Mopeds	2009	7,169	7,169		7,637	7,334		7,727	7,727		0,001	0,001		0,112	0,112	
Mopeds	2010	6,817	6,817		7,261	6,973		7,342	7,342		0,001	0,001		0,108	0,108	

Continued

Motorcycles	1985	1,426	1,186	1,588	2,189	1,401	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1986	1,426	1,186	1,588	2,196	1,403	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1987	1,426	1,186	1,588	2,192	1,401	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1988	1,426	1,186	1,588	2,226	1,410	1,625	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1989	1,426	1,186	1,588	2,244	1,414	1,625	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1990	1,426	1,186	1,588	2,241	1,412	1,625	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1991	1,426	1,186	1,588	2,228	1,408	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1992	1,426	1,186	1,588	2,238	1,410	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1993	1,426	1,186	1,588	2,204	1,400	1,623	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1994	1,426	1,186	1,588	2,234	1,407	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1995	1,426	1,186	1,588	2,236	1,407	1,623	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1996	1,426	1,186	1,588	2,218	1,402	1,622	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1997	1,426	1,186	1,588	2,262	1,413	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1998	1,426	1,186	1,588	2,241	1,406	1,623	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1999	1,426	1,186	1,588	2,278	1,416	1,624	18,848	19,069	24,147	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	2000	1,503	1,232	1,624	2,181	1,415	1,653	18,476	18,693	23,725	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	2001	1,511	1,228	1,600	2,188	1,409	1,628	18,260	18,455	23,434	0,002	0,002	0,002	0,046	0,046	0,046
Motorcycles	2002	1,519	1,223	1,575	2,220	1,408	1,603	18,047	18,219	23,145	0,002	0,002	0,002	0,045	0,045	0,045
Motorcycles	2003	1,524	1,216	1,548	2,226	1,402	1,577	17,851	18,002	22,877	0,002	0,002	0,002	0,044	0,044	0,044
Motorcycles	2004	1,498	1,193	1,513	2,224	1,385	1,542	17,330	17,497	22,330	0,002	0,002	0,002	0,043	0,043	0,043
Motorcycles	2005	1,485	1,178	1,484	2,272	1,386	1,516	16,604	16,797	21,579	0,002	0,002	0,002	0,041	0,041	0,041
Motorcycles	2006	1,475	1,165	1,458	2,300	1,383	1,491	15,823	16,046	20,773	0,002	0,002	0,002	0,040	0,040	0,040
Motorcycles	2007	1,424	1,132	1,420	2,249	1,348	1,453	14,954	15,190	19,752	0,002	0,002	0,002	0,038	0,038	0,038
Motorcycles	2008	1,380	1,099	1,379	2,200	1,313	1,411	14,464	14,697	19,156	0,002	0,002	0,002	0,037	0,037	0,037
Motorcycles	2009	1,337	1,065	1,334	2,182	1,285	1,367	14,245	14,467	18,862	0,002	0,002	0,002	0,035	0,035	0,035
Motorcycles	2010	1,296	1,031	1,288	2,109	1,243	1,320	14,103	14,310	18,655	0,002	0,002	0,002	0,034	0,034	0,034

Annex 3B-8: Fuel consumption (GJ) and emissions (tonnes) per vehicle category and as totals

Sector	Year	FC (PJ)	SO2	NOx	NMVOC	CH4	CO	CO2	N2O	NH3	TSP
Passenger Cars	1985	65,6	1657	53694	69153	1756	530222	4792	171	47	1672
Passenger Cars	1986	66,3	1116	54682	69163	1780	502728	4845	174	48	1695
Passenger Cars	1987	66,5	1114	55580	68858	1803	478298	4858	176	48	1658
Passenger Cars	1988	67,3	1133	57253	68847	1831	441728	4919	180	50	1605
Passenger Cars	1989	66,7	823	57248	67317	1815	410172	4876	179	49	1561
Passenger Cars	1990	70,8	881	61299	70630	1931	416786	5176	191	53	1622
Passenger Cars	1991	75,3	924	63019	72507	2006	432028	5505	208	166	1646
Passenger Cars	1992	78,7	652	61810	70857	1989	414275	5751	231	398	1540
Passenger Cars	1993	80,7	356	59406	67515	1942	398195	5898	248	618	1466
Passenger Cars	1994	83,6	372	56202	63295	1849	365718	6112	271	929	1374
Passenger Cars	1995	84,3	372	51422	57853	1711	343506	6165	288	1220	1245
Passenger Cars	1996	85,1	373	47170	53176	1588	331359	6224	302	1477	1140
Passenger Cars	1997	87,3	380	43810	47947	1489	296092	6380	314	1842	1005
Passenger Cars	1998	89,0	389	39871	42437	1391	273244	6508	312	2222	891
Passenger Cars	1999	89,6	307	35944	36797	1280	238468	6549	307	2506	810
Passenger Cars	2000	89,2	204	32784	30394	1182	215843	6519	300	2682	742
Passenger Cars	2001	88,6	203	30416	27907	1091	206787	6479	287	2659	707
Passenger Cars	2002	89,8	206	28568	24736	996	187506	6567	278	2601	656
Passenger Cars	2003	91,9	211	26870	22407	914	177974	6721	269	2519	659
Passenger Cars	2004	92,7	213	24891	18936	818	154698	6783	259	2424	634
Passenger Cars	2005	91,8	42	22323	16936	714	147170	6718	239	2211	625
Passenger Cars	2006	92,3	42	20147	14286	619	128092	6748	225	2045	604
Passenger Cars	2007	97,0	44	19083	12146	538	112065	7091	223	1900	608
Passenger Cars	2008	98,0	45	17761	10681	465	101924	7172	217	1726	614
Passenger Cars	2009	95,3	44	16233	9123	398	88048	6970	206	1548	571
Passenger Cars	2010	94,8	43	15372	8218	344	81554	6879	202	1376	574
Light Duty Vehicles	1985	12,7	2503	5966	2081	108	14785	941	5	5	1351
Light Duty Vehicles	1986	14,6	1747	6772	2277	121	16165	1081	5	5	1552
Light Duty Vehicles	1987	15,4	1831	7105	2397	127	17079	1133	5	5	1637
Light Duty Vehicles	1988	15,8	1886	7282	2414	131	16881	1166	6	6	1627
Light Duty Vehicles	1989	16,4	1317	7487	2411	133	16795	1210	6	6	1679
Light Duty Vehicles	1990	17,6	1414	7995	2547	142	17762	1296	6	6	1797
Light Duty Vehicles	1991	18,2	1462	8326	2705	148	19031	1344	6	6	1900

Continued											
Light Duty Vehicles	1992	18,1	936	8372	2806	151	19505	1336	7	6	1845
Light Duty Vehicles	1993	18,6	373	8659	2952	156	20837	1374	7	7	1930
Light Duty Vehicles	1994	20,0	401	9245	3134	167	21866	1473	7	7	2046
Light Duty Vehicles	1995	20,0	403	9086	3013	160	21049	1478	9	12	1971
Light Duty Vehicles	1996	20,4	412	8917	2824	150	19934	1505	13	22	1857
Light Duty Vehicles	1997	20,6	418	8708	2577	141	17792	1525	17	32	1623
Light Duty Vehicles	1998	21,2	426	8654	2443	135	17123	1563	22	43	1471
Light Duty Vehicles	1999	21,6	242	8575	2279	125	15810	1597	27	56	1314
Light Duty Vehicles	2000	22,0	51	8525	2067	114	15003	1626	33	69	1171
Light Duty Vehicles	2001	21,8	51	8260	1955	101	14198	1609	37	77	1054
Light Duty Vehicles	2002	22,5	52	8151	1827	92	13273	1661	42	82	942
Light Duty Vehicles	2003	24,4	57	8313	1794	84	13133	1801	48	81	914
Light Duty Vehicles	2004	26,3	61	8386	1669	76	12131	1945	54	79	843
Light Duty Vehicles	2005	28,1	13	8367	1632	65	11831	2078	60	74	817
Light Duty Vehicles	2006	30,3	14	8468	1561	56	11101	2241	67	70	785
Light Duty Vehicles	2007	31,7	15	8184	1453	49	10164	2340	72	63	741
Light Duty Vehicles	2008	30,1	14	7007	1227	38	8663	2220	69	53	635
Light Duty Vehicles	2009	28,3	13	6187	1069	32	7728	2087	65	49	549
Light Duty Vehicles	2010	27,6	13	5753	1015	28	7362	2038	64	45	523
Heavy Duty Vehicles	1985	25,0	5837	24341	1474	199	5972	1852	73	7	902
Heavy Duty Vehicles	1986	28,2	3951	27421	1628	225	6599	2088	81	8	1015
Heavy Duty Vehicles	1987	27,7	3875	26876	1580	221	6429	2047	79	8	994
Heavy Duty Vehicles	1988	27,2	3806	26381	1522	217	6231	2011	77	8	973
Heavy Duty Vehicles	1989	28,3	2643	27461	1570	226	6421	2093	80	8	1012
Heavy Duty Vehicles	1990	29,1	2719	28191	1560	232	6473	2154	81	8	1036
Heavy Duty Vehicles	1991	29,6	2763	28678	1596	235	6608	2189	83	8	1054
Heavy Duty Vehicles	1992	29,0	1763	28112	1534	232	6449	2148	80	8	1031
Heavy Duty Vehicles	1993	28,1	656	27093	1440	224	6154	2079	76	8	993
Heavy Duty Vehicles	1994	30,0	701	28517	1506	241	6412	2220	82	8	1048
Heavy Duty Vehicles	1995	30,2	706	27894	1503	247	6358	2234	84	8	1035
Heavy Duty Vehicles	1996	31,0	725	27668	1462	255	6297	2293	86	9	1026
Heavy Duty Vehicles	1997	31,5	737	27513	1399	258	6183	2331	89	9	980
Heavy Duty Vehicles	1998	32,0	748	27597	1320	257	6078	2365	91	9	913
Heavy Duty Vehicles	1999	33,2	427	28381	1272	261	6117	2457	96	10	871
Heavy Duty Vehicles	2000	32,1	75	27164	1140	245	5745	2372	92	9	780
Heavy Duty Vehicles	2001	33,2	78	27613	1107	248	5835	2455	96	10	742

Continued

Heavy Duty Vehicles	2002	33,0	77	26640	1029	240	5778	2444	95	10	689
Heavy Duty Vehicles	2003	34,8	81	27034	1016	248	6027	2572	99	10	676
Heavy Duty Vehicles	2004	36,0	84	27088	1000	253	6200	2662	103	10	653
Heavy Duty Vehicles	2005	36,5	17	26536	959	251	6266	2700	103	10	623
Heavy Duty Vehicles	2006	39,0	18	27315	969	260	6656	2883	109	11	624
Heavy Duty Vehicles	2007	40,9	19	26824	895	239	6705	3025	114	11	577
Heavy Duty Vehicles	2008	38,4	18	22966	684	179	5840	2842	107	11	442
Heavy Duty Vehicles	2009	32,7	15	18088	491	124	4777	2417	91	9	321
Heavy Duty Vehicles	2010	33,8	16	17594	445	111	4866	2498	94	9	279
Buses	1985	7,0	1622	7041	713	74	2939	521	17	2	300
Buses	1986	7,6	1047	7568	761	79	3099	561	19	2	322
Buses	1987	7,4	1026	7419	746	77	3028	549	18	2	316
Buses	1988	7,5	1031	7455	749	78	3016	551	19	2	317
Buses	1989	7,6	704	7630	762	79	3044	564	19	2	324
Buses	1990	8,1	751	8133	810	85	3267	602	20	2	345
Buses	1991	8,2	752	8150	813	85	3295	604	20	2	346
Buses	1992	7,8	467	7785	783	81	3227	577	19	2	331
Buses	1993	7,9	182	7874	795	82	3314	584	20	2	334
Buses	1994	8,4	194	8273	833	88	3686	624	21	2	349
Buses	1995	8,7	200	8325	823	93	3954	647	22	2	347
Buses	1996	9,2	209	8492	813	98	4129	678	24	2	349
Buses	1997	9,1	208	8285	761	97	3966	673	24	2	331
Buses	1998	8,9	203	7996	698	92	3757	657	24	2	301
Buses	1999	8,6	109	7652	628	87	3483	638	24	2	270
Buses	2000	8,3	19	7282	566	81	3254	614	23	2	243
Buses	2001	8,3	19	7195	532	79	3108	612	23	2	219
Buses	2002	8,3	19	6992	494	76	2986	611	23	2	203
Buses	2003	8,7	20	7135	477	77	2919	643	24	2	190
Buses	2004	8,9	21	7103	455	75	2821	657	24	2	183
Buses	2005	8,8	4	6861	422	72	2644	649	24	2	166
Buses	2006	8,7	4	6658	394	69	2498	645	24	2	156
Buses	2007	8,9	4	6551	369	66	2371	657	25	2	147
Buses	2008	8,5	4	5960	318	56	2119	629	24	2	125
Buses	2009	8,2	4	5435	266	46	1858	608	23	2	105
Buses	2010	8,4	4	5279	234	41	1742	624	23	2	93
Mopeds	1985	0,4	1	7	4929	77	4858	28	0	0	66

Continued											
Mopeds	1986	0,3	1	6	4424	69	4359	25	0	0	59
Mopeds	1987	0,3	1	6	4095	64	4035	23	0	0	55
Mopeds	1988	0,3	1	5	3855	60	3793	22	0	0	52
Mopeds	1989	0,3	1	5	3660	57	3598	21	0	0	49
Mopeds	1990	0,3	1	5	3722	58	3660	21	0	0	50
Mopeds	1991	0,3	1	5	3820	60	3761	22	0	0	51
Mopeds	1992	0,3	1	5	3844	60	3784	22	0	0	52
Mopeds	1993	0,3	1	5	3806	60	3752	22	0	0	51
Mopeds	1994	0,3	1	5	3745	59	3689	21	0	0	50
Mopeds	1995	0,3	1	6	3992	62	3931	23	0	0	54
Mopeds	1996	0,3	1	6	4247	66	4186	24	0	0	57
Mopeds	1997	0,4	1	7	4614	72	4542	26	0	0	62
Mopeds	1998	0,4	1	7	4972	78	4900	28	0	0	67
Mopeds	1999	0,4	1	6	4519	71	4443	26	0	0	61
Mopeds	2000	0,3	1	6	3987	62	4021	24	0	0	55
Mopeds	2001	0,3	1	5	3046	48	3118	19	0	0	42
Mopeds	2002	0,3	1	5	2984	46	3115	19	0	0	42
Mopeds	2003	0,3	1	5	2841	44	2998	19	0	0	41
Mopeds	2004	0,2	1	9	2636	41	2774	18	0	0	38
Mopeds	2005	0,2	0	13	2445	38	2557	17	0	0	35
Mopeds	2006	0,2	0	17	2276	35	2367	16	0	0	33
Mopeds	2007	0,2	0	21	2128	33	2203	16	0	0	31
Mopeds	2008	0,2	0	24	1981	30	2046	15	0	0	29
Mopeds	2009	0,2	0	25	1801	27	1852	14	0	0	27
Mopeds	2010	0,2	0	26	1624	25	1669	13	0	0	24
Motorcycles	1985	0,4	1	71	628	67	6792	32	1	1	16
Motorcycles	1986	0,4	1	71	630	67	6799	32	1	1	16
Motorcycles	1987	0,4	1	69	614	65	6636	31	1	1	16
Motorcycles	1988	0,4	1	70	628	66	6722	32	1	1	16
Motorcycles	1989	0,4	1	69	620	65	6606	31	1	1	16
Motorcycles	1990	0,5	1	74	665	70	7099	33	1	1	17
Motorcycles	1991	0,5	1	76	681	72	7299	34	1	1	17
Motorcycles	1992	0,5	1	82	731	77	7818	37	1	1	19
Motorcycles	1993	0,5	1	87	765	81	8277	39	1	1	20
Motorcycles	1994	0,6	1	92	819	86	8783	41	1	1	21
Motorcycles	1995	0,6	1	93	821	86	8807	41	1	1	21

Continued											
Motorcycles	1996	0,6	1	93	822	87	8876	42	1	1	21
Motorcycles	1997	0,6	1	97	868	91	9248	43	1	1	22
Motorcycles	1998	0,6	1	101	894	94	9595	45	1	1	23
Motorcycles	1999	0,6	1	103	915	95	9718	46	1	1	23
Motorcycles	2000	0,7	1	108	926	97	9873	48	1	1	24
Motorcycles	2001	0,7	2	111	930	97	9812	48	1	1	24
Motorcycles	2002	0,7	2	115	954	99	9901	50	1	1	24
Motorcycles	2003	0,7	2	117	957	98	9836	50	1	1	23
Motorcycles	2004	0,7	2	118	945	97	9511	50	1	1	23
Motorcycles	2005	0,7	0	123	971	97	9294	52	1	1	22
Motorcycles	2006	0,7	0	132	1022	99	9315	54	1	1	22
Motorcycles	2007	0,8	0	138	1055	100	9331	57	1	1	22
Motorcycles	2008	0,8	0	140	1060	101	9298	59	1	1	22
Motorcycles	2009	0,8	0	135	1001	95	8783	57	1	1	21
Motorcycles	2010	0,8	0	136	976	96	8780	57	1	1	20
Total	1985	111,2	11621	91119	78978	2281	565567	8165	267	61	4307
Total	1986	117,5	7862	96521	78883	2341	539748	8631	280	64	4659
Total	1987	117,7	7847	97055	78290	2357	515504	8642	280	64	4675
Total	1988	118,4	7857	98447	78014	2382	478371	8700	283	66	4589
Total	1989	119,7	5488	99900	76340	2375	446637	8795	285	66	4641
Total	1990	126,3	5767	105699	79934	2518	455048	9282	299	70	4867
Total	1991	132,0	5903	108255	82122	2605	472022	9697	318	183	5014
Total	1992	134,4	3820	106166	80556	2590	455058	9870	338	415	4817
Total	1993	136,1	1569	103124	77271	2544	440529	9995	352	635	4794
Total	1994	142,9	1669	102335	73332	2489	410153	10491	383	948	4887
Total	1995	144,2	1682	96825	68005	2359	387606	10588	405	1244	4671
Total	1996	146,6	1721	92346	63344	2245	374781	10766	426	1511	4451
Total	1997	149,5	1744	88420	58165	2147	337823	10978	446	1886	4023
Total	1998	152,0	1768	84227	52763	2047	314697	11167	451	2278	3666
Total	1999	154,0	1088	80661	46410	1919	278038	11312	455	2575	3348
Total	2000	152,5	352	75869	39079	1783	253738	11203	449	2764	3015
Total	2001	152,8	353	73599	35477	1664	242858	11223	445	2749	2787
Total	2002	154,5	357	70472	32024	1549	222559	11352	438	2696	2556
Total	2003	160,6	371	69474	29492	1465	212885	11806	442	2613	2502
Total	2004	164,8	381	67595	25642	1359	188134	12115	442	2517	2374
Total	2005	166,1	77	64224	23365	1237	179761	12214	428	2299	2287

Continued											
Total	2006	171,3	79	62738	20509	1139	160030	12587	426	2130	2224
Total	2007	179,5	83	60801	18046	1025	142838	13187	434	1979	2126
Total	2008	176,0	81	53858	15951	869	129890	12937	417	1793	1868
Total	2009	165,5	76	46103	13751	723	113046	12154	386	1610	1594
Total	2010	165,6	76	44159	12514	644	105972	12108	385	1433	1513

Annex 3B-9: COPERT IV:DEA statistics fuel use ratios and mileage adjustment factors

Sales			1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel ratio	Gasoline	DEA:COPERT IV	1,03	0,98	1,02	1,08	1,11	1,13	1,11	1,09	1,10	1,11	1,09
	Diesel	DEA:COPERT IV	1,19	1,30	1,33	1,29	1,29	1,37	1,36	1,37	1,39	1,38	1,37
Consumption													
Fuel ratio	Gasoline	DEA:COPERT IV	1,07	1,08	1,07	1,08	1,09	1,10	1,10	1,10	1,11	1,12	1,14
	Diesel	DEA:COPERT IV	1,11	1,19	1,27	1,24	1,23	1,27	1,25	1,25	1,27	1,26	1,25
Continued													
Sales			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fuel ratio	Gasoline	DEA:COPERT IV	1,11	1,10	1,11	1,11	1,09	1,08	1,07	1,08	1,07	1,08	1,06
	Diesel	DEA:COPERT IV	1,32	1,32	1,31	1,37	1,40	1,37	1,35	1,37	1,32	1,27	1,29
Consumption													
Fuel ratio	Gasoline	DEA:COPERT IV	1,16	1,14	1,14	1,13	1,11	1,10	1,09	1,08	1,07	1,09	1,08
	Diesel	DEA:COPERT IV	1,22	1,23	1,21	1,23	1,25	1,24	1,23	1,23	1,19	1,15	1,18

Annex 3B-10: Basis fuel consumption and emission factors, deterioration factors, transient factors and specific operational data for non road working machinery and equipment, and recreational craft

Basis factors for diesel fuelled non road machinery.

Engine size [P=kW]	Emission Level	NO_x	VOC	CO	N_2O [g pr kWh]	NH_3	TSP	Fuel
P<19	<1981	12.0	5.0	7	0.035	0.002	2.8	300
P<19	1981-1990	11.5	3.8	6	0.035	0.002	2.3	285
P<19	1991-Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage II	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIA	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIB	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IV	11.2	2.5	5	0.035	0.002	1.6	270
19<=P<37	<1981	18.0	2.5	6.5	0.035	0.002	2	300
19<=P<37	1981-1990	18.0	2.2	5.5	0.035	0.002	1.4	281
19<=P<37	1991-Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage II	6.5	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIA	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIB	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IV	6.2	0.6	2.2	0.035	0.002	0.4	262
37<=P<56	<1981	7.7	2.4	6	0.035	0.002	1.8	290
37<=P<56	1981-1990	8.6	2.0	5.3	0.035	0.002	1.2	275
37<=P<56	1991-Stage I	11.5	1.5	4.5	0.035	0.002	0.8	260
37<=P<56	Stage I	7.7	0.6	2.2	0.035	0.002	0.4	260
37<=P<56	Stage II	5.5	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIA	3.9	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIB	3.9	0.4	2.2	0.035	0.002	0.0225	260
37<=P<56	Stage IV	3.9	0.4	2.2	0.035	0.002	0.0225	260
56<=P<75	<1981	7.7	2.0	5	0.035	0.002	1.4	290
56<=P<75	1981-1990	8.6	1.6	4.3	0.035	0.002	1	275
56<=P<75	1991-Stage I	11.5	1.2	3.5	0.035	0.002	0.4	260
56<=P<75	Stage I	7.7	0.4	1.5	0.035	0.002	0.2	260
56<=P<75	Stage II	5.5	0.3	1.5	0.035	0.002	0.2	260
56<=P<75	Stage IIIA	4.0	0.3	1.5	0.035	0.002	0.2	260
56<=P<75	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	260
56<=P<75	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	260
75<=P<130	<1981	10.5	2.0	5	0.035	0.002	1.4	280
75<=P<130	1981-1990	11.8	1.6	4.3	0.035	0.002	1	268
75<=P<130	1991-Stage I	13.3	1.2	3.5	0.035	0.002	0.4	255
75<=P<130	Stage I	8.1	0.4	1.5	0.035	0.002	0.2	255
75<=P<130	Stage II	5.2	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	255
75<=P<130	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	255
130<=P<560	<1981	17.8	1.5	2.5	0.035	0.002	0.9	270
130<=P<560	1981-1990	12.4	1.0	2.5	0.035	0.002	0.8	260
130<=P<560	1991-Stage I	11.2	0.5	2.5	0.035	0.002	0.4	250
130<=P<560	Stage I	7.6	0.3	1.5	0.035	0.002	0.2	250
130<=P<560	Stage II	5.2	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	250
130<=P<560	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	250

Basis factors for 4-stroke gasoline non road machinery.

Engine	Size code	Size classe [S=ccm]	Emission Level	NO_x	VOC	CO	N_2O [g pr kWh]	NH_3	TSP	Fuel
4-stroke	SH2	20<=S<50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH2	20<=S<50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH2	20<=S<50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH2	20<=S<50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH2	20<=S<50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH3	S>=50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH3	S>=50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH3	S>=50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SN1	S<66	<1981	1.2	26.9	822	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1981-1990	1.8	22.5	685	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1991-Stage I	2.4	18	548	0.002	0.03	0.08	603
4-stroke	SN1	S<66	Stage I	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN1	S<66	Stage II	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN2	66<=S<100	<1981	2.3	10.5	822	0.002	0.03	0.08	627
4-stroke	SN2	66<=S<100	1981-1990	3.5	8.7	685	0.002	0.03	0.08	599
4-stroke	SN2	66<=S<100	1991-Stage I	4.7	7	548	0.002	0.03	0.08	570
4-stroke	SN2	66<=S<100	Stage I	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN2	66<=S<100	Stage II	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN3	100<=S<225	<1981	2.6	19.1	525	0.002	0.03	0.08	601
4-stroke	SN3	100<=S<225	1981-1990	3.8	15.9	438	0.002	0.03	0.08	573
4-stroke	SN3	100<=S<225	1991-Stage I	5.1	12.7	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage I	5.1	11.6	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage II	5.1	9.4	350	0.002	0.03	0.08	546
4-stroke	SN4	S>=225	<1981	1.3	11.1	657	0.002	0.03	0.08	539
4-stroke	SN4	S>=225	1981-1990	2	9.3	548	0.002	0.03	0.08	514
4-stroke	SN4	S>=225	1991-Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage II	2.6	7.4	438	0.002	0.03	0.08	490

Basis factors for 2-stroke gasoline non road machinery.

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	N_2O	NH_3	TSP	Fuel
		[ccm]					[g pr kWh]			
2-stroke	SH2	20<=S<50	<1981	1	305	695	0.002	0.01	7	882
2-stroke	SH2	20<=S<50	1981-1990	1	300	579	0.002	0.01	5.3	809
2-stroke	SH2	20<=S<50	1991-Stage I	1.1	203	463	0.002	0.01	3.5	735
2-stroke	SH2	20<=S<50	Stage I	1.5	188	379	0.002	0.01	3.5	720
2-stroke	SH2	20<=S<50	Stage II	1.5	44	379	0.002	0.01	3.5	500
2-stroke	SH3	S>=50	<1981	1.1	189	510	0.002	0.01	3.6	665
2-stroke	SH3	S>=50	1981-1990	1.1	158	425	0.002	0.01	2.7	609
2-stroke	SH3	S>=50	1991-Stage I	1.2	126	340	0.002	0.01	1.8	554
2-stroke	SH3	S>=50	Stage I	2	126	340	0.002	0.01	1.8	529
2-stroke	SH3	S>=50	Stage II	1.2	64	340	0.002	0.01	1.8	500
2-stroke	SN1	S<66	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage II	0.5	155	418	0.002	0.01	2.6	652

Fuel consumption and emission factors for LPG fork lifts.

NO_x	VOC	CO	NH_3	N_2O	TSP	FC
[g pr kWh]	[g pr kWh]	[g pr kWh]	[g pr kWh]	[g pr kWh]	[g pr kWh]	[g pr kWh]
19	2.2	1.5	0.003	0.05	0.07	311

Fuel consumption and emission factors for All Terrain Vehicles (ATV's).

ATV type	NO_x	VOC	CO	NH_3	N_2O	TSP	Fuel
	[g pr GJ]	[g pr GJ]	[g pr GJ]	[g pr GJ]	[g pr GJ]	[g pr GJ]	[kg pr hour]
Professional	108	1077	16306	2	2	32	1.125
Private	128	1527	22043	2	2	39	0.75

Fuel consumption and emission factors for recreational craft.

Fuel type	Vessel type	Engine	Engine type	Direktiv	Engine size	CO	VOC	N_2O	NH_3	NO_x	TSP	Fuel
					[kW]			[g pr kWh]				
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	2003/44	8	202.5	45.9	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	Konv.	8	427	257.0	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	2003/44	8	202.5	24.0	0.03	0.002	7	0.08	426
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	Konv.	8	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Yawls and cabin boats	Out board	2-stroke	2003/44	20	162	36.5	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	2-stroke	Konv.	20	374	172.0	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	4-stroke	2003/44	20	162	14.0	0.03	0.002	10	0.08	426
Gasoline	Yawls and cabin boats	Out board	4-stroke	Konv.	20	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	2003/44	10	189	43.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	Konv.	10	427	257.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	2003/44	10	189	24.0	0.03	0.002	7	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	Konv.	10	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Speed boats	In board	4-stroke	2003/44	90	141	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	In board	4-stroke	Konv.	90	346	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	Out board	2-stroke	2003/44	50	145.8	31.8	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	2-stroke	Konv.	50	374	172.0	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	4-stroke	2003/44	50	145.8	14.0	0.03	0.002	10	0.08	426
Gasoline	Speed boats	Out board	4-stroke	Konv.	50	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	2-stroke	2003/44	45	147	32.2	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	2-stroke	Konv.	45	374	172.0	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	4-stroke	2003/44	45	147	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	4-stroke	Konv.	45	390	14.0	0.03	0.002	10	0.08	426
Diesel	Motor boats (27-34 ft)	In board		2003/44	150	5	1.7	0.035	0.002	8.6	1	275
Diesel	Motor boats (27-34 ft)	In board		Konv.	150	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (> 34 ft)	In board		2003/44	250	5	1.6	0.035	0.002	8.6	1	275
Diesel	Motor boats (> 34 ft)	In board		Konv.	250	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (< 27 ft)	In board		2003/44	40	5	1.8	0.035	0.002	9.8	1	281
Diesel	Motor boats (< 27 ft)	In board		Konv.	40	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Motor sailors	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Motor sailors	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Sailing boats (> 26 ft)	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Sailing boats (> 26 ft)	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281

CH_4 shares of VOC for diesel, gasoline and LPG.

Fuel type	CH_4 share of VOC
Diesel	0.016
Gasoline 4-stroke	0.1
Gasoline 2-stroke	0.009
LPG	0.05

Deterioration factors for diesel machinery.

Emission Level	NO_x	VOC	CO	TSP
<1981	0.024	0.047	0.185	0.473
1981-1990	0.024	0.047	0.185	0.473
1991-Stage I	0.024	0.047	0.185	0.473
Stage I	0.024	0.036	0.101	0.473
Stage II	0.009	0.034	0.101	0.473
Stage IIIA	0.008	0.027	0.151	0.473
Stage IIIB	0.008	0.027	0.151	0.473
Stage IV	0.008	0.027	0.151	0.473

Deterioration factors for gasoline 2-stroke machinery.

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
2-stroke	SH2	20<=S<50	<1981	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1981-1990	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1991-Stage I	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	Stage I	0	0.29	0.24	0
2-stroke	SH2	20<=S<50	Stage II	0	0.29	0.24	0
2-stroke	SH3	S>=50	<1981	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1981-1990	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1991-Stage I	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	Stage I	0	0.266	0.231	0
2-stroke	SH3	S>=50	Stage II	0	0.266	0.231	0
2-stroke	SN1	S<66	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN1	S<66	Stage II	-0.33	0	1.109	5.103
2-stroke	SN2	66<=S<100	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN2	66<=S<100	Stage II	-0.33	0	1.109	5.103
2-stroke	SN3	100<=S<225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN3	100<=S<225	Stage II	-0.33	0	1.109	5.103
2-stroke	SN4	S>=225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	Stage I	-0.274	0	0.887	1.935
2-stroke	SN4	S>=225	Stage II	-0.274	0	0.887	1.935

Deterioration factors for gasoline 4-stroke machinery.

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
4-stroke	SN1	S<66	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN1	S<66	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN4	S>=225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	Stage I	-0.599	1.095	1.307	1.095
4-stroke	SN4	S>=225	Stage II	-0.599	1.095	1.307	1.095
4-stroke	SH2	20<=S<50	<1981	0	0	0	0
4-stroke	SH2	20<=S<50	1981-1990	0	0	0	0
4-stroke	SH2	20<=S<50	1991-Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage II	0	0	0	0
4-stroke	SH3	S>=50	<1981	0	0	0	0
4-stroke	SH3	S>=50	1981-1990	0	0	0	0
4-stroke	SH3	S>=50	1991-Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage II	0	0	0	0

Transient factors for diesel machinery.

Emission Level	Load	NO_x	VOC	CO	TSP	Fuel
<1981	High	0.95	1.05	1.53	1.23	1.01
1981-1990	High	0.95	1.05	1.53	1.23	1.01
1991-Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage II	High	0.95	1.05	1.53	1.23	1.01
Stage IIIA	High	0.95	1.05	1.53	1.23	1.01
Stage IIIB	High	1	1	1	1	1
Stage IV	High	1	1	1	1	1
<1981	Low	1.1	2.29	2.57	1.97	1.18
1981-1990	Low	1.1	2.29	2.57	1.97	1.18
1991-Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage II	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIA	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIB	Low	1	1	1	1	1
Stage IV	Low	1	1	1	1	1

Annual working hours, load factors and lifetimes for agricultural tractors.

Tractor type	Annual working hours	Load factor	Lifetime (yrs)
Diesel	500 (0-7 years) 500-100 (7-16 years) 100 (>16 years)	0.5	30
Gasoline (certified)	100	0.4	37
Gasoline (non certified)	50	0.4	37

Annual working hours, load factors and lifetimes for harvesters.

Annual working hours	Load factor	Lifetime (yrs)
250-100 (linear decrease 0-24 years)	0.8	25

Annual working hours, load factors and lifetime for machine pool machinery.

Tractor type	Hours pr yr	Load factor	Lifetime (yrs)
Tractors	750	0.5	7
Harvesters	100	0.8	11
Self-propelled vehicles	500	0.75	6

Operational data for other machinery types in agriculture.

Machinery type	Fuel type	Load factor	Lifetime (yrs)	Hours	Size (kW)
ATV private	Gasoline	-	6	250	-
ATV professional	Gasoline	-	8	400	-
Bedding machines	Gasoline	0.3	10	50	3
Fodder trucks	Gasoline	0.4	10	200	8
Other (gasoline)	Gasoline	0.4	10	50	5
Scrapers	Gasoline	0.3	10	50	3
Self-propelled vehicles	Diesel	0.75	15	150	60
Sweepers	Gasoline	0.3	10	50	3

Annual working hours, load factors and lifetimes for forestry machinery.

Machinery type	Hours	Load factors	Lifetime
Chippers	1200	0.5	6
Tractors (other)	100 (1990) 400 (2004)	0.5	15
Tractors (silvicultural)	800	0.5	6
Harvesters	1200	0.5	8
Forwarders	1200	0.5	8
Chain saws (forestry)	800	0.4	3

Annual working hours, load factors and lifetime for fork lifts.

Hours pr yr	Load factor	Lifetime (yrs)
1200 (>=50 kW and <=10 years old) 650 (>=50 kW and >10 years old) 650 (<50 kW)	0.27	20

Operational data for construction machinery.

Machinery type	Load factor	Lifetime	Hours	Size
Track type dozers	0.5	10	1100	140
Track type loaders	0.5	10	1100	100 (1990) 150 (2004)
Wheel loaders (0-5 tonness)	0.5	10	1200	20
Wheel loaders (> 5,1 tonnes)	0.5	10	1200	120
Wheel type excavators	0.6	10	1200	100
Track type excavators (0-5 tonnes)	0.6	10	1100	20
Track type excavators (>5,1 tonnes)	0.6	10	1100	120
Excavators/Loaders	0.45	10	700	50
Dump trucks	0.4	10	900 (1990) 1200 (2004)	60 (1990) 180 (2004)
Mini loaders	0.5	14	700	30
Telescopic loaders	0.5	14	1000	35

Stock and operational data for other machinery types in industry.

Sector	Fuel type	Machinery type	Size (kW)	No	Load Factor	Hours
Construction machinery	Diesel	Tampers/Land rollers	30	2800	0.45	600
Construction machinery	Diesel	Generators (diesel)	45	5000	0.5	200
Construction machinery	Diesel	Kompressors (diesel)	45	5000	0.5	500
Construction machinery	Diesel	Pumps (diesel)	75	1000	0.5	5
Construction machinery	Diesel	Asphalt pavers	80	300	0.35	700
Construction machinery	Diesel	Motor graders	100	100	0.4	700
Construction machinery	Diesel	Refuse compressors	160	100	0.25	1300
Construction machinery	Gasoline	Generators (gasoline)	2.5	11000	0.4	80
Construction machinery	Gasoline	Pumps (gasoline)	4	10000	0.4	300
Construction machinery	Gasoline	Kompressors (gasoline)	4	500	0.35	15
Industry	Diesel	Refrigerating units (distribution)	8	3000	0.5	1250
Industry	Diesel	Refrigerating units (long distance)	15	3500	0.5	200
Industry	Diesel	Tractors (transport, industry)	50	3000	0.4	500
Airport GSE and other	Diesel	Airport GSE and other (light duty)	100	500	0.5	400
Airport GSE and other	Diesel	Airport GSE and other (medium duty)	125	350	0.5	300
Airport GSE and other	Diesel	Airport GSE and other (Heavy duty)	175	650	0.5	200
Building and construction	Diesel	Vibratory plates	6	3500	0.6	300
Building and construction	Diesel	Aereal lifts (diesel)	30	150	0.4	400
Building and construction	Diesel	Sweepers (diesel)	30	200	0.4	300
Building and construction	Diesel	High pressure cleaners (diesel)	30	50	0.8	500
Building and construction	Gasoline	Rammers	2.5	3000	0.4	80
Building and construction	Gasoline	Drills	3	100	0.4	10
Building and construction	Gasoline	Vibratory plates (gasoline)	4	2500	0.5	200
Building and construction	Gasoline	Cutters	4	800	0.5	50
Building and construction	Gasoline	Other (gasoline)	5	1000	0.5	40
Building and construction	Gasoline	High pressure cleaners (gasoline)	5	500	0.6	200
Building and construction	Gasoline	Sweepers (gasoline)	10	500	0.4	150
Building and construction	Gasoline	Slicers	10	100	0.7	150
Building and construction	Gasoline	Aereal lifts (gasoline)	20	50	0.4	400

Operational data for the most important types of household and gardening machinery.

Machinery type	Engine	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chain saws (private)	2-stroke	2	5	0.3	10
Chain saws (professional)	2-stroke	3	270	0.4	3
Cultivators (private-large)	4-stroke	3.7	5	0.6	5
Cultivators (private-small)	4-stroke	1	5	0.6	15
Cultivators (professional)	4-stroke	7	360	0.6	8
Hedge cutters (private)	2-stroke	0.9	10	0.5	10
Hedge cutters (professional)	2-stroke	2	300	0.5	4
Lawn movers (private)	4-stroke	2.5 (2000) 3.5 (2004)	25	0.4	8
Lawn movers (professional)	4-stroke	2.5 (2000) 3.5 (2004)	250	0.4	4
Riders (private)	4-stroke	11	50	0.5	12
Riders (professional)	4-stroke	13	330	0.5	5
Shrub clearers (private)	2-stroke	1	15	0.6	10
Shrub clearers (professional)	2-stroke	2	300	0.6	4
Trimmers (private)	2-stroke	0.9	20	0.5	10
Trimmers (professional)	2-stroke	0.9	200	0.5	4

Stock and operational data for other machines in household and gardening.

Machinery type	Engine	No.	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chippers	2-stroke	200	10	100	0.7	10
Garden shredders	2-stroke	500	3	20	0.7	10
Other (gasoline)	2-stroke	200	2	20	0.5	10
Suction machines	2-stroke	300	4	80	0.5	10
Wood cutters	4-stroke	100	4	15	0.5	10

Operational data for recreational craft.

Fuel type	Vessel type	Engine type	Stroke	Hours	Lifetime	Load factor
Gasoline	Other boats (<20 ft)	Out board engine	2-stroke	30	10	0.5
Gasoline	Other boats (<20 ft)	Out board engine	4-stroke	30	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	2-stroke	5	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	4-stroke	5	10	0.5
Gasoline	Speed boats	In board engine	4-stroke	75	10	0.5
Gasoline	Speed boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Speed boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Water scooters	Built in	2-stroke	10	10	0.5
Gasoline	Water scooters	Built in	4-stroke	10	10	0.5
Diesel	Motor boats (27-34 ft)	In board engine		150	15	0.5
Diesel	Motor boats (>34 ft)	In board engine		100	15	0.5
Diesel	Motor boats (<27 ft)	In board engine		75	15	0.5
Diesel	Motor sailors	In board engine		75	15	0.5
Diesel	Sailing boats (<26ft)	In board engine		25	15	0.5

Annex 3B-11: Stock data for non-road working machinery and equipment

Stock data for diesel tractors 1985-2010.

Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
37	<1981	3882	3792	3542	3543	3403	3234	3106	2922	2861	2610	2605	2273	2193	1918	1796
37	1981-1990	635	731	760	835	855	879	889	883	915	887	945	883	918	869	888
37	1991-Stage I							25	107	153	201	278	354	445	496	554
37	Stage I															
37	Stage II															
37	Stage IIIA															
45	<1981	25988	25387	23709	23718	22781	21650	20796	19563	19154	17475	17441	15219	14684	12840	12025
45	1981-1990	5740	6808	7263	8075	8476	8770	8867	8805	9128	8848	9419	8807	9151	8668	8856
45	1991-Stage I							203	202	209	203	216	202	210	199	203
49	1991-Stage I								154	281	485	602	618	702	749	765
52	1991-Stage I															247
52	Stage I															
52	Stage II															
52	Stage IIIA															
56	1991-Stage I								201	338	428	747	943	1181	1280	1307
60	<1981	54651	53387	49857	49877	47907	45529	43732	41140	40278	36747	36676	32004	30879	27001	25287
60	1981-1990	11751	14613	15795	17797	19395	20542	20770	20624	21380	20725	22063	20628	21434	20304	20744
60	1991-Stage I							863	857	888	861	917	857	891	844	862
63	1991-Stage I								468	855	1325	2014	2384	2837	3011	3076
67	1991-Stage I															671
67	Stage I															
67	Stage II															
67	Stage IIIA															
71	1991-Stage I								411	715	1179	1949	2507	3344	3594	3672
78	<1981	14558	14221	13281	13286	12761	12128	11649	10959	10729	9789	9770	8525	8226	7192	6736
78	1981-1990	4592	6152	7196	8559	10026	11323	11448	11368	11785	11424	12162	11371	11815	11192	11434
78	1991-Stage I							1233	1503	1713	1945	2429	2561	2946	2994	3287
78	Stage I															
78	Stage II															
78	Stage IIIA															
86	1991-Stage I								108	193	333	589	880	1364	1532	1718
86	Stage I															

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86	Stage II															
86	Stage IIIA															
93	1991-Stage I															149
93	Stage I															
93	Stage II															
93	Stage IIIA															
97	1991-Stage I								71	175	443	962	1556	2327	2638	2695
101	<1981	4659	4551	4250	4252	4084	3881	3728	3507	3433	3132	3126	2728	2632	2302	2156
101	1981-1990	1158	1434	1618	1921	2156	2377	2403	2387	2474	2398	2553	2387	2480	2350	2400
101	1991-Stage I							266	264	274	266	283	264	275	260	696
101	Stage I															
101	Stage II															
101	Stage IIIA															
112	1991-Stage I								63	114	166	252	422	690	790	978
112	Stage I															
112	Stage II															
112	Stage IIIA															
127	1991-Stage I								12	36	81	193	279	408	457	590
127	Stage I															
127	Stage II															
127	Stage IIIA															
131	<1981	798	780	728	728	700	665	639	601	588	537	536	467	451	394	369
131	1981-1990	288	421	500	651	753	887	897	890	923	895	952	890	925	876	895
131	1991-Stage I							97	97	100	97	103	97	100	95	97
157	1981-1990		2	3	6	11	15	15	15	16	15	16	15	16	15	15
157	1991-Stage I							9	23	39	102	232	357	545	648	784
157	Stage I															
157	Stage II															
157	Stage IIIA															
186	1991-Stage I															23
186	Stage I															
186	Stage II															
186	Stage IIIA															

Continued

Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2009	2010
37	<1981	1601	1449	1298	1148	993	833	664	504	342	176	176	

37	1981-1990	871	876	882	892	900	906	903	914	930	959	959	991
37	1991-Stage I	568	572	576	582	587	592	590	597	607	626	626	647
37	Stage I		33	56	83	84	84	84	85	86	89	89	92
37	Stage II					23	53	162	324	330	340	340	351
37	Stage IIIA									109	205	205	333
45	<1981	10715	9700	8690	7685	6646	5577	4447	3376	2290	1180	1180	
45	1981-1990	8681	8731	8800	8894	8974	9037	9006	9116	9274	9563	9563	9883
45	1991-Stage I	199	200	202	204	206	207	207	209	213	219	219	227
49	1991-Stage I	750	754	760	768	775	780	778	787	801	826	826	853
52	1991-Stage I	358	360	363	367	370	373	372	376	383	395	395	408
52	Stage I		132	242	377	381	383	382	387	393	406	406	419
52	Stage II					68	147	241	347	353	364	364	377
52	Stage IIIA									86	133	133	202
56	1991-Stage I	1281	1289	1299	1313	1325	1334	1329	1346	1369	1412	1412	1459
60	<1981	22533	20397	18273	16162	13976	11729	9351	7099	4815	2482	2482	
60	1981-1990	20333	20451	20612	20834	21019	21167	21096	21353	21723	22401	22401	23150
60	1991-Stage I	845	850	856	866	873	879	876	887	903	931	931	962
63	1991-Stage I	3015	3033	3057	3090	3117	3139	3128	3167	3221	3322	3322	3433
67	1991-Stage I	1343	1351	1361	1376	1388	1398	1393	1410	1435	1479	1479	1529
67	Stage I		533	835	1113	1123	1131	1127	1141	1161	1197	1197	1237
67	Stage II					375	729	1144	1524	1550	1599	1599	1652
67	Stage IIIA									303	472	472	658
71	1991-Stage I	3600	3620	3649	3688	3721	3747	3735	3780	3846	3966	3966	4098
78	<1981	6002	5433	4868	4305	3723	3124	2491	1891	1283	661	661	
78	1981-1990	11208	11273	11361	11484	11586	11668	11628	11770	11974	12348	12348	12761
78	1991-Stage I	3436	3727	3756	3797	3830	3857	3844	3891	3959	4082	4082	4219
78	Stage I			325	329	332	334	333	337	343	354	354	365
78	Stage II				227	310	400	463	469	477	492	492	508
78	Stage IIIA								63	121	147	147	183
86	1991-Stage I	1876	2023	2039	2061	2079	2094	2087	2112	2149	2216	2216	2290
86	Stage I			134	136	137	138	137	139	142	146	146	151
86	Stage II				91	343	530	760	769	783	807	807	834
86	Stage IIIA								226	434	529	529	657
93	1991-Stage I	245	325	327	331	334	336	335	339	345	356	356	368
93	Stage I			114	115	116	117	116	118	120	123	123	128
93	Stage II				107	186	313	512	518	527	544	544	562
93	Stage IIIA								264	470	574	574	682

Continued													
97	1991-Stage I	2642	2657	2678	2707	2731	2750	2741	2774	2822	2911	2911	3008
101	<1981	1921	1739	1558	1378	1191	1000	797	605	410	212	212	
101	1981-1990	2353	2367	2385	2411	2432	2449	2441	2471	2514	2592	2592	2679
101	1991-Stage I	1116	1567	1579	1596	1611	1622	1616	1636	1664	1716	1716	1774
101	Stage I			232	234	236	238	237	240	244	252	252	260
101	Stage II				136	357	635	776	785	799	824	824	851
101	Stage IIIA								188	336	410	410	487
112	1991-Stage I	1265	1626	1639	1656	1671	1683	1677	1698	1727	1781	1781	1841
112	Stage I			465	470	474	478	476	482	490	505	505	522
112	Stage II				337	732	1170	1763	1785	1815	1872	1872	1935
112	Stage IIIA								378	663	823	823	971
127	1991-Stage I	707	847	854	863	871	877	874	884	900	928	928	959
127	Stage I			152	154	155	156	156	158	161	166	166	171
127	Stage II				78	268	453	591	599	609	628	628	649
127	Stage IIIA								292	675	880	880	1048
131	<1981	329	298	267	236	204	171	137	104	70	36	36	
131	1981-1990	878	883	890	899	907	914	911	922	938	967	967	999
131	1991-Stage I	95	96	96	97	98	99	99	100	102	105	105	108
157	1981-1990	15	15	15	15	16	16	16	16	16	17	17	17
157	1991-Stage I	900	905	912	922	930	937	934	945	961	991	991	1025
157	Stage I		89	89	90	91	92	91	92	94	97	97	100
157	Stage II			149	415	695	1089	1085	1098	1117	1152	1152	1191
157	Stage IIIA							623	1453	2140	2586	2586	3047
186	1991-Stage I	53	54	54	55	55	56	55	56	57	59	59	61
186	Stage I		47	48	48	49	49	49	49	50	52	52	54
186	Stage II			68	207	320	481	480	486	494	509	509	526
186	Stage IIIA							272	685	1103	1427	1427	1665

Stock data for gasoline tractors 1985-2005.

Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Certified	<1981	13176	12541	11906	11270	10635	10000	9053	8148	7285	6465	5687	4951	4258	3607	2998
Non certified	<1981	26352	25082	23811	22541	21270	20000	19042	18041	16998	15913	14785	13616	12403	11149	9852

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Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005
Certified	<1981	2432	1908	1427	987	591	236
Non certified	<1981	8512	7131	5707	4240	2732	1180

Stock data for harvesters 1985-2010.

Size Group	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0<S<=50	<1981	26601	24394	22599	22144	19842	18915	17241	15607	14575	12673	10700	9491	6966	5446	3589
0<S<=50	1981-1990	519	534	550	582	566	591	594	601	635	636	633	683	641	686	672
50<S<=60	<1981	2703	2648	2634	2785	2711	2828	2847	2876	3040	3044	3029	3271	3068	2930	2235
50<S<=60	1981-1990	853	1102	1164	1275	1258	1333	1341	1355	1432	1434	1427	1541	1446	1548	1516
50<S<=60	1991-Stage I							8	8	8	8	8	9	9	9	9
60<S<=70	<1981	1786	1750	1741	1841	1792	1869	1881	1901	2009	2012	2002	2162	2028	2171	2127
60<S<=70	1981-1990	1138	1679	1943	2237	2213	2348	2363	2388	2524	2527	2515	2716	2547	2727	2671
60<S<=70	1991-Stage I							8	16	18	21	22	24	23	24	24
70<S<=80	<1981	929	910	905	958	932	972	979	989	1045	1046	1041	1125	1055	1129	1106
70<S<=80	1981-1990	383	699	1026	1165	1318	1493	1502	1518	1604	1606	1598	1726	1619	1733	1698
70<S<=80	1991-Stage I							72	77	83	86	87	96	91	98	96
70<S<=80	Stage I															1
80<S<=90	<1981	323	317	315	333	324	338	340	344	363	364	362	391	367	393	385
80<S<=90	1981-1990	383	562	645	967	1107	1466	1475	1491	1575	1577	1570	1695	1590	1702	1667
80<S<=90	1991-Stage I							61	158	181	200	200	217	207	222	217
80<S<=90	Stage I															1
90<S<=100	1981-1990	89	175	235	387	515	670	674	681	720	721	717	775	726	778	762
90<S<=100	1991-Stage I							180	257	320	329	351	382	367	393	385
90<S<=100	Stage I															1
100<S<=120	1981-1990		54	106	219	334	589	592	599	633	634	630	681	639	684	670
100<S<=120	1991-Stage I							129	253	316	375	440	567	586	673	660
100<S<=120	Stage I															2
120<S<=140	1981-1990				4	69	183	184	186	197	197	196	212	199	213	208
120<S<=140	1991-Stage I							70	148	189	215	319	484	626	804	860
120<S<=140	Stage I															21
120<S<=140	Stage II															
120<S<=140	Stage IIIA															
140<S<=160	1991-Stage I								8	36	69	112	271	354	554	632
140<S<=160	Stage II															
140<S<=160	Stage IIIA															
160<S<=180	1991-Stage I											26	69	200	374	440
160<S<=180	Stage II															
160<S<=180	Stage IIIA															
180<S<=200	1991-Stage I												20	67	117	193
180<S<=200	Stage II															

Continued

180<S<=200	Stage IIIA		
200<S<=220	1991-Stage I	45	92
200<S<=220	Stage II		
200<S<=220	Stage IIIA		
220<S<=240	1991-Stage I		3
220<S<=240	Stage II		
220<S<=240	Stage IIIA		
240<S<=260	1991-Stage I		3
240<S<=260	Stage II		
240<S<=260	Stage IIIA		
260<S<=280	1991-Stage I		14
260<S<=280	Stage II		
260<S<=280	Stage IIIA		
280<S<=300	1991-Stage I		
280<S<=300	Stage II		
280<S<=300	Stage IIIA		
300<S<=320	Stage II		
300<S<=320	Stage IIIA		

Continued

Size Group	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0<S<=50	<1981	2873	1854	1275	754	269						
0<S<=50	1981-1990	715	758	778	816	882	913	779	628	448	268	78
50<S<=60	<1981	1999	1570	1260	897	391						
50<S<=60	1981-1990	1612	1711	1755	1841	1990	2060	1856	1645	1335	1034	730
50<S<=60	1991-Stage I	10	10	10	11	12	12	12	12	12	12	13
60<S<=70	<1981	2073	1648	1340	981	482						
60<S<=70	1981-1990	2841	3014	3093	3243	3506	3630	3344	3062	2659	2284	1922
60<S<=70	1991-Stage I	25	27	27	29	31	32	32	32	32	33	35
70<S<=80	<1981	1176	1248	1105	735	216						
70<S<=80	1981-1990	1806	1916	1966	2061	2229	2307	2164	2043	1939	1862	1813
70<S<=80	1991-Stage I	102	109	112	117	126	131	130	129	131	134	141
70<S<=80	Stage I	1	1	1	1	1	1	1	1	1	1	2
80<S<=90	<1981	409	434	445	467	216						
80<S<=90	1981-1990	1773	1881	1931	2024	2189	2266	2123	2002	1897	1819	1768
80<S<=90	1991-Stage I	231	245	252	264	285	295	294	292	295	303	317
80<S<=90	Stage I	1	1	1	1	1	1	1	1	1	1	2

Continued												
90<S<=100	1981-1990	810	860	882	925	1000	1035	1031	1023	986	964	957
90<S<=100	1991-Stage I	410	435	446	468	506	524	521	518	523	538	563
90<S<=100	Stage I	1	1	1	1	1	1	1	1	1	1	2
100<S<=120	1981-1990	712	756	775	813	879	910	906	900	909	934	978
100<S<=120	1991-Stage I	702	744	764	801	866	896	892	886	896	920	963
100<S<=120	Stage I	2	2	2	3	3	3	3	3	3	3	3
120<S<=140	1981-1990	222	235	241	253	274	283	282	280	283	291	304
120<S<=140	1991-Stage I	918	977	1003	1051	1137	1177	1172	1163	1176	1208	1264
120<S<=140	Stage I	26	31	32	33	36	37	37	37	37	38	40
120<S<=140	Stage II					3	4	4	4	4	4	4
120<S<=140	Stage IIIA							1	1	1	4	5
140<S<=160	1991-Stage I	715	795	816	855	925	957	953	946	957	983	1028
140<S<=160	Stage II			20	35	48	56	56	56	56	58	60
140<S<=160	Stage IIIA							5	8	12	16	18
160<S<=180	1991-Stage I	533	602	618	648	700	725	722	716	724	744	779
160<S<=180	Stage II			40	70	91	105	105	104	105	108	113
160<S<=180	Stage IIIA							9	14	20	24	27
180<S<=200	1991-Stage I	249	300	308	323	349	362	360	357	361	371	389
180<S<=200	Stage II			61	91	114	129	128	127	129	132	138
180<S<=200	Stage IIIA							9	14	20	24	27
200<S<=220	1991-Stage I	142	187	192	201	218	225	224	223	225	231	242
200<S<=220	Stage II			40	70	91	105	105	104	105	108	113
200<S<=220	Stage IIIA							9	14	20	24	27
220<S<=240	1991-Stage I	48	151	155	162	175	181	181	179	181	186	195
220<S<=240	Stage II			72	114	164	221	220	219	221	227	238
220<S<=240	Stage IIIA							61	123	196	237	276
240<S<=260	1991-Stage I	71	142	145	152	165	170	170	169	170	175	183
240<S<=260	Stage II			72	125	201	301	299	297	301	309	323
240<S<=260	Stage IIIA							113	232	371	450	525
260<S<=280	1991-Stage I	61	131	134	140	152	157	157	155	157	161	169
260<S<=280	Stage II			72	125	201	301	299	297	301	309	323
260<S<=280	Stage IIIA							113	232	371	450	525
280<S<=300	1991-Stage I		33,2	34	36	39	40	40	40	40	41	43
280<S<=300	Stage II			72	125	201	301	299	297	301	309	323
280<S<=300	Stage IIIA							113	232	371	450	525
300<S<=320	Stage II				25	60	108	108	107	108	111	116

Continued

300<S<=320	Stage IIIA	57	116	185	225	262

Stock data for fork lifts 1985-2010.

FuelCode	Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
205B	35	<1981	387	361	336	311	285	260	234	209	183	158	133	107	84	58	30
205B	35	1981-1990	120	162	202	239	270	297	297	297	297	297	297	297	297	297	297
205B	35	1991-Stage I							26	49	65	93	131	168	218	247	275
205B	35	Stage II															
205B	35	Stage IIIA															
205B	45	<1981	1612	1506	1400	1294	1188	1082	976	870	764	658	552	446	349	243	126
205B	45	1981-1990	499	674	839	994	1122	1233	1233	1233	1233	1233	1233	1233	1233	1233	1233
205B	45	1991-Stage I							108	203	270	386	544	699	905	1063	1063
205B	45	Stage I															151
205B	45	Stage II															
205B	45	Stage IIIA															
205B	50	<1981	2173	2031	1888	1745	1602	1459	1316	1174	1031	888	745	602	471	328	170
205B	50	1981-1990	673	909	1131	1340	1512	1662	1662	1662	1662	1662	1662	1662	1662	1662	1662
205B	50	1991-Stage I							145	273	363	519	732	940	1217	1469	1469
205B	50	Stage I															240
205B	50	Stage II															
205B	50	Stage IIIA															
205B	75	<1981	497	465	432	399	367	334	301	269	236	203	170	138	108	75	39
205B	75	1981-1990	154	208	259	307	347	382	382	382	382	382	382	382	382	382	382
205B	75	1991-Stage I							33	63	84	120	169	217	281	354	354
205B	75	Stage I															70
205B	75	Stage II															
205B	75	Stage IIIA															
205B	120	<1981	111	103	96	89	81	74	67	60	52	45	38	31	24	17	9
205B	120	1981-1990	34	46	57	68	77	85	85	85	85	85	85	85	85	85	85
205B	120	1991-Stage I							7	14	19	27	38	49	63	97	97
205B	120	Stage I															32
205B	120	Stage II															
205B	120	Stage IIIA															
3030	33		5420	5427	5390	5323	5265	5215	5156	5068	4947	4863	4835	4792	4732	4765	4712
3030	40		4917	4923	4889	4828	4775	4730	4676	4596	4486	4410	4384	4344	4289	4295	4223
3030	50		2149	2151	2137	2110	2087	2067	2044	2008	1960	1926	1915	1897	1874	1926	1941
3030	78		97	97	96	95	94	93	92	91	89	88	88	87	86	90	92
3030	120															1	2

Continued

FuelCode	Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
205B	35	<1981											
205B	35	1981-1990	297	277	249	232	198	177	135	95	58	27	
205B	35	1991-Stage I	304	304	304	304	304	304	304	304	304	304	304
205B	35	Stage II		23	53	75	89	117	152	152	152	152	152
205B	35	Stage IIIA								41	76	92	99
205B	45	<1981											
205B	45	1981-1990	1233	1151	1036	964	820	734	559	394	239	111	
205B	45	1991-Stage I	1063	1063	1063	1063	1063	1063	1063	1063	1063	1063	1063
205B	45	Stage I	303	422	524	664	664	664	664	664	664	664	664
205B	45	Stage II					104	232	452	612	612	612	612
205B	45	Stage IIIA									126	181	225
205B	50	<1981											
205B	50	1981-1990	1662	1551	1396	1299	1105	989	753	531	322	150	
205B	50	1991-Stage I	1469	1469	1469	1469	1469	1469	1469	1469	1469	1469	1469
205B	50	Stage I	461	682	897	1135	1135	1135	1135	1135	1135	1135	1135
205B	50	Stage II					187	447	818	1134	1134	1134	1134
205B	50	Stage IIIA									181	275	354
205B	75	<1981											
205B	75	1981-1990	382	357	321	299	255	228	174	123	75	35	
205B	75	1991-Stage I	354	354	354	354	354	354	354	354	354	354	354
205B	75	Stage I	162	234	311	311	311	311	311	311	311	311	311
205B	75	Stage II				58	129	208	326	326	326	326	326
205B	75	Stage IIIA								142	213	252	294
205B	120	<1981											
205B	120	1981-1990	85	80	72	67	57	51	39	28	17	8	
205B	120	1991-Stage I	97	97	97	97	97	97	97	97	97	97	97
205B	120	Stage I	71	89	118	118	118	118	118	118	118	118	118
205B	120	Stage II				16	38	58	112	112	112	112	112
205B	120	Stage IIIA								58	70	76	140
3030	33		4718	4677	4655	4595	4494	4345	4220	4154	4043	3941	3746
3030	40		4218	4214	4244	4224	4166	4116	4048	4005	3951	3878	3723
3030	50		1897	1938	2003	2020	2018	2029	2061	2136	2198	2192	2142
3030	78		88	95	98	99	104	104	114	123	147	149	151
3030	120		2	2	3	3	3	3	3	3	3	3	7

Stock data for construction machinery 1985-2010.

EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Track type dozers	<1981	125	100	75	50	25										
Track type dozers	1981-1990	125	150	175	200	225	250	221	193	166	139	114	89	66	43	21
Track type dozers	1991-Stage I							25	48	71	93	114	134	153	172	189
Track type dozers	Stage II															
Track type dozers	Stage IIIA															
Track type loaders	<1981	50	40	30	20	10										
Track type loaders	1981-1990	50	60	70	80	90	100	89	79	68	58	48	38	28	19	9
Track type loaders	1991-Stage I							10	20	29	39	48	57	66	75	83
Track type loaders	Stage II															
Track type loaders	Stage IIIA															
Wheel loaders (0-5 tonnes)	1981-1990							186	331	434	496	517	496	434	331	186
Wheel loaders (0-5 tonnes)	1991-Stage I							21	83	186	331	517	744	1013	1323	1674
Wheel loaders (0-5 tonnes)	Stage II															
Wheel loaders (0-5 tonnes)	Stage IIIA															
Wheel loaders (> 5,1 tonnes)	<1981	1250	1000	750	500	250										
Wheel loaders (> 5,1 tonnes)	1981-1990	1250	1500	1750	2000	2250	2500	2228	1960	1698	1441	1188	941	698	460	228
Wheel loaders (> 5,1 tonnes)	1991-Stage I							248	490	728	960	1188	1411	1629	1841	1822
Wheel loaders (> 5,1 tonnes)	Stage I															228
Wheel loaders (> 5,1 tonnes)	Stage II															
Wheel loaders (> 5,1 tonnes)	Stage IIIA															
Wheel type excavators	<1981	500	400	300	200	100										
Wheel type excavators	1981-1990	500	600	700	800	900	1000	862	732	611	498	394	298	211	132	62
Wheel type excavators	1991-Stage I							96	183	262	332	394	447	491	528	493
Wheel type excavators	Stage I															62
Wheel type excavators	Stage II															
Wheel type excavators	Stage IIIA															
Track type excavators (0-5 tonnes)	1981-1990							459	816	1071	1224	1275	1224	1071	816	459
Track type excavators (0-5 tonnes)	1991-Stage I							51	204	459	816	1275	1837	2500	3265	4132
Track type excavators (0-5 tonnes)	Stage II															
Track type excavators (0-5 tonnes)	Stage IIIA															
Track type excavators (>5,1 tonnes)	<1981	1000	800	600	400	200										
Track type excavators (>5,1 tonnes)	1981-1990	1000	1200	1400	1600	1800	2000	1798	1596	1394	1194	993	794	594	396	198
Track type excavators (>5,1 tonnes)	1991-Stage I							200	399	598	796	993	1190	1387	1583	1581
Track type excavators (>5,1 tonnes)	Stage I															198
Track type excavators (>5,1 tonnes)	Stage II															

Continued

Track type excavators (>5,1 tonnes)	Stage IIIA															
Excavators/Loaders	<1981	2100	1680	1260	840	420										
Excavators/Loaders	1981-1990	2100	2520	2940	3360	3780	4200	3807	3408	3003	2592	2175	1752	1323	888	447
Excavators/Loaders	1991-Stage I							423	852	1287	1728	2175	2628	3087	3552	3575
Excavators/Loaders	Stage I															447
Excavators/Loaders	Stage II															
Excavators/Loaders	Stage IIIA															
Dump trucks	<1981	250	200	150	100	50										
Dump trucks	1981-1990	250	300	350	400	450	500	489	469	441	404	358	304	241	169	89
Dump trucks	1991-Stage I							54	117	189	269	358	455	561	676	711
Dump trucks	Stage I															89
Dump trucks	Stage II															
Dump trucks	Stage IIIA															
Mini loaders	<1981	1800	1600	1400	1200	1000	800	635	447	235						
Mini loaders	1981-1990	1000	1200	1400	1600	1800	2000	2118	2237	2355	2473	2332	2168	1980	1768	1532
Mini loaders	1991-Stage I							212	447	706	989	1296	1626	1980	2357	2758
Mini loaders	Stage II															
Mini loaders	Stage IIIA															
Telescopic loaders	1981-1990											149	265	348	398	414
Telescopic loaders	1991-Stage I											83	199	348	530	746
Telescopic loaders	Stage II															
Telescopic loaders	Stage IIIA															

Continued

EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Track type dozers	<1981											
Track type dozers	1981-1990											
Track type dozers	1991-Stage I	206	201	177	154	132	128	125	116	95	59	27
Track type dozers	Stage II			20	38	56	86	100	116	126	119	109
Track type dozers	Stage IIIA							25	58	95	119	137
Track type loaders	<1981											
Track type loaders	1981-1990											
Track type loaders	1991-Stage I	91	91	81	71	62	61	71	68	55	38	19
Track type loaders	Stage II			9	18	26	40	56	68	73	76	75
Track type loaders	Stage IIIA							14	34	55	76	94
Wheel loaders (0-5 tonnes)	1981-1990											
Wheel loaders (0-5 tonnes)	1991-Stage I	2067	2046	1984	1881	1736	1444	1269	1045	726	353	

Continued

Wheel loaders (0-5 tonnes)	Stage II		227	496	806	1158	1444	1903	2090	2177	2117	2024
Wheel loaders (0-5 tonnes)	Stage IIIA								348	726	1058	1349
Wheel loaders (> 5,1 tonnes)	<1981											
Wheel loaders (> 5,1 tonnes)	1981-1990											
Wheel loaders (> 5,1 tonnes)	1991-Stage I	1802	1559	1322	1089	861	677	485	273			
Wheel loaders (> 5,1 tonnes)	Stage I	450	668	881	871	861	902	969	1092	1174	854	547
Wheel loaders (> 5,1 tonnes)	Stage II				218	431	677	969	1092	1174	1138	1094
Wheel loaders (> 5,1 tonnes)	Stage IIIA								273	587	854	1094
Wheel type excavators	<1981											
Wheel type excavators	1981-1990											
Wheel type excavators	1991-Stage I	459	372	293	223	162	118	74	38			
Wheel type excavators	Stage I	115	160	196	179	162	157	148	152	146	103	62
Wheel type excavators	Stage II				45	81	118	148	152	146	138	124
Wheel type excavators	Stage IIIA								38	73	103	124
Track type excavators (0-5 tonnes)	1981-1990											
Track type excavators (0-5 tonnes)	1991-Stage I	5101	5050	4897	4642	4285	3889	3599	3027	2073	995	
Track type excavators (0-5 tonnes)	Stage II		561	1224	1990	2857	3889	5399	6054	6220	5968	5554
Track type excavators (0-5 tonnes)	Stage IIIA								1009	2073	2984	3702
Track type excavators (>5,1 tonnes)	<1981											
Track type excavators (>5,1 tonnes)	1981-1990											
Track type excavators (>5,1 tonnes)	1991-Stage I	1579	1380	1181	983	785	683	536	313			
Track type excavators (>5,1 tonnes)	Stage I	395	591	787	786	785	910	1073	1251	1338	980	623
Track type excavators (>5,1 tonnes)	Stage II				197	393	683	1073	1251	1338	1307	1245
Track type excavators (>5,1 tonnes)	Stage IIIA								313	669	980	1245
Excavators/Loaders	<1981											
Excavators/Loaders	1981-1990											
Excavators/Loaders	1991-Stage I	3599	3170	2735	2295	1848	1370	938	481			
Excavators/Loaders	Stage I	900	1359	1824	2295	2310	2283	2344	2403	2314	1688	1137
Excavators/Loaders	Stage II					462	913	1406	1922	1851	1688	1516
Excavators/Loaders	Stage IIIA									463	844	1137
Dump trucks	<1981											
Dump trucks	1981-1990											
Dump trucks	1991-Stage I	745	682	611	530	442	385	301	176			
Dump trucks	Stage I	186	292	407	530	552	642	752	880	943	739	514
Dump trucks	Stage II					110	257	451	704	754	739	685
Dump trucks	Stage IIIA									189	369	514

Continued												
Mini loaders	<1981											
Mini loaders	1981-1990	1273	990	684	354							
Mini loaders	1991-Stage I	3183	3301	3419	3537	3656	2756	2294	1077	715	498	329
Mini loaders	Stage II		330	684	1061	1462	1531	1720	923	715	597	494
Mini loaders	Stage IIIA								154	238	299	329
Telescopic loaders	1981-1990	398	348	265	149							
Telescopic loaders	1991-Stage I	994	1160	1326	1491	1657	1740	1837	1846	1687	1343	1009
Telescopic loaders	Stage II		116	265	447	663	966	1378	1582	1687	1612	1514
Telescopic loaders	Stage IIIA								264	562	806	1009

Stock data for machine pools 1985-2010.

EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Tractors (machine pools)	<1981	1236	627													
Tractors (machine pools)	1981-1990	3091	3763	4575	4515	4370	4100	3643	2808	2368	1786	1214	604			
Tractors (machine pools)	1991-Stage I							607	1123	1776	2382	3035	3624	4324	4210	4336
Tractors (machine pools)	Stage I															
Tractors (machine pools)	Stage II															
Tractors (machine pools)	Stage IIIA															
Harvesters (machine pools)	<1981	969	776	661	472	287	139									
Harvesters (machine pools)	1981-1990	807	932	1157	1257	1294	1385	1385	1197	927	794	712	512	421	282	162
Harvesters (machine pools)	1991-Stage I							139	266	348	454	593	615	737	751	729
Harvesters (machine pools)	Stage II															
Harvesters (machine pools)	Stage IIIA															
Self-propelled vehicles (machine pools)	1981-1990									72	61	38				
Self-propelled vehicles (machine pools)	1991-Stage I									72	122	190	263	278	277	295
Self-propelled vehicles (machine pools)	Stage II															
Self-propelled vehicles (machine pools)	Stage IIIA															

Continued

EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tractors (machine pools)	<1981											
Tractors (machine pools)	1981-1990											
Tractors (machine pools)	1991-Stage I	3956	4069	3323	2566	2066	1421	927	487			
Tractors (machine pools)	Stage I			554	513	517	474	464	487	487		
Tractors (machine pools)	Stage II				513	1033	1421	1855	1946	1946	1946	1460
Tractors (machine pools)	Stage IIIA								487	973	1460	1946
Harvesters (machine pools)	<1981											
Harvesters (machine pools)	1981-1990	78										
Harvesters (machine pools)	1991-Stage I	778	779	651	531	472	300	257	211	169	127	85
Harvesters (machine pools)	Stage II			65	118	177	171	172	169	169	169	169
Harvesters (machine pools)	Stage IIIA							43	85	127	169	211
Self-propelled vehicles (machine pools)	1981-1990											
Self-propelled vehicles (machine pools)	1991-Stage I	289	314	237	203	153	99	49				
Self-propelled vehicles (machine pools)	Stage II			47	102	153	199	194	189	142	94	47
Self-propelled vehicles (machine pools)	Stage IIIA							49	94	142	189	236

Stock data for household and gardening 1985-2010.

SNAP	EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0809	Lawn movers (private)	<1981	253125	168750	84375												
0809	Lawn movers (private)	1981-1990	421875	506250	590625	675000	675000	675000	590625	506250	421875	337500	253125	168750	84375		
0809	Lawn movers (private)	1991-Stage I							84375	168750	253125	337500	421875	506250	590625	675000	675000
0809	Lawn movers (private)	Stage I															
0809	Lawn movers (private)	Stage II															
0809	Cultivators (private-large)	<1981	73333	66000	58667	51333	44000	36667	29333	22000	14667	7333					
0809	Cultivators (private-large)	1981-1990	36667	44000	51333	58667	66000	73333	73333	73333	73333	73333	73333	66000	58667	51333	44000
0809	Cultivators (private-large)	1991-Stage I							7333	14667	22000	29333	36667	44000	51333	58667	66000
0809	Cultivators (private-large)	Stage II															
0809	Cultivators (private-small)	1981-1990	10000	10000	10000	10000	10000	10000	8000	6000	4000	2000					
0809	Cultivators (private-small)	1991-Stage I							2000	4000	6000	8000	10000	10000	10000	10000	10000
0809	Cultivators (private-small)	Stage II															
0809	Chain saws (private)	<1981	125000	100000	75000	50000	25000										
0809	Chain saws (private)	1981-1990	125000	150000	175000	200000	225000	250000	227250	204000	180250	156000	131250	106000	80250	54000	27250
0809	Chain saws (private)	1991-Stage I							25250	51000	77250	104000	131250	159000	187250	216000	245250
0809	Chain saws (private)	Stage I															
0809	Chain saws (private)	Stage II															
0809	Riders (private)	<1981	40950	35100	29250	23400	17550	11700	5880								
0809	Riders (private)	1981-1990	29250	35100	40950	46800	52650	58500	58796	59388	54248	49167	44056	38828	33392	27660	21544
0809	Riders (private)	1991-Stage I							5880	11878	18083	24583	31469	38828	46748	55320	64631
0809	Riders (private)	Stage I															
0809	Riders (private)	Stage II															
0809	Shrub clearers (private)	<1981	24000	19200	14400	9600	4800										
0809	Shrub clearers (private)	1981-1990	24000	28800	33600	38400	43200	48000	47520	46080	43680	40320	36000	30720	24480	17280	9120
0809	Shrub clearers (private)	1991-Stage I							5280	11520	18720	26880	36000	46080	57120	69120	82080
0809	Shrub clearers (private)	Stage I															
0809	Shrub clearers (private)	Stage II															
0809	Hedge cutters (private)	<1981	6850	5480	4110	2740	1370										
0809	Hedge cutters (private)	1981-1990	6850	8220	9590	10960	12330	13700	15237	16128	16373	15972	14925	13232	10893	7908	4277
0809	Hedge cutters (private)	1991-Stage I							1693	4032	7017	10648	14925	19848	25417	31632	38493
0809	Hedge cutters (private)	Stage I															
0809	Hedge cutters (private)	Stage II															
0809	Trimmers (private)	<1981	25500	20400	15300	10200	5100										
0809	Trimmers (private)	1981-1990	25500	30600	35700	40800	45900	51000	48086	44686	40800	36429	31571	26229	20400	14086	7286
0809	Trimmers (private)	1991-Stage I							5343	11171	17486	24286	31571	39343	47600	56343	65571

Continued

0809	Trimmers (private)	Stage I															
0809	Trimmers (private)	Stage II															
0811	Lawn movers (professional)	1981-1990	25000	25000	25000	25000	25000	25000	18750	12500	6250						
0811	Lawn movers (professional)	1991-Stage I							6250	12500	18750	25000	25000	25000	25000	25000	25000
0811	Lawn movers (professional)	Stage I															
0811	Lawn movers (professional)	Stage II															
0811	Cultivators (professional)	<1981	3750	2500	1250												
0811	Cultivators (professional)	1981-1990	6250	7500	8750	10000	10000	10000	8750	7500	6250	5000	3750	2500	1250		
0811	Cultivators (professional)	1991-Stage I							1250	2500	3750	5000	6250	7500	8750	10000	10000
0811	Cultivators (professional)	Stage I															
0811	Cultivators (professional)	Stage II															
0811	Chain saws (professional)	1981-1990	10000	10000	10000	10000	10000	10000	7333	4000							
0811	Chain saws (professional)	1991-Stage I							3667	8000	13000	14000	15000	16000	17000	18000	19000
0811	Chain saws (professional)	Stage I															
0811	Chain saws (professional)	Stage II															
0811	Riders (professional)	1981-1990	4800	4800	4800	4800	4800	4800	3878	2966	2035	1056					
0811	Riders (professional)	1991-Stage I							970	1978	3053	4224	5520	5760	6000	6240	6480
0811	Riders (professional)	Stage I															
0811	Riders (professional)	Stage II															
0811	Shrub clearers (professional)	1981-1990	2000	2000	2000	2000	2000	2000	1650	1200	650						
0811	Shrub clearers (professional)	1991-Stage I							550	1200	1950	2800	3000	3200	3400	3600	3800
0811	Shrub clearers (professional)	Stage I															
0811	Shrub clearers (professional)	Stage II															
0811	Hedge cutters (professional)	1981-1990	1300	1300	1300	1300	1300	1300	1178	920	528						
0811	Hedge cutters (professional)	1991-Stage I							393	920	1583	2380	2650	2920	3190	3460	3730
0811	Hedge cutters (professional)	Stage I															
0811	Hedge cutters (professional)	Stage II															
0811	Trimmers (professional)	1981-1990	9000	9000	9000	9000	9000	9000	7071	4929	2571						
0811	Trimmers (professional)	1991-Stage I							2357	4929	7714	10714	11143	11571	12000	12429	12857
0811	Trimmers (professional)	Stage I															
0811	Trimmers (professional)	Stage II															

Continued

SNAP	EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0809	Lawn movers (private)	<1981											
0809	Lawn movers (private)	1981-1990											
0809	Lawn movers (private)	1991-Stage I	675000	675000	675000	675000	675000	595000	513750	428125	342500	256875	171250

Continued													
0809	Lawn movers (private)	Stage I						85000	171250	256875	256875	256875	256875
0809	Lawn movers (private)	Stage II									85625	171250	256875
0809	Cultivators (private-large)	<1981											
0809	Cultivators (private-large)	1981-1990	36667	29333	22000	14667	7333						
0809	Cultivators (private-large)	1991-Stage I	73333	80667	88000	95333	102667	102667	95333	88000	80667	73333	66000
0809	Cultivators (private-large)	Stage II						7333	14667	22000	29333	36667	44000
0809	Cultivators (private-small)	1981-1990											
0809	Cultivators (private-small)	1991-Stage I	10000	10000	10000	10000	10000	8000	6000	4000	2000		
0809	Cultivators (private-small)	Stage II						2000	4000	6000	8000	10000	10000
0809	Chain saws (private)	<1981											
0809	Chain saws (private)	1981-1990											
0809	Chain saws (private)	1991-Stage I	275000	280750	286500	292250	298000	268200	238400	208600	178800	149000	119200
0809	Chain saws (private)	Stage I						29800	59600	89400	89400	89400	89400
0809	Chain saws (private)	Stage II									29800	59600	89400
0809	Riders (private)	<1981											
0809	Riders (private)	1981-1990	14954	7910									
0809	Riders (private)	1991-Stage I	74771	87015	101775	109920	119360	117741	114313	107663	99047	86666	74285
0809	Riders (private)	Stage I						10704	22863	23925	24762	24762	24762
0809	Riders (private)	Stage II								11963	24762	37143	49523
0809	Shrub clearers (private)	<1981											
0809	Shrub clearers (private)	1981-1990											
0809	Shrub clearers (private)	1991-Stage I	96000	107000	118000	129000	140000	126000	112000	98000	84000	70000	56000
0809	Shrub clearers (private)	Stage I						14000	28000	42000	42000	42000	42000
0809	Shrub clearers (private)	Stage II									14000	28000	42000
0809	Hedge cutters (private)	<1981											
0809	Hedge cutters (private)	1981-1990											
0809	Hedge cutters (private)	1991-Stage I	46000	52900	59800	66700	73600	66240	58880	51520	44160	36800	29440
0809	Hedge cutters (private)	Stage I						7360	14720	22080	22080	22080	22080
0809	Hedge cutters (private)	Stage II									7360	14720	22080
0809	Trimmers (private)	<1981											
0809	Trimmers (private)	1981-1990											
0809	Trimmers (private)	1991-Stage I	75286	77714	80143	82571	85000	76500	68000	59500	51000	42500	34000
0809	Trimmers (private)	Stage I						8500	17000	25500	25500	25500	25500
0809	Trimmers (private)	Stage II									8500	17000	25500
0811	Lawn movers (professional)	1981-1990											
0811	Lawn movers (professional)	1991-Stage I	25000	25000	25000	25000	25000	18750	12500	6250			

Continued

0811	Lawn movers (professional)	Stage I						6250	12500	18750	18750	12500	6250
0811	Lawn movers (professional)	Stage II									6250	12500	18750
0811	Cultivators (professional)	<1981											
0811	Cultivators (professional)	1981-1990											
0811	Cultivators (professional)	1991-Stage I	10000	10000	10000	10000	10000	8750	7500	6250	5000	3750	2500
0811	Cultivators (professional)	Stage I						1250	2500	3750	3750	3750	3750
0811	Cultivators (professional)	Stage II									1250	2500	3750
0811	Chain saws (professional)	1981-1990											
0811	Chain saws (professional)	1991-Stage I	20000	27500	35000	42500	50000	33333	16667				
0811	Chain saws (professional)	Stage I						16667	33333	50000	50000	33333	16667
0811	Chain saws (professional)	Stage II										16667	33333
0811	Riders (professional)	1981-1990											
0811	Riders (professional)	1991-Stage I	6720	7802	9726	12492	16100	15728	13398	9444	4800		
0811	Riders (professional)	Stage I						3932	8932	9444	9600	9600	4800
0811	Riders (professional)	Stage II								4722	9600	14400	19200
0811	Shrub clearers (professional)	1981-1990											
0811	Shrub clearers (professional)	1991-Stage I	4000	5500	7000	8500	10000	7500	5000	2500			
0811	Shrub clearers (professional)	Stage I						2500	5000	7500	7500	5000	2500
0811	Shrub clearers (professional)	Stage II									2500	5000	7500
0811	Hedge cutters (professional)	1981-1990											
0811	Hedge cutters (professional)	1991-Stage I	4000	4600	5200	5800	6400	4800	3200	1600			
0811	Hedge cutters (professional)	Stage I						1600	3200	4800	4800	3200	1600
0811	Hedge cutters (professional)	Stage II									1600	3200	4800
0811	Trimmers (professional)	1981-1990											
0811	Trimmers (professional)	1991-Stage I	13286	13714	14143	14571	15000	11250	7500	3750			
0811	Trimmers (professional)	Stage I						3750	7500	11250	11250	7500	3750
0811	Trimmers (professional)	Stage II									3750	7500	11250

Stock data for small boats and pleasure crafts 1985-2010.

Fuel type	Motor type	Boat type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel		Motor boats (27-34 ft)	1550	1550	1719	1889	2058	2228	2397	2567	2736	2906	3075	3244	3414	3583	3753
Diesel		Motor boats (> 34 ft)	450	450	503	556	608	661	714	767	819	872	925	978	1031	1083	1136
Diesel		Motor boats <(27 ft)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Diesel		Motor sailors	3500	3500	3583	3667	3750	3833	3917	4000	4083	4167	4250	4333	4417	4500	4583
Diesel		Sailing boats (> 26 ft)	7500	7500	7917	8333	8750	9167	9583	10000	10417	10833	11250	11667	12083	12500	12917
Fuel	2-stroke	Other boats (< 20 ft)	4000	4000	4056	4111	4167	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439
Fuel	2-stroke	Yawls and cabin boats	4000	4000	4056	4111	4167	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439
Fuel	2-stroke	Sailing boats (< 26 ft)	19000	19000	18778	18556	18333	18111	17889	17667	17444	17222	17000	16778	16390	15843	15144
Fuel	2-stroke	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	2970	2910	2820
Fuel	2-stroke	Water scooters	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	990	970	940
Fuel	4-stroke	Other boats (< 20 ft)													46	140	283
Fuel	4-stroke	Yawls and cabin boats													46	140	283
Fuel	4-stroke	Sailing boats (< 26 ft)													166	490	967
Fuel	4-stroke	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Fuel	4-stroke	Speed boats													30	90	180
Fuel	4-stroke	Water scooters													10	30	60

Fuel type	Motor type	Boat type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Diesel		Motor boats (27-34 ft)	3922	4092	4261	4431	4600	4600	4600	4600	4600	4600	4600
Diesel		Motor boats (> 34 ft)	1189	1242	1294	1347	1400	1400	1400	1400	1400	1400	1400
Diesel		Motor boats <(27 ft)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Diesel		Motor sailors	4667	4750	4833	4917	5000	5000	5000	5000	5000	5000	5000
Diesel		Sailing boats (> 26 ft)	13333	13750	14167	14583	15000	15000	15000	15000	15000	15000	15000
Fuel	2-stroke	Other boats (< 20 ft)	4300	4108	3862	3560	3200	2750	2250	1800	1400	1050	750
Fuel	2-stroke	Yawls and cabin boats	4300	4108	3862	3560	3200	2750	2250	1800	1400	1050	750
Fuel	2-stroke	Sailing boats (< 26 ft)	14300	13317	12201	10960	9600	8250	6750	5400	4200	3150	2250
Fuel	2-stroke	Speed boats	2700	2550	2370	2160	1920	1650	1350	1080	840	630	450
Fuel	2-stroke	Water scooters	900	850	790	720	640	550	450	360	280	210	150
Fuel	4-stroke	Other boats (< 20 ft)	478	725	1027	1384	1800	2250	2750	3200	3600	3950	4250
Fuel	4-stroke	Yawls and cabin boats	478	725	1027	1384	1800	2250	2750	3200	3600	3950	4250
Fuel	4-stroke	Sailing boats (< 26 ft)	1589	2350	3243	4262	5400	6750	8250	9600	10800	11850	12750
Fuel	4-stroke	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Fuel	4-stroke	Speed boats	300	450	630	840	1080	1350	1650	1920	2160	2370	2550
Fuel	4-stroke	Water scooters	100	150	210	280	360	450	550	640	720	790	850

Engine sizes (kW) for recreational craft 1985-2010.

Motor type	Boat type	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004-2010
2-stroke	Other boats (< 20 ft)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2-stroke	Yawls and cabin boats	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
2-stroke	Sailing boats (< 26 ft)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2-stroke	Speed boats	25	31	32	33	35	36	38	39	40	42	43	44	46	47	49	50
2-stroke	Water scooters	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4-stroke	Other boats (< 20 ft)									8	8	8	8	8	8	8	8
4-stroket	Yawls and cabin boats									20	20	20	20	20	20	20	20
4-stroke	Sailing boats (< 26 ft)									10	10	10	10	10	10	10	10
4-stroke	Speed boats (in board eng.)	45	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90
4-stroke	Speed boats (out board eng.)									40	42	43	44	46	47	49	50
4-stroke	Water scooters									45	45	45	45	45	45	45	45
Diesel	Motor boats (27-34 ft)	70	88	92	97	101	106	110	114	119	123	128	132	137	141	146	150
Diesel	Motor boats (> 34 ft)	120	149	156	163	171	178	185	192	199	207	214	221	228	236	243	250
Diesel	Motor boats <(27 ft)	20	24	26	27	28	29	30	31	32	33	34	36	37	38	39	40
Diesel	Motor sailors	20	22	23	23	24	24	25	26	26	27	27	28	28	29	29	30
Diesel	Sailing boats (> 26 ft)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Annex 3B-12: Traffic data and different technical and operational data for Danish domestic ferries

Annual traffic data for ferries (no. of round trips) for Danish domestic ferries.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Korsør-Nyborg, DSB	9305	9167	9237	8959	8813	8789	8746	3258	0	0
Korsør-Nyborg, Vognmandsruten	7512	7363	7468	7496	7502	7828	7917	8302	3576	0
Halsskov-Knudshoved	10601	10582	11701	11767	12420	12970	13539	13612	5732	0
Kalundborg-Juelsminde	0	1326	1733	1542	1541	1508	856	0	0	0
Kalundborg-Århus	1907	2400	3162	2921	2913	3540	4962	4888	4483	1454
Sjællands Odde-Ebeltoft	3908	3978	4008	3988	4325	4569	5712	8153	7851	7720
Sjællands Odde-Århus	0	0	0	0	0	0	0	0	0	2339
Hundested-Grenaa	1026	1025	1032	1030	718	602	67	0	0	0
København-Rønne	558	545	484	412	427	426	437	465	458	506
Køge-Rønne	0	0	0	0	0	0	0	0	0	0
Kalundborg-Samsø	873	873	860	881	826	811	813	823	824	850
Tårs-Spodsbjerg	7656	8835	9488	9535	9402	9562	9000	9129	7052	6442
Hirtshals-Torshavn	0	0	0	0	0	0	0	0	0	0
Hanstholm-Torshavn	0	14	15	0	0	0	0	0	0	48
Esbjerg-Torshavn	9	9	9	15	14	13	0	0	0	0
Local ferries	176891	179850	181834	178419	202445	209129	182750	197489	200027	202054

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Korsør-Nyborg, DSB	0	0	0	0	0	0	0	0	0	0	0
Korsør-Nyborg, Vognmandsruten	0	0	0	0	0	0	0	0	0	0	0
Halsskov-Knudshoved	0	0	0	0	0	0	0	0	0	0	0
Kalundborg-Juelsminde	0	0	0	0	0	0	0	0	0	0	0
Kalundborg-Århus	1870	1804	2037	1800	1750	1725	1724	1695	1694	1668	1552
Sjællands Odde-Ebeltoft	4775	4226	3597	3191	2906	2889	2690	2670	2577	2454	2409
Sjællands Odde-Århus	1799	1817	1825	2359	2863	2795	2853	2810	2814	2810	2735
Hundested-Grenaa	0	0	0	0	0	0	0	0	0	0	0
København-Rønne	491	430	413	397	293	0	0	0	0	0	0
Køge-Rønne	0	0	0	0	154	488	436	399	428	407	459
Kalundborg-Samsø	828	817	833	831	841	867	862	887	921	969	937
Tårs-Spodsbjerg	6477	6498	6468	6516	6497	6494	6460	6493	6504	6474	6529
Hirtshals-Torshavn	0	0	0	0	0	0	0	0	0	0	13
Hanstholm-Torshavn	67	94	85	50	59	51	51	48	52	27	20
Esbjerg-Torshavn	0	0	0	0	0	0	0	0	0	35	30
Local ferries	201833	200130	208396	208501	206297	205564	203413	205260	210089	209082	205461

Ferry data: Service, name, engine year, main engine MCR (kW), engine type, specific fuel consumption (sfc), aux. engine (kW).

Ferry service	Ferry name	Engine year	Main engine MCR (kW)	Engine type	Sfc (g/kWh)	Fuel type	Aux engine (kW)
Esbjerg-Torshavn	Gamle Norrøna	1973	11768	Medium speed (4-stroke)	239	Diesel	2354
Esbjerg-Torshavn	Nye Norrøna	2003	21600	Medium speed (4-stroke)	190	Fuel	4320
Halsskov-Knudshoved	ARVEPRINS KNUD	1963	8238	Slow speed (2-stroke)	220	Fuel	1666
Halsskov-Knudshoved	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	Diesel	1692
Halsskov-Knudshoved	HEIMDAL	1983	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	Fuel	1840
Halsskov-Knudshoved	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Halsskov-Knudshoved	KRAKA	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	LODBROG	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	Fuel	1360
Halsskov-Knudshoved	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	Fuel	1360
Halsskov-Knudshoved	ROMSØ	1973	8826	Medium speed (4-stroke)	230	Diesel	1728
Halsskov-Knudshoved	SPROGØ	1962	6400	Slow speed (2-stroke)	220	Fuel	1840
Hanstholm-Torshavn	Gamle Norrøna	1973	11768	Medium speed (4-stroke)	239	Diesel	2354
Hanstholm-Torshavn	Nye Norrøna	2003	21600	Medium speed (4-stroke)	190	Fuel	4320
Hirtshals-Torshavn	Nye Norrøna	2003	21600	Medium speed (4-stroke)	190	Fuel	4320
Hundested-Grenaa	DJURSLAND	1974	9856	Medium speed (4-stroke)	230	Diesel	900
Hundested-Grenaa	KATTEGAT	1995	23200	High speed (4-stroke)	205	Diesel	1223
Hundested-Grenaa	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	235	Fuel	1375
Hundested-Grenaa	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	Fuel	1360
Kalundborg-Juelsminde	Mercandia I	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia II	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia III	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia IV	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Samsø	HOLGER DANSKE	1976	2354	High speed (4-stroke)	225	Diesel	600
Kalundborg-Samsø	KALUNDBORG	1952	3825	Slow speed (2-stroke)	235	Fuel	570
Kalundborg-Samsø	KYHOLM	1998	2940	High speed (4-stroke)	195	Diesel	864
Kalundborg-Samsø	VESBORG	1995	1770	High speed (4-stroke)	200	Diesel	494
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	Diesel	2220
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	ASK	1984	9840	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	Diesel	800
Kalundborg-Århus	CAT-LINK IV	1998	28320	High speed (4-stroke)	205	Diesel	920

Continued							
Kalundborg-Århus	CAT-LINK V	1998	28320	High speed (4-stroke)	205	Diesel	920
Kalundborg-Århus	KATTEGAT SYD	1979	7650	Medium speed (4-stroke)	225	Diesel	1366
Kalundborg-Århus	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	Fuel	1840
Kalundborg-Århus	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Kalundborg-Århus	KRAKA	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	NIELS KLIM	1986	12474	Slow speed (2-stroke)	215	Fuel	4440
Kalundborg-Århus	PEDER PAARS	1985	12474	Slow speed (2-stroke)	215	Fuel	4440
Kalundborg-Århus	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	Fuel	1360
Kalundborg-Århus	ROSTOCK LINK	1975	8385	Medium speed (4-stroke)	230	Diesel	2500
Kalundborg-Århus	SØLØVEN/SØBJØRNEN	1992	4000	High speed (4-stroke)	210	Diesel	272
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	Diesel	2220
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	URD	1981	9840	Medium speed (4-stroke)	215	Diesel	3000
Korsør-Nyborg, DSB	ASA-THOR	1965	6472	Slow speed (2-stroke)	220	Fuel	1305
Korsør-Nyborg, DSB	DRONNING INGRID	1980	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	Diesel	1692
Korsør-Nyborg, DSB	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	1981	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	PRINS JOACHIM	1980	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	1962	6400	Slow speed (2-stroke)	220	Fuel	1840
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	1989	2950	High speed (4-stroke)	220	Diesel	0
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	1989	2950	High speed (4-stroke)	220	Diesel	0
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	1988	2950	High speed (4-stroke)	220	Diesel	0
København-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	233	Fuel	2889
København-Rønne	JENS KOFOED	2009	12950	Medium speed (4-stroke)	190	Fuel	2889
København-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	233	Fuel	2889
København-Rønne	POVL ANKER	2009	12950	Medium speed (4-stroke)	190	Fuel	2889
Køge-Rønne	DUEODDE	2005	8640	Medium speed (4-stroke)	190	Fuel	1545
Køge-Rønne	HAMMERODDE	2005	8640	Medium speed (4-stroke)	190	Fuel	1545
Køge-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	233	Fuel	2889
Køge-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	233	Fuel	2889
Køge-Rønne	POVL ANKER	2009	12950	Medium speed (4-stroke)	190	Fuel	2889
Sjællands Odde-Ebeltoft	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MAREN MOLS	1975	12062	Medium speed (4-stroke)	230	Fuel	1986

Continued							
Sjællands Odde-Ebeltoft	MAREN MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	METTE MOLS	1975	12062	Medium speed (4-stroke)	230	Fuel	1986
Sjællands Odde-Ebeltoft	METTE MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	MIE MOLS	1971	5884	Medium speed (4-stroke)	230	Diesel	
Sjællands Odde-Ebeltoft	MIE MOLS 2	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MADS MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MAX MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MIE MOLS	1996	24800	Gas turbine	240	Diesel	752
Tårs-Spodsbjerg	FRIGG SYDFYEN	1984	1300	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	ODIN SYDFYEN	1982	1180	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	SPODSBJERG	1972	1530	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	2006	1545	Medium speed (4-stroke)	190	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	1978	1176	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	2008	1176	Medium speed (4-stroke)	190	Diesel	300
Sjællands Odde-Århus	MIE MOLS	1996	24800	Gas turbine	240	Diesel	752
Tårs-Spodsbjerg	FRIGG SYDFYEN	1984	1300	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	ODIN SYDFYEN	1982	1180	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	SPODSBJERG	1972	1530	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	2006	1545	Medium speed (4-stroke)	190	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	1978	1176	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	2008	1176	Medium speed (4-stroke)	190	Diesel	300

Ferry data: Sailing time (single trip).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006-2009	2010
Esbjerg-Torshavn	Gamle Norrøna	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860					
Esbjerg-Torshavn	Nye Norrøna														1860	1860	1860	1860	1860
Halsskov-Knudshoved	ARVEPRINS KNUD	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	DRONNING MARGRETHE II	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	HEIMDAL	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	KNUDSHOVED	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	KONG FREDERIK IX	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	KRAKA	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	LODBROG	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	PRINSESSE ELISABETH	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	ROMSØ	60	60	60	60	60	60	60	60	60									
Halsskov-Knudshoved	SPROGØ	60	60	60	60	60	60	60	60	60									
Hanstholm-Torshavn	Gamle Norrøna	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740					
Hanstholm-Torshavn	Nye Norrøna														1740	1740	1740	1740	1740
Hirtshals-Torshavn	Nye Norrøna																		1740
Hundested-Grenaa	DJURSLAND	160	160	160	160	160													
Hundested-Grenaa	KATTEGAT						90	90											
Hundested-Grenaa	KONG FREDERIK IX					170													
Hundested-Grenaa	PRINSESSE ANNE-MARIE					165													
Kalundborg-Juelsminde	Mercandia I	160	160	160	160	160	160	160											
Kalundborg-Juelsminde	Mercandia II	160	160	160	160	160	160	160											
Kalundborg-Juelsminde	Mercandia III	160	160	160	160	160	160	160											
Kalundborg-Juelsminde	Mercandia IV	160	160	160	160	160	160	160											
Kalundborg-Samsø	HOLGER DANSKE			120	120	120	120	120	120	120									
Kalundborg-Samsø	KALUNDBORG	120	120	120															
Kalundborg-Samsø	KYHOLM									110	110	110	110	110	110	110	110	110	110
Kalundborg-Samsø	VESBORG									120									
Kalundborg-Århus	ASK		195	195	195	195	195	195	195	195	195								
Kalundborg-Århus	CAT-LINK I						80	85	90	95									
Kalundborg-Århus	CAT-LINK II						80	85	90	95									
Kalundborg-Århus	CAT-LINK III							85	90	95									
Kalundborg-Århus	CAT-LINK IV									80	80								
Kalundborg-Århus	CAT-LINK V									80	80								
Kalundborg-Århus	KATTEGAT SYD										195								
Kalundborg-Århus	KNUDSHOVED		190																

Continued

Kalundborg-Århus	KONG FREDERIK IX		190	190	190	190	190	190												
Kalundborg-Århus	KRAKA									195										
Kalundborg-Århus	MAREN MOLS											160	160	155	155	155	155		165	165
Kalundborg-Århus	METTE MOLS											160	160	155	155	155	155		165	165
Kalundborg-Århus	NIELS KLIM	185	185																	
Kalundborg-Århus	PEDER PAARS	185	185																	
Kalundborg-Århus	PRINSESSE ELISABETH		185																	
Kalundborg-Århus	ROSTOCK LINK										195									
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90												
Kalundborg-Århus	URD		195	195	195	195	195	195	195	195	195									
Korsør-Nyborg, DSB	ASA-THOR	65	65	65	65	65	65	65	65											
Korsør-Nyborg, DSB	DRONNING INGRID	65	65	65	65	65	65	65	65											
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	65	65	65	65	65	65	65	65											
Korsør-Nyborg, DSB	KONG FREDERIK IX	75	75	75	75	75	75	75	75											
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	65	65	65	65	65	65	65	65											
Korsør-Nyborg, DSB	PRINS JOACHIM	65	65	65	65	65	65	65	65											
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	75	75	75	75	75	75	75	75											
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70										
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70										
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70										
København-Rønne	JENS KOFOED	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420		420	420
København-Rønne	POVL ANKER	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420		420	420
Køge-Rønne	DUEODDE																375		375	375
Køge-Rønne	HAMMERODDE																375		375	375
Køge-Rønne	JENS KOFOED															375	375			
Køge-Rønne	POVL ANKER															375	375		375	375
Sjællands Odde-Ebeltoft	MAI MOLS							45	45	45	45	45	45	45	45	45	45		50	50
Sjællands Odde-Ebeltoft	MAREN MOLS	100	100	100	100	100	100	100												
Sjællands Odde-Ebeltoft	MAREN MOLS 2							100	100	100	95									
Sjællands Odde-Ebeltoft	METTE MOLS	100	100	100	100	100	100	100												
Sjællands Odde-Ebeltoft	METTE MOLS 2							100	100	100	95									
Sjællands Odde-Ebeltoft	MIE MOLS	105	105	105	105	105	105	105												
Sjællands Odde-Ebeltoft	MIE MOLS 2							45	45	45	45	45	45	45	45	45	45		50	50
Sjællands Odde-Århus	MADS MOLS										60	65	65	65	65	65	65		70	70
Sjællands Odde-Århus	MAI MOLS													65	65	65	65		68	68
Sjællands Odde-Århus	MAX MOLS										60	65	65	65	65	65	65		70	70
Sjællands Odde-Århus	MIE MOLS													65	65	65	65		68	68

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Tårs-Spodsbjerg	FRIGG SYDFYEN	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45		45	45
Tårs-Spodsbjerg	ODIN SYDFYEN	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45		45	45
Tårs-Spodsbjerg	SPODSBJERG	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45		45	45
Tårs-Spodsbjerg	THOR SYDFYEN	45	45	45	45	45	17	45	45	45	45	45	45	45	45	45	45		45	45

Ferry data: Load factor (% MCR).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Esbjerg-Torshavn	Gamle Norrøna	90	90	90	90	90	90	90	90	90	90	90	90	90								
Esbjerg-Torshavn	Nye Norrøna														90	90	90	90	90	90	90	90
Halsskov-Knudshoved	ARVEPRINS KNUD	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	HEIMDAL	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	KNUDSHOVED	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	KONG FREDERIK IX	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	KRAKA	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	LODBROG	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	PRINSESSE ELISABETH	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	ROMSØ	85	85	85	85	85	85	85	85	85												
Halsskov-Knudshoved	SPROGØ	85	85	85	85	85	85	85	85	85												
Hanstholm-Torshavn	Gamle Norrøna	90	90	90	90	90	90	90	90	90	90	90	90	90								
Hanstholm-Torshavn	Nye Norrøna														90	90	90	90	90	90	90	90
Hirtshals-Torshavn	Nye Norrøna																					90
Hundested-Grenaa	DJURSLAND	80	80	80	80	80																
Hundested-Grenaa	KATTEGAT						85	85														
Hundested-Grenaa	KONG FREDERIK IX					65																
Hundested-Grenaa	PRINSESSE ANNE-MARIE					85																
Kalundborg-Juelsminde	Mercandia I	75	75	75	75	75	75	75														
Kalundborg-Juelsminde	Mercandia II	70	70	70	70	70	70	70														
Kalundborg-Juelsminde	Mercandia III	70	70	70	70	70	70	70														
Kalundborg-Juelsminde	Mercandia IV	70	70	70	70	70	70	70														
Kalundborg-Samsø	HOLGER DANSKE			85	85	85	85	85	85	85												
Kalundborg-Samsø	KALUNDBORG	80	80	80																		
Kalundborg-Samsø	KYHOLM									85	85	85	85	85	85	85	85	85	85	85	85	85
Kalundborg-Samsø	VESBORG									95												
Kalundborg-Århus	ASK		85	85	85	80	80	80	80	80	80											
Kalundborg-Århus	CAT-LINK I						95	90	90	85												
Kalundborg-Århus	CAT-LINK II						95	90	90	85												
Kalundborg-Århus	CAT-LINK III							95	95	90												
Kalundborg-Århus	CAT-LINK IV									95	95											

Continued

Kalundborg-Århus	CAT-LINK V									95	95											
Kalundborg-Århus	KATTEGAT SYD										85											
Kalundborg-Århus	KNUDSHOVED		85																			
Kalundborg-Århus	KONG FREDERIK IX		85	85	85	85	85	85														
Kalundborg-Århus	KRAKA									85												
Kalundborg-Århus	MAREN MOLS											85	85	85	85	85	85	82	80	80	80	80
Kalundborg-Århus	METTE MOLS											85	85	85	85	85	85	82	80	80	80	80
Kalundborg-Århus	NIELS KLIM	85	85																			
Kalundborg-Århus	PEDER PAARS	85	85																			
Kalundborg-Århus	PRINSESSE ELISABETH		80																			
Kalundborg-Århus	ROSTOCK LINK										80											
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90														
Kalundborg-Århus	URD		85	85	85	85	85	85	85	80	80											
Korsør-Nyborg, DSB	ASA-THOR	85	85	85	85	85	85	85	85													
Korsør-Nyborg, DSB	DRONNING INGRID	60	60	60	60	60	60	60	60													
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85													
Korsør-Nyborg, DSB	KONG FREDERIK IX	70	70	70	70	70	70	70	70													
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	60	60	60	60	60	60	60	60													
Korsør-Nyborg, DSB	PRINS JOACHIM	60	60	60	60	60	60	60	60													
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	70	70	70	70	70	70	70	70													
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70												
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70												
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70												
København-Rønne	JENS KOFOED	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
København-Rønne	POVL ANKER	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Køge-Rønne	DUEODDE																69	65	65	65	65	65
Køge-Rønne	HAMMERODDE																69	65	66	66	66	66
Køge-Rønne	JENS KOFOED															31	31					
Køge-Rønne	POVL ANKER															31	31	45	49	49	49	49
Sjællands Odde-Ebeltoft	MAI MOLS							80	80	80	80	80	80	80	80	80	80	79	78	78	78	78
Sjællands Odde-Ebeltoft	MAREN MOLS	75	75	75	75	75	75	75														
Sjællands Odde-Ebeltoft	MAREN MOLS 2							80	80	80	85											
Sjællands Odde-Ebeltoft	METTE MOLS	75	75	75	75	75	75	75														
Sjællands Odde-Ebeltoft	METTE MOLS 2							80	80	80	85											

Sjællands Odde-Ebeltoft	MIE MOLS	85	85	85	85	85	85	85														
Sjællands Odde-Ebeltoft	MIE MOLS 2							80	80	80	80	80	80	80	80	80	80	79	78	78	78	78
Sjællands Odde-Århus	MADS MOLS										90	85	85	85	85	85	85	67	67	67	67	67
Sjællands Odde-Århus	MAI MOLS													75	75	75	75	69	69	69	69	69
Sjællands Odde-Århus	MAX MOLS										90	85	85	85	85	85	85	67	67	67	67	67
Sjællands Odde-Århus	MIE MOLS													75	75	75	75	69	69	69	69	69
Tårs-Spodsbjerg	FRIGG SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	ODIN SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	SPODSBJERG	75	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	THOR SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80

Ferry data: Round trip shares (%).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007-2009	2010
Esbjerg-Torshavn	Gamle Norrøna	100	100	100	100	100	100	100	100	100	100	100	100	100						
Esbjerg-Torshavn	Nye Norrøna														100	100	100	100	100	100
Halsskov-Knudshoved	ARVEPRINS KNUD	21	20	20	20	21	19	19	18	20										
Halsskov-Knudshoved	DRONNING MARGRETHE II	2	0	0	0	0	0	0	0	0										
Halsskov-Knudshoved	HEIMDAL	23	24	22	24	23	21	21	19	22										
Halsskov-Knudshoved	KNUDSHOVED	0	0	0	0	0	0	2	5	0										
Halsskov-Knudshoved	KONG FREDERIK IX	0	0	0	0	0	0	0	0	0										
Halsskov-Knudshoved	KRAKA	24	25	23	23	21	20	20	20	21										
Halsskov-Knudshoved	LODBROG	0	0	0	0	0	0	0	7	14										
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	0	0	0	0	0	6	2	0	0										
Halsskov-Knudshoved	PRINSESSE ELISABETH	0	0	0	3	0	0	0	0	0										
Halsskov-Knudshoved	ROMSØ	21	22	21	16	20	19	21	21	23										
Halsskov-Knudshoved	SPROGØ	9	9	15	14	15	15	14	11	1										
Hanstholm-Torshavn	Gamle Norrøna	100	100	100	100	100	100	100	100	100	100	100	100	100						
Hanstholm-Torshavn	Nye Norrøna														100	100	100	100	100	100
Hirtshals-Torshavn	Nye Norrøna																			100
Hundested-Grenaa	DJURSLAND	100	100	100	100	50														
Hundested-Grenaa	KATTEGAT						100	100												
Hundested-Grenaa	KONG FREDERIK IX					5														
Hundested-Grenaa	PRINSESSE ANNE-MARIE					45														
Kalundborg-Juelsminde	Mercandia I	25	25	25	25	25	25	25												
Kalundborg-Juelsminde	Mercandia II	25	25	25	25	25	25	25												
Kalundborg-Juelsminde	Mercandia III	25	25	25	25	25	25	25												
Kalundborg-Juelsminde	Mercandia IV	25	25	25	25	25	25	25												
Kalundborg-Samsø	HOLGER DANSKE			95	100	100	100	100	100	92										
Kalundborg-Samsø	KALUNDBORG	100	100	5																
Kalundborg-Samsø	KYHOLM									6	100	100	100	100	100	100	100	100	100	100
Kalundborg-Samsø	VESBORG									2										
Kalundborg-Århus	ASK		16	32	26	33	27	18	11	12	2									
Kalundborg-Århus	CAT-LINK I						17	25	28	11										
Kalundborg-Århus	CAT-LINK II						1	23	28	8										
Kalundborg-Århus	CAT-LINK III							8	24	19										
Kalundborg-Århus	CAT-LINK IV									23	26									
Kalundborg-Århus	CAT-LINK V									15	26									
Kalundborg-Århus	KATTEGAT SYD										2									
Kalundborg-Århus	KNUDSHOVED		4																	

Continued																					
Kalundborg-Århus	KONG FREDERIK IX		4	0	7	0	0	2													
Kalundborg-Århus	KRAKA									2											
Kalundborg-Århus	MAREN MOLS											50	50	50	50	50	50	50		50	50
Kalundborg-Århus	METTE MOLS											50	50	50	50	50	50	50		50	50
Kalundborg-Århus	NIELS KLIM	50	20																		
Kalundborg-Århus	PEDER PAARS	50	16																		
Kalundborg-Århus	PRINSESSE ELISABETH		4																		
Kalundborg-Århus	ROSTOCK LINK										22										
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		21	36	34	34	28	5													
Kalundborg-Århus	URD		16	32	33	33	27	18	11	9	22										
Korsør-Nyborg, DSB	ASA-THOR	13	13	13	11	9	9	9	6												
Korsør-Nyborg, DSB	DRONNING INGRID	26	28	26	28	28	29	28	31												
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	3	0	3	1	3	1	2	0												
Korsør-Nyborg, DSB	KONG FREDERIK IX	0	0	0	0	3	4	1	0												
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	27	28	27	29	28	29	29	32												
Korsør-Nyborg, DSB	PRINS JOACHIM	25	27	25	27	27	27	27	28												
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	6	4	5	4	1	1	4	3												
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	33	33	33	33	33	33	33	33	33											
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	33	33	33	33	33	33	33	33	33											
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	34	34	34	34	34	34	34	34	34											
København-Rønne	JENS KOFOED	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50		50	50
København-Rønne	POVL ANKER	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50		50	50
Køge-Rønne	DUEODDE																25	49		47	47
Køge-Rønne	HAMMERODDE																35	49		53	53
Køge-Rønne	JENS KOFOED															50	20				
Køge-Rønne	POVL ANKER															50	20	3		1	1
Sjællands Odde-Ebeltoft	MAI MOLS							21	35	35	35	50	50	50	50	50	50	50		50	50
Sjællands Odde-Ebeltoft	MAREN MOLS	40	40	40	40	40	40	15													
Sjællands Odde-Ebeltoft	MAREN MOLS 2							18	15	15	15										
Sjællands Odde-Ebeltoft	METTE MOLS	40	40	40	40	40	40	17													
Sjællands Odde-Ebeltoft	METTE MOLS 2							15	15	15	15										
Sjællands Odde-Ebeltoft	MIE MOLS	20	20	20	20	20	20	5													
Sjællands Odde-Ebeltoft	MIE MOLS 2							9	35	35	35	50	50	50	50	50	50	50		50	50
Sjællands Odde-Århus	MADS MOLS										50	95	90	95	60	60	35	30		31	31
Sjællands Odde-Århus	MAI MOLS													1	10	15	15	20		19	19
Sjællands Odde-Århus	MAX MOLS										50	5	10	3	20	10	35	30		31	31
Sjællands Odde-Århus	MIE MOLS													1	10	15	15	20		19	19
Tårs-Spodsbjerg	FRIGG SYDFYEN	41	40	39	38	36	36	36	32	33	45	45	45	45	45	45	45	45		45	45

Continued

Tårs-Spodsbjerg	ODIN SYDFYEN	41	40	39	38	36	36	36	32	33	45	45	45	45	45	45	45	45		45	45
Tårs-Spodsbjerg	SPODSBJERG	4	2	8	8	9	8	8	19	20	10	10	10	10	10	10	10	10		10	10
Tårs-Spodsbjerg	THOR SYDFYEN	14	18	14	16	19	20	20	17	14	0	0	0	0	0	0	0	0		0	0

Annex 3B-13 Fuel consumption and emission factors, engine specific (NO_x, CO, VOC (NMVOC and CH_4)), and fuel type specific (S-%, SO_2, PM) for ship engines

Specific fuel consumption and NO_x emission factors (g pr kWh) per engine year for diesel ship engines.

Year	High speed 4-stroke sfc (g pr kWh)	Medium speed 4-stroke sfc (g pr kWh)	Slow speed 2-stroke sfc (g pr kWh)	High speed 4-stroke NO_X (g pr kWh)	Medium speed 4-stroke NO_X (g pr kWh)	Slow speed 2-stroke NO_X (g pr kWh)
1949	265.5	255.5	235.5	7.3	8.0	14.5
1950	265.0	255.0	235.0	7.3	8.0	14.5
1951	264.5	254.5	234.5	7.3	8.0	14.5
1952	264.0	254.0	234.0	7.3	8.0	14.5
1953	263.5	253.5	233.5	7.3	8.0	14.5
1954	263.0	253.0	233.0	7.3	8.0	14.5
1955	262.4	252.4	232.4	7.3	8.0	14.5
1956	261.9	251.9	231.9	7.4	8.1	14.6
1957	261.3	251.3	231.3	7.5	8.2	14.7
1958	260.7	250.7	230.7	7.6	8.3	14.8
1959	260.1	250.1	230.1	7.7	8.4	14.9
1960	259.5	249.5	229.5	7.8	8.5	15.0
1961	258.9	248.9	228.9	7.9	8.6	15.1
1962	258.2	248.2	228.2	8.0	8.7	15.1
1963	257.6	247.6	227.6	8.1	8.8	15.2
1964	256.9	246.9	226.9	8.2	8.9	15.3
1965	256.1	246.1	226.1	8.3	9.0	15.4
1966	255.4	245.4	225.4	8.3	9.1	15.5
1967	254.6	244.6	224.6	8.4	9.2	15.6
1968	253.8	243.8	223.8	8.5	9.3	15.7
1969	253.0	243.0	223.0	8.6	9.4	15.8
1970	252.1	242.1	222.1	8.7	9.5	15.9
1971	251.2	241.2	221.2	8.8	9.6	16.0
1972	250.3	240.3	220.3	8.9	9.7	16.1
1973	249.3	239.3	219.3	9.0	9.8	16.2
1974	248.3	238.3	218.3	9.1	9.9	16.3
1975	247.3	237.3	217.3	9.2	10.0	16.4
1976	246.2	236.2	216.2	9.3	10.1	16.4
1977	245.0	235.0	215.0	9.3	10.2	16.5
1978	243.8	233.8	213.8	9.4	10.3	16.6
1979	242.6	232.6	212.6	9.5	10.4	16.7
1980	241.3	231.3	211.3	9.6	10.5	16.8
1981	239.9	229.9	209.9	9.7	10.6	16.9
1982	238.5	228.5	208.5	9.8	10.7	17.0
1983	237.0	227.0	207.0	9.9	10.8	17.4
1984	235.5	225.5	205.5	10.0	10.9	17.8
1985	233.9	223.9	203.9	10.1	11.0	18.2
1986	232.2	222.2	202.2	10.2	11.1	18.6
1987	230.5	220.5	200.5	10.3	11.3	19.0
1988	228.6	218.6	198.6	10.5	11.4	19.3
1989	226.7	216.7	196.7	10.6	11.6	19.5
1990	224.8	214.8	194.8	10.7	11.7	19.8
1991	222.7	212.7	192.7	10.9	11.9	20.0
1992	220.5	210.5	190.5	11.0	12.0	19.8
1993	218.3	208.3	188.3	11.1	12.1	19.6
1994	216.0	206.0	186.0	11.3	12.3	19.4
1995	213.6	203.6	183.6	11.4	12.4	19.3
1996	211.0	201.0	181.0	11.5	12.6	19.1
1997	208.4	198.4	178.4	11.7	12.7	18.9
1998	205.7	195.7	175.7	11.8	12.9	18.7

Continued						
Year	High speed 4-stroke sfc (g pr kWh)	Medium speed 4-stroke sfc (g pr kWh)	Slow speed 2-stroke sfc (g pr kWh)	High speed 4-stroke NO_X (g pr kWh)	Medium speed 4-stroke NO_X (g pr kWh)	Slow speed 2-stroke NO_X (g pr kWh)
1999	202.9	192.9	172.9	11.9	13.0	18.5
2000	199.9	189.9	169.9	11.0	12.0	16.0

CO, VOC, NMVOC and CH_4 emission factors (g/kg fuel) for ship engines

	High speed 4-stroke CO	Medium speed 4-stroke CO	Slow speed 2-stroke CO	High speed 4-stroke VOC	Medium speed 4-stroke VOC	Slow speed 2-stroke VOC
1949	6.03	6.26	6.79	1.88	1.96	2.12
1950	6.04	6.27	6.81	1.89	1.96	2.13
1951	6.05	6.29	6.82	1.89	1.96	2.13
1952	6.06	6.30	6.84	1.89	1.97	2.14
1953	6.07	6.31	6.85	1.90	1.97	2.14
1954	6.08	6.33	6.87	1.90	1.98	2.15
1955	6.10	6.34	6.88	1.91	1.98	2.15
1956	6.11	6.35	6.90	1.91	1.99	2.16
1957	6.12	6.37	6.92	1.91	1.99	2.16
1958	6.14	6.38	6.93	1.92	1.99	2.17
1959	6.15	6.40	6.95	1.92	2.00	2.17
1960	6.17	6.41	6.97	1.93	2.00	2.18
1961	6.18	6.43	6.99	1.93	2.01	2.18
1962	6.20	6.45	7.01	1.94	2.01	2.19
1963	6.21	6.46	7.03	1.94	2.02	2.20
1964	6.23	6.48	7.05	1.95	2.03	2.20
1965	6.25	6.50	7.08	1.95	2.03	2.21
1966	6.26	6.52	7.10	1.96	2.04	2.22
1967	6.28	6.54	7.12	1.96	2.04	2.23
1968	6.30	6.56	7.15	1.97	2.05	2.23
1969	6.32	6.58	7.17	1.98	2.06	2.24
1970	6.35	6.61	7.20	1.98	2.06	2.25
1971	6.37	6.63	7.23	1.99	2.07	2.26
1972	6.39	6.66	7.26	2.00	2.08	2.27
1973	6.42	6.69	7.29	2.01	2.09	2.28
1974	6.44	6.71	7.33	2.01	2.10	2.29
1975	6.47	6.74	7.36	2.02	2.11	2.30
1976	6.50	6.77	7.40	2.03	2.12	2.31
1977	6.53	6.81	7.44	2.04	2.13	2.33
1978	6.56	6.84	7.48	2.05	2.14	2.34
1979	6.60	6.88	7.53	2.06	2.15	2.35
1980	6.63	6.92	7.57	2.07	2.16	2.37
1981	6.67	6.96	7.62	2.08	2.17	2.38
1982	6.71	7.00	7.67	2.10	2.19	2.40
1983	6.75	7.05	7.73	2.11	2.20	2.42
1984	6.79	7.10	7.79	2.12	2.22	2.43
1985	6.84	7.15	7.85	2.14	2.23	2.45
1986	6.89	7.20	7.91	2.15	2.25	2.47
1987	6.94	7.26	7.98	2.17	2.27	2.49
1988	7.00	7.32	8.05	2.19	2.29	2.52
1989	7.06	7.38	8.13	2.21	2.31	2.54
1990	7.12	7.45	8.22	2.22	2.33	2.57
1991	7.18	7.52	8.30	2.25	2.35	2.59
1992	7.25	7.60	8.40	2.27	2.37	2.62
1993	7.33	7.68	8.50	2.29	2.40	2.66
1994	7.41	7.77	8.60	2.31	2.43	2.69

Continued						
1995	7.49	7.86	8.72	2.34	2.46	2.72
1996	7.58	7.96	8.84	2.37	2.49	2.76
1997	7.68	8.06	8.97	2.40	2.52	2.80
1998	7.78	8.18	9.11	2.43	2.56	2.85
1999	7.89	8.30	9.26	2.46	2.59	2.89
2000	8.00	8.43	9.42	2.50	2.63	2.94

	High speed 4-stroke NMVOC	Medium speed 4-stroke NMVOC	Slow speed 2-stroke NMVOC	High speed 4-stroke CH_4	Medium speed 4-stroke CH_4	Slow speed 2-stroke CH_4
1949	1.83	1.90	2.06	0.06	0.06	0.06
1950	1.83	1.90	2.06	0.06	0.06	0.06
1951	1.83	1.91	2.07	0.06	0.06	0.06
1952	1.84	1.91	2.07	0.06	0.06	0.06
1953	1.84	1.91	2.08	0.06	0.06	0.06
1954	1.84	1.92	2.08	0.06	0.06	0.06
1955	1.85	1.92	2.09	0.06	0.06	0.06
1956	1.85	1.93	2.09	0.06	0.06	0.06
1957	1.86	1.93	2.10	0.06	0.06	0.06
1958	1.86	1.93	2.10	0.06	0.06	0.07
1959	1.86	1.94	2.11	0.06	0.06	0.07
1960	1.87	1.94	2.11	0.06	0.06	0.07
1961	1.87	1.95	2.12	0.06	0.06	0.07
1962	1.88	1.95	2.13	0.06	0.06	0.07
1963	1.88	1.96	2.13	0.06	0.06	0.07
1964	1.89	1.96	2.14	0.06	0.06	0.07
1965	1.89	1.97	2.14	0.06	0.06	0.07
1966	1.90	1.98	2.15	0.06	0.06	0.07
1967	1.90	1.98	2.16	0.06	0.06	0.07
1968	1.91	1.99	2.17	0.06	0.06	0.07
1969	1.92	2.00	2.17	0.06	0.06	0.07
1970	1.92	2.00	2.18	0.06	0.06	0.07
1971	1.93	2.01	2.19	0.06	0.06	0.07
1972	1.94	2.02	2.20	0.06	0.06	0.07
1973	1.95	2.03	2.21	0.06	0.06	0.07
1974	1.95	2.04	2.22	0.06	0.06	0.07
1975	1.96	2.04	2.23	0.06	0.06	0.07
1976	1.97	2.05	2.24	0.06	0.06	0.07
1977	1.98	2.06	2.26	0.06	0.06	0.07
1978	1.99	2.07	2.27	0.06	0.06	0.07
1979	2.00	2.09	2.28	0.06	0.06	0.07
1980	2.01	2.10	2.30	0.06	0.06	0.07
1981	2.02	2.11	2.31	0.06	0.07	0.07
1982	2.03	2.12	2.33	0.06	0.07	0.07
1983	2.05	2.14	2.34	0.06	0.07	0.07
1984	2.06	2.15	2.36	0.06	0.07	0.07
1985	2.07	2.17	2.38	0.06	0.07	0.07
1986	2.09	2.18	2.40	0.06	0.07	0.07
1987	2.10	2.20	2.42	0.07	0.07	0.07
1988	2.12	2.22	2.44	0.07	0.07	0.08
1989	2.14	2.24	2.47	0.07	0.07	0.08
1990	2.16	2.26	2.49	0.07	0.07	0.08
1991	2.18	2.28	2.52	0.07	0.07	0.08
1992	2.20	2.30	2.55	0.07	0.07	0.08
1993	2.22	2.33	2.58	0.07	0.07	0.08
1994	2.25	2.35	2.61	0.07	0.07	0.08

Continued						
1995	2.27	2.38	2.64	0.07	0.07	0.08
1996	2.30	2.41	2.68	0.07	0.07	0.08
1997	2.33	2.44	2.72	0.07	0.08	0.08
1998	2.36	2.48	2.76	0.07	0.08	0.09
1999	2.39	2.51	2.81	0.07	0.08	0.09
2000	2.43	2.55	2.85	0.08	0.08	0.09

S-%, SO_2 and PM emission factors (g per kg fuel and g per GJ) per fuel type for diesel ship engines

Fuel type	SNAPCode	Year	S %	SO_2 (g/kg)	TSP (g/kg)	PM_{10} (g/kg)	$PM_{2.5}$ (g/kg)	SO_2 (g/GJ)	TSP (g/GJ)	PM_{10} (g/GJ)	$PM_{2.5}$ (g/GJ)
Fuel	National sea	1990	2,64	52,8	6,1	6,0	6,0	1291,0	149,2	147,8	147,0
Fuel	National sea	1991	2,35	47,0	4,9	4,9	4,8	1149,1	120,2	119,0	118,4
Fuel	National sea	1992	1,80	36,0	3,3	3,2	3,2	880,2	79,8	79,0	78,6
Fuel	National sea	1993	2,39	47,8	5,1	5,0	5,0	1168,7	123,9	122,6	122,0
Fuel	National sea	1994	2,62	52,4	6,0	6,0	5,9	1281,2	147,0	145,6	144,8
Fuel	National sea	1995	2,95	59,0	7,7	7,6	7,6	1442,5	188,0	186,1	185,2
Fuel	National sea	1996	2,57	51,4	5,8	5,7	5,7	1256,7	141,7	140,2	139,5
Fuel	National sea	1997	2,74	54,8	6,6	6,5	6,5	1339,9	160,8	159,2	158,4
Fuel	National sea	1998	1,97	39,4	3,7	3,7	3,6	963,3	90,6	89,7	89,2
Fuel	National sea	1999	1,97	39,4	3,7	3,7	3,6	963,3	90,6	89,7	89,2
Fuel	National sea	2000	1,81	36,2	3,3	3,3	3,2	885,1	80,4	79,6	79,2
Fuel	National sea	2001	1,70	34,0	3,0	3,0	3,0	831,3	74,1	73,4	73,0
Fuel	National sea	2002	1,51	30,2	2,6	2,6	2,6	738,4	64,3	63,7	63,3
Fuel	National sea	2003	1,62	32,4	2,9	2,8	2,8	792,2	69,8	69,1	68,8
Fuel	National sea	2004	1,98	39,6	3,7	3,7	3,7	968,2	91,3	90,4	89,9
Fuel	National sea	2005	2,00	40,0	3,8	3,8	3,7	978,0	92,6	91,7	91,3
Fuel	National sea	2006	1,94	38,8	3,6	3,6	3,6	948,7	88,6	87,7	87,3
Fuel	National sea	2007	1,20	24,0	2,1	2,1	2,1	586,8	51,0	50,5	50,3
Fuel	National sea	2008	1,20	24,0	2,1	2,1	2,1	586,8	51,0	50,5	50,3
Fuel	National sea	2009	1,20	24,0	2,1	2,1	2,1	586,8	51,0	50,5	50,3
Fuel	International sea	1990	2,96	59,2	7,7	7,7	7,6	1447,4	189,4	187,5	186,6
Fuel	International sea	1991	2,89	57,8	7,4	7,3	7,2	1413,2	179,8	178,0	177,1
Fuel	International sea	1992	2,88	57,6	7,3	7,2	7,2	1408,3	178,5	176,7	175,8
Fuel	International sea	1993	3,20	64,0	9,3	9,2	9,1	1564,8	226,5	224,2	223,1
Fuel	International sea	1994	3,03	60,6	8,2	8,1	8,0	1481,7	199,6	197,6	196,6
Fuel	International sea	1995	3,30	66,0	10,0	9,9	9,8	1613,7	244,0	241,6	240,4
Fuel	International sea	1996	3,42	68,4	10,9	10,8	10,8	1672,4	266,9	264,2	262,9
Fuel	International sea	1997	3,45	69,0	11,2	11,0	11,0	1687,0	272,9	270,2	268,8
Fuel	International sea	1998	3,42	68,4	10,9	10,8	10,8	1672,4	266,9	264,2	262,9
Fuel	International sea	1999	3,45	69,0	11,2	11,0	11,0	1687,0	272,9	270,2	268,8
Fuel	International sea	2000	3,36	67,2	10,4	10,3	10,3	1643,0	255,2	252,6	251,4
Fuel	International sea	2001	3,42	68,4	10,9	10,8	10,8	1672,4	266,9	264,2	262,9
Fuel	International sea	2002	3,44	68,8	11,1	11,0	10,9	1682,2	270,9	268,2	266,8
Fuel	International sea	2003	3,11	62,2	8,7	8,6	8,5	1520,8	211,8	209,7	208,6
Fuel	International sea	2004	3,20	64,0	9,3	9,2	9,1	1564,8	226,5	224,2	223,1
Fuel	International sea	2005	3,50	70,0	11,6	11,5	11,4	1711,5	283,2	280,4	279,0

Continued												
Fuel	International sea	2006	3,35	67,0	10,4	10,3	10,2	1638,1	253,3	250,8	249,5
Fuel	International sea	2007	1,50	30,0	2,6	2,6	2,6	733,5	63,8	63,2	62,9
Fuel	International sea	2008	1,50	30,0	2,6	2,6	2,6	733,5	63,8	63,2	62,9
Fuel	International sea	2009	1,50	30,0	2,6	2,6	2,6	733,5	63,8	63,2	62,9
Fuel	International sea	1990	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1991	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1992	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1993	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1994	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1995	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1996	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1997	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1998	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	1999	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2000	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2001	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2002	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2003	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2004	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2005	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2006	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2007	0,20	4,0	1,0	1,0	1,0	93,7	23,2	23,0	22,9
Diesel	-	2008	0,10	2,0	0,9	0,9	0,9	46,8	21,5	21,3	21,2
Diesel	-	2009	0,10	2,0	0,9	0,9	0,9	46,8	21,5	21,3	21,2

Annex 3B-14: Fuel sales figures from DEA, and further processed fuel consumption data suited for the Danish inventory

Enhed: TJ	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Agriculture and forestry, DEA statistics															
- LPG	88	84	354	311	457	438	412	359	234	205	204	212	184	219	162
- gasoline	425	184	315	317	304	274	251	240	208	166	161	191	70	61	56
- gas/diesel oil	9 199	9 634	9 498	9 520	10 605	10 528	10 700	11 028	11 423	11 494	11 585	13 088	13 875	13 310	13 909
Nurseries, DEA statistics															
- LPG	8	5	47	47	53	50	47	39	26	23	23	22	20	24	17
- gasoline	10	3	6	6	11	10	10	12	23	18	18	19	7	6	6
- gas/diesel oil	1 705	1 270	1 405	1 383	1 231	1 409	1 687	1 887	1 205	963	1 138	487	356	341	347
Fishery, DEA statistics															
- LPG	-	-	34	29	50	42	34	30	12	18	16	36	5	1	16
- gasoline	-	1	2	2	9	9	10	8	7	7	8	7	6	6	60
- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- gas/diesel oil	9 152	10 248	8 390	9 499	10 038	10 422	10 809	10 868	8 843	8 796	8 277	8 750	8 748	9 186	9 282
- fuel oil	27	5	82	68	251	285	113	231	146	8	19	219	260	27	-
Manufacturing industry, DEA statistics															
- LPG	2 860	2 839	2 688	2 553	2 080	2 032	2 076	1 827	1 858	2 029	2 234	2 404	2 106	2 017	1 917
- gasoline	262	273	453	326	136	177	161	158	145	138	110	86	82	137	80
- gas/diesel oil	15 576	15 441	14 743	13 346	12 670	12 259	12 934	11 901	11 323	10 154	10 401	10 184	8 921	8 720	8 852
- fuel oil	29 465	29 451	21 518	19 056	16 741	15 989	17 133	16 694	14 600	15 438	14 000	12 632	11 009	10 943	8 704
Building and construction, DEA statistics															
- LPG	305	343	500	451	575	500	573	708	579	522	501	509	471	575	422
- gasoline	19	85	52	48	36	34	26	24	20	23	25	34	27	23	27
- gas/diesel oil	5 313	4 962	4 378	4 220	3 945	3 548	3 797	3 839	3 871	4 145	5 317	5 572	6 079	5 947	6 556
Housing, DEA statistics															
- gasoline	1 006	1 046	1 073	1 114	1 128	1 131	1 146	1 158	1 168	1 194	1 233	1 258	1 299	1 317	1 357
- gas/dieselolie	74 257	69 392	68 349	59 832	46 935	41 152	45 219	38 406	45 029	39 770	40 004	41 836	36 491	34 902	32 936
Tower blocks															
- gas/dieselolie	10 584	9 968	10 112	7 266	7 350	5 311	5 420	4 507	4 938	3 909	3 284	3 460	3 105	2 948	2 739
Road transport, DEA statistics															
- gasoline	66 037	68 670	70 502	73 151	74 152	74 326	75 290	76 084	76 697	78 425	80 998	82 656	85 341	86 520	89 129
- gas/diesel oil	45 609	49 738	49 626	49 686	51 854	54 746	58 427	57 511	56 796	58 755	58 561	59 851	60 528	61 072	63 619
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Non-road, DEA statistics															
- LPG	2 955	2 929	3 089	2 911	2 590	2 520	2 535	2 224	2 118	2 257	2 461	2 638	2 310	2 260	2 097
- gasoline	1 722	1 590	1 898	1 810	1 616	1 626	1 595	1 592	1 563	1 540	1 547	1 589	1 485	1 545	1 526
- gas/diesel oil	31 793	31 307	30 025	28 469	28 451	27 744	29 118	28 655	27 822	26 755	28 441	29 331	29 231	28 319	29 665
Non-road, NERI model															
- LPG	1232	1233	1225	1209	1196	1185	1172	1151	1124	1105	1099	1088	1075	1086	1077
- gasoline	2998	2950	2903	2856	2813	2770	2702	2641	2587	2550	2521	2499	2479	2463	2456
- gas/diesel oil	26357	26895	26577	27075	26940	26800	26734	26046	26073	25235	25798	25139	25536	24844	24885
Recreational craft, NERI model															
- gasoline	270	270	279	289	299	309	319	329	339	348	358	368	377	385	391
- gas/diesel oil	219	219	247	277	309	343	378	415	454	495	537	581	628	676	726
Non-road, added 0202															
- gas/diesel oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-road, added 0203 and 0301															
- gas/diesel oil	5436	4412	3448	1395	1510	944	2384	2609	1748	1521	2642	4192	3695	3475	4780
- LPG	1724	1696	1864	1701	1393	1335	1363	1073	994	1152	1362	1549	1235	1175	1020
Non-road, added 0203															
- gas/diesel oil	1864	1537	1252	534	628	406	1014	1176	794	708	1182	1940	1799	1675	2297
- LPG	56	52	242	209	274	259	247	192	122	116	125	137	109	126	87
Non-road, added 0301															
- gas/diesel oil	3572	2875	2196	860	882	538	1370	1433	955	813	1460	2252	1896	1800	2483
- LPG	1668	1644	1622	1492	1119	1076	1116	881	872	1036	1237	1412	1126	1048	933
Non-road, added road transport															
- gasoline	-1276	-1360	-1005	-1046	-1197	-1145	-1107	-1049	-1023	-1010	-975	-909	-994	-918	-931
Fisheries, added national sea transport															
- fuel oil	27	5	82	68	251	285	113	231	146	8	19	219	260	27	0
Fisheries, consumed by recreational craft															
- gasoline	0	1	2	2	9	9	10	8	7	7	8	7	6	6	60
National sea transport, input NERI model															
- LPG	3	1	3	-	2	2	2	3	16	1	2	1	2	3	1
- kerosene	5	-	5	3	1	0	2	1	1	1	1	1	0	1	0
- gas/diesel oil	3 074	3 045	3 032	3 230	2 669	2 782	3 313	3 501	4 971	5 035	6 049	6 764	5 899	4 113	3 409
- fuel oil	2 541	3 424	3 922	2 795	4 228	3 845	4 429	3 646	2 797	2 160	1 592	1 379	1 210	1 367	1 435
Fisheries, input NERI model															
- LPG	-	-	34	29	50	42	34	30	12	18	16	36	5	1	16
- gasoline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- gas/diesel oil	8 932	10 029	8 143	9 222	9 729	10 080	10 431	10 453	8 389	8 301	7 740	8 169	8 120	8 510	8 556
International sea transport, input NERI model															
- gas/diesel oil	7 171	7 867	8 547	9 743	10 514	11 633	12 590	16 881	19 114	24 123	26 743	27 231	25 325	31 243	26 085
- fuel oil	10 123	12 236	20 883	27 532	27 667	28 543	23 470	20 998	36 988	39 024	39 509	35 739	32 427	26 952	28 526
National sea transport, output NERI model															
- gas/diesel oil	5285	5285	5285	5285	5285	5285	6015	6920	6673	6618	7028	8465	8967	7333	6201
- fuel oil	4571	4571	4571	4571	4571	4571	3926	3202	3201	3362	3382	2826	2052	1590	1455
- kerosene	5	0	5	3	1	0	2	1	1	1	1	1	0	1	0
- LPG	3	1	3	0	2	2	2	3	16	1	2	1	2	3	1
Fisheries, output NERI model															
- gas/diesel oil	7064	8131	6233	7509	7455	7920	8170	7482	7075	7097	7134	6744	5328	5566	6375
- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- LPG	0	0	34	29	50	42	34	30	12	18	16	36	5	1	16
International sea transport, output NERI model															
- gas/diesel oil	6828	7524	8204	9400	10171	11289	12149	16433	18726	23742	26370	26955	25049	30967	25474
- fuel oil	9394	11507	20155	26804	26938	27815	22742	20269	36259	38296	38780	35010	31698	26223	27797
National sea transport, added 0301															
- fuel oil	-2 030	-1 147	- 649	-1 776	- 343	- 726	504	445	- 404	-1 201	-1 789	-1 447	- 842	- 223	- 20
Road transport, NERI excl. traded fuels															
- gasoline	64 492	67 041	69 220	71 819	72 664	72 882	73 874	74 714	75 342	77 074	79 674	81 385	83 976	85 223	87 867
- gas/diesel oil	45 609	49 738	49 626	49 686	51 854	54 746	58 427	57 511	56 796	58 755	58 561	59 851	60 528	61 072	63 619
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Road transport, input NERI model incl. traded fuels															
- gasoline	62 077	62 442	62 716	63 442	62 546	66 279	70 589	74 320	76 459	79 209	80 101	80 958	83 089	84 832	84 506
- gas/diesel oil	49 016	54 939	54 827	54 887	57 055	59 947	61 296	59 950	59 522	63 561	64 013	65 590	66 374	67 206	69 501
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Continued

Enhed: TJ	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture and forestry, DEA statistics											
- LPG	179	190	159	153	138	121	116	110	103	114	126
- gasoline	38	39	28	42	51	52	20	21	20	31	31
- gas/diesel oil	13 689	13 437	13706	13463	12934	12464	13047	12481	13658	14346	14471
Nurseries, DEA statistics											

- LPG	19	20	17	16	14	12	12	11	10	11	13
- gasoline	4	4	3	5	6	6	2	2	2	3	3
- gas/diesel oil	698	581	529	556	488	407	391	418	483	508	513
Fishery, DEA statistics											
- LPG	13	19	21	20	18	20	20	18	12	12	12
- gasoline	67	3	3	0	0	0	1	1	1	1	1
- kerosene	25	1	1	1	1	1	0	0	0	0	0
- gas/diesel oil	9 347	8 908	8888	8428	7337	7340	7362	6854	6258	6075	6037
- fuel oil	-	-	4	84	35	126	86	13	14	17	0
Manufacturing industry, DEA statistics											
- LPG	1 819	1 526	1405	1472	1488	1478	1482	1216	1178	1029	1093
- gasoline	97	69	42	26	30	21	32	16	15	97	84
- gas/diesel oil	8 635	10 099	9155	9964	10515	10022	9132	8170	7449	6141	6244
- fuel oil	8 221	7 395	7818	6916	6940	6055	8527	6422	5319	4256	5281
Building and construction, DEA statistics											
- LPG	165	179	236	226	228	224	248	222	172	103	94
- gasoline	33	24	26	27	27	27	27	28	26	20	22
- gas/diesel oil	5 950	6 356	6226	6226	6227	6338	6187	6410	6339	5429	5341
Housing, DEA statistics											
- gasoline	1 355	1 317	1313	1303	1288	1250	1216	1193	1135	1092	1016
- gas/dieselolie	27 929	28 996	26967	24932	22863	21712	19572	18012	16585	15625	16536
Tower blocks											
- gas/dieselolie	2 346	2 511	2031	2095	2427	2151	1625	1411	1610	1658	1460
Road transport, DEA statistics											
- gasoline	88 975	86 474	86 247	85 611	84 629	82 118	79 822	78 325	74 545	71 689	66 750
- gas/diesel oil	64 282	66 254	66 814	70 875	75 422	79 476	86 223	93 111	93 437	88 454	92 718
- bioethanol	-	-	-	-	-	-	151	252	210	204	1 118
- biodiesel	-	-	-	-	-	-	-	-	10	139	16
Non-road, DEA statistics											
- LPG	2 018	1 736	1 581	1 641	1 640	1 612	1 610	1 337	1 292	1 155	1 232
- gasoline	1 525	1 453	1 412	1 404	1 402	1 356	1 296	1 259	1 199	1 242	1 155
- gas/diesel oil	28 972	30 473	29 616	30 209	30 164	29 232	28 757	27 479	27 929	26 425	26 569
Non-road, NERI model											
- LPG	1071	1073	1084	1079	1065	1049	1038	1040	986	817	985
- gasoline	2458	2622	2833	3090	3391	3604	3807	3923	3975	3942	3957
- gas/diesel oil	24630	24923	25100	25301	25670	26361	27733	29495	30490	27022	29882
Recreational craft, NERI model											

- gasoline	396	400	403	404	404	393	382	371	361	353	346
- gas/diesel oil	777	831	886	944	1002	1002	1002	1002	1002	1002	1002
Non-road, added 0202											
- gas/diesel oil	0	0	0	0	0	0	0	-2016	-2561	-598	-3314
Non-road, added 0203 and 0301											
- gas/diesel oil	4342	5550	4516	4908	4494	2871	1025	0	0	0	0
- LPG	947	662	497	563	575	562	572	298	306	338	247
Non-road, added 0203											
- gas/diesel oil	2156	2553	2171	2278	2000	1264	479	0	0	0	0
- LPG	93	80	55	58	53	46	46	27	27	37	28
Non-road, added 0301											
- gas/diesel oil	2186	2997	2346	2630	2494	1607	546	0	0	0	0
- LPG	854	582	442	505	522	516	526	271	279	301	219
Non-road, added road transport											
- gasoline	-932	-1169	-1421	-1686	-1990	-2248	-2511	-2663	-2776	-2700	-2802
Fisheries, added national sea transport											
- fuel oil	0	0	4	84	35	126	86	13	14	17	0
Fisheries, consumed by recreational craft											
- gasoline	67	3	3	0	0	0	1	1	1	1	1
National sea transport, input NERI model											
- LPG	0	-	-	0	0	0	0	0	-	-	-
- kerosene	1	1	1	1	1	1	0	-	-	-	-
- gas/diesel oil	5 348	5 608	5 855	6 009	5 259	6 646	5 986	5 233	6 954	6 489	5 665
- fuel oil	1 509	1 513	2 068	1 907	1 704	1 506	1 367	1 110	1 174	1 062	868
Fisheries, input NERI model											
- LPG	13	19	21	20	18	20	20	18	12	12	12
- gasoline	-	-	-	-	-	-	-	-	-	-	-
- kerosene	25	1	1	1	1	1	0	0	0	-	-
- gas/diesel oil	8 570	8 077	8 001	7 484	6 335	6 338	6 360	5 852	5 256	5 073	5 035
International sea transport, input NERI model											
- gas/diesel oil	20 892	19 022	19 505	18 549	14 357	11 630	10 829	9 124	11 218	10 433	11 493
- fuel oil	33 165	25 924	17 547	20 462	17 298	20 591	31 565	35 243	27 164	11 091	17 493
National sea transport, output NERI model											
- gas/diesel oil	5258	5233	5061	4475	4591	4559	4427	4435	4393	4315	4071
- fuel oil	1444	1400	1387	1862	1853	1859	2026	2005	2142	2289	2459
- kerosene	1	1	1	1	1	1	0	0	0	0	0

- LPG	0	0	0	0	0	0	0	0	0	0	12
Fisheries, output NERI model											
- gas/diesel oil	7422	9384	9664	9294	7286	8725	8166	6966	8106	7517	7768
- kerosene	25	1	1	1	1	1	0	0	0	0	0
- LPG	13	19	21	20	18	20	20	18	12	12	0
International sea transport, output NERI model											
- gas/diesel oil	22129	18090	18636	18273	14074	11330	10583	8809	10928	10164	11356
- fuel oil	32437	25195	16818	19247	16118	19411	30172	33848	25650	9416	15808
National sea transport, added 0301											
- fuel oil	65	113	681	45	- 148	- 353	- 659	- 895	- 968	-1 227	-1 591
Road transport, NERI excl. traded fuels											
- gasoline	87 713	84 907	84 426	83 521	82 235	79 477	76 930	75 292	71 409	68 637	63 603
- gas/diesel oil	64 282	66 254	66 814	70 875	75 422	79 476	86 223	93 111	93 437	88 454	92 718
- bioethanol	-	-	-	-	-	-	151	252	210	204	1 118
- biodiesel	-	-	-	-	-	-	-	-	10	139	16
Road transport, input NERI model incl. traded fuels											
- gasoline	83 312	81 852	81 963	81 878	80 593	77 835	76 109	75 292	71 409	67 815	62 782
- gas/diesel oil	69 196	70 916	72 552	78 766	84 209	88 264	95 010	103 871	103 480	97 421	101 685
- bioethanol	-	-	-	-	-	-	151	252	210	204	1 118
- biodiesel	-	-	-	-	-	-	-	-	10	139	16

Annex 3B-15: Emission factors and total emissions in CollectER format

1990 emission factors for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year		SNAP ID	Category		Fuel type	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
						g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ
1990	A	070101	Passenger cars	Highway	Diesel	93,68	281,80	25,07	3,74	179,70	74,00	0,00	0,47	79,48
1990	A	070101	Passenger cars	Highway	Gasoline	2,28	1341,85	372,77	10,99	3471,98	73,00	2,75	0,85	12,32
1990	A	070101	Passenger cars	Highway	LPG	0,00	1151,70	187,09	10,06	3914,25	63,10	0,00	0,00	10,06
1990	A	070102	Passenger cars	Rural	Diesel	93,68	282,97	42,09	6,82	268,08	74,00	0,00	0,57	75,13
1990	A	070102	Passenger cars	Rural	Gasoline	2,28	1157,33	489,92	13,86	3975,56	73,00	3,09	0,95	14,22
1990	A	070102	Passenger cars	Rural	LPG	0,00	1248,46	305,18	16,91	1146,38	63,10	0,00	0,00	14,49
1990	A	070103	Passenger cars	Urban	Diesel	93,68	228,36	83,84	8,41	317,11	74,00	0,00	0,35	122,24
1990	A	070103	Passenger cars	Urban	Gasoline	2,28	616,49	943,13	49,98	9909,86	73,00	3,10	0,62	13,42
1990	A	070103	Passenger cars	Urban	LPG	0,00	620,57	439,16	23,63	1315,38	63,10	0,00	0,00	11,82
1990	A	070201	Light duty vehicles	Highway	Diesel	93,68	270,67	30,19	2,60	344,14	74,00	0,00	0,32	104,48
1990	A	070201	Light duty vehicles	Highway	Gasoline	2,28	1369,26	170,29	10,11	2987,40	73,00	2,63	0,81	16,17
1990	A	070201	Light duty vehicles	Highway	LPG	0,00	1151,70	187,09	10,06	3914,25	63,10	0,00	0,00	10,06
1990	A	070202	Light duty vehicles	Rural	Diesel	93,68	299,25	33,22	4,26	358,42	74,00	0,00	0,36	107,73
1990	A	070202	Light duty vehicles	Rural	Gasoline	2,28	1188,86	262,59	15,25	2316,18	73,00	2,48	0,76	15,25
1990	A	070202	Light duty vehicles	Rural	LPG	0,00	1248,46	305,18	16,91	1146,38	63,10	0,00	0,00	14,49
1990	A	070203	Light duty vehicles	Urban	Diesel	93,68	487,30	55,86	6,31	411,00	74,00	0,00	0,26	131,44
1990	A	070203	Light duty vehicles	Urban	Gasoline	2,28	626,69	712,66	40,57	7326,15	73,00	2,22	0,44	8,90
1990	A	070203	Light duty vehicles	Urban	LPG	0,00	620,31	439,26	23,62	1316,15	63,10	0,00	0,00	11,81
1990	A	070301	Heavy duty vehicles	Highway	Diesel	93,68	987,62	45,46	6,46	204,32	74,00	3,21	0,32	35,10
1990	A	070301	Heavy duty vehicles	Highway	Gasoline	2,28	1037,78	474,61	9,69	7610,35	73,00	0,83	0,28	55,35
1990	A	070302	Heavy duty vehicles	Rural	Diesel	93,68	984,23	57,01	6,77	210,50	74,00	2,89	0,29	35,69
1990	A	070302	Heavy duty vehicles	Rural	Gasoline	2,28	1141,55	820,40	16,74	8371,39	73,00	0,91	0,30	60,88
1990	A	070303	Heavy duty vehicles	Urban	Diesel	93,68	957,32	74,12	11,98	243,37	74,00	2,21	0,22	39,97
1990	A	070303	Heavy duty vehicles	Urban	Gasoline	2,28	456,62	696,09	14,21	7102,99	73,00	0,61	0,20	40,59
1990	A	070400	Mopeds	Urban	Gasoline	2,28	18,26	12503,20	200,00	12602,74	73,00	0,91	0,91	171,69
1990	A	070501	Motorcycles	Highway	Gasoline	2,28	264,11	1072,19	129,96	16302,60	73,00	1,35	1,35	31,73
1990	A	070502	Motorcycles	Rural	Gasoline	2,28	185,41	981,69	159,32	15782,07	73,00	1,66	1,66	38,90
1990	A	070503	Motorcycles	Urban	Gasoline	2,28	112,92	1149,21	155,11	15187,59	73,00	1,61	1,61	37,87
1990	A	080100	Military		AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	A	080100	Military		Diesel	93,68	785,58	58,23	7,33	258,20	74,00	1,72	0,30	65,61
1990	A	080100	Military		Gasoline	2,28	932,90	1154,80	31,10	6608,56	73,00	2,99	0,78	14,43
1990	A	080100	Military		Jet fuel	22,99	250,57	24,94	2,65	229,89	72,00	2,30	0,00	1,16

1990	A	080200	Railways	Diesel	93,68	1225,13	79,94	3,07	223,21	74,00	2,04	0,20	50,26
1990	A	080200	Railways	Kerosene	5,00	50,00	3,00	7,00	20,00	72,00	2,00	0,00	121,95
1990	A	080300	Inland waterways	Diesel	93,68	983,64	171,79	2,79	453,65	74,00	2,96	0,17	106,93
1990	A	080300	Inland waterways	Gasoline	2,28	291,33	3606,55	50,38	13853,27	73,00	0,78	0,08	182,44
1990	A	080402	National sea traffic	Diesel	93,68	1104,18	50,57	1,56	166,83	74,00	4,68	0,00	23,21
1990	A	080402	National sea traffic	Kerosene	2,30	50,00	3,00	7,00	20,00	72,00	0,00	0,00	5,00
1990	A	080402	National sea traffic	LPG	0,00	1249,00	384,94	20,26	443,00	63,10	0,00	0,00	0,20
1990	A	080402	National sea traffic	Residual oil	1290,95	1615,26	53,44	1,65	176,29	78,00	4,89	0,00	149,25
1990	A	080403	Fishing	Diesel	93,68	1052,12	49,13	1,52	162,08	74,00	4,68	0,00	23,21
1990	A	080403	Fishing	Kerosene	2,30	50,00	3,00	7,00	20,00	72,00	0,00	0,00	5,00
1990	A	080403	Fishing	LPG	0,00	1249,00	384,94	20,26	443,00	63,10	0,00	0,00	0,20
1990	A	080404	International sea traffic	Diesel	93,68	1208,60	49,46	1,53	163,17	74,00	4,68	0,00	23,21
1990	A	080404	International sea traffic	Residual oil	1447,43	1689,57	53,98	1,67	178,09	78,00	4,89	0,00	189,43
1990	A	080501	Air traffic, Dom. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	A	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	22,99	314,51	14,93	1,59	90,41	72,00	5,70	0,00	1,16
1990	A	080502	Air traffic, Int. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	A	080502	Air traffic, Int. < 3000 ft.	Jet fuel	22,99	309,25	16,47	1,75	168,98	72,00	7,10	0,00	1,16
1990	A	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	22,99	330,11	12,36	1,31	90,75	72,00	2,30	0,00	1,16
1990	A	080504	Air traffic, Int. > 3000 ft.	Jet fuel	22,99	244,20	6,48	0,69	54,10	72,00	2,30	0,00	1,16
1990	A	080600	Agriculture	Diesel	93,68	758,87	156,85	2,55	635,53	74,00	2,93	0,17	144,45
1990	A	080600	Agriculture	Gasoline	2,28	31,60	949,55	88,42	47524,17	73,00	1,28	0,09	6,56
1990	A	080700	Forestry	Diesel	93,68	857,48	156,47	2,54	645,65	74,00	2,97	0,17	149,05
1990	A	080700	Forestry	Gasoline	2,28	40,39	7206,91	60,42	18057,40	73,00	0,37	0,07	101,22
1990	A	080800	Industry	Diesel	93,68	933,58	178,23	2,90	655,80	74,00	2,94	0,17	154,50
1990	A	080800	Industry	Gasoline	2,28	136,27	1610,77	120,61	14797,46	73,00	1,33	0,09	12,40
1990	A	080800	Industry	LPG	0,00	1328,11	146,09	7,69	104,85	63,10	3,50	0,21	4,89
1990	A	080900	Household and gardening	Gasoline	2,28	63,98	3366,01	95,22	32901,19	73,00	1,15	0,08	20,75
1990	A	081100	Commercial and institutional	Gasoline	2,28	68,83	2280,66	97,87	29887,31	73,00	1,09	0,08	24,00
1990	P	080501	Air traffic, Dom. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	P	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	22,99	283,87	20,73	2,20	129,70	72,00	4,58	0,00	1,16
1990	P	080502	Air traffic, Int. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	P	080502	Air traffic, Int. < 3000 ft.	Jet fuel	22,99	324,87	34,25	3,64	157,15	72,00	3,79	0,00	1,16
1990	P	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	22,99	314,86	11,78	1,25	84,05	72,00	2,30	0,00	1,16
1990	P	080504	Air traffic, Int. > 3000 ft.	Jet fuel	22,99	290,20	10,08	1,07	37,65	72,00	2,30	0,00	1,16

2009 emission factors for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year		SNAP ID	Category		Fuel type	SO_2 g pr GJ	NOx g pr GJ	NMVOC g pr GJ	CH_4 g pr GJ	CO g pr GJ	CO_2 g pr GJ	N_2O g pr GJ	NH_3 g pr GJ	TSP g pr GJ
2010	A	070101	Passenger cars	Highway	Diesel	0,47	284,85	5,92	0,11	12,74	73,99	2,02	0,49	13,92
2010	A	070101	Passenger cars	Highway	Gasoline	0,44	121,50	28,25	2,64	632,54	71,72	0,63	30,82	0,83
2010	A	070101	Passenger cars	Highway	LPG	0,00	186,36	29,88	4,13	1272,01	63,10	0,91	0,00	10,04
2010	A	070102	Passenger cars	Rural	Diesel	0,47	241,95	8,57	0,22	24,56	73,99	2,15	0,53	11,52
2010	A	070102	Passenger cars	Rural	Gasoline	0,44	99,05	31,18	3,20	487,36	71,72	1,19	32,47	0,77
2010	A	070102	Passenger cars	Rural	LPG	0,00	204,10	43,03	6,93	523,16	63,10	1,88	0,00	14,45
2010	A	070103	Passenger cars	Urban	Diesel	0,47	242,76	26,57	0,62	65,38	73,99	4,76	0,38	19,49
2010	A	070103	Passenger cars	Urban	Gasoline	0,44	118,76	217,20	8,76	2381,85	71,72	2,20	10,20	0,82
2010	A	070103	Passenger cars	Urban	LPG	0,00	126,34	105,19	10,96	809,82	63,10	3,79	0,00	13,34
2010	A	070201	Light duty vehicles	Highway	Diesel	0,47	212,34	20,08	0,20	126,33	73,99	1,52	0,37	20,34
2010	A	070201	Light duty vehicles	Highway	Gasoline	0,44	146,85	17,21	2,62	513,88	71,72	1,46	22,97	1,24
2010	A	070201	Light duty vehicles	Highway	LPG	0,00	78,50	11,18	1,84	889,72	63,10	0,44	0,00	10,04
2010	A	070202	Light duty vehicles	Rural	Diesel	0,47	221,92	22,73	0,45	108,30	73,99	1,66	0,40	16,61
2010	A	070202	Light duty vehicles	Rural	Gasoline	0,44	128,51	25,37	2,77	388,59	71,72	2,24	21,80	1,10
2010	A	070202	Light duty vehicles	Rural	LPG	0,00	86,46	15,69	3,08	398,46	63,10	0,99	0,00	14,45
2010	A	070203	Light duty vehicles	Urban	Diesel	0,47	213,35	41,33	0,97	136,53	73,99	3,16	0,28	25,16
2010	A	070203	Light duty vehicles	Urban	Gasoline	0,44	112,14	150,53	6,68	3040,41	71,72	3,84	5,51	0,76
2010	A	070203	Light duty vehicles	Urban	LPG	0,00	57,09	41,77	4,96	458,44	63,10	2,28	0,00	13,56
2010	A	070301	Heavy duty vehicles	Highway	Diesel	0,47	506,51	11,35	3,17	135,97	73,99	3,22	0,32	8,38
2010	A	070301	Heavy duty vehicles	Highway	Gasoline	0,44	1037,78	474,61	9,69	7610,35	71,72	0,83	0,28	55,35
2010	A	070302	Heavy duty vehicles	Rural	Diesel	0,47	532,88	13,72	3,29	131,60	73,99	2,89	0,29	8,42
2010	A	070302	Heavy duty vehicles	Rural	Gasoline	0,44	1141,55	820,40	16,74	8371,39	71,72	0,91	0,30	60,88
2010	A	070303	Heavy duty vehicles	Urban	Diesel	0,47	582,20	17,38	4,29	141,03	73,99	2,29	0,23	9,32
2010	A	070303	Heavy duty vehicles	Urban	Gasoline	0,44	456,62	696,09	14,21	7102,99	71,72	0,61	0,20	40,59
2010	A	070400	Mopeds	Urban	Gasoline	0,44	143,26	8633,88	138,08	9299,22	71,72	1,27	1,27	136,26
2010	A	070501	Motorcycles	Highway	Gasoline	0,44	270,09	826,21	101,94	11962,07	71,72	1,28	1,28	22,07
2010	A	070502	Motorcycles	Rural	Gasoline	0,44	192,34	806,39	123,40	11187,72	71,72	1,56	1,56	26,91
2010	A	070503	Motorcycles	Urban	Gasoline	0,44	118,68	987,22	126,73	10745,90	71,72	1,52	1,52	26,22
2010	A	080100	Military		AvGas	22,99	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2010	A	080100	Military		Diesel	0,47	362,43	18,55	1,76	99,64	74,00	2,80	0,36	13,88
2010	A	080100	Military		Gasoline	0,44	114,24	166,31	7,28	1499,83	73,00	1,58	21,86	1,59
2010	A	080100	Military		Jet fuel	22,99	250,57	24,94	2,65	229,89	72,00	2,30	0,00	1,16
2010	A	080200	Railways		Diesel	0,47	861,00	57,78	2,22	147,00	74,00	2,04	0,20	29,00
2010	A	080300	Inland waterways		Diesel	46,84	834,21	160,37	2,61	443,15	74,00	2,97	0,17	98,22
2010	A	080300	Inland waterways		Gasoline	0,46	536,58	1176,04	62,64	13132,16	73,00	1,46	0,10	36,12
2010	A	080402	National sea traffic		Diesel	46,84	950,95	51,95	1,51	84,45	74,00	4,68	0,00	21,55
2010	A	080402	National sea traffic		Residual oil	489,00	1901,30	62,53	1,93	206,29	78,00	4,89	0,00	43,98
2010	A	080403	Fishing		Diesel	46,84	1373,14	57,40	1,78	189,36	74,00	4,68	0,00	21,55
2010	A	080403	Fishing		LPG									

2010	A	080404	International sea traffic	Residual oil	489,00	2114,39	62,58	1,94	206,46	78,00	4,89	0,00	43,98
2010	A	080501	Air traffic, Dom. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2010	A	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	22,99	284,91	12,67	1,35	135,85	72,00	10,60	0,00	1,16
2010	A	080502	Air traffic, Int. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2010	A	080502	Air traffic, Int. < 3000 ft.	Jet fuel	22,99	300,20	21,33	2,27	172,31	72,00	7,43	0,00	1,16
2010	A	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	22,99	259,66	8,48	0,90	107,16	72,00	2,30	0,00	1,16
2010	A	080504	Air traffic, Int. > 3000 ft.	Jet fuel	22,99	238,78	6,06	0,64	50,18	72,00	2,30	0,00	1,16
2010	A	080600	Agriculture	Diesel	2,34	597,19	57,54	0,94	339,56	74,00	3,17	0,18	45,70
2010	A	080600	Agriculture	Gasoline	0,46	111,24	1198,22	160,47	21839,49	73,00	1,72	1,52	31,17
2010	A	080700	Forestry	Diesel	2,34	410,67	30,56	0,50	245,71	74,00	3,21	0,18	27,30
2010	A	080700	Forestry	Gasoline	0,46	65,70	5061,02	40,93	17576,18	73,00	0,45	0,09	80,63
2010	A	080800	Industry	Diesel	2,34	553,14	60,60	0,99	320,23	74,00	3,10	0,18	52,14
2010	A	080800	Industry	Gasoline	0,46	209,05	1535,64	108,73	13878,11	73,00	1,48	0,10	17,69
2010	A	080800	Industry	LPG	0,00	1328,11	146,09	7,69	104,85	63,10	3,50	0,21	4,89
2010	A	080900	Household and gardening	Gasoline	0,46	100,65	2363,13	75,84	29784,64	73,00	1,25	0,09	16,72
2010	A	081100	Commercial and institutional	Gasoline	0,46	91,81	1867,73	67,37	30544,46	73,00	1,12	0,09	28,18
2010	P	080501	Air traffic, Dom. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2010	P	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	22,99	277,85	14,59	1,55	181,79	72,00	7,00	0,00	1,16
2010	P	080502	Air traffic, Int. < 3000 ft.	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2010	P	080502	Air traffic, Int. < 3000 ft.	Jet fuel	22,99	336,87	32,23	3,42	239,55	72,00	3,96	0,00	1,16
2010	P	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	22,99	269,07	11,59	1,23	59,94	72,00	2,30	0,00	1,16
2010	P	080504	Air traffic, Int. > 3000 ft.	Jet fuel	22,99	305,04	9,40	1,00	32,03	72,00	2,30	0,00	1,16

1990 emissions for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year		SNAP ID	Category		Fuel type	Fuel	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
						PJ	tonnes	tonnes	tonnes	tonnes	tonnes	ktonnes	tonnes	tonnes	tonnes
1990	A	070101	Passenger cars	Highway	Diesel	1,3624	127,63	383,94	34,15	5,10	244,82	100,82	0,00	0,64	108,29
1990	A	070101	Passenger cars	Highway	Gasoline	10,513	24,00	14106,72	3918,93	115,49	36500,40	767,44	28,88	8,88	129,48
1990	A	070101	Passenger cars	Highway	LPG	0,0106	0,00	12,21	1,98	0,11	41,48	0,67	0,00	0,00	0,11
1990	A	070102	Passenger cars	Rural	Diesel	2,8483	266,82	806,00	119,90	19,42	763,57	210,78	0,00	1,62	213,99
1990	A	070102	Passenger cars	Rural	Gasoline	23,727	54,17	27460,47	11624,47	328,81	94329,55	1732,10	73,38	22,58	337,30
1990	A	070102	Passenger cars	Rural	LPG	0,0224	0,00	28,02	6,85	0,38	25,73	1,42	0,00	0,00	0,33
1990	A	070103	Passenger cars	Urban	Diesel	3,6613	342,98	836,08	306,97	30,81	1161,04	270,93	0,00	1,27	447,55
1990	A	070103	Passenger cars	Urban	Gasoline	28,626	65,36	17647,76	26998,31	1430,70	283681,58	2089,71	88,80	17,76	384,24
1990	A	070103	Passenger cars	Urban	LPG	0,0289	0,00	17,92	12,68	0,68	37,98	1,82	0,00	0,00	0,34
1990	A	070201	Light duty vehicles	Highway	Diesel	2,0446	191,53	553,43	61,73	5,31	703,63	151,30	0,00	0,66	213,62
1990	A	070201	Light duty vehicles	Highway	Gasoline	0,2642	0,60	361,80	45,00	2,67	789,37	19,29	0,69	0,21	4,27
1990	A	070201	Light duty vehicles	Highway	LPG	0,0075	0,00	8,67	1,41	0,08	29,47	0,48	0,00	0,00	0,08
1990	A	070202	Light duty vehicles	Rural	Diesel	6,5399	612,64	1957,06	217,28	27,88	2344,06	483,95	0,00	2,32	704,56
1990	A	070202	Light duty vehicles	Rural	Gasoline	0,9806	2,24	1165,83	257,50	14,96	2271,31	71,59	2,43	0,75	14,96
1990	A	070202	Light duty vehicles	Rural	LPG	0,022	0,00	27,41	6,70	0,37	25,17	1,39	0,00	0,00	0,32
1990	A	070203	Light duty vehicles	Urban	Diesel	6,4489	604,11	3142,56	360,27	40,67	2650,51	477,22	0,00	1,68	847,63
1990	A	070203	Light duty vehicles	Urban	Gasoline	1,2168	2,78	762,54	867,15	49,36	8914,36	88,83	2,71	0,54	10,82
1990	A	070203	Light duty vehicles	Urban	LPG	0,026	0,00	16,13	11,42	0,61	34,22	1,64	0,00	0,00	0,31
1990	A	070301	Heavy duty vehicles	Highway	Diesel	8,6373	809,11	8530,39	392,61	55,81	1764,75	639,16	27,68	2,77	303,17
1990	A	070301	Heavy duty vehicles	Highway	Gasoline	0,0467	0,11	48,43	22,15	0,45	355,19	3,41	0,04	0,01	2,58
1990	A	070302	Heavy duty vehicles	Rural	Diesel	15,813	1481,29	15563,42	901,53	107,06	3328,63	1170,15	45,62	4,56	564,38
1990	A	070302	Heavy duty vehicles	Rural	Gasoline	0,0815	0,19	93,08	66,89	1,37	682,60	5,95	0,07	0,02	4,96
1990	A	070303	Heavy duty vehicles	Urban	Diesel	12,591	1179,53	12054,04	933,28	150,80	3064,32	931,77	27,82	2,78	503,32
1990	A	070303	Heavy duty vehicles	Urban	Gasoline	0,0766	0,17	35,00	53,36	1,09	544,44	5,60	0,05	0,02	3,11
1990	A	070400	Mopeds	Urban	Gasoline	0,2904	0,66	5,30	3631,21	58,08	3660,12	21,20	0,27	0,27	49,86
1990	A	070501	Motorcycles	Highway	Gasoline	0,0704	0,16	18,59	75,46	9,15	1147,38	5,14	0,10	0,10	2,23
1990	A	070502	Motorcycles	Rural	Gasoline	0,1687	0,39	31,28	165,63	26,88	2662,69	12,32	0,28	0,28	6,56
1990	A	070503	Motorcycles	Urban	Gasoline	0,2166	0,49	24,46	248,88	33,59	3289,15	15,81	0,35	0,35	8,20
1990	A	080100	Military		AvGas	0,0049	0,11	4,22	6,11	0,11	34,26	0,36	0,01	0,01	0,05
1990	A	080100	Military		Diesel	0,1462	13,69	114,82	8,51	1,07	37,74	10,82	0,25	0,04	9,59
1990	A	080100	Military		Gasoline	0,001	0,00	0,92	1,14	0,03	6,51	0,07	0,00	0,00	0,01
1990	A	080100	Military		Jet fuel	1,4968	34,41	375,06	37,33	3,96	344,09	107,77	3,44		1,74
1990	A	080200	Railways		Diesel	4,01	375,64	4912,78	320,54	12,32	895,07	296,74	8,18	0,82	201,55
1990	A	080200	Railways		Gasoline	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1990	A	080300	Inland waterways		Diesel	0,3426	32,10	337,02	58,86	0,96	155,43	25,35	1,01	0,06	36,64

Continued

1990	A	080300	Inland waterways	Gasoline	0,3091	0,71	90,06	1114,91	15,58	4282,54	22,57	0,24	0,02	56,40
1990	A	080402	National sea traffic	Diesel	5,2854	495,12	5836,01	267,28	8,27	881,74	391,12	24,76		122,69
1990	A	080402	National sea traffic	Residual oil	4,5713	5901,32	7383,82	244,28	7,56	805,87	356,56	22,35		682,25
1990	A	080403	Fishing	Diesel	7,9199	741,91	8332,71	389,10	12,03	1283,63	586,07	37,10		183,85
1990	A	080403	Fishing	Gasoline	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1990	A	080403	Fishing	Residual oil	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00		0,00
1990	A	080404	International sea traffic	Diesel	11,289	1057,56	13644,52	558,38	17,27	1842,07	835,42	52,88		262,07
1990	A	080404	International sea traffic	Residual oil	27,815	40259,78	46994,61	1501,54	46,44	4953,54	2169,54	136,01		5268,82
1990	A	080501	Air traffic, Dom. < 3000 ft.	AvGas	0,1049	2,40	90,15	130,41	2,30	731,69	7,66	0,21	0,17	1,05
1990	A	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	0,4222	9,71	132,78	6,30	0,67	38,17	30,40	2,40		0,49
1990	A	080502	Air traffic, Int. < 3000 ft.	AvGas	0,0307	0,70	26,34	38,10	0,67	213,76	2,24	0,06	0,05	0,31
1990	A	080502	Air traffic, Int. < 3000 ft.	Jet fuel	0,1323	3,04	40,93	2,18	0,23	22,36	9,53	0,94		0,15
1990	A	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	1,026	23,59	338,70	12,68	1,35	93,11	73,87	2,36		1,19
1990	A	080504	Air traffic, Int. > 3000 ft.	Jet fuel	1,6119	37,06	393,62	10,45	1,11	87,20	116,06	3,71		1,87
1990	A	080600	Agriculture	Diesel	16,496	1545,32	12518,46	2587,36	42,07	10483,86	1220,72	48,34	2,76	2382,90
1990	A	080600	Agriculture	Gasoline	0,7089	1,62	22,40	673,10	62,68	33688,19	51,75	0,91	0,06	4,65
1990	A	080700	Forestry	Diesel	0,1453	13,62	124,63	22,74	0,37	93,84	10,76	0,43	0,02	21,66
1990	A	080700	Forestry	Gasoline	0,3414	0,78	13,79	2460,65	20,63	6165,33	24,92	0,13	0,03	34,56
1990	A	080800	Industry	Diesel	10,158	951,61	9483,66	1810,53	29,44	6661,90	751,72	29,87	1,71	1569,49
1990	A	080800	Industry	Gasoline	0,1752	0,40	23,88	282,25	21,13	2592,92	12,79	0,23	0,02	2,17
1990	A	080800	Industry	LPG	1,1849	0,00	1573,62	173,10	9,11	124,23	74,76	4,14	0,25	5,80
1990	A	080900	Household and gardening	Gasoline	0,5351	1,22	34,24	1801,26	50,96	17606,46	39,06	0,62	0,04	11,10
1990	A	081100	Commercial and institutional	Gasoline	1,0098	2,31	69,51	2303,07	98,83	30181,04	73,72	1,10	0,08	24,24
1990	P	080501	Air traffic, Dom. < 3000 ft.	AvGas	0,0086	0,20	7,42	10,74	0,19	60,25	0,63	0,02	0,01	0,09
1990	P	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	0,5022	11,54	142,54	10,41	1,11	65,13	36,16	2,30		0,58
1990	P	080502	Air traffic, Int. < 3000 ft.	AvGas	0,0056	0,13	4,82	6,97	0,12	39,13	0,41	0,01	0,01	0,06
1990	P	080502	Air traffic, Int. < 3000 ft.	Jet fuel	2,0012	46,00	650,12	68,54	7,28	314,49	144,09	7,58		2,32
1990	P	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	1,3052	30,00	410,96	15,38	1,63	109,71	93,97	3,00		1,51
1990	P	080504	Air traffic, Int. > 3000 ft.	Jet fuel	20,33	467,36	5899,81	204,92	21,76	765,45	1463,78	46,74		23,58

2009 emissions for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year		SNAP ID	Category		Fuel type	Fuel	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
						PJ	tonnes	tonnes	tonnes	tonnes	tonnes	ktonnes	tonnes	tonnes	tonnes
2010	A	070101	Passenger cars	Highway	Diesel	6,4666	3,03	1841,97	38,27	0,73	82,38	478,45	13,03	3,19	89,98
2010	A	070101	Passenger cars	Highway	Gasoline	10,76	4,77	1307,36	303,95	28,45	6806,03	771,73	6,82	331,58	8,98
2010	A	070101	Passenger cars	Highway	LPG	9E-05	0,00	0,02	0,00	0,00	0,11	0,01	0,00	0,00	0,00
2010	A	070102	Passenger cars	Rural	Diesel	13,997	6,55	3386,42	119,91	3,13	343,79	1035,58	30,07	7,37	161,17
2010	A	070102	Passenger cars	Rural	Gasoline	23,492	10,42	2326,86	732,57	75,16	11448,93	1684,92	28,01	762,84	18,10
2010	A	070102	Passenger cars	Rural	LPG	0,0002	0,00	0,03	0,01	0,00	0,09	0,01	0,00	0,00	0,00
2010	A	070103	Passenger cars	Urban	Diesel	14,088	6,60	3420,03	374,30	8,72	921,12	1042,34	67,00	5,42	274,60
2010	A	070103	Passenger cars	Urban	Gasoline	26,01	11,54	3088,90	5649,29	227,80	61951,38	1865,53	57,20	265,19	21,35
2010	A	070103	Passenger cars	Urban	LPG	0,0002	0,00	0,02	0,02	0,00	0,15	0,01	0,00	0,00	0,00
2010	A	070201	Light duty vehicles	Highway	Diesel	3,7375	1,75	793,62	75,04	0,73	472,16	276,53	5,68	1,37	76,02
2010	A	070201	Light duty vehicles	Highway	Gasoline	0,3037	0,13	44,60	5,23	0,80	156,06	21,78	0,44	6,97	0,38
2010	A	070201	Light duty vehicles	Highway	LPG	0,0002	0,00	0,02	0,00	0,00	0,18	0,01	0,00	0,00	0,00
2010	A	070202	Light duty vehicles	Rural	Diesel	10,854	5,08	2408,59	246,66	4,89	1175,43	803,03	18,04	4,36	180,28
2010	A	070202	Light duty vehicles	Rural	Gasoline	1,0221	0,45	131,35	25,93	2,83	397,19	73,31	2,29	22,28	1,12
2010	A	070202	Light duty vehicles	Rural	LPG	0,0006	0,00	0,05	0,01	0,00	0,22	0,03	0,00	0,00	0,01
2010	A	070203	Light duty vehicles	Urban	Diesel	10,485	4,91	2237,06	433,33	10,21	1431,60	775,79	33,16	2,95	263,83
2010	A	070203	Light duty vehicles	Urban	Gasoline	1,2265	0,54	137,53	184,62	8,19	3728,99	87,97	4,71	6,76	0,93
2010	A	070203	Light duty vehicles	Urban	LPG	0,0005	0,00	0,03	0,02	0,00	0,24	0,03	0,00	0,00	0,01
2010	A	070301	Heavy duty vehicles	Highway	Diesel	10,936	5,12	5539,16	124,13	34,65	1487,02	809,14	35,19	3,52	91,61
2010	A	070301	Heavy duty vehicles	Highway	Gasoline	0,0285	0,01	29,55	13,52	0,28	216,72	2,04	0,02	0,01	1,58
2010	A	070302	Heavy duty vehicles	Rural	Diesel	18,166	8,51	9680,08	249,28	59,84	2390,59	1344,05	52,57	5,26	152,95
2010	A	070302	Heavy duty vehicles	Rural	Gasoline	0,0463	0,02	52,89	38,01	0,78	387,86	3,32	0,04	0,01	2,82
2010	A	070303	Heavy duty vehicles	Urban	Diesel	12,972	6,07	7552,31	225,52	55,65	1829,45	959,78	29,73	2,97	120,95
2010	A	070303	Heavy duty vehicles	Urban	Gasoline	0,0416	0,02	19,01	28,99	0,59	295,77	2,99	0,03	0,01	1,69
2010	A	070400	Mopeds	Urban	Gasoline	0,1794	0,08	25,71	1549,32	24,78	1668,71	12,87	0,23	0,23	24,45
2010	A	070501	Motorcycles	Highway	Gasoline	0,1358	0,06	36,68	112,21	13,84	1624,55	9,74	0,17	0,17	3,00
2010	A	070502	Motorcycles	Rural	Gasoline	0,2972	0,13	57,16	239,63	36,67	3324,58	21,31	0,46	0,46	8,00
2010	A	070503	Motorcycles	Urban	Gasoline	0,3565	0,16	42,31	351,93	45,18	3830,78	25,57	0,54	0,54	9,35
2010	A	080100	Military		AvGas	0,0062	0,14	5,32	7,69	0,14	43,15	0,45	0,01	0,01	0,06
2010	A	080100	Military		Diesel	0,5963	0,28	216,13	11,06	1,05	59,42	44,13	1,67	0,21	8,28
2010	A	080100	Military		Gasoline	0,0057	0,00	0,65	0,95	0,04	8,52	0,41	0,01	0,12	0,01
2010	A	080100	Military		Jet fuel	0,8618	19,81	215,95	21,49	2,28	198,12	62,05	1,98	0,00	1,00
2010	A	080200	Railways		Diesel	3,2728	1,53	2817,86	189,10	7,27	481,10	242,19	6,68	0,65	94,91
2010	A	080200	Railways		Gasoline	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2010	A	080300	Inland waterways		Diesel	1,0021	46,94	836,00	160,72	2,61	444,10	74,16	2,98	0,17	98,43

Continued														
2010	A	080300	Inland waterways	Gasoline	0,3458	0,16	185,55	406,67	21,66	4541,02	25,24	0,50	0,04	12,49
2010	A	080402	National sea traffic	Diesel	4,0709	190,67	3871,19	211,47	6,13	343,78	301,24	19,07	0,00	87,71
2010	A	080402	National sea traffic	Residual oil	2,4588	1202,35	4674,93	153,75	4,76	507,22	191,79	12,02		108,15
2010	A	080403	Fishing	Diesel	7,7679	363,84	10666,46	445,87	13,79	1470,92	574,83	36,38	0,00	167,38
2010	A	080403	Fishing	Gasoline	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2010	A	080404	International sea traffic	Diesel	11,356	531,89	17907,60	646,66	20,00	2133,32	840,33	53,19		244,68
2010	A	080404	International sea traffic	Residual oil	15,808	7730,14	33424,56	989,32	30,60	3263,74	1233,03	77,30		695,29
2010	A	080501	Air traffic, Dom. < 3000 ft.	AvGas	0,0682	1,56	58,62	84,80	1,49	475,78	4,98	0,14	0,11	0,68
2010	A	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	0,2571	5,91	73,26	3,26	0,35	34,93	18,51	2,73		0,30
2010	A	080502	Air traffic, Int. < 3000 ft.	AvGas	0,0007	0,01	0,56	0,81	0,01	4,54	0,05	0,00	0,00	0,01
2010	A	080502	Air traffic, Int. < 3000 ft.	Jet fuel	0,3084	7,09	92,59	6,58	0,70	53,14	22,21	2,29		0,36
2010	A	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	0,5834	13,41	151,48	4,95	0,53	62,52	42,00	1,34		0,68
2010	A	080504	Air traffic, Int. > 3000 ft.	Jet fuel	3,4263	78,77	818,13	20,77	2,21	171,92	246,69	7,88		3,97
2010	A	080600	Agriculture	Diesel	16,708	39,13	9977,82	961,34	15,63	5673,29	1236,39	53,02	3,03	763,57
2010	A	080600	Agriculture	Gasoline	0,501	0,23	55,73	600,29	80,39	10941,16	36,57	0,86	0,76	15,62
2010	A	080700	Forestry	Diesel	0,1591	0,37	65,32	4,86	0,08	39,08	11,77	0,51	0,03	4,34
2010	A	080700	Forestry	Gasoline	0,0714	0,03	4,69	361,53	2,92	1255,55	5,21	0,03	0,01	5,76
2010	A	080800	Industry	Diesel	13,015	30,48	7199,37	788,73	12,82	4167,94	963,14	40,30	2,30	678,64
2010	A	080800	Industry	Gasoline	0,1567	0,07	32,75	240,60	17,04	2174,38	11,44	0,23	0,02	2,77
2010	A	080800	Industry	LPG	0,9849	0,00	1308,04	143,88	7,57	103,27	62,15	3,44	0,21	4,82
2010	A	080900	Household and gardening	Gasoline	0,86	0,39	86,56	2032,41	65,22	25616,27	62,78	1,08	0,08	14,38
2010	A	081100	Commercial and institutional	Gasoline	2,3683	1,08	217,44	4423,32	159,55	72338,05	172,88	2,65	0,21	66,75
2010	P	080501	Air traffic, Dom. < 3000 ft.	AvGas	0,0005	0,01	0,47	0,68	0,01	3,81	0,04	0,00	0,00	0,01
2010	P	080501	Air traffic, Dom. < 3000 ft.	Jet fuel	0,2971	6,83	82,55	4,33	0,46	54,01	21,39	2,08		0,34
2010	P	080502	Air traffic, Int. < 3000 ft.	AvGas	9E-05	0,00	0,08	0,12	0,00	0,66	0,01	0,00	0,00	0,00
2010	P	080502	Air traffic, Int. < 3000 ft.	Jet fuel	2,5457	58,52	857,57	82,06	8,71	609,82	183,29	10,09	0,00	2,95
2010	P	080503	Air traffic, Dom. > 3000 ft.	Jet fuel	0,954	21,93	256,68	11,05	1,17	57,18	68,68	2,19	0,00	1,11
2010	P	080504	Air traffic, Int. > 3000 ft.	Jet fuel	27,343	628,57	8340,59	257,10	27,30	875,66	1968,68	62,86	0,00	31,72

Annex 3B-16: Fuel consumption and emissions in CRF format

Fuel

IPCC ID	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry-Other (1A2f)	11,7	11,7	11,6	11,6	11,6	11,5	11,5	11,5	11,5	11,5	11,6	11,7	11,7	11,9	11,9
Civil Aviation (1A3a)	3,6	3,3	3,7	3,8	3,6	3,4	2,8	2,7	2,6	2,7	2,8	2,8	2,9	2,7	2,4
Road (1A3b)	111,2	117,5	117,7	118,4	119,7	126,3	132,0	134,4	136,1	142,9	144,2	146,6	149,5	152,0	154,0
Railways (1A3c)	4,9	4,9	4,4	4,6	4,2	4,0	4,1	4,3	4,5	4,1	4,1	4,1	4,0	3,3	3,1
Navigation (1A3d)	10,4	10,3	10,4	10,4	10,5	10,5	10,6	10,9	10,7	10,8	11,3	12,2	12,0	10,0	8,8
Comm./Inst. (1A4a)	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,1	1,1	1,1	1,1	1,2
Residential (1A4b)	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,6	0,6	0,6
Ag./for./fish. (1A4c)	24,4	26,0	23,8	25,5	25,3	25,7	25,7	24,3	23,8	22,9	23,4	22,2	21,0	20,4	21,1
Military (1A5)	5,5	4,3	5,0	2,7	2,3	1,6	3,9	1,9	3,3	3,5	3,4	2,4	2,3	2,8	2,5
Navigation int. (1A3d)	16,2	19,0	28,4	36,2	37,1	39,1	34,9	36,7	55,0	62,0	65,1	62,0	56,7	57,2	53,3
Civil Aviation int. (1A3a)	19,3	20,9	22,4	24,0	25,1	24,1	22,7	23,5	23,0	25,2	25,9	27,4	27,9	30,0	31,8

IPCC ID	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Industry-Other (1A2f)	12,0	12,1	12,3	12,4	12,5	13,0	13,9	14,8	15,1	11,2	14,2
Civil Aviation (1A3a)	2,1	2,3	2,0	1,9	1,8	1,9	2,0	2,2	2,2	2,1	2,2
Road (1A3b)	152,5	152,8	154,5	160,6	164,8	166,1	171,3	179,5	176,0	165,5	165,6
Railways (1A3c)	3,1	2,9	2,8	3,0	2,9	3,1	3,1	3,1	3,2	3,1	3,3
Navigation (1A3d)	7,9	7,9	7,7	7,7	7,9	7,8	7,8	7,8	7,9	8,0	7,9
Comm./Inst. (1A4a)	1,2	1,3	1,5	1,8	2,0	2,2	2,4	2,4	2,4	2,4	2,4
Residential (1A4b)	0,6	0,6	0,7	0,7	0,8	0,8	0,8	0,9	0,9	0,9	0,9
Ag./for./fish. (1A4c)	21,8	23,9	24,2	23,9	22,2	23,8	23,7	23,3	25,2	24,8	25,2
Military (1A5)	1,5	1,3	1,2	1,3	3,3	3,7	1,7	2,4	1,5	2,2	1,5
Navigation int. (1A3d)	54,6	43,3	35,5	37,5	30,2	30,7	40,8	42,7	36,6	19,6	27,2
Civil Aviation int. (1A3a)	32,6	33,1	28,6	29,7	34,0	35,7	35,9	36,8	36,8	32,2	33,6

Emissions 1985-1999

pol_name	IPCC ID	Unit	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SO_2	Industry-Other (1A2f)	[tonnes]	2402	1441	1440	1438	956	952	955	957	957	959	968	244	246	249	251
SO_2	Civil Aviation (1A3a)	[tonnes]	82	77	85	86	83	77	64	62	61	63	63	65	68	62	56
SO_2	Road (1A3b)	[tonnes]	11621	7862	7847	7857	5488	5767	5903	3820	1569	1669	1682	1721	1744	1768	1088
SO_2	Railways (1A3c)	[tonnes]	1152	695	618	641	393	376	382	263	105	95	96	95	93	78	40
SO_2	Navigation (1A3d)	[tonnes]	7480	7480	7484	7228	7231	6429	5111	3506	4410	4974	5588	4400	3650	2283	2051
SO_2	Comm./Inst. (1A4a)	[tonnes]	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
SO_2	Residential (1A4b)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SO_2	Ag./for./fish. (1A4c)	[tonnes]	4766	3484	3173	3073	2269	2303	2317	2186	2150	2072	2120	978	853	856	931
SO_2	Military (1A5)	[tonnes]	408	260	193	72	70	48	206	82	76	80	80	56	54	65	47
SO_2	Navigation int. (1A3d)	[tonnes]	17037	20752	35647	46755	47058	41317	33277	30084	58492	58965	65049	61075	55822	46756	49282
SO_2	Civil Aviation int. (1A3a)	[tonnes]	444	480	515	551	578	554	521	541	530	580	596	629	642	689	731
NO_x	Industry-Other (1A2f)	[tonnes]	10903	10964	11011	11044	11065	11081	11282	11440	11558	11677	11882	12080	12248	12425	12262
NO_x	Civil Aviation (1A3a)	[tonnes]	1203	1132	1237	1252	1208	1123	920	902	900	940	958	971	998	911	815
NO_x	Road (1A3b)	[tonnes]	91119	96521	97055	98447	99900	105699	108255	106166	103124	102335	96825	92346	88420	84227	80661
NO_x	Railways (1A3c)	[tonnes]	6025	6063	5391	5589	5145	4913	4995	5284	5485	4971	5015	4977	4846	4089	3730
NO_x	Navigation (1A3d)	[tonnes]	13299	13339	13414	13486	13568	13649	13180	12882	12753	12999	13679	14757	13544	11175	8720
NO_x	Comm./Inst. (1A4a)	[tonnes]	66	67	68	70	70	70	75	80	85	89	93	95	98	101	102
NO_x	Residential (1A4b)	[tonnes]	31	32	33	34	34	34	36	38	40	42	43	45	46	48	49
NO_x	Ag./for./fish. (1A4c)	[tonnes]	18159	19915	18153	20143	20342	21066	21722	20824	20763	20524	21442	21138	20176	20119	21495
NO_x	Military (1A5)	[tonnes]	2353	2026	1627	992	882	495	1864	1014	1296	1279	1760	958	1197	1386	1074
NO_x	Navigation int. (1A3d)	[tonnes]	22455	26921	42068	54983	56940	60639	53939	55808	87852	99296	105113	100507	93239	92360	89143
NO_x	Civil Aviation int. (1A3a)	[tonnes]	5663	6129	6569	7035	7313	7016	6586	6846	6702	7317	7517	7904	8058	8662	9204
NMVOC	Industry-Other (1A2f)	[tonnes]	2422	2395	2368	2339	2304	2266	2231	2191	2147	2107	2088	2095	2083	2074	1997
NMVOC	Civil Aviation (1A3a)	[tonnes]	216	213	190	198	193	186	168	164	161	191	206	194	186	169	162
NMVOC	Road (1A3b)	[tonnes]	78978	78883	78290	78014	76340	79934	82122	80556	77271	73332	68005	63344	58165	52763	46410
NMVOC	Railways (1A3c)	[tonnes]	393	396	352	365	336	321	326	345	358	324	327	325	316	267	276
NMVOC	Navigation (1A3d)	[tonnes]	1560	1560	1592	1622	1654	1686	1719	1761	1786	1820	1879	1975	1969	1873	1776
NMVOC	Comm./Inst. (1A4a)	[tonnes]	2347	2333	2318	2303	2303	2303	2314	2302	2265	2285	2367	2458	2547	2636	2741
NMVOC	Residential (1A4b)	[tonnes]	1844	1833	1821	1809	1805	1801	1797	1792	1789	1785	1780	1774	1767	1759	1758
NMVOC	Ag./for./fish. (1A4c)	[tonnes]	6357	6417	6216	6284	6207	6149	5777	5298	4944	4638	4516	4208	3966	3691	3563
NMVOC	Military (1A5)	[tonnes]	587	457	172	483	309	53	162	87	122	119	148	90	103	114	105
NMVOC	Navigation int. (1A3d)	[tonnes]	825	974	1472	1892	1947	2060	1839	1928	2933	3318	3501	3343	3082	3102	2929
NMVOC	Civil Aviation int. (1A3a)	[tonnes]	261	288	313	342	361	331	309	316	309	308	343	360	365	386	395
CH_4	Industry-Other (1A2f)	[tonnes]	63	63	62	61	61	60	58	57	56	54	53	53	53	53	51

Continued

CH_4	Civil Aviation (1A3a)	[tonnes]	8	8	8	8	8	7	6	6	6	7	7	7	7	7	6
CH_4	Road (1A3b)	[tonnes]	2281	2341	2357	2382	2375	2518	2605	2590	2544	2489	2359	2245	2147	2047	1919
CH_4	Railways (1A3c)	[tonnes]	15	15	14	14	13	12	13	13	14	12	13	12	12	10	11
CH_4	Navigation (1A3d)	[tonnes]	30	30	31	31	32	32	33	34	34	35	36	38	38	35	34
CH_4	Comm./Inst. (1A4a)	[tonnes]	104	102	100	99	99	99	97	95	92	90	89	89	89	89	90
CH_4	Residential (1A4b)	[tonnes]	55	54	53	52	51	51	50	49	48	48	47	46	45	45	45
CH_4	Ag./for./fish. (1A4c)	[tonnes]	155	154	147	146	142	139	132	123	116	110	106	100	94	89	88
CH_4	Military (1A5)	[tonnes]	30	25	17	18	13	5	18	10	13	13	18	10	12	14	11
CH_4	Navigation int. (1A3d)	[tonnes]	26	30	46	59	60	64	57	60	91	103	108	103	95	96	91
CH_4	Civil Aviation int. (1A3a)	[tonnes]	25	27	30	32	33	31	29	30	29	31	35	37	38	40	41
CO	Industry-Other (1A2f)	[tonnes]	9863	9784	9702	9611	9502	9379	9294	9188	9070	8956	8910	8963	8939	8907	8647
CO	Civil Aviation (1A3a)	[tonnes]	1256	1241	1118	1167	1140	1098	989	955	930	1098	1180	1117	1085	973	932
CO	Road (1A3b)	[tonnes]	565567	539748	515504	478371	446637	455048	472022	455058	440529	410153	387606	374781	337823	314697	278038
CO	Railways (1A3c)	[tonnes]	1098	1105	982	1018	937	895	910	963	999	906	914	907	883	745	717
CO	Navigation (1A3d)	[tonnes]	5472	5473	5636	5797	5962	6126	6297	6491	6623	6805	7057	7246	7150	6983	6779
CO	Comm./Inst. (1A4a)	[tonnes]	31348	30972	30583	30181	30181	30181	29610	28987	28319	27809	27575	27800	28012	28211	28817
CO	Residential (1A4b)	[tonnes]	19086	18725	18352	17968	17789	17606	17238	16880	16708	16556	16422	16311	16217	16136	16286
CO	Ag./for./fish. (1A4c)	[tonnes]	61165	59707	57256	55768	53717	51734	48771	45427	42608	39735	37673	34858	32455	29823	27820
CO	Military (1A5)	[tonnes]	4171	3074	1306	3133	1936	423	1001	507	841	865	876	613	590	669	675
CO	Navigation int. (1A3d)	[tonnes]	2722	3214	4855	6243	6424	6796	6065	6361	9677	10946	11548	11030	10168	10233	9662
CO	Civil Aviation int. (1A3a)	[tonnes]	1103	1207	1289	1416	1564	1442	1357	1399	1388	1342	1421	1502	1564	1662	1743
CO_2	Industry-Other (1A2f)	[ktonnes]	850	849	848	846	843	839	841	841	839	839	846	851	858	865	871
CO_2	Civil Aviation (1A3a)	[ktonnes]	256	241	268	271	262	243	199	193	190	196	199	205	212	194	174
CO_2	Road (1A3b)	[ktonnes]	8165	8631	8642	8700	8795	9282	9697	9870	9995	10491	10588	10766	10978	11167	11312
CO_2	Railways (1A3c)	[ktonnes]	364	366	326	338	311	297	302	319	331	300	303	301	293	247	232
CO_2	Navigation (1A3d)	[ktonnes]	784	784	787	790	793	796	803	817	803	814	850	917	898	745	655
CO_2	Comm./Inst. (1A4a)	[ktonnes]	74	74	74	74	74	74	74	75	75	77	78	80	81	83	85
CO_2	Residential (1A4b)	[ktonnes]	40	40	39	39	39	39	39	39	39	39	40	40	41	41	42
CO_2	Ag./for./fish. (1A4c)	[ktonnes]	1806	1922	1758	1887	1874	1899	1903	1794	1760	1695	1728	1642	1554	1510	1564
CO_2	Military (1A5)	[ktonnes]	402	316	361	196	165	119	287	141	237	252	252	176	171	204	182
CO_2	Navigation int. (1A3d)	[ktonnes]	1238	1454	2179	2786	2854	3005	2673	2797	4214	4744	4976	4725	4326	4337	4053
CO_2	Civil Aviation int. (1A3a)	[ktonnes]	1391	1503	1613	1725	1809	1736	1632	1693	1659	1818	1867	1971	2010	2159	2290
N_2O	Industry-Other (1A2f)	[tonnes]	34	34	34	34	34	34	34	35	35	35	35	36	36	36	37
N_2O	Civil Aviation (1A3a)	[tonnes]	10	10	11	11	11	10	9	9	9	9	10	11	11	9	9
N_2O	Road (1A3b)	[tonnes]	267	280	280	283	285	299	318	338	352	383	405	426	446	451	455

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N_2O	Railways (1A3c)	[tonnes]	10	10	9	9	9	8	8	9	9	8	8	8	8	7	6
N_2O	Navigation (1A3d)	[tonnes]	48	48	48	48	48	48	49	50	49	49	51	55	54	44	39
N_2O	Comm./Inst. (1A4a)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
N_2O	Residential (1A4b)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
N_2O	Ag./for./fish. (1A4c)	[tonnes]	81	87	78	85	85	87	88	83	81	79	81	77	71	70	74
N_2O	Military (1A5)	[tonnes]	12	9	11	6	5	4	8	4	7	8	7	5	5	6	6
N_2O	Navigation int. (1A3d)	[tonnes]	78	92	137	175	179	189	168	176	265	298	313	297	272	273	255
N_2O	Civil Aviation int. (1A3a)	[tonnes]	47	50	54	58	61	59	56	58	57	63	64	69	70	75	80
NH_3	Industry-Other (1A2f)	[tonnes]	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
NH_3	Civil Aviation (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tonnes]	61	64	64	66	66	70	183	415	635	948	1244	1511	1886	2278	2575
NH_3	Railways (1A3c)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Comm./Inst. (1A4a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tonnes]	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
NH_3	Military (1A5)	[tonnes]	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1
NH_3	Navigation int. (1A3d)	[tonnes]		0						0	0						
NH_3	Civil Aviation int. (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
TSP	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
TSP	Road (1A3b)	[tonnes]	4307	4659	4675	4589	4641	4867	5014	4817	4794	4887	4671	4451	4023	3666	3348
TSP	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
TSP	Navigation (1A3d)	[tonnes]	1099	1099	1103	1098	1103	898	710	519	660	762	919	723	670	451	417
TSP	Comm./Inst. (1A4a)	[tonnes]	24	24	24	24	24	24	24	23	22	23	24	25	27	28	29
TSP	Residential (1A4b)	[tonnes]	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11
TSP	Ag./for./fish. (1A4c)	[tonnes]	2783	2820	2673	2723	2665	2628	2534	2362	2300	2119	2087	1892	1783	1633	1576
TSP	Military (1A5)	[tonnes]	100	100	49	18	26	11	112	66	62	54	114	44	70	73	44
TSP	Navigation int. (1A3d)	[tonnes]	2832	3448	5914	7810	7866	5531	4371	3999	8648	8194	10076	9968	9231	7717	8177
TSP	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
PM_{10}	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
PM_{10}	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
PM_{10}	Road (1A3b)	[tonnes]	4307	4659	4675	4589	4641	4867	5014	4817	4794	4887	4671	4451	4023	3666	3348
PM_{10}	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
PM_{10}	Navigation (1A3d)	[tonnes]	1089	1089	1093	1088	1093	890	704	515	655	756	911	717	664	448	414

Continued

PM_{10}	Comm./Inst. (1A4a)	[tonnes]	24	24	24	24	24	24	24	23	22	23	24	25	27	28	29
PM_{10}	Residential (1A4b)	[tonnes]	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11
PM_{10}	Ag./for./fish. (1A4c)	[tonnes]	2781	2818	2671	2721	2663	2626	2532	2360	2298	2117	2086	1891	1782	1632	1575
PM_{10}	Military (1A5)	[tonnes]	100	100	49	18	26	11	112	66	62	54	114	44	70	73	44
PM_{10}	Navigation int. (1A3d)	[tonnes]	2803	3413	5855	7732	7788	5476	4327	3959	8561	8112	9975	9869	9139	7639	8095
PM_{10}	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
$PM_{2.5}$	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
$PM_{2.5}$	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
$PM_{2.5}$	Road (1A3b)	[tonnes]	4307	4659	4675	4589	4641	4867	5014	4817	4794	4887	4671	4451	4023	3666	3348
$PM_{2.5}$	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
$PM_{2.5}$	Navigation (1A3d)	[tonnes]	1084	1084	1088	1083	1088	886	701	513	652	753	907	714	662	446	413
$PM_{2.5}$	Comm./Inst. (1A4a)	[tonnes]	24	24	24	24	24	24	24	23	22	23	24	25	27	28	29
$PM_{2.5}$	Residential (1A4b)	[tonnes]	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11
$PM_{2.5}$	Ag./for./fish. (1A4c)	[tonnes]	2780	2817	2670	2720	2662	2625	2531	2359	2297	2116	2085	1890	1781	1631	1574
$PM_{2.5}$	Military (1A5)	[tonnes]	100	100	49	18	26	11	112	66	62	54	114	44	70	73	44
$PM_{2.5}$	Navigation int. (1A3d)	[tonnes]	2789	3396	5825	7693	7748	5448	4305	3939	8518	8071	9925	9819	9093	7601	8054
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
Arsenic	Industry-Other (1A2f)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Civil Aviation (1A3a)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Road (1A3b)	[kg]						1	1	1	1	1	1	1	1	1	1
Arsenic	Railways (1A3c)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Navigation (1A3d)	[kg]						62	55	47	47	49	50	44	36	28	25
Arsenic	Comm./Inst. (1A4a)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Residential (1A4b)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Ag./for./fish. (1A4c)	[kg]						9	10	9	8	8	8	8	6	7	7
Arsenic	Military (1A5)	[kg]						0	0	0	0	0	0	0	0	0	0
Arsenic	Navigation int. (1A3d)	[kg]						353	292	267	465	496	505	325	417	357	369
Arsenic	Civil Aviation int. (1A3a)	[kg]						0	0	0	0	0	0	0	0	0	0
Cadmium	Industry-Other (1A2f)	[kg]						2	2	2	2	2	2	2	2	2	2
Cadmium	Civil Aviation (1A3a)	[kg]						0	0	0	0	0	0	0	0	0	0
Cadmium	Road (1A3b)	[kg]						26	27	28	29	30	30	31	31	32	32
Cadmium	Railways (1A3c)	[kg]						1	1	1	1	1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]						5	4	4	4	4	4	4	4	3	3
Cadmium	Comm./Inst. (1A4a)	[kg]						0	0	0	0	0	0	0	0	0	0
Cadmium	Residential (1A4b)	[kg]						0	0	0	0	0	0	0	0	0	0

Continued												
Cadmium	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	4	4	4	4
Cadmium	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0
Cadmium	Navigation int. (1A3d)	[kg]	23	20	19	31	34	35	20	29	26	26
Cadmium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Chromium	Industry-Other (1A2f)	[kg]	7	7	7	7	7	7	7	7	7	7
Chromium	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Chromium	Road (1A3b)	[kg]	60	63	63	64	67	68	69	71	72	73
Chromium	Railways (1A3c)	[kg]	3	3	3	3	3	3	3	3	2	2
Chromium	Navigation (1A3d)	[kg]	28	25	23	22	23	24	22	19	15	14
Chromium	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Chromium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Chromium	Ag./for./fish. (1A4c)	[kg]	19	19	18	17	17	17	16	15	15	16
Chromium	Military (1A5)	[kg]	0	1	1	1	1	1	0	1	1	1
Chromium	Navigation int. (1A3d)	[kg]	147	123	115	195	210	214	131	178	157	160
Chromium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Copper	Industry-Other (1A2f)	[kg]	5	5	5	5	5	5	6	6	6	6
Copper	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Copper	Road (1A3b)	[kg]	88	92	96	98	102	103	104	107	109	109
Copper	Railways (1A3c)	[kg]	2	2	2	2	2	2	2	2	2	1
Copper	Navigation (1A3d)	[kg]	63	56	48	47	49	50	45	36	29	26
Copper	Comm./Inst. (1A4a)	[kg]	1	1	1	1	1	1	1	1	1	1
Copper	Residential (1A4b)	[kg]	1	1	1	1	1	1	1	1	1	1
Copper	Ag./for./fish. (1A4c)	[kg]	18	18	17	16	16	16	17	14	14	15
Copper	Military (1A5)	[kg]	0	1	0	0	0	1	0	1	1	0
Copper	Navigation int. (1A3d)	[kg]	353	292	267	465	496	505	325	417	357	369
Copper	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Mercury	Industry-Other (1A2f)	[kg]	1	1	1	1	1	1	1	1	1	1
Mercury	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Mercury	Road (1A3b)	[kg]	21	22	22	23	24	24	24	25	25	25
Mercury	Railways (1A3c)	[kg]	0	1	1	1	1	1	1	0	0	0
Mercury	Navigation (1A3d)	[kg]	9	9	10	9	10	10	11	12	10	8
Mercury	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Mercury	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Mercury	Ag./for./fish. (1A4c)	[kg]	12	12	11	10	10	10	10	8	8	9
Mercury	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0

Continued												
Mercury	Navigation int. (1A3d)	[kg]	27	25	29	40	47	50	14	45	49	43
Mercury	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Nickel	Industry-Other (1A2f)	[kg]	2	2	2	2	2	2	2	2	2	2
Nickel	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Nickel	Road (1A3b)	[kg]	29	31	32	32	34	34	35	36	36	37
Nickel	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1
Nickel	Navigation (1A3d)	[kg]	3362	2889	2360	2359	2477	2492	2087	1520	1179	1077
Nickel	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Nickel	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Nickel	Ag./for./fish. (1A4c)	[kg]	16	17	16	15	15	15	14	12	12	13
Nickel	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0
Nickel	Navigation int. (1A3d)	[kg]	20420	16701	14894	26627	28129	28488	19451	23291	19285	20431
Nickel	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Lead	Industry-Other (1A2f)	[kg]	12	12	12	12	12	12	12	12	12	12
Lead	Civil Aviation (1A3a)	[kg]	1534	1423	1378	1328	1639	1788	1640	1559	1399	1387
Lead	Road (1A3b)	[kg]	97617	75968	68889	29932	123	125	126	129	131	133
Lead	Railways (1A3c)	[kg]	4	5	5	5	5	5	5	4	4	4
Lead	Navigation (1A3d)	[kg]	35	34	33	32	33	34	35	32	26	23
Lead	Comm./Inst. (1A4a)	[kg]	1	1	1	1	1	1	1	1	1	1
Lead	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Lead	Ag./for./fish. (1A4c)	[kg]	38	38	36	35	34	35	33	30	29	31
Lead	Military (1A5)	[kg]	63	81	62	121	86	104	99	125	118	79
Lead	Navigation int. (1A3d)	[kg]	162	140	138	221	243	251	132	214	201	196
Lead	Civil Aviation int. (1A3a)	[kg]	490	465	452	456	153	175	126	145	145	124
Selenium	Industry-Other (1A2f)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Road (1A3b)	[kg]	0	0	0	0	1	1	1	1	1	1
Selenium	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Navigation (1A3d)	[kg]	69	67	64	63	64	66	67	62	50	43
Selenium	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Ag./for./fish. (1A4c)	[kg]	37	38	35	33	33	33	32	25	26	30
Selenium	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Navigation int. (1A3d)	[kg]	325	279	275	442	486	503	264	427	402	391
Selenium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0

Continued												
Zinc	Industry-Other (1A2f)	[kg]	419	420	420	419	419	422	425	428	432	435
Zinc	Civil Aviation (1A3a)	[kg]	6	5	5	5	6	7	6	6	5	5
Zinc	Road (1A3b)	[kg]	5196	5460	5628	5723	6002	6072	6123	6267	6372	6449
Zinc	Railways (1A3c)	[kg]	150	152	161	167	151	153	152	148	124	117
Zinc	Navigation (1A3d)	[kg]	191	187	184	183	188	195	202	193	165	151
Zinc	Comm./Inst. (1A4a)	[kg]	51	51	52	52	53	54	55	56	57	59
Zinc	Residential (1A4b)	[kg]	27	27	27	27	27	27	28	28	28	29
Zinc	Ag./for./fish. (1A4c)	[kg]	766	762	724	717	683	698	664	655	626	632
Zinc	Military (1A5)	[kg]	6	62	37	34	30	67	27	49	57	39
Zinc	Navigation int. (1A3d)	[kg]	744	643	638	1017	1121	1162	595	991	940	910
Zinc	Civil Aviation int. (1A3a)	[kg]	2	2	2	2	1	1	0	1	1	0
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	1	1	1	1	1	1	1	1	0	0
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Comm./Inst. (1A4a)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	0	0	1	1	1	1	1	1	1
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	45	44	45	46	45	46	46	46	46	46
Flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	1	1	1	0	0	0
Flouranthene	Road (1A3b)	[kg]	813	833	813	789	773	723	680	652	621	599
Flouranthene	Railways (1A3c)	[kg]	5	5	6	6	6	6	6	6	5	4
Flouranthene	Navigation (1A3d)	[kg]	66	68	71	70	70	74	82	82	67	58
Flouranthene	Comm./Inst. (1A4a)	[kg]	4	4	4	4	5	5	5	5	5	5
Flouranthene	Residential (1A4b)	[kg]	2	2	2	2	2	2	2	2	2	2
Flouranthene	Ag./for./fish. (1A4c)	[kg]	136	135	128	127	121	124	117	107	104	110
Flouranthene	Military (1A5)	[kg]	1	7	4	4	3	8	3	6	6	4
Flouranthene	Navigation int. (1A3d)	[kg]	198	184	205	288	334	355	344	316	338	304
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	6	6	6	6
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0

Continued												
Benzo(b) flouranthene	Road (1A3b)	[kg]	66	68	67	66	67	65	63	62	61	60
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	2	1	1	1	1	1	1
Benzo(b) flouranthene	Navigation (1A3d)	[kg]	5	5	6	5	5	6	7	7	6	5
Benzo(b) flouranthene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	15	15	14	14	13	13	13	12	11	12
Benzo(b) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	1
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	13	12	15	19	23	25	24	22	25	22
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	6	6	6	6
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	66	68	68	67	69	69	69	68	68	68
Benzo(k) flouranthene	Railways (1A3c)	[kg]	2	2	2	2	2	2	2	2	1	1
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	2	2	2	2	2	3	3	3	3	2
Benzo(k) flouranthene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	12	12	11	11	11	11	10	10	9	9
Benzo(k) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	1
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	6	6	7	9	11	11	11	10	12	10
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Road (1A3b)	[kg]	47	48	48	47	48	46	44	44	43	43
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	1	1	1	1	1	2	2	1	1
Benzo(a) pyrene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	6	6	6	6	5	5	5	5	5	5
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	1	0	0	0	0
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	4	3	4	5	6	7	6	6	6	6
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	6	6	6	6	5	6	5	5	5	5
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	99	102	101	99	99	94	90	88	86	84
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0

Continued												
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	8	9	11	10	10	11	13	14	11	10
Benzo(g,h,i) perylene	Comm./Inst. (1A4a)	[kg]	1	1	1	1	1	1	1	1	1	1
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	21	21	20	19	19	19	18	16	15	16
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	0
Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]	23	23	29	36	44	48	48	44	51	44
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]	45	46	47	47	48	47	47	47	47	48
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]	7	7	8	8	8	9	10	11	9	8
indeno(1,2,3-c,d) pyrene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]	14	15	14	13	13	13	12	11	11	11
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]	0	0	0	0	0	1	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]	19	19	23	29	36	39	39	36	42	36
indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0

Emissions 2000-2010

pol_name	IPCC ID	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SO_2	Industry-Other (1A2f)	[tonnes]	253	256	258	261	263	28	30	32	33	24	31
SO_2	Civil Aviation (1A3a)	[tonnes]	49	52	45	44	41	43	46	51	52	49	50
SO_2	Road (1A3b)	[tonnes]	352	353	357	371	381	77	79	83	81	76	76
SO_2	Railways (1A3c)	[tonnes]	7	7	7	7	7	1	1	1	1	1	2
SO_2	Navigation (1A3d)	[tonnes]	1844	1733	1582	1984	2319	2339	2431	1686	1510	1593	1440
SO_2	Comm./Inst. (1A4a)	[tonnes]	3	3	4	4	5	1	1	1	1	1	1
SO_2	Residential (1A4b)	[tonnes]	1	1	2	2	2	0	0	0	0	0	0
SO_2	Ag./for./fish. (1A4c)	[tonnes]	1021	1209	1236	1203	1022	852	800	690	419	392	404
SO_2	Military (1A5)	[tonnes]	27	12	19	17	46	57	26	40	19	25	20
SO_2	Navigation int. (1A3d)	[tonnes]	55367	43830	30036	30982	26540	34283	50417	25652	19326	7383	8262
SO_2	Civil Aviation int. (1A3a)	[tonnes]	750	761	657	683	781	822	824	845	845	740	773
NO_x	Industry-Other (1A2f)	[tonnes]	12096	11869	11617	11214	10744	10664	10807	10667	9978	7137	8540
NO_x	Civil Aviation (1A3a)	[tonnes]	723	752	641	595	551	583	602	693	697	635	623
NO_x	Road (1A3b)	[tonnes]	75869	73599	70472	69474	67595	64224	62738	60801	53858	46103	44159
NO_x	Railways (1A3c)	[tonnes]	3727	3396	3396	3540	3478	3724	3542	3555	2920	2603	2818
NO_x	Navigation (1A3d)	[tonnes]	8087	8197	8315	8443	8469	8634	8979	9057	9316	9534	9582
NO_x	Comm./Inst. (1A4a)	[tonnes]	104	112	124	138	155	177	199	215	222	220	217
NO_x	Residential (1A4b)	[tonnes]	50	54	59	64	69	72	76	79	82	84	87
NO_x	Ag./for./fish. (1A4c)	[tonnes]	22807	25787	26036	25286	22447	24009	22832	20889	22027	20790	20770
NO_x	Military (1A5)	[tonnes]	544	670	465	511	1252	1287	597	752	477	696	438
NO_x	Navigation int. (1A3d)	[tonnes]	94441	75429	60383	65339	53439	56540	78012	83555	70401	35658	51332
NO_x	Civil Aviation int. (1A3a)	[tonnes]	9446	9600	8724	9084	10472	11025	11158	11402	11292	9843	10110
NMVOC	Industry-Other (1A2f)	[tonnes]	1926	1873	1815	1754	1676	1620	1583	1498	1357	976	1173
NMVOC	Civil Aviation (1A3a)	[tonnes]	156	155	151	144	158	165	156	164	146	125	109
NMVOC	Road (1A3b)	[tonnes]	39079	35477	32024	29492	25642	23365	20509	18046	15951	13751	12514
NMVOC	Railways (1A3c)	[tonnes]	253	248	243	223	217	235	230	231	205	174	189
NMVOC	Navigation (1A3d)	[tonnes]	1731	1702	1661	1602	1534	1423	1305	1190	1096	1013	937
NMVOC	Comm./Inst. (1A4a)	[tonnes]	2845	3504	4188	4897	5631	5775	5922	6022	5844	5159	4423
NMVOC	Residential (1A4b)	[tonnes]	1757	1824	1894	1972	2053	2084	2115	2134	2109	2071	2032
NMVOC	Ag./for./fish. (1A4c)	[tonnes]	3414	3378	3199	2987	2698	2712	2662	2598	2631	2504	2374
NMVOC	Military (1A5)	[tonnes]	55	53	45	45	100	106	51	68	40	56	41
NMVOC	Navigation int. (1A3d)	[tonnes]	3045	2433	1989	2130	1731	1792	2418	2563	2195	1160	1636
NMVOC	Civil Aviation int. (1A3a)	[tonnes]	407	404	388	397	448	460	469	472	456	383	367
CH_4	Industry-Other (1A2f)	[tonnes]	50	49	48	47	46	45	44	43	40	30	37

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CH_4	Civil Aviation (1A3a)	[tonnes]	5	6	5	5	6	7	6	7	6	5	4
CH_4	Road (1A3b)	[tonnes]	1783	1664	1549	1465	1359	1237	1139	1025	869	723	644
CH_4	Railways (1A3c)	[tonnes]	10	10	9	9	8	9	9	9	8	7	7
CH_4	Navigation (1A3d)	[tonnes]	33	33	34	34	35	35	35	35	35	35	35
CH_4	Comm./Inst. (1A4a)	[tonnes]	92	101	113	127	144	157	169	175	174	167	160
CH_4	Residential (1A4b)	[tonnes]	45	48	51	55	60	62	64	65	66	66	65
CH_4	Ag./for./fish. (1A4c)	[tonnes]	88	90	90	89	85	90	97	104	111	114	113
CH_4	Military (1A5)	[tonnes]	6	6	5	5	12	12	6	7	4	5	4
CH_4	Navigation int. (1A3d)	[tonnes]	94	75	62	66	54	55	75	79	68	36	51
CH_4	Civil Aviation int. (1A3a)	[tonnes]	42	42	40	41	47	48	50	50	48	40	39
CO	Industry-Other (1A2f)	[tonnes]	8395	8227	8030	7842	7600	7497	7515	7383	7010	5123	6446
CO	Civil Aviation (1A3a)	[tonnes]	895	891	863	835	858	861	842	902	823	717	688
CO	Road (1A3b)	[tonnes]	253738	242858	222559	212885	188134	179761	160030	142838	129890	113046	105972
CO	Railways (1A3c)	[tonnes]	694	637	627	611	599	648	626	629	526	450	481
CO	Navigation (1A3d)	[tonnes]	6832	7034	7217	7408	7601	7631	7281	6915	6565	6213	5841
CO	Comm./Inst. (1A4a)	[tonnes]	29423	32889	37681	43798	51239	58128	64197	67870	70290	72227	72338
CO	Residential (1A4b)	[tonnes]	16451	17390	18463	19890	21444	22482	23547	24366	25092	25341	25616
CO	Ag./for./fish. (1A4c)	[tonnes]	25842	24444	22571	20670	18575	17655	17414	18148	18992	19445	19380
CO	Military (1A5)	[tonnes]	396	304	309	297	697	790	376	534	302	410	309
CO	Navigation int. (1A3d)	[tonnes]	10044	8025	6562	7025	5709	5912	7977	8454	7243	3826	5397
CO	Civil Aviation int. (1A3a)	[tonnes]	1790	1795	1608	1668	1848	1907	1852	1906	1979	1690	1716
CO_2	Industry-Other (1A2f)	[ktonnes]	877	886	895	905	910	948	1019	1087	1108	821	1037
CO_2	Civil Aviation (1A3a)	[ktonnes]	154	163	141	138	128	135	143	161	162	153	156
CO_2	Road (1A3b)	[ktonnes]	11203	11223	11352	11806	12115	12214	12587	13187	12937	12154	12108
CO_2	Railways (1A3c)	[ktonnes]	228	211	210	218	216	232	227	228	237	230	242
CO_2	Navigation (1A3d)	[ktonnes]	588	587	578	576	588	585	588	586	593	598	593
CO_2	Comm./Inst. (1A4a)	[ktonnes]	87	98	112	129	149	162	172	175	176	174	173
CO_2	Residential (1A4b)	[ktonnes]	43	46	49	53	57	59	61	62	63	63	63
CO_2	Ag./for./fish. (1A4c)	[ktonnes]	1615	1769	1793	1768	1639	1758	1750	1727	1863	1837	1865
CO_2	Military (1A5)	[ktonnes]	111	97	89	92	239	271	126	175	108	160	107
CO_2	Navigation int. (1A3d)	[ktonnes]	4168	3304	2691	2853	2299	2352	3136	3292	2809	1487	2073
CO_2	Civil Aviation int. (1A3a)	[ktonnes]	2350	2384	2058	2141	2447	2574	2581	2647	2647	2316	2421
N_2O	Industry-Other (1A2f)	[tonnes]	37	38	38	38	39	40	43	46	47	35	44
N_2O	Civil Aviation (1A3a)	[tonnes]	8	8	8	8	8	8	8	9	9	8	8
N_2O	Road (1A3b)	[tonnes]	449	445	438	442	442	428	426	434	417	386	385

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N_2O	Railways (1A3c)	[tonnes]	6	6	6	6	6	6	6	6	7	6	7
N_2O	Navigation (1A3d)	[tonnes]	34	34	34	33	34	34	34	34	35	35	35
N_2O	Comm./Inst. (1A4a)	[tonnes]	1	1	2	2	2	2	3	3	3	3	3
N_2O	Residential (1A4b)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1
N_2O	Ag./for./fish. (1A4c)	[tonnes]	78	88	90	88	80	87	86	83	91	89	91
N_2O	Military (1A5)	[tonnes]	3	3	3	3	8	9	4	6	4	6	4
N_2O	Navigation int. (1A3d)	[tonnes]	262	208	170	180	145	148	197	207	177	94	130
N_2O	Civil Aviation int. (1A3a)	[tonnes]	82	82	72	75	85	89	89	91	91	79	83
NH_3	Industry-Other (1A2f)	[tonnes]	2	2	2	2	2	2	2	3	3	2	3
NH_3	Civil Aviation (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tonnes]	2764	2749	2696	2613	2517	2299	2130	1979	1793	1610	1433
NH_3	Railways (1A3c)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Comm./Inst. (1A4a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tonnes]	3	3	3	3	3	3	3	3	4	4	4
NH_3	Military (1A5)	[tonnes]	0	0	0	0	1	1	0	0	1	1	0
NH_3	Navigation int. (1A3d)	[tonnes]											
NH_3	Civil Aviation int. (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	854	587	686
TSP	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3	3	3
TSP	Road (1A3b)	[tonnes]	3015	2787	2556	2502	2374	2287	2224	2126	1868	1594	1513
TSP	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101	84	95
TSP	Navigation (1A3d)	[tonnes]	383	373	357	387	430	425	421	336	327	327	307
TSP	Comm./Inst. (1A4a)	[tonnes]	30	38	46	55	63	65	66	66	67	67	67
TSP	Residential (1A4b)	[tonnes]	11	11	12	13	13	13	14	14	14	14	14
TSP	Ag./for./fish. (1A4c)	[tonnes]	1507	1498	1429	1351	1244	1213	1144	1076	1045	992	957
TSP	Military (1A5)	[tonnes]	15	31	15	18	38	33	15	15	12	18	9
TSP	Navigation int. (1A3d)	[tonnes]	8791	7143	4988	4501	3978	5761	7888	2365	1873	820	940
TSP	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43	37	39
PM_{10}	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	854	587	686
PM_{10}	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3	3	3
PM_{10}	Road (1A3b)	[tonnes]	3015	2787	2556	2502	2374	2287	2224	2126	1868	1594	1513
PM_{10}	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101	84	95
PM_{10}	Navigation (1A3d)	[tonnes]	381	371	355	384	427	422	418	334	325	324	305

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PM_{10}	Comm./Inst. (1A4a)	[tonnes]	30	38	46	55	63	65	66	66	67	67	67
PM_{10}	Residential (1A4b)	[tonnes]	11	11	12	13	13	13	14	14	14	14	14
PM_{10}	Ag./for./fish. (1A4c)	[tonnes]	1505	1496	1426	1349	1242	1211	1143	1074	1043	991	955
PM_{10}	Military (1A5)	[tonnes]	15	31	15	18	38	33	15	15	12	18	9
PM_{10}	Navigation int. (1A3d)	[tonnes]	8703	7072	4938	4456	3938	5703	7809	2341	1854	812	931
PM_{10}	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43	37	39
$PM_{2.5}$	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	854	587	686
$PM_{2.5}$	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3	3	3
$PM_{2.5}$	Road (1A3b)	[tonnes]	3015	2787	2556	2502	2374	2287	2224	2126	1868	1594	1513
$PM_{2.5}$	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101	84	95
$PM_{2.5}$	Navigation (1A3d)	[tonnes]	379	370	354	383	425	421	417	333	324	323	304
$PM_{2.5}$	Comm./Inst. (1A4a)	[tonnes]	30	38	46	55	63	65	66	66	67	67	67
$PM_{2.5}$	Residential (1A4b)	[tonnes]	11	11	12	13	13	13	14	14	14	14	14
$PM_{2.5}$	Ag./for./fish. (1A4c)	[tonnes]	1504	1495	1425	1348	1242	1210	1142	1073	1042	990	954
$PM_{2.5}$	Military (1A5)	[tonnes]	15	31	15	18	38	33	15	15	12	18	9
$PM_{2.5}$	Navigation int. (1A3d)	[tonnes]	8659	7036	4913	4434	3918	5675	7770	2330	1845	808	926
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43	37	39
Arsenic	Industry-Other (1A2f)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Road (1A3b)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Arsenic	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Navigation (1A3d)	[kg]	24	23	23	28	28	28	30	30	31	33	35
Arsenic	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Ag./for./fish. (1A4c)	[kg]	9	11	11	11	9	10	10	8	10	9	9
Arsenic	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Arsenic	Navigation int. (1A3d)	[kg]	422	329	227	257	213	250	381	424	326	127	206
Arsenic	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Cadmium	Industry-Other (1A2f)	[kg]	2	2	2	2	2	2	3	3	3	2	3
Cadmium	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Cadmium	Road (1A3b)	[kg]	32	32	33	34	35	35	36	37	37	36	36
Cadmium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]	3	2	2	3	3	3	3	3	3	3	3
Cadmium	Comm./Inst. (1A4a)	[kg]	0	0	0	0	1	1	1	1	1	1	1
Cadmium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0

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Cadmium	Ag./for./fish. (1A4c)	[kg]	4	5	5	5	4	5	5	5	5	5	5
Cadmium	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Cadmium	Navigation int. (1A3d)	[kg]	29	23	17	18	15	17	24	27	21	9	14
Cadmium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Chromium	Industry-Other (1A2f)	[kg]	7	7	7	8	8	8	9	9	9	7	9
Chromium	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Chromium	Road (1A3b)	[kg]	73	74	75	80	83	85	88	94	94	90	92
Chromium	Railways (1A3c)	[kg]	2	2	2	2	2	2	2	2	2	2	2
Chromium	Navigation (1A3d)	[kg]	13	12	12	14	14	14	15	15	15	16	17
Chromium	Comm./Inst. (1A4a)	[kg]	0	0	1	1	1	1	1	1	1	1	1
Chromium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Chromium	Ag./for./fish. (1A4c)	[kg]	16	18	19	18	17	18	18	17	19	18	19
Chromium	Military (1A5)	[kg]	0	1	0	0	1	1	0	0	0	1	0
Chromium	Navigation int. (1A3d)	[kg]	179	140	100	111	92	106	157	174	136	56	88
Chromium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Copper	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	7	7	7	5	7
Copper	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Copper	Road (1A3b)	[kg]	109	109	111	114	116	115	116	120	117	112	111
Copper	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	2
Copper	Navigation (1A3d)	[kg]	25	24	24	29	29	29	31	31	32	34	36
Copper	Comm./Inst. (1A4a)	[kg]	1	1	1	2	2	2	2	2	2	2	2
Copper	Residential (1A4b)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Copper	Ag./for./fish. (1A4c)	[kg]	16	18	18	18	16	17	17	16	18	17	17
Copper	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0	1	0
Copper	Navigation int. (1A3d)	[kg]	422	329	227	257	213	250	381	424	326	127	206
Copper	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Mercury	Industry-Other (1A2f)	[kg]	1	1	1	1	1	1	2	2	2	1	2
Mercury	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Mercury	Road (1A3b)	[kg]	25	25	25	26	26	26	27	28	27	26	25
Mercury	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Mercury	Navigation (1A3d)	[kg]	7	7	7	6	6	6	6	6	6	6	6
Mercury	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Mercury	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Mercury	Ag./for./fish. (1A4c)	[kg]	11	13	13	13	10	12	12	10	12	11	11
Mercury	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0

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Mercury	Navigation int. (1A3d)	[kg]	42	34	30	31	24	23	27	27	25	17	21
Mercury	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Nickel	Industry-Other (1A2f)	[kg]	2	2	2	2	2	2	3	3	3	2	3
Nickel	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Nickel	Road (1A3b)	[kg]	36	36	37	38	39	39	40	41	41	39	39
Nickel	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Nickel	Navigation (1A3d)	[kg]	1068	1036	1026	1374	1367	1371	1494	1479	1578	1687	1811
Nickel	Comm./Inst. (1A4a)	[kg]	0	0	0	1	1	1	1	1	1	1	1
Nickel	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Nickel	Ag./for./fish. (1A4c)	[kg]	15	18	19	18	15	17	16	15	17	16	16
Nickel	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Nickel	Navigation int. (1A3d)	[kg]	23829	18510	12366	14147	11846	14256	22148	24842	18832	6924	11614
Nickel	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Lead	Industry-Other (1A2f)	[kg]	13	13	13	13	13	14	15	16	16	12	15
Lead	Civil Aviation (1A3a)	[kg]	1369	1343	1328	1252	1304	1297	1245	1329	1182	991	929
Lead	Road (1A3b)	[kg]	133	135	138	145	152	154	160	169	169	163	168
Lead	Railways (1A3c)	[kg]	3	3	3	3	3	4	3	3	4	3	4
Lead	Navigation (1A3d)	[kg]	21	20	20	21	21	21	22	22	22	23	23
Lead	Comm./Inst. (1A4a)	[kg]	1	1	1	1	2	2	2	2	2	2	2
Lead	Residential (1A4b)	[kg]	0	0	1	1	1	1	1	1	1	1	1
Lead	Ag./for./fish. (1A4c)	[kg]	33	38	39	38	34	37	36	34	38	37	37
Lead	Military (1A5)	[kg]	114	89	106	79	84	60	47	81	40	66	80
Lead	Navigation int. (1A3d)	[kg]	210	166	126	137	112	121	172	186	151	70	104
Lead	Civil Aviation int. (1A3a)	[kg]	118	114	113	106	111	117	22	10	113	52	10
Selenium	Industry-Other (1A2f)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Road (1A3b)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Selenium	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Navigation (1A3d)	[kg]	39	38	37	39	40	40	41	40	42	43	43
Selenium	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Ag./for./fish. (1A4c)	[kg]	35	44	45	44	34	41	38	33	38	35	36
Selenium	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Selenium	Navigation int. (1A3d)	[kg]	421	331	252	274	224	243	345	372	302	140	208
Selenium	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Continued													
Zinc	Industry-Other (1A2f)	[kg]	438	443	447	452	455	474	510	544	555	411	519
Zinc	Civil Aviation (1A3a)	[kg]	5	5	5	5	5	5	5	5	4	4	3
Zinc	Road (1A3b)	[kg]	6430	6461	6593	6854	7065	7044	7193	7491	7408	7125	7171
Zinc	Railways (1A3c)	[kg]	115	106	106	110	109	117	114	115	119	116	122
Zinc	Navigation (1A3d)	[kg]	142	143	143	149	152	152	153	152	154	156	157
Zinc	Comm./Inst. (1A4a)	[kg]	60	68	77	89	103	112	119	121	122	121	119
Zinc	Residential (1A4b)	[kg]	29	32	34	36	39	41	42	43	44	44	43
Zinc	Ag./for./fish. (1A4c)	[kg]	630	658	662	659	645	668	678	698	738	741	749
Zinc	Military (1A5)	[kg]	14	31	15	21	51	46	23	25	24	42	24
Zinc	Navigation int. (1A3d)	[kg]	973	766	588	637	519	560	788	848	692	326	481
Zinc	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Comm./Inst. (1A4a)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	1	0	0	0	0	1	1	0	0	0
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	48	48	49	49	50	52	56	60	61	45	57
Flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Flouranthene	Road (1A3b)	[kg]	581	567	571	601	629	649	686	758	777	763	794
Flouranthene	Railways (1A3c)	[kg]	4	4	4	4	4	4	4	4	5	4	5
Flouranthene	Navigation (1A3d)	[kg]	52	51	50	49	50	50	49	49	50	50	49
Flouranthene	Comm./Inst. (1A4a)	[kg]	5	6	7	8	9	10	10	10	10	10	10
Flouranthene	Residential (1A4b)	[kg]	3	3	3	3	3	3	4	4	4	4	4
Flouranthene	Ag./for./fish. (1A4c)	[kg]	118	133	135	132	119	130	128	123	134	131	133
Flouranthene	Military (1A5)	[kg]	2	4	2	3	6	6	3	3	3	5	3
Flouranthene	Navigation int. (1A3d)	[kg]	298	238	208	215	171	164	203	205	187	114	149
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	7	7	7	5	7
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Continued													
Benzo(b) flouranthene	Road (1A3b)	[kg]	59	58	59	62	64	65	68	74	73	70	72
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Benzo(b) flouranthene	Navigation (1A3d)	[kg]	4	4	4	4	4	4	4	4	4	4	4
Benzo(b) flouranthene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	1	1	0	0
Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	12	13	13	13	12	13	13	13	14	13	14
Benzo(b) flouranthene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0	1	0
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	21	17	15	16	12	11	13	12	12	8	10
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	5	5	6	6	6	6	7	7	5	6
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	67	67	68	71	74	75	79	84	83	78	80
Benzo(k) flouranthene	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	2	2	2	2	2	2	2	2	2	2	2
Benzo(k) flouranthene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	9	10	10	10	9	10	10	10	11	11	11
Benzo(k) flouranthene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0	1	0
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	10	8	7	7	6	5	6	6	6	4	5
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	4	4	3	3
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Road (1A3b)	[kg]	43	42	43	45	48	49	52	57	58	57	58
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Benzo(a) pyrene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	5	5	6	5	6
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	6	4	4	4	3	3	4	4	3	2	3
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	5	5	5	5	5	6	6	6	7	5	6
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	83	81	83	87	90	93	97	107	109	107	110
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Continued													
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	8	8	8	7	7	7	7	7	7	7	7
Benzo(g,h,i) perylene	Comm./Inst. (1A4a)	[kg]	1	1	1	1	1	2	2	2	2	2	2
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	0	0	0	0	1	1	1	1	1	1	1
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	18	20	21	20	17	20	19	18	20	19	19
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0	1	0
Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]	40	32	31	31	24	21	23	21	22	17	20
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	4	4	3	3
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]	47	47	48	51	53	55	57	62	63	61	63
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]	7	7	6	6	6	6	6	6	6	6	5
indeno(1,2,3-c,d) pyrene	Comm./Inst. (1A4a)	[kg]	0	0	0	0	0	1	1	1	1	1	1
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]	13	15	15	15	13	14	14	13	14	13	14
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]	33	26	25	25	20	17	19	17	18	14	17
indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Annex 3B-17: Uncertainty estimates

Uncertainty estimation, CO_2

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg	Gg	%	%	%	%	%	%	%	%	%
Road transport	CO_2	9282	12108	2	5	5,385	3,990	0,06894462	0,8911	0,3447	2,5205	2,5440
Military	CO_2	119	107	2	5	5,385	0,035	-0,0026576	0,0079	-0,0133	0,0223	0,0259
Railways	CO_2	297	242	2	5	5,385	0,080	-0,0084443	0,0178	-0,0422	0,0504	0,0658
Navigation (small boats)	CO_2	48	99	41	5	41,304	0,251	0,00307343	0,0073	0,0154	0,4242	0,4245
Navigation (large vessels)	CO_2	748	494	11	5	12,083	0,365	-0,0298481	0,0363	-0,1492	0,5653	0,5847
Fisheries	CO_2	591	575	2	5	5,385	0,189	-0,0099746	0,0423	-0,0499	0,1197	0,1296
Agriculture	CO_2	1272	1273	24	5	24,515	1,910	-0,0189445	0,0937	-0,0947	3,1800	3,1814
Forestry	CO_2	36	17	30	5	30,414	0,032	-0,0019086	0,0013	-0,0095	0,0530	0,0539
Industry (mobile)	CO_2	839	1037	41	5	41,304	2,620	0,00199985	0,0763	0,0100	4,4243	4,4243
Residential	CO_2	39	63	35	5	35,355	0,136	0,00116245	0,0046	0,0058	0,2287	0,2288
Commercial/Institutional	CO_2	74	173	35	5	35,355	0,374	0,00619781	0,0127	0,0310	0,6298	0,6306
Civil aviation	CO_2	243	156	10	5	11,180	0,106	-0,0100308	0,0115	-0,0502	0,1620	0,1696
Total		13.587	16343				26,699					36,7952
Total uncertainties				**Year (%):**			**5,167**			**Trend (%):**		**6,066**

Uncertainty estimation, CH_4

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg	Mg	%	%	%	%	%	%	%	%	%
Road transport	CH_4	2518	644	2	40	40,050	24,121	-0,0939264	0,2203	-3,7571	0,6230	3,8084
Military	CH_4	5	4	2	100	100,020	0,328	0,00055275	0,0012	0,0553	0,0034	0,0554
Railways	CH_4	12	7	2	100	100,020	0,680	0,00094452	0,0025	0,0945	0,0070	0,0947
Navigation (small boats)	CH_4	17	24	41	100	108,079	2,454	0,00623542	0,0083	0,6235	0,4815	0,7878
Navigation (large vessels)	CH_4	16	11	11	100	100,603	1,046	0,00181933	0,0038	0,1819	0,0592	0,1913
Fisheries	CH_4	13	14	2	100	100,020	1,290	0,00308187	0,0047	0,3082	0,0133	0,3085
Agriculture	CH_4	105	96	24	100	102,840	9,237	0,0197364	0,0329	1,9736	1,1150	2,2668
Forestry	CH_4	21	3	30	100	104,403	0,293	-0,0016	0,0010	-0,1600	0,0436	0,1658
Industry (mobile)	CH_4	60	37	41	100	108,079	3,784	0,00533736	0,0128	0,5337	0,7425	0,9145
Residential	CH_4	51	65	35	100	105,948	6,464	0,01593453	0,0223	1,5935	1,1044	1,9388
Commercial/Institutional	CH_4	99	160	35	100	105,948	15,811	0,04220095	0,0546	4,2201	2,7016	5,0108
Civil aviation	CH_4	7	4	10	100	100,499	0,377	0,00046654	0,0014	0,0467	0,0194	0,0505
Total		2923	1069				732,838					25,0317
Total uncertainties				**Year (%):**			**27,071**			**Trend (%):**		**5,003**

Uncertainty estimation, N_2O

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg	Mg	%	%	%	%	%	%	%	%	%
Road transport	N_2O	299	385	2	50	50,040	33,407	0,07021027	0,7825	3,5105	2,2134	4,1500
Military	N_2O	4	4	2	1000	1000,002	6,359	-0,0013644	0,0075	-1,3644	0,0211	1,3646
Railways	N_2O	8	7	2	1000	1000,002	11,564	-0,0059063	0,0136	-5,9063	0,0383	5,9064
Navigation (small boats)	N_2O	1	3	41	1000	1000,840	6,032	0,00407682	0,0071	4,0768	0,4096	4,0973
Navigation (large vessels)	N_2O	47	31	11	1000	1000,060	53,854	-0,0489403	0,0631	-48,9403	0,9819	48,9501
Fisheries	N_2O	37	36	2	1000	1000,002	63,018	-0,0144001	0,0739	-14,4001	0,2089	14,4016
Agriculture	N_2O	49	54	24	1000	1000,288	93,352	-0,0078106	0,1094	-7,8106	3,7129	8,6481
Forestry	N_2O	1	1	30	1000	1000,450	0,939	-0,000233	0,0011	-0,2330	0,0467	0,2376
Industry (mobile)	N_2O	34	44	41	1000	1000,840	76,228	0,0077842	0,0893	7,7842	5,1765	9,3483
Residential	N_2O	1	1	35	1000	1000,612	1,866	0,00071793	0,0022	0,7179	0,1082	0,7260
Commercial/Institutional	N_2O	1	3	35	1000	1000,612	4,601	0,0027744	0,0054	2,7744	0,2668	2,7872
Civil aviation	N_2O	10	8	10	1000	1000,050	14,683	-0,007273	0,0172	-7,2730	0,2434	7,2770
Total		493	577				22943,418					2889,9973
Total uncertainties			**Year (%):**				**151,471**		**Trend (%):**			**53,759**

Annex 3C - Industrial Processes

No annexes for industrial processes in this submission.

Annex 3D - Solvents and Other Product Use

Annex 3D-1 Tentative list of chemicals

The National Atmospheric Inventory for Great Britain (http://www.naei.org.uk/) covers the following sectors and chemicals:

Total emission
Energy Production
Comm+ Residn Combusn.
Industrial Combustion
Production Processes
Extr & Distrib of Fossil Fuels
Solvent Use
Road Transport
Other Transp & Mach
Waste Treatment & Disp
Nature (Forests)

1 (1-methylethyl)cyclohexane
2 (1-methylpropyl)cyclohexane
3 (2-methyl-1-propyl)acetate
4 (2-methylbutyl)cyclohexane
5 (2-methylpropyl)cyclohexane
6 1-(2-butoxy-1-methyl-ethoxy)-2-propanol
7 1-(2-ethoxy-1-methyl-ethoxy)-2-propanol
8 1-(2-methoxy-1-methyl-ethoxy)2-propanol
9 1-(butoxyethoxy)-2-propanol
10 1,1,1-trichloroethane
11 1,1,1-trichlorotrifluoroethane
12 1,1,2,2-tetrachloroethane
13 1,1,2-trimethylcyclohexane
14 1,1,2-trimethylcyclopentane
15 1,1,3-trimethylcyclohexane
16 1,1,4,4-tetramethylcyclohexane
17 1,1-dichloroethane
18 1,1-dichloroethene
19 1,1-dichlorotetrafluoroethane
20 1,1-dimethylcyclohexane
21 1,1-dimethylcyclopentane
22 1,2,3,4-tetrahydronaphthalene
23 1,2,3,4-tetramethylbenzene
24 1,2,3,5-tetramethylbenzene
25 1,2,3,5-tetramethylcyclohexane
26 1,2,3-trichlorobenzene
27 1,2,3-trimethylbenzene
28 1,2,3-trimethylcyclohexane
29 1,2,3-trimethylcyclopentane
30 1,2,4,4-tetramethylcyclopentane
31 1,2,4,5-tetramethylbenzene
32 1,2,4-trichlorobenzene
33 1,2,4-trimethlycyclopentane
34 1,2,4-trimethylbenzene
35 1,2,4-trimethylcyclohexane
36 1,2,4-trimethylcyclopentane
37 1,2-diaminoethane
38 1,2-dibromoethane

39 1,2-dichlorobenzene
40 1,2-dichloroethane
41 1,2-dichloroethene
42 1,2-dichlorotetrafluoroethane
43 1,2-dimethyl-3-isopropylcyclopentane
44 1,2-dimethylcyclohexane
45 1,2-dimethylcyclopentane
46 1,2-ethanedioldiacetate
47 1,2-ethylmethylcyclopentane
48 1,2-propanediol
49 1,3,4,5,6-pentahydroxy-2-hexanone
50 1,3,5-trichlorobenzene
51 1,3,5-trimethylbenzene
52 1,3,5-trimethylcyclohexane
53 1,3-butadiene
54 1,3-dichlorobenzene
55 1,3-diethylbenzene
56 1,3-dimethyl-4-ethylbenzene
57 1,3-dimethyl-5-propylbenzene
58 1,3-dimethylcyclohexane
59 1,3-dimethylcyclopentane
60 1,3-dioxolane
61 1,3-ethylmethylcyclopentane
62 1,3-hexadiene
63 1,4-butyrolacetone
64 1,4-dichlorobenzene
65 1,4-diethylbenzene
66 1,4-dimethyl-2-isopropylbenzene
67 1,4-dimethylcyclohexane
68 1,4-dimethylpiperazine
69 1,4-dioxane
70 11-methyl-1-dodecanol
71 1-butanal
72 1-butanol
73 1-butene
74 1-butoxy-2-propanol
75 1-butyne
76 1-chloro-2,3-epoxypropane
77 1-chloro-4-nitrobenzene
78 1-chloropropane
79 1-decene
80 1-ethoxy-2-propanol
81 1-ethoxy-2-propyl acetate
82 1-ethyl-1,4-dimethylcyclohexane
83 1-ethyl-2,2,6-trimethylcyclohexane
84 1-ethyl-2,3-dimethylbenzene
85 1-ethyl-2,3-dimethylcyclohexane
86 1-ethyl-2-propylbenzene
87 1-ethyl-2-propylcyclohexane
88 1-ethyl-3,5-dimethylbenzene
89 1-ethyl-3-methylcyclohexane
90 1-ethyl-4-methylcyclohexane
91 1-ethylpropylbenzene
92 1-heptene
93 1-hexanal
94 1-hexene

95 1-hydrophenol
96 1-methoxy-2-ethanol
97 1-methoxy-2-propanol
98 1-methoxy-2-propyl acetate
99 1-methyl-1-phenylcyclopropane
100 1-methyl-1-propylcyclopentane
101 1-methyl-2-isopropylbenzene
102 1-methyl-2-propylbenzene
103 1-methyl-3-(isopropyl)benzene
104 1-methyl-3-isopropylcyclopentane
105 1-methyl-3-propylbenzene
106 1-methyl-4-isopropylbenzene
107 1-methyl-4-isopropylcyclohexane
108 1-methyl-4-tertbutylbenzene
109 1-methylbutylbenzene
110 1-methylindan
111 1-methylindene
112 1-nonene
113 1-octene
114 1-pentanal
115 1-pentanol
116 1-pentene
117 1-propanal
118 1-propanol
119 2-(2-aminoethylamino)ethanol
120 2-(2-butoxyethoxy)ethanol
121 2-(2-butoxyethoxy)ethyl acetate
122 2-(2-ethoxyethoxy)ethanol
123 2-(2-ethoxyethoxy)ethyl acetate
124 2-(2-hydroxy-ethoxy)ethanol
125 2-(2-hydroxy-propoxy)-1-propanol
126 2-(methoxyethoxy)ethanol
127 2,2,3,3-tetramethylhexane
128 2,2,4,6,6-pentamethylheptane
129 2,2,4-trimethyl-1,3-pentanediol
130 2,2,4-trimethylpentane
131 2,2,5-trimethylhexane
132 2,2-dimethylbutane
133 2,2-dimethylhexane
134 2,2-dimethylpentane
135 2,2-dimethylpropane
136 2,2'-iminodi(ethylamine)
137 2,2'-iminodiethanol
138 2,3,3,4-tetramethylpentane
139 2,3,3-trimethyl-1-butene
140 2,3,4-trimethylhexane
141 2,3,4-trimethylpentane
142 2,3,5-trimethylhexane
143 2,3-dimethylbutane
144 2,3-dimethylfuran
145 2,3-dimethylheptane
146 2,3-dimethylhexane
147 2,3-dimethylnonane
148 2,3-dimethyloctane
149 2,3-dimethylpentane
150 2,3-dimethylundecane

151 2,4,6-trichloro-1,3,5-triazine
152 2,4-difluoroaniline
153 2,4-dimethyl-1-(1-methylethyl)benzene
154 2,4-dimethylfuran
155 2,4-dimethylheptane
156 2,4-dimethylhexane
157 2,4-dimethylpentane
158 2,4-toluene diisocyanate
159 2,5-dimethyldecane
160 2,5-dimethylfuran
161 2,5-dimethylheptane
162 2,5-dimethylhexane
163 2,5-dimethyloctane
164 2,6-dimethyldecane
165 2,6-dimethylheptane
166 2,6-dimethyloctane
167 2,6-dimethylundecane
168 2,6-toluene diisocyanate
169 2,7-dimethyloctane
170 2-[2-(2-ethoxy-ethoxy)-ethoxy]ethanol
171 2-acetoxy-propyl acetate
172 2-aminoethanol
173 2-butanol
174 2-butanone
175 2-butanone oxime
176 2-butene
177 2-butoxyethanol
178 2-butoxyethyl acetate
179 2-chloroethanol
180 2-chloropropane
181 2-chlorotoluene
182 2-ethoxyethanol
183 2-ethoxyethyl acetate
184 2-ethoxypropanol
185 2-ethyl hexanol
186 2-ethyl-1,3-dimethylbenzene
187 2-ethyltoluene
188 2-hexoxyethanol
189 2-hydrophenol
190 2-isopropoxyethanol
191 2-methoxy-2-methylpropane
192 2-methoxyethanol
193 2-methoxyethyl acetate
194 2-methoxypropane
195 2-methyl benzaldehyde
196 2-methyl-1,3-dioxolane
197 2-methyl-1-butene
198 2-methyl-1-butylbenzene
199 2-methyl-1-pentene
200 2-methyl-1-propanol
201 2-methyl-2,4-pentanediol
202 2-methyl-2-butene
203 2-methyl-2-hexene
204 2-methyl-5-ethyloctane
205 2-methylbutanal
206 2-methylbutane

207 2-methyldecalin
208 2-methyldecane
209 2-methylfuran
210 2-methylheptane
211 2-methylhexane
212 2-methylnonane
213 2-methyloctane
214 2-methylpentane
215 2-methylpropanal
216 2-methylpropane
217 2-methylpropenal
218 2-methylpropene
219 2-methylpropyl acetate
220 2-methylpyridine
221 2-methylundecane
222 2-pentanone
223 2-pentene
224 2-phenoxy ethanol
225 2-phenylpropene
226 2-propanol
227 2-propen-1-ol
228 2-propyl acetate
229 3-(2-hydroxy-propoxy)-1-propanol
230 3,3,4-trimethylhexane
231 3,3,5-trimethylheptane
232 3,3-dimethylheptane
233 3,3-dimethyloctane
234 3,3-dimethylpentane
235 3,4-dimethylheptane
236 3,4-dimethylhexane
237 3,5-dimethyloctane
238 3,6-dimethyloctane
239 3,7-dimethylnonane
240 3A,4,7,7A-tetrahydro-4,7-methanoindene
241 3-chloro-4-fluoropicoline
242 3-chloropropene
243 3-chloropyridine
244 3-ethyl-2-methylheptane
245 3-ethyl-2-methylhexane
246 3-ethylheptane
247 3-ethylhexane
248 3-ethyloctane
249 3-ethylpentane
250 3-ethyltoluene
251 3-hydrophenol
252 3-methyl benzaldehyde
253 3-methyl-1-butene
254 3-methylbutanal
255 3-methylbutanol
256 3-methyldecane
257 3-methylfuran
258 3-methylheptane
259 3-methylhexane
260 3-methylnonane
261 3-methyloctane
262 3-methylpentane

263 3-methylundecane
264 3-pentanone
265 4,4-dimethylheptane
266 4,4'-methylenedianiline
267 4,5-dimethylnonane
268 4,6-dimethylindan
269 4,7-dimethylindan
270 4-4'-methylenediphenyl diisocyanate
271 4-bromophenyl acetate
272 4-chlorotoluene
273 4-ethyl morpholine
274 4-ethyl-1,2-dimethylbenzene
275 4-ethyloctane
276 4-ethyltoluene
277 4-methyl benzaldehyde
278 4-methyl-1,3-dioxol-2-one
279 4-methyl-1-pentene
280 4-methyl-2-pentanol
281 4-methyl-2-pentanone
282 4-methyl-4-hydroxy-2-pentanone
283 4-methyldecane
284 4-methylheptane
285 4-methylnonane
286 4-methyloctane
287 4-methylpentene
288 4-propylheptane
289 5-methyl-2-hexanone
290 5-methyldecane
291 5-methylnonane
292 5-methylundecane
293 6-ethyl-2-methyldecane
294 6-ethyl-2-methyloctane
295 6-methylundecane
296 8-methyl-1-nonanol
297 acenaphthene
298 acenaphthylene
299 acetaldehyde
300 acetic acid
301 acetic anhydride
302 acetone
303 acetonitrile
304 acetyl chloride
305 acetylene
306 acrolein
307 acrylamide
308 acrylic acid
309 acrylonitrile
310 aniline
311 anthanthrene
312 anthracene
313 atrazine
314 benzaldehyde
315 benzene
316 benzene-1,2,4-tricarboxylic acid 1,2-
317 benzo (a) anthracene
318 benzo (a) pyrene

319 benzo (b) fluoranthene
320 benzo (c) phenanthrene
321 benzo (e) pyrene
322 benzo (g,h,i) fluoranthene
323 benzo (g,h,i) perylene
324 benzo (k) fluoranthene
325 benzophenone
326 benzopyrenes
327 benzyl alcohol
328 benzyl chloride
329 biphenyl
330 bis(2-hydroxyethyl)ether
331 bis(chloromethyl)ether
332 bis(tributyltin) oxide
333 bromoethane
334 bromoethene
335 bromomethane
336 butane
337 butanethiols
338 butene
339 butoxyl
340 butyl acetate
341 butyl acrylate
342 butyl glycolate
343 butyl lactate
344 butylbenzene
345 butylcyclohexane
346 butyrolactone
347 C10 alkanes
348 C10 alkenes
349 C10 aromatic hydrocarbons
350 C10 cycloalkanes
351 C11 alkanes
352 C11 alkenes
353 C11 aromatic hydrocarbons
354 C11 cycloalkanes
355 C12 alkanes
356 C12 cycloalkanes
357 C13 alkanes
358 C13+ alkanes
359 C13+ aromatic hydrocarbons
360 C14 alkanes
361 C15 alkanes
362 C16 alkanes
363 C2-alkyl-anthracenes
364 C2-alkyl-benzanthracenes
365 C2-alkyl-benzophenanthrenes
366 C2-alkyl-chrysenes
367 C2-alkyl-phenanthrenes
368 C5 alkenes
369 C6 alkenes
370 C7 alkanes
371 C7 alkenes
372 C7 cycloalkanes
373 C8 alkanes
374 C8 alkenes

375 C8 cycloalkanes
376 C9 alkanes
377 C9 alkenes
378 C9 aromatic hydrocarbons
379 C9 cycloalkanes
380 camphor/fenchone
381 carbon disulphide
382 carbon tetrachloride
383 carbonyl sulphide
384 chlorobenzene
385 chlorobutane
386 chlorocyclohexane
387 chlorodifluoromethane
388 chloroethane
389 chloroethene
390 chloroethylene
391 chlorofluoromethane
392 chloromethane
393 chrysene
394 cis-1,3-dimethylcyclopentane
395 cis-2-butene
396 cis-2-hexene
397 cis-2-pentene
398 coronene
399 crotonaldehyde
400 cycloheptane
401 cyclohexanamine
402 cyclohexane
403 cyclohexanol
404 cyclohexanone
405 cyclopenta (c,d) pyrene
406 cyclopenta-anthracenes
407 cyclopentane
408 cyclopenta-phenanthrenes
409 cyclopentene
410 decalin
411 decane
412 diacetoneketogulonic acid
413 diazinon
414 dibenzanthracenes
415 dibenzo (a,h) anthracene
416 dibenzopyrenes
417 dichlorobutenes
418 dichlorodifluoromethane
419 dichlorofluoromethane
420 dichloromethane
421 dichlorvos
422 diethyl disulphide
423 diethyl ether
424 diethyl sulphate
425 diethylamine
426 diethylbenzene
427 difluoromethane
428 dihydroxyacetone
429 diisopropyl ether
430 diisopropylbenzene

431 dimethoxymethane
432 dimethyl disulphide
433 dimethyl esters
434 dimethyl ether
435 dimethyl sulphate
436 dimethyl sulphide
437 dimethylamine
438 dimethylbutene
439 dimethylcyclopentane
440 dimethylformamide
441 dimethylhexene
442 dimethylnonane
443 dimethylpentane
444 dipentene
445 dipropyl ether
446 dodecane
447 ethane
448 ethanethiol
449 ethanol
450 ethofumesate
451 ethyl acetate
452 ethyl acrylate
453 ethyl butanoate
454 ethyl chloroformate
455 ethyl hexanol
456 ethyl lactate
457 ethyl pentanoate
458 ethyl propionate
459 ethylamine
460 ethylbenzene
461 ethylcyclohexane
462 ethylcyclopentane
463 ethyldimethylbenzene
464 ethylene
465 ethylene glycol
466 ethylene oxide
467 ethylisopropylbenzene
468 fenitrothion
469 fluoranthene
470 fluorene
471 formaldehyde
472 formanilide
473 formic acid
474 fumaric acid
475 glycerol
476 glyoxal
477 heptadecane
478 heptane
479 hexachlorocyclohexane
480 hexachloroethane
481 hexadecane
482 hexafluoropropene
483 hexamethylcyclotrisiloxane
484 hexamethyldisilane
485 hexamethyldisiloxane
486 hexamethylenediamine

487 hexane
488 hexylcyclohexane
489 indan
490 indeno (1,2,3-c,d) pyrene
491 iodomethane
492 isobutylbenzene
493 isobutylcyclohexane
494 isopentylbenzene
495 isophorone
496 isoprene
497 isoprene + BVOC (1)
498 isopropylbenzene
499 isopropylcyclohexane
500 limonene
501 malathion
502 maleic anhydride
503 m-cresol
504 menthene
505 methacrylic acid
506 methanethiol
507 methanol
508 methyl acetate
509 methyl acrylate
510 methyl butanoate
511 methyl ethyl ether
512 methyl formate
513 methyl glyoxal
514 methyl methacrylate
515 methyl naphthalenes
516 methyl pentanoate
517 methyl styrene
518 methylamine
519 methyl-anthracenes
520 methyl-benzanthracenes
521 methyl-benzphenanthrenes
522 methylcyclodecane
523 methylcyclohexane
524 methylcyclopentane
525 methylethylbenzene
526 methyl-fluoranthenes
527 methylhexane
528 methylindane
529 methyl-phenanthrenes
530 methylpropene
531 methylpropylbenzene
532 methyltetralin
533 m-xylene
534 N-(hydroxymethyl) acrylamide
535 N,N-diethyl benzenamine
536 N,N-dimethyl benzenamine
537 naphthalene
538 naphthol
539 Nedocromil Sodium
540 nitrobenzene
541 nitromethane
542 nitropentane

543 nitropropane
544 N-methyl pyrrolidone
545 nonane
546 o-cresol
547 octahydroindan
548 octamethylcyclotetrasiloxane
549 octane
550 octylamine
551 o-xylene
552 palmitic acid
553 p-benzoquinone
554 p-cresol
555 pentadecane
556 pentafluoroethane
557 pentane
558 pentanethiols
559 pentylbenzene
560 pentylcyclohexane
561 permethrin
562 perylene
563 phenol
564 phenoxyacetic acid (phenoxy acid)
565 phenylacetic acid
566 phenylacetonitrile
567 phthalic anhydride
568 pine oil
569 polyethylene glycol
570 polyisobutene
571 polyvinyl chloride
572 potassium phenylacetate
573 propadiene
574 propane
575 propanetriol
576 propanoic acid
577 propionitrile
578 propyl acetate
579 propyl butanoate
580 propyl propionate
581 propylamine
582 propylbenzene
583 propylcyclohexane
584 propylcyclopentane
585 propylene
586 propylene oxide
587 propyne
588 p-xylene
589 pyrene
590 pyridine
591 salicylic acid
592 sec-butylbenzene
593 sec-butylcyclohexane
594 simazine
595 sodium 2-ethylhexanoate
596 sodium acetate
597 sodium phenylacetate
598 styrene

599 sulphanilamide
600 terpenes
601 tert-butylamine
602 tert-butylbenzene
603 tert-butylcyclohexane
604 tert-butylcyclopropane
605 tert-pentylbenzene
606 tetrachloroethene
607 tetradecane
608 tetrafluoroethene
609 tetrahydrofuran
611 tetramethylcyclohexane
612 toluene
613 toluene-2,3-diamine
614 toluene-2,4-diamine
615 toluene-2,4-diisocyanate
616 toluene-2,5-diamine
617 toluene-2,6-diamine
618 toluene-2,6-diisocyanate
619 toluene-3,4-diamine
620 toluene-3,5-diamine
621 trans-2-butene
622 trans-2-hexene
623 trans-2-pentene
624 trans-3-hexene
625 trialkyl phosphate
626 trichloroethene
627 trichlorofluoromethane
628 trichloromethane
629 tridecane
630 triethanolamine
631 triethylamine
632 trifluoroethene
633 trifluoromethane
634 trifluralin
635 trimethylamine
636 trimethylfluorosilane
637 tri-n-butyl phosphate
638 undecane
639 unspeciated alcohols
640 unspeciated aliphatic hydrocarbons
641 unspeciated alkanes
642 unspeciated alkenes
643 unspeciated amines
644 unspeciated aromatic hydrocarbons
645 unspeciated carboxylic acids
646 unspeciated cycloalkanes
647 unspeciated hydrocarbons
648 unspeciated ketones
649 urea
650 vinyl acetate
(1) BVOC- biogenic VOCs, such as alpha-pinene and other terpenes

Annex 3D-2 NMVOC and CO_2 equivalent emissions, 1990-2010

Table 3D-2a NMVOC emissions (Gg per year), 1990-1999.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	6.02	6.90	7.56	6.89	7.56	6.89	8.46	7.16	7.00	7.55
Degreasing and dry cleaning (3B)	7.05E-05	6.56E-05	6.26E-05	7.27E-05	9.38E-05	7.67E-05	7.38E-05	4.46E-05	5.48E-05	3.45E-05
Chemical products, manufacturing and processing (3C)	7.96	9.12	8.89	6.92	9.00	9.11	9.20	7.82	7.45	7.07
Other (3D)	23.7	26.41	28.50	25.17	30.0	28.8	31.2	29.3	26.6	25.6
Total NMVOC	37.6	42.4	44.9	39.0.	46.5	44.8	48.8	44.2	41.0	40.2
Total CO_2-eqv.	92.3	105	111	96.5	112	107	119	107	100	99

Table 3D-2b NMVOC emissions (Gg per year), 2000-2009.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Paint application (3A)	7.44	6.08	6.08	5.95	5.40	4.89	4.07	3.39	3.66	3.32
Degreasing and dry cleaning (3B)	2.93E-05	1.25E-05	2.98E-05	2.89E-05	2.4E-05	1.83E-05	1.46E-05	2.17E-05	1.5E-05	1.31E-05
Chemical products, manufacturing and processing (3C)	6.74	6.10	6.39	4.76	5.90	6.12	5.94	6.07	5.84	4.90
Other (3D)	26.6	23.8	23.4	21.4	20.6	20.0	20.3	17.7	18.0	19.2
Total NMVOC	40.7	36.0	35.8	32.1	31.9	31.0	30.3	27.1	27.5	27.4
Total CO_2-eqv.	99.1	87.1	87.4	79.2	77.2	74.6	70.8	63.4	64.8	64.6

Table 3D-2c NMVOC emissions (Gg per year), 2010

	2010
Paint application (3A)	3.11
Degreasing and dry cleaning (3B)	1.24E-05
Chemical products, manufacturing and processing (3C)	4.96
Other (3D)	18.7
Total NMVOC	26.8
Total CO_2-eqv.	62.2

Annex 3D-3 Activity data for used NMVOC, 1990-2010

Table 3D-3 Activity data for used amounts of NMVOC in Gg per year, 1990-2010

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	13.9	16.1	17.3	15.3	16.1	15.3	18.5	16.0	16.2	16.8
Degreasing and dry cleaning (3B)	0.705	0.656	0.626	0.727	0.938	0.766	0.738	0.446	0.548	0.345
Chemical products, manufacturing and processing (3C)	81.4	91.0	114	77.8	93.3	101	105	104	106	97.7
Other (3D)	37.9	43.0	44.9	38.6	45.9	47.8	50.0	48.0	45.1	43.4
Total NMVOC	134	151	177	132	156	165	174	168	167	158
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Paint application (3A)	17.3	14.2	14.3	13.4	12.8	12.1	10.2	8.76	9.10	8.04
Degreasing and dry cleaning (3B)	0.293	0.125	0.298	0.289	0.240	0.183	0.146	0.217	0.150	0.131
Chemical products, manufacturing and processing (3C)	114	110	108	103	127	148	150	163	155	137
Other (3D)	44.4	39.8	42.3	35.5	35.2	39.7	35.1	31.8	32.9	35.0
Total NMVOC	175.5	164.6	165.0	152.0	175.1	200.4	195.7	204.1	196.8	179.8

Continued	2010
Paint application (3A)	7.46
Degreasing and dry cleaning (3B)	0.124
Chemical products, manufacturing and processing (3C)	128
Other (3D)	33.0
Total NMVOC	168.8

Annex 3D-4 Activity data for solvent and product use, 1990-2010

Table 3D-4 Activity data for product use (Gg per year), 1990-2010

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	92.6	107	115	102	108	102	123	107	108	112
Degreasing and dry cleaning (3B)	1.41	1.31	1.25	1.45	1.88	1.53	1.48	0.892	1.10	0.689
Chemical products, manufacturing and processing (3C)	407	455	569	389	467	505	524	519	528	488
Other (3D)	210	215	224	193	229	260	250	240	225	217
Total products	710	779	910	685	805	869	898	867	863	818
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Paint application (3A)	115	94.7	95.4	89.5	85.2	80.9	67.7	58.4	60.6	53.6
Degreasing and dry cleaning (3B)	0.586	0.251	0.597	0.578	0.481	0.366	0.292	0.433	0.299	0.263
Chemical products, manufacturing and processing (3C)	568	552	541	514	635	742	751	817	773	683
Other (3D)	250	224	242	214	211	227	210	185	189	203
Total products	934	870	879	818	931	1050	1029	1061	1022	940

Continued	2010
Paint application (3A)	49.8
Degreasing and dry cleaning (3B)	0.247
Chemical products, manufacturing and processing (3C)	641
Other (3D)	187
Total products	878

Annex 3D-5 Emissions from other product use, 1990-2010

Table 3D-5 Emissions of CO_2 and N_2O from other product use, 1990-2010.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emission from											
3D1 & 3D4	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Use of fireworks	Gg	0.06	0.07	0.08	0.07	0.08	0.13	0.12	0.09	0.15	0.29
Use of tobacco	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Use of charcoal for BBQ	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	Gg	0.06	0.07	0.08	0.07	0.08	0.13	0.12	0.09	0.15	0.29
N_2O emission from											
3D1 & 3D4	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Use of fireworks	Mg	2.47	3.28	3.54	3.13	3.80	5.80	5.32	4.19	6.82	12.91
Use of tobacco	Mg	0.74	0.70	0.70	0.67	0.66	0.66	0.64	0.65	0.64	0.65
Use of charcoal for BBQ	Mg	0.22	0.19	0.29	0.21	0.18	0.24	0.30	0.40	0.31	0.33
Total	Mg	3.43	4.16	4.53	4.01	4.64	6.70	6.27	5.24	7.77	13.89
CO_2-eqvivalents	Gg	1.12	1.36	1.48	1.31	1.52	2.21	2.06	1.72	2.56	4.60
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 emission from											
3D1 & 3D4	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Use of fireworks	Gg	0.21	0.17	0.20	0.26	0.37	0.16	0.18	0.19	0.19	0.23
Use of tobacco	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Use of charcoal for BBQ	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	Gg	0.21	0.17	0.20	0.26	0.37	0.16	0.18	0.19	0.19	0.23
N_2O emission from											
3D1 & 3D4	Mg	2.06	7.76	8.59	13.3	19.1	34.2	35.6	40.7	33.0	45.8
Use of fireworks	Mg	9.39	7.41	9.17	11.71	16.72	7.13	8.15	8.66	8.45	10.41
Use of tobacco	Mg	0.65	0.62	0.61	0.65	0.65	0.62	0.63	0.60	0.59	0.58
Use of charcoal for BBQ	Mg	0.40	0.33	0.49	0.60	0.49	0.45	0.62	0.36	0.31	0.41
Total	Mg	12.5	16.1	18.9	26.3	37.0	42.4	45.0	50.3	42.4	57.2
CO_2-eqvivalents	Gg	4.09	5.17	6.05	8.40	11.8	13.3	14.1	15.8	13.3	18.0

Continued		2010
CO_2 emission from		
3D1 & 3D4	Gg	NO
Use of fireworks	Gg	0.23
Use of tobacco	Gg	NO

Continued		
Use of charcoal for BBQ	Gg	NO
Total	Gg	0.23
N_2O emission from		
3D1 & 3D4	Mg	34.3
Use of fireworks	Mg	10.49
Use of tobacco	Mg	0.56
Use of charcoal for BBQ	Mg	0.25
Total	Mg	45.6
CO_2-eqvivalents	Gg	14.4

Annex 3D-6 Activity data for other product use, 1990-2010

Table 3D-6 Activity data for the national use of other products, 1990-2010

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3D1 & 3D4	Gg	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fireworks	Gg	1.3	1.7	1.8	1.6	2.0	3.0	2.8	2.2	3.5	6.7
Tobacco	Gg	11.5	10.8	10.9	10.4	10.3	10.3	9.9	10.1	10.0	10.1
BBQ	Gg	7.2	6.2	9.5	7.1	6.0	7.9	10.2	13.5	10.2	11.0
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3D1 & 3D4	Gg	0.00206	0.00776	0.00859	0.0133	0.0191	0.0342	0.0356	0.0407	0.0330	0.0458
Fireworks	Gg	4.9	3.8	4.7	6.1	8.6	3.7	4.2	4.5	4.4	5.4
Tobacco	Gg	10.1	9.6	9.5	10.1	10.1	9.6	9.7	9.3	9.2	9.0
BBQ	Gg	13.4	10.9	16.4	20.0	16.2	14.9	20.6	12.2	10.4	13.7
Continued		2010									
3D1 & 3D4	Gg	0.0343									
Fireworks	Gg	5.4									
Tobacco	Gg	8.8									
BBQ	Gg	8.4									

Annex 3E - Agriculture

Table 1 Changes in housing type 1990 – 2010 – **Cattle.**

Dairy cattle:

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy cattle	Tethered with urine and solid manure	35	31	18	6	6	7	6	5	5
	Tethered with slurry	44	42	28	14	12	10	9	7	7
	Loose-holding with beds, slatted floor	13	17	34	43	43	42	44	45	45
	Loose-holding with beds, slatted floor, scrape	1	1	3	11	15	13	14	14	14
	Loose-holding with beds, solid floor	4	3	6	16	15	20	20	21	21
	Loose-holding with beds, drained floor	0	0	0	0	0	0	0	0	0
	Loose-holding with beds, solid floor with tilt	0	0	0	0	0	1	1	2	2
	Deep litter (all)	0	0	0	1	2	2	2	2	2
	Deep litter, long eating space, solid floor	1	1	3	2	2	1	1	1	1
	Deep litter, slatted floor	2	5	7	5	4	2	2	2	2
	Deep litter, slatted floor, scrape	0	0	1	1	2	2	2	2	2

Heifers:

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Heifer calves, 0-6 mth.	Deep litter (boxes)	100	100	100	85	91	96	96	96	96
	Deep litter, solid floor	0	0	0	15	9	4	4	4	4
Heifer, 6 mth.-calving	Tethered with urine and solid manure	19	14	9	6	7	7	6	6	6
	Tethered with slurry	19	14	9	4	3	2	2	2	2
	Slatted floor-boxes	40	35	32	32	36	39	37	35	35
	Loose-housing with beds, slatted floor	4	7	14	19	16	12	14	16	16
	Loose-housing with beds, slatted floor, scrape	0	0	0	2	3	5	6	6	6
	Loose-housing with beds, solid floor	0	0	0	2	3	5	6	6	6
	Deep litter (all)	3	1	0	8	15	23	22	22	22
	Deep litter, long eating space, solid floor	1	2	3	2	2	2	2	2	2
	Deep litter, solid floor	9	19	25	19	10	1	1	1	1
	Deep litter, slatted floor	4	7	6	4	3	2	2	2	2
	Deep litter, slatted floor, scrape	1	1	2	2	2	2	2	2	2

Table 1 - *Continued* - Changes in housing type 1990 – 2010 – **Cattle.**

Bulls:

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Bull calves, 0-6 mth.	Deep litter (boxes)	100	100	100	84	90	97	97	97	97
	Deep litter, solid floor	0	0	0	16	10	3	3	3	3
Bull, 6 mth - 440 kg	Tethered with urine and solid manure	20	14	10	6	5	4	4	3	3
	Tethered with slurry	20	14	10	5	3	1	1	1	1
	Slatted floor-boxes	41	37	33	29	30	30	30	27	27
	Deep litter (all)	3	1	0	19	38	57	58	61	61
	Deep litter, long eating space, solid floor	1	3	3	2	1	1	1	1	1
	Deep litter, solid floor	10	20	33	34	19	5	4	4	4
	Deep litter, slatted floor	4	9	9	4	3	1	1	2	2
	Deep litter, slatted floor, scrape	1	2	2	1	1	1	1	1	1

Suckling cattle:

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Suckling cattle	Tethered with urine and solid manure	10	10	9	9	14	18	16	15	15
	Tethered with slurry	0	0	0	3	6	9	9	9	9
	Deep litter (all)	73	55	45	51	58	66	68	68	69
	Deep litter, long eating space, solid floor	0	0	0	0	1	1	1	1	1
	Deep litter, solid floor	17	35	46	35	19	2	2	3	3
	Deep litter, slatted floor	0	0	0	1	1	1	1	1	1
	Deep litter, slatted floor, scrape	0	0	0	1	1	2	2	2	2
	Boxes with sloping bedded floor	0	0	0	0	0	1	1	1	0

Table 1 - *Continued* Changes in housing type 1990 – 2010 **– Swine.**

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Sows	Full slatted floor	11	15	17	14	14	14	14	15	15
	Partly slatted floor	56	59	59	65	70	76	77	77	77
	Solid floor	29	16	6	4	3	2	1	1	1
	Deep litter	4	5	7	5	3	1	2	1	1
	Deep litter + slatted floor	0	2	4	6	5	5	4	4	4
	Deep litter + solid floor	0	2	4	4	3	1	1	1	1
	Outdoor sows	0	1	3	2	2	1	1	1	1
Weaners	Fully slatted floor	54	51	38	29	27	26	23	22	22
	Partly slatted floor	20	31	47	57	60	63	67	68	68
	Solid floor	21	11	5	4	3	1	1	0	0
	Deep litter (to-climate housings)	5	5	5	4	4	3	2	2	2
	Deep litter + slatted floor	0	2	5	0	0	0	0	0	0
	Partly slatted and drained floor	0	0	0	6	6	7	7	8	8
Fattening pigs	Fully slatted floor	51	60	58	53	53	53	53	54	54
	Partly slatted floor	23	24	31	0	0	0	0	0	0
	Solid floor	22	11	5	3	4	4	3	2	2
	Deep litter	4	3	1	2	3	4	3	2	2
	Partly slatted floor and partly deep litter	0	2	5	4	2	1	0	0	0
	Partly slatted and drained floor	0	0	0	38	38	38	41	42	42

Table 1 - *Continued* Changes in housing type 1990 – 2010 – **Poultry.**

Livestock categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
Free-range hens	0	5	9	8	6	6	6	6	7
Organic hens	0	3	12	14	14	15	16	15	15
Barn hens	5	15	17	25	24	20	19	19	17
Battery hens, manure shed	24	26	29	32	36	39	42	44	45
Battery hens, manure tank	13	8	5	5	6	8	8	7	7
Battery hens, manure cellar	58	43	28	16	14	12	9	9	9
Hens for production of brood egg	100	100	100	100	100	100	100	100	100
Pullet, consumption, net	17	12	8	6	6	7	7	7	7
Pullet, consumption, floor	57	63	69	70	72	73	84	78	78
Pullet, brood egg, floor	26	25	23	24	22	20	9	15	15
Broilers, (conv. 30 days)	0	0	0	0	0	1	0	0	0
Broilers, (conv. 32 days)	0	0	0	4	5	1	2	7	3
Broilers, (conv. 35 days)	0	0	0	45	41	45	49	57	76
Broilers, (conv. 40 days)	100	100	100	49	54	53	49	36	21
Broilers, (conv. 45 days)	0	0	0	2	0	0	0	0	0
Broilers, barn (56 days)	0	0	0	0	0	0	0	0	0

Organic broilers (81 days)	0	0	0	0	0	0	0	0	0
Turkey, male	50	50	50	50	50	50	50	50	50
Turkey, female	50	50	50	50	50	50	50	50	50
Ducks	100	100	100	100	100	100	100	100	100
Geese	100	100	100	100	100	100	100	100	100
Pheasant	100	100	100	100	100	100	100	100	100

Table 1 - *Continued* Changes in housing type 1990 – 2010 - **Fur farming**.

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Mink	Slurry system	18	25	42	73	81	88	92	95	97
	Solid manure and urine	82	75	58	27	19	12	8	5	3
Foxes	Slurry system	0	0	2	0	0	0	0	0	0
	Solid manure and urine	100	100	98	100	100	100	100	100	100

Table 1 - *Continued* Changes in housing type 1990 – 2010 - **Horses, sheep, goats and ostrich**.

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Horses, sheep, goats, ostrich	Deep litter	100	100	100	100	100	100	100	100	100

Table 1 - *Continued* Changes in housing type 1990 – 2010 - **Deer and pheasant**.

Livestock categories	Housing type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Deer and pheasant	Pasture	100	100	100	100	100	100	100	100	100

Reference: 1990 – 2004 = The Danish Agricultural Advisory Service, 2005-2009 = The Danish Plant Directorate.

Table 2 Number of animals allocated on subcategories for 1990-2010, 1 000 head.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy Cattle	753	702	636	564	550	545	558	563	568
Non-Dairy Cattle									
Bulls 0-6	217	190	150	132	124	133	125	117	132
Bulls 6-	263	213	176	142	137	154	139	145	141
Heifers 0-6	225	215	185	148	143	144	151	151	156
Heifers 6-	695	647	598	483	480	484	485	468	473
Suckling Cattle	87	122	125	101	100	106	107	96	101
Sheep	92	81	112	126	128	124	117	116	111
Goats									
Meat goat	7	7	8	5	6	8	10	11	10
Milk goat	IE	IE	IE	4	3	2	4	4	5
Mohair goat	IE	IE	IE	2	3	3	1	1	1
Horses									
< 300 kg	IE	IE	IE	44	45	46	48	44	41
300-500 kg	80	84	89	60	61	63	65	60	56
500-700 kg	51	54	57	67	68	70	72	67	63
> 700 kg	4	4	5	5	5	6	6	5	5
Swine									
Sows	904	1 015	1 083	1 151	1 127	1 148	1 059	1 088	1 117
Weaners	4 881	5 613	5 330	6 165	6 142	6 268	5 893	5 882	6 166
Fattening pigs	3 712	4 456	5 508	6 218	6 092	6 307	5 785	5 399	5 890
Poultry									
Hens	4 381	4 366	3 720	3 241	2 818	3 223	3 590	3 345	3 970
Pullets	1 315	1 723	1 216	1 928	1 084	986	1 384	1 092	1 278
Broilers	9 802	12 585	16 047	11 905	12 924	11 758	9 737	14 787	12 836
Other poultry	750	946	849	456	423	418	396	382	431
Pheasant									
Pheasant hen	63	63	63	63	63	63	63	63	63
Pheasant chicken	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Ostrich									
Ostrich hen	NO	0.11	0.30	0.12	0.12	0.02	0.02	0.01	0.01
Ostrich chicken	NO	3.2	8.6	3.5	3.5	0.6	0.4	0.3	0.3
Fur Farming									
Mink	2 233	1 834	2 188	2 547	2 704	2 832	2 807	2 720	2 657
Foxes	31	16	11	5	4	5	3	1	2
Deer	10	10	10	10	10	10	10	9	10

IE = Included else ware (mane category).

Table 3 (a-d) NH_3 emission factors for housing units, 2010.

a) **Cattle**

		Urine	Slurry	Solid manure	Deep litter manure
		TAN	TAN	Total N	Total N
Housing type		Pct. loss of TAN ex animal		pct. loss of N ex animal	
Tethered	urine and solid manure	10	-	5	-
	slurry manure	-	6	-	-
Loose-housing with beds	slatted floor	-	16	-	-
	slatted floor and scrape	-	12	-	-
	solid floor	-	20	-	-
	drained floor	-	8	-	-
	solid floor with tilt and scrape	-	8	-	-
	solid floor with tilt	-	12	-	-
Deep litter	All	-	-	-	6
	solid floor	-	-	-	6
	slatted floor	-	16	-	6
	slatted floor and scrape	-	12	-	6
	solid floor and scrape	-	20	-	6
Boxes	sloping bedded floor	-	16	-	-
	slatted floor	-	16	-	-

b) **Swine**

			Urine	Slurry	Solid manure	Deep litter
			TAN	TAN	Total N	Total N
	Housing type	Floor or manure type	Pct. loss of TAN ex animal		pct. loss of N ex animal	
Sows	Individual, mating and gestation	Partly slatted floor	-	13	-	-
		Full slatted floor	-	19	-	-
		Solid floor	21	-	16	-
	Group, mating and gestation	Deep litter	-	-	-	15
		Deep litter + slatted floor	-	16	-	15
		Deep litter + solid floor	-	19	-	15
		Partly slatted floor	-	16	-	-
	Farrowing crate	Full slatted floor	-	13	-	-
		Partly slatted floor	-	26	-	-
	Farrowing pen	Solid floor	20	-	15	-
		Partly slatted floor	-	22	15	-
Weaners		Full slatted floor	-	24	-	-
		Drained + partly slatted floor	-	21	-	-
		Deep litter (to-clima stables)	-	10	-	15
		Solid floor	37	-	25	-
		Deep litter	-	-	-	15
Fattening pigs		Partly slatted floor (50-75 % solid)	-	13	-	-
		Partly slatted floor (25-49% solid)	-	17	-	-
		Drained + partly slatted floor	-	21	-	-
		Full slatted floor	-	24	-	-
		Solid floor	27	-	18	-
		Deep litter, divided	-	18	-	15
		Deep litter	-	-	-	15

c) **Poultry**

			Solid manure Total N	Deep litter Total N
	Housing type	Floor or manure type	pct. loss of N ex animal	
Hens and pullets	Free-range, organic and barn	Deep pit	40	25
		Deep litter	-	28
		Manure belt	10	25
	Battery	Deep pit	12	-
		Manure belt	10	-
Broilers	Conventional	Deep litter	-	20
	Organic and barn	Deep litter	-	25
Turkeys, ducks and geese		Deep litter	-	20

d) **Other**

	Urine TAN	Slurry TAN	Solid manure Total N	Deep litter Total N
	Pct. loss of TAN ex animal		pct. loss of N ex animal	
Fur animals	35	47	35	-
Horses, sheep and goats	-	-	-	15

Table 4 NH_3 emission factors for storage units, 2010

			Urine	Slurry[1]	Solid manure	Deep litter	Pct. of solid manure stored in heap on field
Cattle		Total N	2	2.1	4	1	35
		TAN	2.2	3.5	-	-	-
Pigs	Sows	Total N	2	2.4	19	6.5	50
		TAN	2.2	2.9	-	-	-
	Weaners	Total N	2	2.4	19	9.8	-
		TAN	2.2	2.9	-	-	-
	Fattening pigs	Total N	2	2.4	19	9,8	75
		TAN	2.2	2.9	-	-	-
Poultry	Hens and pullets	Total N	-	2	7.5	4.8	95
	Broilers	Total N	-	-	11.5	6.8	85
	Turkeys, ducks, and geese	Total N	-	-	-	6.8, 8(Turkeys)	-
Fur animals		Total N	0	3.1	11.5	-	-
		TAN	0	3.1	-	-	-
Sheep and goats		Total N	-	-	-	4	-
Horses		Total N	-	-	-	4	-

Table 5 Parameters for winter feeding plans

		Feeding code* PDIR (2002)	% dm*	% Crude protein*	% Raw fat*	% Raw ashes*	% Carbonhydrates	FU/kg dm*	kg dm/day**	MJ/day	GE_{FU}
Heifers:	Straw	781	85.0	4.0	1.9	4.5	89.6	0.2	33.4	571.8	
	Maize silage	593	31.0	8.7	2.2	4.2	84.9	0.9	57.5	1 009.0	
	Toasted soya	155	87.5	49.1	3.2	7.4	40.3	1.4	8.1	161.7	
	Total	-	-	-	-	-	-	-	99.0	1 742.4	25.8
Suckling cows:	Straw	781	85.0	4.0	1.9	4.5	89.6	0.2	1.6	119.1	
Periode 1 (2 mth)	Toasted soya	155	87.5	49.1	3.2	7.4	40.3	1.4	3.4	49.6	
	Barley	201	85.0	11.2	2.9	2.2	83.7	1.1	1.8	29.2	
Periode 2 (4 mth)	Straw	781	85.0	4.0	1.9	4.5	89.6	0.2	3.2	238.2	
	Toasted soya	155	87.5	49.1	3.2	7.4	40.3	1.4	3.0	29.1	
	Barley	202	85.0	11.2	2.9	2.2	83.7	1.1	3.2	52.0	
	Total	-	-	-	-	-	-	-	15.2	517.1	34.0
Horses:	Straw	781	85.0	4.0	1.9	4.5	89.6	0.2	4.0	58.2	
	Hay	665	85.0	12.1	2.6	7.7	77.6	0.6	3.0	44.0	
	Oat	202	86.0	12.1	5.7	2.7	79.5	0.9	2.5	40.1	
	Supplemental		86.4	15.4	4.3	6.6	73.7	1.0	1.0	15.5	
	Total	-	-	-	-	-	-	-	-	157.7	29.8
Sheep and Goats:	Straw	781	85.0	4.0	1.9	4.5	89.6	0.2	1.0	14.6	
	Toasted soya	155	87.5	49.1	3.2	7.4	40.3	1.4	0.1	1.8	
	Barley	202	85.0	11.2	2.9	2.2	83.7	1.1	0.4	6.2	
	Grass pills (dried)	707	92.0	17.0	3.1	11.0	68.9	0.6	1.0	15.7	
	Total	-	-	-	-	-	-	-	-	38.2	30.0
Summer grazing											
Grazing	Clover grass, 2 weeks old	422	18.0	22.0	4.1	9.4	64.5	1.0	1.0	18.8	
	Total	-	-	-	-	-	-	-	1.0	18.8	18.8
Swine:	Full feeding										
	Sows	-	87.1	16.1	5.2	5.5	73.2	1.2	-	64.2	17.5
	Weaners	-	87.4	18.8	5.7	5.5	70.0	1.3	-	2.1	16.5
	Fattening pigs	-	86.9	17.0	4.7	5.1	73.3	1.2	-	9.6	17.3

Table 6 Energy factors used for GE.

	MJ per kg dm
$E_{Crude\ protein}$	24.237
$E_{Raw\ fat}$	34.116
$E_{Carbonhydrates}$	17.3

Table 7 Feed intake 1990-2010, FU per animal per year.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy cattle	5 549	5 896	5 941	6 557	6 620	6 683	6 687	6 845	6 878
Non-dairy cattle:									
Calves, bull	1 190	1 200	1 205	1 228	1 225	1 227	1 230	1 230	1 230
Calves, heifer	1 734	1 743	1 728	1 820	1 931	2 043	2 043	2 040	2 041
Bulls > ½ year	1 995	2 082	1 846	2 275	2 331	2 228	2 382	2 178	2 227
Heifer > ½ year	1 721	1 735	1 737	1 851	1 951	2 048	2 048	2 046	2 045
Suckling cattle	2 515	2 515	2 515	2 378	2 378	2 417	2 417	2 417	2 417
Sheep (mother sheep incl. lambs)	728	728	728	728	728	728	728	728	728
Goats (mother goats incl. kids)	669	669	669	655	654	653	664	664	664
Horses	1 995	1 995	1 995	1 996	1 996	1 995	1 995	1 995	1 996
Swine:									
Sows (incl. pigs < 7.4 kg)	1 300	1 300	1 340	1 450	1 470	1 490	1 484	1 500	1 520
Weaners (7.4 – 32 kg)	128	167	209	206	217	217	244	229	222
Fattening pigs (32 – 107 kg)	1 015	950	826	790	806	796	813	816	756
Other:									
Deer	668	668	668	668	668	668	668	668	668

Table 8 Grazing animals 1990 – 2010, number of days on grass pr year.

Livestock category	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy cattle	55	55	55	32	25	18	18	18	18
Heifer > ½ year	165	196	196	156	144	132	132	132	132
Suckling cattle	184	224	224	224	224	224	224	224	224
Sheep and goats	265	265	265	265	265	265	265	265	265
Horses	183	183	183	183	183	183	183	183	183

Table 9a Average gross energy intake (GE) 1990 – 2010, MJ pr head pr day.

Livestock category	1990	1995	2000	2005	2006	2007	2008	2009	2010
Dairy cattle	278.2	295.6	297.9	328.7	331.9	335.1	335.3	343.2	344.8
Non-dairy cattle (heifer)	107.2	105.2	105.2	115.6	123.1	130.5	130.5	130.3	130.3
Sheep (mother sheep incl. lambs)	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6
Goats (mother goats incl. kids)	40.1	40.1	40.1	39.2	39.2	39.1	39.8	39.8	39.8
Horses	133.0	133.0	133.0	133.0	133.0	133.0	133.0	133.0	133.0
Swine (fattening pigs)	43.3	38.9	38.1	38.9	39.9	40.7	39.9	40.4	40.3
Poultry	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0
Other:									
Deer	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5
Fur farming	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ostrich	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0
Pheasant	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0

Table 9b Average gross energy intake (GE) 1990 – 2010, MJ pr head pr day – Subcategories for cattle and swine.

Subcategories for cattle and swine	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cattle									
Dairy, large breed	285.8	302.4	304.1	335.9	338.7	341.5	341.8	350.2	351.7
Dairy, Jersey	237.2	250.7	253.2	278.8	284.7	290.5	290.6	296.3	299.1
Calves, bull	59.6	60.2	60.4	61.6	61.4	61.5	61.7	61.7	61.7
Calves, heifer	86.5	87.2	86.5	91.3	96.8	102.4	102.4	102.3	102.3
Bulls > ½ year	113.6	114.3	114.7	115.8	115.9	115.8	116.0	116.2	116.3
Heifer > ½ year	107.2	105.2	105.2	115.6	123.1	130.5	130.5	130.3	130.3
Suckling cattle	181.6	170.2	170.2	160.9	160.9	163.6	163.6	163.6	163.6
Swine									
Sows (incl. pigs < 7.4 kg)	62.3	62.3	64.2	69.5	70.4	71.4	71.1	71.9	72.8
Weaners (7.4 – 32 kg)	11.1	13.2	13.8	13.8	14.4	14.6	15.2	14.3	14.1
Fattening pigs (32 – 107 kg)	43.3	38.9	38.1	38.9	39.9	40.7	39.9	40.4	40.3

Table 10a VS daily excretion (average) 1990 – 2010, kg dm pr head pr day – CRF categories.

365 housing days	1990	1995	2000	2005	2006	2007	2008	2009	2010
Livestock category									
Dairy cattle	5.54	5.70	6.03	6.59	6.47	6.13	6.07	6.21	6.23
Non-dairy cattle (weighted average)	1.72	1.89	2.01	2.69	2.74	2.75	2.75	2.76	2.76
Sheep (mother sheep incl. lambs)	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Goats (mother goats incl. kids)	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.07
Horses	3.67	3.67	3.67	3.65	3.65	3.65	3.65	3.65	3.65
Swine (weighted average)	0.23	0.22	0.22	0.22	0.22	0.22	0.21	0.21	0.20
Poultry (weighted average)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Fur farming	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Deer	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72

Table 10b VS daily excretion (average) 1990 – 2010, kg dm pr head pr day – Subcategories.

365 housing days	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cattle:									
Dairy cattle	5.54	5.70	6.03	6.59	6.47	6.13	6.07	6.21	6.23
Calves, bull	1.49	1.50	1.51	1.53	1.53	1.53	1.53	1.53	1.53
Bulls > ½ year	1.77	2.29	2.74	3.40	3.62	3.83	3.89	4.03	4.04
Calves, heifer	1.30	1.30	1.31	1.69	1.70	1.80	1.80	1.80	1.80
Heifer > ½ year	1.81	2.07	2.18	2.72	2.73	2.84	2.82	2.80	2.80
Suckling cattle	6.72	5.67	5.64	5.46	5.28	4.14	4.19	4.22	4.23
Swine:									
Sows (incl. pigs < 7.4 kg)	0.53	0.55	0.62	0.62	0.54	0.47	0.46	0.46	0.45
Piglets (7.4 – 32 kg)	0.11	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.10
Slaughtering pigs (32 – 107 kg)	0.34	0.33	0.32	0.34	0.34	0.35	0.33	0.33	0.33
Poultry:									
Hens	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Pullet	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Broilers	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Turkeys, geese and ducks	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02

Table 11 Basic data from Sommer et al.(2001) used to estimation of lower emission of N_2O and CH_4 from biogas treated slurry.

CH_4 (housing + storage).					
	Reference situation	Biogas scenario I	Difference	Reduction potential	Lower emission compared with the reference situation
	kg CO_2-eqv/kg VS excreted	Pct.	Pct.		
Cattle	1.1458	0.8778	0.2680	23	77
Pigs	1.1481	0.6864	0.4617	40	60
N_2O (field)					
	Reference situation	Biogas scenario I	Difference	Reduction potential	Lower emission compared with the reference situation
	kg CO_2-eqv/kg VS excreted	Pct.	Pct.		
Cattle	0.1624	0.1032	0.0592	36	64
Pigs	0.2127	0.1258	0.0869	41	59

Reference: Sommer et al., 2001 (see appendix 3 page 50).

Calculation example of CH_4 emission form biogas treated slurry:

Reference situation (whiteout biogas treatment): 0.7236+0.4222 = 1.1458 kg CO_2-eqv/kg VS ex

Biogas scenario I (biogas treatment): 0.7236+0.0770+0.0772 = 0.8778 kg CO_2-eqv/kg VS ex

Reduction potential: (1.1458-0.8778) = 0.2680 → 0.2680/(1.1458*100%) = 23 %

This leads to an emission from treated cattle slurry which is 77 % compared with untreated slurry

Table 12a Calculation of lower CH_4 emission as a consequence of biogas treated slurry.

Year	Biogas treated slurry, 1000 Gg	Cattle slurry, 1000 Gg	Pig slurry, 1000 Gg	VS cattle slurry, 1000 Gg	VS pig slurry, 1000 Gg	CH_4 emission, untreated cattle slurry, Gg	CH_4 emission, treated cattle slurry, Gg	Lower CH_4 emission, cattle slurry, Gg	CH_4 emission, untreated pig slurry, Gg	CH_4 emission, tretaed pig slurry, Gg	Lower CH_4 emission, pig slurry, Gg	**Lower CH_4 emission total, Gg**
1990	0.19	0.09	0.10	0.007	0.005	0.113	0.087	0.026	0.154	0.092	0.062	**0.088**
1991	0.32	0.14	0.18	0.012	0.009	0.191	0.146	0.045	0.259	0.155	0.104	**0.149**
1992	0.39	0.18	0.21	0.014	0.010	0.233	0.178	0.054	0.316	0.189	0.127	**0.181**
1993	0.46	0.21	0.25	0.017	0.012	0.274	0.210	0.064	0.372	0.223	0.150	**0.214**
1994	0.54	0.24	0.30	0.020	0.014	0.322	0.247	0.075	0.437	0.261	0.176	**0.251**
1995	0.64	0.29	0.35	0.024	0.017	0.382	0.292	0.089	0.518	0.310	0.208	**0.298**
1996	0.69	0.31	0.38	0.026	0.019	0.411	0.315	0.096	0.558	0.334	0.225	**0.321**
1997	0.83	0.37	0.46	0.031	0.022	0.495	0.379	0.116	0.672	0.402	0.270	**0.386**
1998	1.01	0.45	0.56	0.037	0.027	0.602	0.461	0.141	0.817	0.489	0.329	**0.470**
1999	1.04	0.47	0.57	0.039	0.028	0.620	0.475	0.145	0.842	0.503	0.338	**0.483**
2000	1.16	0.52	0.64	0.043	0.031	0.692	0.530	0.162	0.939	0.561	0.377	**0.539**
2001	1.26	0.57	0.69	0.047	0.034	0.751	0.576	0.176	1.020	0.610	0.410	**0.586**
2002	1.44	0.65	0.79	0.053	0.039	0.859	0.658	0.201	1.165	0.697	0.469	**0.669**
2003	1.76	0.79	0.97	0.065	0.047	1.049	0.804	0.245	1.424	0.851	0.573	**0.818**
2004	1.88	0.85	1.03	0.070	0.050	1.121	0.859	0.262	1.521	0.910	0.612	**0.874**
2005	1.93	0.87	1.06	0.072	0.052	1.151	0.882	0.269	1.562	0.934	0.628	**0.897**
2006	2.14	0.96	1.18	0.079	0.057	1.276	0.978	0.298	1.732	1.035	0.696	**0.995**
2007	2.15	0.97	1.18	0.080	0.058	1.282	0.982	0.300	1.740	1.040	0.700	**1.000**
2008	2.19	0.99	1.20	0.081	0.059	1.306	1.000	0.305	1.772	1.060	0.713	**1.018**
2009	2.39	1.08	1.31	0.089	0.064	1.425	1.092	0.333	1.934	1.156	0.778	**1.111**
2010	2.39	1.08	1.31	0.089	0.064	1.425	1.092	0.333	1.934	1.156	0.778	**1.111**

Table 12b Calculation of lower N_2Oemission as a consequence of biogas treated slurry.

Year	Biogas treated slurry, 1000 Gg	Cattle slurry, 1000 Gg	Pig slurry, 1000 Gg	N_2O emission, untreated cattle slurry, Gg	N_2O emission treated cattle slurry, Gg	Lower N_2O emission, cattle slurry, Gg	N_2O emission untreated pig slurry, Gg	N_2Oemission treated pig slurry, Gg	Lower N_2O emission, pig slurry, Gg	**Lowe N_2O emission total, Gg**
1990	0.19	0.09	0.10	0.006	0.004	0.002	0.007	0.004	0.003	**0.005**
1991	0.32	0.14	0.18	0.010	0.006	0.004	0.012	0.007	0.005	**0.008**
1992	0.39	0.18	0.21	0.012	0.008	0.004	0.015	0.009	0.006	**0.010**
1993	0.46	0.21	0.25	0.014	0.009	0.005	0.017	0.010	0.007	**0.012**
1994	0.54	0.24	0.30	0.016	0.010	0.006	0.020	0.012	0.008	**0.014**
1995	0.64	0.29	0.35	0.019	0.012	0.007	0.024	0.014	0.010	**0.017**
1996	0.69	0.31	0.38	0.021	0.013	0.008	0.026	0.015	0.010	**0.018**
1997	0.83	0.37	0.46	0.025	0.016	0.009	0.031	0.018	0.013	**0.022**
1998	1.01	0.45	0.56	0.031	0.019	0.011	0.038	0.022	0.015	**0.026**
1999	1.04	0.47	0.57	0.031	0.020	0.011	0.039	0.023	0.016	**0.027**
2000	1.16	0.52	0.64	0.035	0.022	0.013	0.043	0.026	0.018	**0.030**
2001	1.26	0.57	0.69	0.038	0.024	0.014	0.047	0.028	0.019	**0.033**
2002	1.44	0.65	0.79	0.044	0.028	0.016	0.054	0.032	0.022	**0.038**
2003	1.76	0.79	0.97	0.053	0.034	0.019	0.065	0.039	0.027	**0.046**
2004	1.88	0.85	1.03	0.057	0.036	0.021	0.070	0.041	0.029	**0.049**
2005	1.93	0.87	1.06	0.058	0.037	0.021	0.072	0.042	0.029	**0.051**
2006	2.14	0.96	1.18	0.065	0.041	0.024	0.080	0.047	0.033	**0.056**
2007	2.15	0.97	1.18	0.065	0.041	0.024	0.080	0.047	0.033	**0.056**
2008	2.19	0.99	1.20	0.066	0.042	0.024	0.081	0.048	0.033	**0.057**
2009	2.39	1.08	1.31	0.072	0.046	0.026	0.089	0.053	0.036	**0.063**
2010	2.39	1.08	1.31	0.072	0.046	0.026	0.089	0.053	0.036	**0.063**

Table 13 Background data for calculation of N content in nitrogen fixing crops.

Crop	Dry matter content[1]	N-content in dm[1]	Straw yield in pct. of grain yield[2]	Share, root + stubble[3]	Share of N in crop which is fixed[3]	N-fixed
	pct.	pct.	pct.	pct.	pct.	kg N/tonnes harvested
Based on yield						
Field peas, grain	85	3.97		25	75	
Field peas, straw	87	1.15	60			
Legumes grown to maturity, in total						37.3
Lucerne	21	3.04		60	75	7.7
Crops for silage	23	2.64		25	80	6.1
Legumes, marrow-stem kale and green fodder	23	2.64		25	80	6.1
Grass and clover fields as well as fields sown with an under crop	13	4.00		75	90	8.2
Peas for conservation[4]	23	2.64		25	80	6.1
Fields with aftermath	13	4.00		75	90	8.2
Based on area	kg N/ha/year					
Seed of leguminous grass crops:						
Red clover	200					
White clover	180					
Black medick	180					

[1] Feedstuff table (DAAC, 2000)

[2] Kyllingsbæk (2000)

[3] Kristensen (2002) and Kyllingsbæk (2000)

[4] Assumed that peas constitute 80% of the total area

Table 14 Estimated share of nitrogen fixing plants in crops.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999-2010
					pct.					
Cereals for silage										
Share of peas (whole-crop)	30	30	35	35	40	40	45	45	50	50
Share of peas in whole-crop	40	40	40	40	40	40	40	40	40	40
Legumes, marrow-stem kale and other green fodder										
Share with legumes:	60	60	60	60	60	60	60	60	60	60
of which share with peas	40	40	40	40	40	40	40	40	40	40
Peas for conservation	80	80	80	80	80	80	80	80	80	80
Grass in rotation										
Share of clover grass fields	74	76	78	80	82	84	85	86	87	88
Clover percentage in the clover grass fields	20	20	20	20	20	22	24	26	28	30
Grass not in a rotation										
Clover percentage	5	5	5	5	5	5	5	5	5	5
Fields with aftermath										
Share with clover grass	74	76	78	80	82	84	85	86	87	88
Clover percentage	30	30	30	30	30	30	30	30	30	30

Table 15 Area of N-fixing crops 1990-2010, ha

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Legumes to maturity	114 354	74 178	35 590	15 819	11 353	5 639	4 910	6 332	10 349
Lucerne	8 494	10 099	5 245	4 575	3 982	3 682	3 756	5 366	6 405
Crops for silage	47 772	87 893	118 763	75 512	63 998	60 348	52 251	55 848	62 845
Legumes/marrow-stem kale	2 584	2 964	585	NO	NO	NO	NO	NO	NO
Grass and clover in rotation	248 815	238 384	246 656	253 007	270 840	262 429	300 251	305 476	320 914
Grass not in rotation	217 235	207 122	166 261	192 968	189 384	196 630	189 962	191 529	199 859
Fields with catch crop	232 000	236 000	309 100	121 800	115 400	126 000	113 900	115 200	116 600
Peas for conservation	8 791	5 529	4 149	2 999	2 841	2 741	3 592	3 737	2 677
Seeds of leguminous grass crops	2 334	3 835	4 603	5 258	6 274	5 454	4 457	4 542	4 483
Total area of N-fixing crops	882 379	866 004	890 952	671 938	664 072	662 923	673 079	688 030	724 132

NO = Not occurring

Table 16 Background data for estimation of N_2O emission from crop residue 2010.

	Stubble	Husks	Top	Leafs	Nitrogen content in crop residue	
Crop type	kg N pr ha	kg N pr ha	kg N pr ha	kg N pr ha	kg N pr ha pr year	Gg N pr year
Winter wheat	6.3	10.7	-	-	17.0	12.65
Spring wheat	6.3	7.4	-	-	13.7	0.19
Winter rye	6.3	10.7	-	-	17.0	0.87
Triticale	6.3	10.7	-	-	17.0	0.70
Winter barley	6.3	5.9	-	-	12.2	1.74
Spring barley	6.3	4.1	-	-	10.4	4.43
Oats	6.3	4.1	-	-	10.4	0.44
Winter rape	4.4	-	-	-	4.4	0.72
Spring rape	4.4	-	-	-	4.4	0.01
Potatoes (top), non-harvest	-	-	48.7	-	48.7	1.86
Beet (top), non-harvest	-	-	56.7[a]	-	56.7	2.46
Straw, non-harvest	-	-	-	-	6.6[a]	9.70
Pulse	11.3	-	-	-	11.3	0.12
Lucerne	32.3	-	-	-	10.8	0.07
Maize – for green fodder	6.3	-	-	-	6.3	1.08
Cereal – for green fodder	6.3	-	-	-	6.3	0.40
Peas for conservation	11.3	-	-	-	11.3	0.03
Vegetables	11.3	-	-	-	11.3	0.09
Grass field legumes	11.3	-	-	-	5.7	0.03
Grass- and clover field in rotation	32.3		-	10.0	26.2	8.39
Grass- and clover field out of rotation	38.8		-	20.0	20.0	4.00
Catch crop	6.3	-	-	-	6.3	0.73
Seeds of grass crops	6.3	10.7	-	-	13.9	0.81
Set-a-side	38.8	-	-	15.0	18.9	0.19
Total N from crop residue						51.69

[a] express the yield for 2010 - varies from year to year. Based on yield data from Statistics Denmark and N-content from the feeding plan.

Reference: Djurhuus and Hansen 2003.

Table 17 Area of agricultural land, 1990 – 2010, ha.

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Garden centre, fruit & berries	11 687	12 135	11 050	10 682	10 499	10 738	11 106	9 661	9 410
Agriculture crops excl. grass in rotation	2 294 434	2 039 330	2 021 092	2 065 948	2 062 352	2 029 577	2 084 866	2 082 006	2 076 103
Vegetables grown in the open	16 105	12 584	10 628	9 431	9 930	9 818	11 048	11 463	10 720
Permanent grass	217 235	207 122	166 261	192 968	189 384	196 630	189 962	192 433	199 859
Fallow	NO	216 493	191 295	175 200	167 502	153 570	70 662	5 699	9 874
Grass in rotation	248 815	238 384	246 656	253 007	270 840	262 429	300 251	305 889	320 914
Sum	2 788 276	2 726 048	2 646 982	2 707 236	2 710 507	2 662 762	2 667 895	2 607 151	2 626 880

NO = Not occurring.

Nitrogen leaching and Run-off

Calculations of nitrogen lost by leaching from groundwater are based on two models described in Børgesen and Grant (2003) (in Danish). The model SKEP/DAISY is a dynamic model, N-LES is an empirical model and SKEP is an up scaling model. The SKEP/DAISY calculations were done for 10 scenarios (the years 1984, 1989 and 1995-2002) and the N-LES calculations were done for an 11 year period (1990-2000). Both calculations were up scaled nation wide. The key parameters for the models were land use, nitrogen from synthetic fertilizer and manure, application practice for manure and NH_3 evaporation at application of manure (SKEP/DAISY only). The calculations were normalised to an average climate. A schematic overview of the models is seen below.

Figure 1: Model calculation of nitrogen leaching from groundwater nationwide by SKEP/DAISY and N-LES

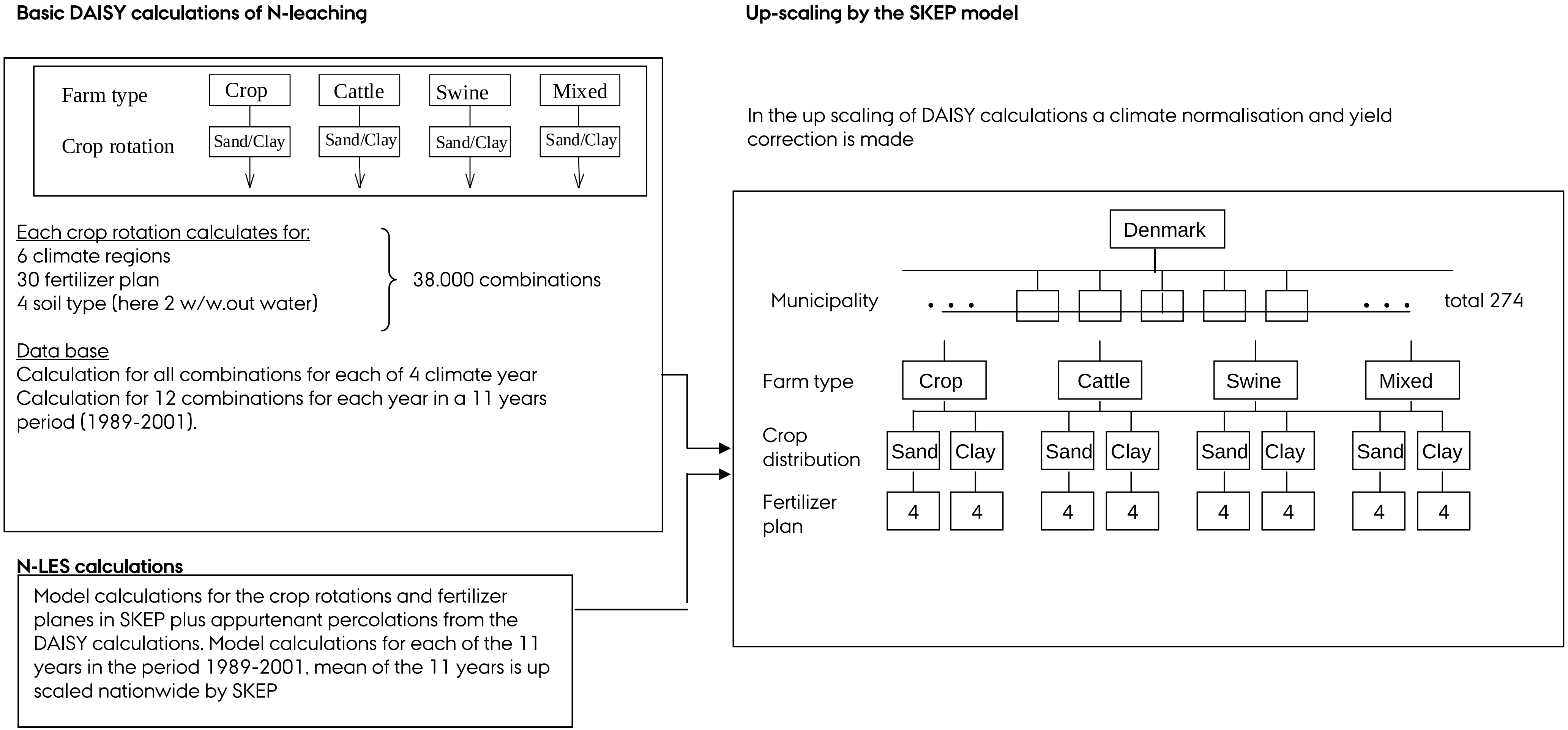

Table 18 QA/QC procedure, stage I - III

Stage I: Check of input data	Variable	Reference
Livestock production	- number of animal	DSt
	- slaugther data	
Normative figures	- N-excretion	DCA
	- use of straw	
	- amount of manure	
	- feed intake	
	- milk yield	
Housing types	- distribution	DAAS + DP
Grazing days		DAAS
Crops	- land use	DSt
	- crop yield	
	- crop production	
Synthetic fertiliser	- N-content	DP
	- fertiliser types	
N-leaching	- amount of nitrogen leached	DCE
Atmospheric deposition	- all NH_3 emission sources	DCE – NH_3 inventory
Sewage sludge and industrial waste	- Amount of sludge applied to soils	EPA + DP
Stage II: Check of IDA data – overall	**Emission source**	**Variable**
Recalculation	- CO_2–eqv. total emission	- compared with latest submission
	- CH_4, N_2O, NMVOC	
	- emission from field burning	
Time series	- CO_2–eqv. total emission	- trends
	- CH_4, N_2O, NMVOC	- jumps and dips
	- emission from field burning	
Stage III: Check of IDA data – specific	**Emission source**	**Variable**
CH_4	- enteric fermentation	- IEF (jumps and dips)
		- Ym (dairy cattle + heifer)
		- GE
CH_4	- manure management	- IEF (jumps and dips)
		- VS
		- biogas
N_2O	- manure management	- trends (jumps and dips)
		- IEF
		- biogas
N_2O	- synthetic fertiliser	- trends (jumps and dips)
		- IEF
N_2O	- animal waste applied to soil	- trends (jumps and dips)
		- IEF
N_2O	- N-fixing crops	- trends (jumps and dips)
		- IEF
N_2O	- crop residue	- trends (jumps and dips)
		- IEF
N_2O	- pasture, range and paddock	- trends (jumps and dips)
		- IEF
N_2O	- atmospheric deposition	- trends (jumps and dips)
		- IEF
N_2O	- N-leaching and run-off	- trends (jumps and dips)
		- IEF
N_2O	- sewage sludge + industrial waste	- trends (jumps and dips)
		- IEF
NMVOC	- crops	- trends (jumps and dips)

Annex 3F - LULUCF

Table 3F.1 Estimation of forest percentage and forest area.

Equation	Description
$X_j = \dfrac{A_j}{A_{15,j}}$	The forest percentage (X) of the *j*th sample plot (SSU) is estimated as the forested area (*A*) divided by the total area of the 15 m radius sample plot ($A_{15,j}$).
$\overline{X}_Z = \dfrac{1}{n_Z}\sum_Z X_j R_j$	Average forest percentage ($\overline{X}$) of all inventoried plots (SSU) with forest status *Z* based on aerial photos. R_j is an indicator variable that is 1 for inventoried plots and 0 otherwise. n_Z is the number of inventoried plots identified as forest or OWL from the air photos.
$\overline{\overline{X}} = \dfrac{1}{n}\left(\sum_{j=1}^{n} X_j R_j + N_{21}\overline{X}_1 + N_{22}\overline{X}_2\right)$	Overall average forest percentage ($\overline{\overline{X}}$). *n* is the total number of inventoried and non-inventoried sample plots. N_{21} and N_{22} is the number of non-inventoried sample plots with forest and OWL, respectively.
$A_{Forest} = \overline{\overline{X}} \cdot A_{Total}$	Total forest area. A_{Total} is the total land area, $\overline{\overline{X}}$ is the estimated forest percentage and A_{Forest} is the total forest area.

Table 3F.2 Estimation of forest area with a specific characteristic.

Equation	Description
$\overline{X}_k = \dfrac{\sum_{j=1}^{n} R_{jk} A_j}{\sum_{j=1}^{n} A_j}$	Proportion of the forest area with a given characteristic ($\overline{X}_k$). R_{jk} is an indicator variable which is 1 if the the forest area on the *j*th sample plots has the *k*'th characteristic and 0 otherwise. A_j is the sample plot area and *n* is the total number of inventoried sample plots with forest cover.
$A_k = \overline{X}_k \cdot A_{Forest}$	Total area with a given characteristic (A_k). $\overline{X}_k$ is the estimated proportion of the forest area with the *k*'th characteristic and A_{Forest} is the total forest area.

Table 3F.3 Estimation of diameter-height equations.

Equation	Description
$h_{ij} = 13 + \left(\bar{h}_j - 13\right) \cdot \exp\left(\alpha_1 \cdot \left(1 - \frac{\bar{d}_j}{d_{ij}}\right) + \alpha_2 \cdot \left(\frac{1}{\bar{d}_j} - \frac{1}{d_{ij}}\right)\right)$	Site specific dh-regression for calculating height of trees not measured for height. h_{ij} and d_{ij} is the height and diameter of the i'th tree on the j'th sample plot. $\bar{h}_j$ and $\bar{d}_j$ are the average height and diameter of trees measured for height on the jth sample plot. α_1 and α_2 are species and growth-region specific parameters
$h_{ij} = 13 + \beta_1 \cdot \exp(-\frac{\beta_2}{d_{ij}})$	General dh-regression for calculating height of trees not measured for height. h_{ij} and d_{ij} is the height and diameter of the i'th tree on the j'th sample plot. β_1 and β_2 are species and growth-region specific parameters

Table 3F.4 Estimation of quadratic mean diameter.

Equation	Description
$g_{ij} = \frac{\pi}{4} d_{ij}^2$	Basal area (g) of the ith tree on the jth plot is calculated from the diameter at breast height (d) (1.3 m above ground) assuming a circular stem form.
$G_j = \sum_{i=1}^{m} \frac{1}{A_{c,ij}} g_{ij}$	Basal area per hectare (G) the jth sample plot is calculated as the scaled sum of individual tree basal areas. Basal area (g) of the ith tree on the jth sample plot is scaled according to the plot area ($A_{c,ij}$) of the cth concentric circle (c=3,5; 10; 15 m).
$N_j = \sum_{i=1}^{m} \frac{1}{A_{c,ij}}$	Stem number per hectare (N) the jth sample plot is calculated as the scaled number of individual trees. The ith tree on the jth sample plot is scaled according to the plot area ($A_{c,ij}$) of the cth concentric circle (c=3,5; 10; 15 m).
$D_{g,j} = \sqrt{\frac{4}{\pi} \frac{G_j}{N_J}}$	The mean squared diameter is calculated from the calculated basal area and stem number for each plot.

Table 3F.5 Estimation of biomass and carbon of trees.

Equation	Description
$v_{ij} = F\left(d_{ij}, h_{ij}, D_{g,j}\right)$	The volume (v) of the ith tree on the jth sample plots is calculated using the existing volume functions (F) using the tree diameter and height and the quadratic mean diameter.
$B_{ij} = V_{ij} \cdot Density_{ij}$	Biomass (B) of the ith tree on the jth sample plot is estimated as the total volume (V_{Tot}) times the species specific density.
$E_{ij} = F\left(d_{ij}, h_{ij}\right)$	Expansion factor model for beech and Norway spruce
$v_{tot,ij} = B_{ij} \cdot E_{ij}$	The total above and below ground volume (v_{tot}) of the ith tree on the jth sample plot. B_{ij} is the calculated above-ground biomass of the tree and E is the expansion factor.
$C_{ij} = B_{ij} \cdot 0.5$	Carbon of the ith tree on the jth sample plot is calculated as the biomass (B) times 0.5.

Table 3F.6 Estimation of total biomass and carbon pools.

Equation	Description
$V_{cj} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_{c,i} v_{ij}$	Volume, biomass or carbon per hectare (V) of the cth concentric circle on the jth sample plot (c=3,5; 10; 15 m). R_c is an indicator variable that is 1 if the ith tree is measured on the cth circle and 0 otherwise. $A_{c,ij}$ is the area of the jth sample plot and cth concentric circle; m is the number of trees on the jth sample plot.
$\overline{V}_c = \frac{\sum_{j=1}^{n} A_{cj} V_{cj}}{\sum_{j=1}^{n} A_{cj}}$	The average area weighted volume, biomass or carbon per hectare ($\overline{V}$) of the cth concentric circle. $A_{c,ij}$ is the area of the jth sample plot and cth concentric circle; n is the number of sample plots.
$\overline{\overline{V}} = \overline{V}_{3,5} + \overline{V}_{10} + \overline{V}_{15}$	The overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_c$) for the three concentric circles (c=3.5, 10 and 15)
$V = \overline{\overline{V}} \cdot A_{Skov}$	Total volume, biomass or carbon V is the overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}$) times the forest area A_{Forest}.

Table 3F.7 Estimation of biomass and carbon with a given characteristic.

Equation	Description
$V_{cj,k} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_{c,ij} R_{k,ij} v_{ij}$	Volume, biomass or carbon per hectare (*V*) with the *k*th characteristic of the *c*th concentric circle on the *j*th sample plot (c=3,5; 10; 15 m). R_c is an indicator variable that is 1 if the *i*th tree is measured on the *c*th circle and 0 otherwise. R_k is an indicator variable that is 1 if the tree has *k*th characteristic and 0 otherwise. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *m* is the number of trees on the *j*th sample plot.
$\overline{V}_{c,k} = \frac{\sum_{j=1}^{n} A_{cj} V_{cj,k}}{\sum_{j=1}^{n} A_{cj}}$	The average area weighted volume, biomass or carbon per hectare ($\overline{V}$) with the *k*th characteristic of the cth concentric circle. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *m* is the number of trees on the *j*th sample plot.
$\overline{\overline{V}}_k = \overline{V}_{3{,}5,k} + \overline{V}_{10,k} + \overline{V}_{15,k}$	The overall average volume, biomass or carbon per hectare with the *k*th characteristic ($\overline{\overline{V}}$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_{c,k}$) for the three concentric circles (*c*=3.5, 10 and 15)
$V_k = \overline{\overline{V}}_k \cdot A_{Forest}$	Total volume, biomass or carbon with the k^{th} characteristic (V_k) is the overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}_k$) times the forest area A_{Forest}.

Table 3F.8 Estimation of biomass and carbon content of dead wood.

Equation	Description
$v_{s,ij} = F\left(d_{s,ij}, h_{s,ij}, D_{g,j}\right)$	The volume (v_s) of the *i*th standing, dead tree on the *j*th sample plots is calculated using the existing volume functions (*F*) using the tree diameter and height and the squared mean diameter.
$v_{l,ij} = \frac{\pi}{4} d_{l,ij}^2 \cdot l_{l,ij}$	Volume of lying dead trees (v_l) is calculated as the length (*l*) and the ith tree on the jth sample plot times the cross sectional area. The cross sectional area is calculated from the mid-diameter (d_l) of the dead wood.
$B_{s,ij} = v_{s,ij} \cdot D_{ij} \cdot r_{k,ij}$ $B_{l,ij} = v_{l,ij} \cdot D_{ij} \cdot r_{k,ij}$	Biomass of the *i*th standing (B_s) or lying (B_l) tree on the jth sample plot is calculated as the volume (v_s or v_l) times the species specific density (*D*) and a the *k*th reduction factor according to the structural decay of the wood observed in the field.
$B_{s,tot,ij} = B_{s,ij} \cdot E_{ij}$	The total above and below ground volume ($B_{s,tot}$) of the *i*th standing, dead tree on the *j*th sample plot. v_s is the calculated biomass of the tree and *E* is the expansion factor.
$K_{s,ij} = B_{s,ij} \cdot 0.5$ $K_{l,ij} = B_{l,ij} \cdot 0.5$	Carbon in standing or lying dead wood (C_s or C_l) is calculated as the biomass (B_s or B_l) times 0.5.

Table 3F.9 Estimation of total biomass and carbon pools of dead wood.

Equation	Description
$$V_{D,cj} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_c v_{s,ij} + R_c v_{l,ij}$$	Deadwood volume, biomass or carbon pools per hectare (V_D) for the *c*th circle and the *j*th sample plot. v_s and v_l is the volume of standing and lying deadwood respectively. R_c is an indicator variable that is 1 if the tree is measured in the *c*th circle and 0 otherwise. A_C is the sample plot area of the *c*th circle. *m* is the number of trees within the *j*th sample plot.
$$\overline{V}_{D,c} = \frac{\sum_{j=1}^{n} A_{cj} V_{cj}}{\sum_{j=1}^{n} A_{cj}}$$	The average area weighted deadwood volume, biomass or carbon per hectare ($\overline{V}_D$) of the cth concentric circle. $A_{c,ij}$ is the area of the jth sample plot and cth concentric circle; *n* is the number of sample plots.
$$\overline{\overline{V}}_D = \overline{V}_{D,3,5} + \overline{V}_{D,10} + \overline{V}_{D,15}$$	The overall average deadwood volume, biomass or carbon per hectare ($\overline{\overline{V}}_D$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_{D,c}$) for the three concentric circles (c=3.5, 10 and 15)
$$V_D = \overline{\overline{V}}_D \cdot A_{Forest}$$	Total deadwood volume, biomass or carbon V_D is the overall average deadwood volume, biomass or carbon per hectare ($\overline{\overline{V}}_D$) times the forest area A_{Forest}.

Table 3F.10 Estimation of forest floor carbon.

Equation	Description
$$C_{floor,s,j} = Depth_j \cdot A_j \cdot B_s \cdot F_{s,j}$$	Forest floor carbon ($C_{floor,s,j}$) of the *s*th species, on the *j*th plot with an area of *A*. B_s is the species specific forest floor density and *F* is the fraction of species *s*.
$$C_{floor,j} = \sum_{s=1}^{k} C_{floor,s,j}$$	Total forest floor carbon on the jth plot.
$$C_{floor} = \frac{\sum_{j=1}^{n} C_{floor,j}}{\sum_{j=1}^{n} A_j} \cdot A_{Forest}$$	Total forest floor carbon is estimated as the area weighted average forest floor carbon content times the total forest area.

Annex 3G - Waste

Annex 3G-1 Emissions from the waste sector, 1990-2010

Table 3G-1.1 Emissions for the waste sector, Gg CO_2 equivalents.

		1990	1991	1992	1993	1994	1995	1996
6 A. Solid Waste Disposal on Land	CH_4	1477	1479	1459	1437	1352	1261	1215
6 B. Wastewater Handling	CH_4	66	66	67	67	68	69	70
6 B. Wastewater Handling	N_2O	109	107	95	113	120	115	98
6 C. Waste incineration	CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6 C. Waste incineration	N_2O	0.20	0.20	0.20	0.21	0.21	0.21	0.21
6 D. Waste Other	CO_2	18	19	20	18	18	20	20
6 D. Waste Other	CH_4	28	31	34	36	39	36	43
6 D. Waste Other	N_2O	11	12	14	15	16	15	18
6. Waste	Total	1764	1771	1750	1754	1690	1610	1572
Continued		1997	1998	1999	2000	2001	2002	2003
6 A. Solid Waste Disposal on Land	CH_4	1127	1054	1061	1050	1044	973	987
6 B. Wastewater Handling	CH_4	72	72	72	74	74	73	75
6 B. Wastewater Handling	N_2O	92	95	92	99	93	108	86
6 C. Waste incineration	CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6 C. Waste incineration	N_2O	0.21	0.21	0.22	0.22	0.22	0.23	0.22
6 D. Waste Other	CO_2	19	18	19	19	19	18	20
6 D. Waste Other	CH_4	48	50	59	62	64	62	65
6 D. Waste Other	N_2O	21	25	34	41	41	50	50
6. Waste	Total	1496	1443	1467	1478	1454	1397	1390
Continued		2004	2005	2006	2007	2008	2009	2010
6 A. Solid Waste Disposal on Land	CH_4	873	846	881	835	805	765	693
6 B. Wastewater Handling	CH_4	74	74	74	75	75	75	75
6 B. Wastewater Handling	N_2O	83	94	81	93	112	81	83
6 C. Waste incineration	CH_4	0.01	0.01	0.01	0.02	0.02	0.02	0.02
6 C. Waste incineration	N_2O	0.23	0.24	0.27	0.28	0.28	0.29	0.29
6 D. Waste Other	CO_2	18	18	19	19	22	21	18
6 D. Waste Other	CH_4	62	66	70	78	72	76	82
6 D. Waste Other	N_2O	30	31	34	39	36	39	43
6. Waste	Total	1240	1227	1254	1235	1210	1144	1079

Annex 3G-2 Solid Waste Disposal on Land, 6A

The following Table 3G-2.1 shows the total waste production in Denmark, divided after means of handling. (DEPA, 1996a, 1998a, 1999a, 2001a, 2001b, 2002a, 2004a, 2004b, 2005a, 2006a, 2006b, 2008, 2010, 2011a)

Table 3G-2.1 All nationally produced waste categorised after handling method, collected for the ISAG database 1994-2009.

Year	Recycled	Combusted	Landfilled		Special Treatment	Temporary Storage	Total
	Gg	Gg	Gg	%	Gg	Gg	Gg
1994	6157	2216	2604	23.4	102	0	11105
1995	7046	2306	1957	17.1	145	0	11466
1996	7787	2507	2507	19.4	95	0	12912
1997	8046	2622	2083	16.2	86	0	12857
1998	7542	2740	1859	15.2	84	0	12233
1999	7815	2929	1467	11.9	17	0	12313
2000	8461	3064	1482	11.4	17	0	13031
2001	8101	3221	1300	10.2	20	109	12768
2002	8382	3344	1174	9.0	22	163	13105
2003	8218	3287	966	7.7	20	108	12614
2004	8746	3437	1000	7.5	16	136	13359
2005	9545	3473	957	6.7	18	191	14210
2006	10768	3489	975	6.3	19	181	15459
2007	10480	3584	956	6.3	20	167	15235
2008	10725	3590	1045	6.7	21	167	15575
2009	9536	3386	753	5.4	18	152	13872

Table 3G-2.2 presents the annual net emission of methane generated from the amount of landfilled waste and deducted the recovered methane and the oxidised methane; calculated using the FOD model.

Table 3G-2.2 Annual amounts of deposited waste, generated methane, recovered methane collected for biogas production, oxidised methane in the top layer and resulting net emission for the Danish SWDS.

Year	Landfilled waste	Generated methane	Recovered methane	Methane oxidised in the top layers	Net methane emission	
	Gg	Gg CH_4	Gg CH_4	Gg CH_4	Gg CH_4	Gg CO_2-eqv
1990	3175	81.5	0.5	8.1	72.8	1530
1991	3032	82.0	0.8	8.1	73.1	1535
1992	2890	82.0	1.5	8.0	72.4	1521
1993	2747	81.5	1.9	8.0	71.7	1505
1994	2604	80.6	5.0	7.6	68.0	1428
1995	1957	79.7	8.0	7.2	64.5	1354
1996	2507	78.9	8.8	7.0	63.0	1323
1997	2083	77.9	12.0	6.6	59.2	1244
1998	1859	76.9	14.2	6.3	56.4	1183
1999	1467	75.5	12.4	6.3	56.8	1192
2000	1482	74.5	11.9	6.3	56.4	1183
2001	1300	72.4	10.8	6.2	55.4	1164
2002	1174	69.5	12.1	5.7	51.7	1085
2003	966	66.5	8.6	5.8	52.1	1095
2004	1000	63.4	11.9	5.1	46.3	973
2005	957	60.4	10.5	5.0	44.9	942
2006	975	57.6	5.9	5.2	46.5	976
2007	956	55.1	5.9	4.9	44.3	931
2008	1045	52.5	5.2	4.7	42.6	894
2009	753	50.1	5.1	4.5	40.5	851
2010	970	47.7	6.6	4.1	37.0	777

The following Tables 3G-2.3a and b, presents activity data for Solid Waste Disposal on Land. As presented, the basis of calculation starts in the year 1960.

Table 3G-2.3a Waste amounts divided between eight waste categories, Gg, 1960-1989

Year	Domestic Waste	Bulky Waste	Garden Waste	Commercial & Office Waste	Industrial Waste	Building & Construction Waste	Sludge	Ash & Slag	Waste Total
1960	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1961	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1962	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1963	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1964	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1965	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1966	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1967	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1968	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1969	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1970	84.6	88.4	66.8	23.7	344.0	713.7	154.8	169.2	1645.3
1971	92.3	96.5	72.9	25.8	375.2	778.6	168.9	184.6	1794.9
1972	100.0	104.5	79.0	28.0	406.5	843.5	183.0	200.0	1944.5
1973	107.7	112.5	85.1	30.2	437.8	908.4	197.1	215.4	2094.1
1974	115.4	120.6	91.2	32.3	469.0	973.3	211.2	230.8	2243.7
1975	123.1	128.6	97.2	34.5	500.3	1038.2	225.2	246.2	2393.2
1976	130.8	136.7	103.3	36.6	531.6	1103.0	239.3	261.5	2542.8
1977	138.5	144.7	109.4	38.8	562.8	1167.9	253.4	276.9	2692.4
1978	146.2	152.7	115.5	40.9	594.1	1232.8	267.5	292.3	2842.0
1979	153.8	160.8	121.5	43.1	625.4	1297.7	281.5	307.7	2991.5
1980	161.5	168.8	127.6	45.2	656.7	1362.6	295.6	323.1	3141.1
1981	169.2	176.8	133.7	47.4	687.9	1427.5	309.7	338.5	3290.7
1982	176.9	184.9	139.8	49.5	719.2	1492.3	323.8	353.8	3440.3
1983	184.6	192.9	145.8	51.7	750.5	1557.2	337.8	369.2	3589.8
1984	192.3	201.0	151.9	53.8	781.7	1622.1	351.9	384.6	3739.4
1985	200.0	209.0	158.0	56.0	813.0	1687.0	366.0	400.0	3889.0
1986	199.8	217.3	143.4	66.7	814.9	1539.9	337.2	427.0	3746.2
1987	199.6	225.7	128.9	77.3	816.8	1392.8	308.4	454.0	3603.4
1988	199.3	234.0	114.3	88.0	818.7	1245.7	279.7	481.0	3460.7
1989	199.1	242.3	99.8	98.7	820.6	1098.6	250.9	508.0	3317.9

Table 3G-2.3b Waste amounts divided between eight waste categories, Gg, 1990-2010

Year	Domestic Waste	Bulky Waste	Garden Waste	Commercial & Office Waste	Industrial Waste	Building & Construction Waste	Sludge	Ash & Slag	Waste Total
1990	198.9	250.7	85.2	109.3	822.4	951.4	222.1	535.0	3175.1
1991	198.7	259.0	70.7	120.0	824.3	804.3	193.3	562.0	3032.3
1992	198.4	267.3	56.1	130.7	826.2	657.2	164.6	589.0	2889.6
1993	198.2	275.7	41.6	141.3	828.1	510.1	135.8	616.0	2746.8
1994	198.0	284.0	27.0	152.0	830.0	363.0	107.0	643.0	2604.0
1995	190.0	286.0	17.0	128.0	779.0	321.0	101.0	135.0	1957.0
1996	132.0	275.0	6.0	135.0	822.0	317.0	117.0	703.0	2507.0
1997	83.0	248.0	6.0	170.0	707.0	264.0	130.0	475.0	2083.0
1998	98.0	234.0	20.0	161.0	746.0	266.0	124.0	210.0	1859.0
1999	117.0	239.0	3.0	164.0	582.0	224.0	126.0	12.0	1467.0
2000	85.0	264.0	7.0	152.0	611.0	269.0	94.0	0.0	1482.0
2001	50.0	180.0	3.0	150.0	583.0	260.0	64.0	10.0	1300.0
2002	37.0	161.0	4.0	137.0	520.0	229.0	48.0	38.0	1174.0
2003	24.0	143.0	4.0	131.0	379.0	170.0	55.0	60.0	966.0
2004	11.0	132.0	5.0	140.0	452.0	172.0	42.0	46.0	1000.0
2005	11.9	164.5	5.4	152.4	352.2	207.7	34.6	28.0	956.7
2006	13.5	156.4	5.7	150.8	375.3	203.9	39.4	30.6	975.5
2007	19.0	146.2	6.4	160.4	364.1	171.9	43.4	44.4	955.6
2008	20.0	109.0	7.0	152.0	389.0	177.0	33.0	158.0	1045.0
2009	12.8	88.3	2.6	121.5	336.5	126.2	25.1	39.7	752.8
2010	16.5	113.8	3.4	156.6	433.7	162.7	32.4	51.1	970.1

The Tables 3G-2.4a, b, c, d, e, f, g and h present the composition (divided in nine waste types) of the landfilled waste in 1985-2008 for the eight different waste categories. Waste compositions for 1960-1984 are kept constant on the 1985 level, and 2009-2010 on the 2008 level.

Carbon content for decomposable waste types and emission factors are also shown in the following tables. For waste types considered inert (DOC_f=0) no information about the carbon content is provided and accordingly the emission factor are set equal to zero.

Table 3G-2.4a Composition of the waste category "Domestic Waste" according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	20%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	66.67	0.00	0.00	0.00	-
1985	0.379	0.017	0.128	0.264	0.068	0.034	0.017	0.047	0.047	1.00
1986	0.337	0.015	0.113	0.235	0.061	0.125	0.015	0.042	0.058	1.00
1987	0.295	0.013	0.099	0.205	0.053	0.216	0.013	0.036	0.069	1.00
1988	0.252	0.011	0.085	0.176	0.045	0.307	0.011	0.031	0.080	1.00
1989	0.210	0.009	0.071	0.147	0.038	0.398	0.009	0.026	0.091	1.00
1990	0.168	0.008	0.057	0.117	0.030	0.489	0.008	0.021	0.102	1.00
1991	0.126	0.006	0.043	0.088	0.023	0.580	0.006	0.016	0.113	1.00
1992	0.084	0.004	0.028	0.059	0.015	0.671	0.004	0.010	0.124	1.00
1993	0.042	0.002	0.014	0.029	0.008	0.763	0.002	0.005	0.135	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.854	0.000	0.000	0.146	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.909	0.000	0.000	0.091	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.924	0.000	0.000	0.076	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.940	0.000	0.000	0.060	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.892	0.000	0.000	0.108	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.962	0.000	0.000	0.038	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.948	0.000	0.000	0.052	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.901	0.000	0.000	0.099	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.788	0.000	0.000	0.212	1.00
2003	0.000	0.000	0.000	0.000	0.000	0.680	0.000	0.000	0.320	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.235	0.000	0.000	0.765	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.278	0.000	0.000	0.722	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.365	0.000	0.000	0.635	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.790	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.094	0.000	0.000	0.906	1.00

Table 3G-2.4b Composition of the waste category "Bulky Waste" according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	40%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	133.33	0.00	0.00	0.00	-
1985	0.000	0.078	0.233	0.000	0.047	0.457	0.085	0.085	0.016	1.00
1986	0.000	0.069	0.207	0.000	0.041	0.452	0.076	0.076	0.080	1.00
1987	0.000	0.060	0.181	0.000	0.036	0.446	0.066	0.066	0.144	1.00
1988	0.000	0.052	0.155	0.000	0.031	0.440	0.057	0.057	0.209	1.00
1989	0.000	0.043	0.129	0.000	0.026	0.434	0.047	0.047	0.273	1.00
1990	0.000	0.034	0.103	0.000	0.021	0.429	0.038	0.038	0.337	1.00
1991	0.000	0.026	0.078	0.000	0.016	0.423	0.028	0.028	0.402	1.00
1992	0.000	0.017	0.052	0.000	0.010	0.417	0.019	0.019	0.466	1.00
1993	0.000	0.009	0.026	0.000	0.005	0.411	0.009	0.009	0.530	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.405	0.000	0.000	0.595	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.441	0.000	0.000	0.559	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.457	0.000	0.000	0.543	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.408	0.000	0.000	0.592	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.436	0.000	0.000	0.564	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.412	0.000	0.000	0.588	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.441	0.000	0.000	0.559	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.211	0.000	0.000	0.789	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.080	0.000	0.000	0.920	1.00
2003	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.000	0.965	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.984	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.982	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.031	0.000	0.000	0.969	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.089	0.000	0.000	0.911	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.976	1.00

Table 3G-2.4c Composition of the waste category "Garden Waste" according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	25%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	83.33	0.00	0.00	0.00	-
1985	0.000	0.000	0.000	0.000	0.000	0.760	0.000	0.000	0.240	1.00
1986	0.000	0.000	0.000	0.000	0.000	0.744	0.000	0.000	0.256	1.00
1987	0.000	0.000	0.000	0.000	0.000	0.728	0.000	0.000	0.272	1.00
1988	0.000	0.000	0.000	0.000	0.000	0.711	0.000	0.000	0.289	1.00
1989	0.000	0.000	0.000	0.000	0.000	0.695	0.000	0.000	0.305	1.00
1990	0.000	0.000	0.000	0.000	0.000	0.679	0.000	0.000	0.321	1.00
1991	0.000	0.000	0.000	0.000	0.000	0.663	0.000	0.000	0.337	1.00
1992	0.000	0.000	0.000	0.000	0.000	0.647	0.000	0.000	0.353	1.00
1993	0.000	0.000	0.000	0.000	0.000	0.630	0.000	0.000	0.370	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.614	0.000	0.000	0.386	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.367	0.000	0.000	0.633	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.285	0.000	0.000	0.715	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.201	0.000	0.000	0.799	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.073	0.000	0.000	0.927	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.566	0.000	0.000	0.434	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.730	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.605	0.000	0.000	0.395	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.509	0.000	0.000	0.491	1.00
2003	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.996	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.995	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.997	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.039	0.000	0.000	0.961	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.076	0.000	0.000	0.924	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.955	1.00

Table 3G-2.4d Composition of the waste category "Commercial & Office Waste" according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	0%	40%	0%	0%	0%	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	133.33	0.00	0.00	0.00	-
1985	0.252	0.311	0.039	0.107	0.049	0.097	0.049	0.049	0.049	1.00
1986	0.224	0.276	0.035	0.095	0.043	0.121	0.043	0.043	0.119	1.00
1987	0.196	0.242	0.030	0.083	0.038	0.145	0.038	0.038	0.190	1.00
1988	0.168	0.207	0.026	0.071	0.032	0.169	0.032	0.032	0.261	1.00
1989	0.140	0.173	0.022	0.059	0.027	0.193	0.027	0.027	0.332	1.00
1990	0.112	0.138	0.017	0.047	0.022	0.218	0.022	0.022	0.403	1.00
1991	0.084	0.104	0.013	0.036	0.016	0.242	0.016	0.016	0.474	1.00
1992	0.056	0.069	0.009	0.024	0.011	0.266	0.011	0.011	0.544	1.00
1993	0.028	0.035	0.004	0.012	0.005	0.290	0.005	0.005	0.615	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.314	0.000	0.000	0.686	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.346	0.000	0.000	0.654	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.394	0.000	0.000	0.606	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.258	0.000	0.000	0.742	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.382	0.000	0.000	0.618	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.542	0.000	0.000	0.458	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.441	0.000	0.000	0.559	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.123	0.000	0.000	0.877	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.176	0.000	0.000	0.824	1.00
2003	0.000	0.000	0.000	0.000	0.006	0.089	0.000	0.000	0.905	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.086	0.000	0.000	0.914	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.071	0.000	0.000	0.929	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.081	0.000	0.000	0.919	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.158	0.000	0.000	0.842	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.074	0.000	0.000	0.926	1.00

Table 3G-2.4e Composition of the waste category “Industrial Waste” according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	0%	35%	0%	0%	0%	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	116.67	0.00	0.00	0.00	-
1985	0.062	0.019	0.070	0.015	0.012	0.058	0.037	0.183	0.543	1.00
1986	0.055	0.017	0.062	0.013	0.011	0.071	0.033	0.163	0.575	1.00
1987	0.049	0.015	0.054	0.011	0.010	0.083	0.029	0.142	0.607	1.00
1988	0.042	0.012	0.046	0.010	0.008	0.095	0.025	0.122	0.639	1.00
1989	0.035	0.010	0.039	0.008	0.007	0.108	0.021	0.102	0.671	1.00
1990	0.028	0.008	0.031	0.006	0.006	0.120	0.017	0.081	0.703	1.00
1991	0.021	0.006	0.023	0.005	0.004	0.132	0.012	0.061	0.735	1.00
1992	0.014	0.004	0.015	0.003	0.003	0.145	0.008	0.041	0.767	1.00
1993	0.007	0.002	0.008	0.002	0.001	0.157	0.004	0.020	0.799	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.169	0.000	0.000	0.831	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.195	0.000	0.000	0.805	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.189	0.000	0.000	0.811	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.800	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.199	0.000	0.000	0.801	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.027	0.000	0.000	0.973	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.153	0.000	0.000	0.847	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.095	0.000	0.124	0.781	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.129	0.823	1.00
2003	0.000	0.000	0.000	0.000	0.001	0.045	0.000	0.000	0.954	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.058	0.910	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.138	0.827	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.126	0.834	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.028	0.919	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.037	0.000	0.018	0.945	1.00

Table 3G-2.4f Composition of the waste category "Building & Construction Waste" according to waste type

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	40%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	133.33	0.00	0.00	0.00	-
1985	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1986	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1987	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1988	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1989	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1990	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1991	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1992	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1993	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.930	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.084	0.000	0.000	0.916	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.139	0.000	0.000	0.861	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.081	0.000	0.000	0.919	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.069	0.000	0.000	0.931	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.060	0.000	0.000	0.940	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.069	0.000	0.000	0.931	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.078	0.000	0.000	0.922	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	0.951	1.00
2003	0.000	0.000	0.000	0.000	0.000	0.047	0.000	0.000	0.953	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.975	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.975	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.046	0.000	0.000	0.954	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.968	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.976	1.00

Table 3G-2.4g Composition of the waste category “Sludge” according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	57%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	190.00	0.00	0.00	0.00	-
1985	0.000	0.000	0.000	0.000	0.000	0.828	0.000	0.000	0.172	1.00
1986	0.000	0.000	0.000	0.000	0.000	0.820	0.000	0.000	0.180	1.00
1987	0.000	0.000	0.000	0.000	0.000	0.812	0.000	0.000	0.188	1.00
1988	0.000	0.000	0.000	0.000	0.000	0.804	0.000	0.000	0.196	1.00
1989	0.000	0.000	0.000	0.000	0.000	0.796	0.000	0.000	0.204	1.00
1990	0.000	0.000	0.000	0.000	0.000	0.788	0.000	0.000	0.212	1.00
1991	0.000	0.000	0.000	0.000	0.000	0.779	0.000	0.000	0.221	1.00
1992	0.000	0.000	0.000	0.000	0.000	0.771	0.000	0.000	0.229	1.00
1993	0.000	0.000	0.000	0.000	0.000	0.763	0.000	0.000	0.237	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.755	0.000	0.000	0.245	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.723	0.000	0.000	0.277	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.711	0.000	0.000	0.289	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.757	0.000	0.000	0.243	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.732	0.000	0.000	0.268	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.794	0.000	0.000	0.206	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.773	0.000	0.000	0.227	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.670	0.000	0.000	0.330	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.567	0.000	0.000	0.433	1.00
2003	0.000	0.000	0.000	0.000	0.001	0.565	0.000	0.000	0.434	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.386	0.000	0.000	0.614	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.273	0.000	0.000	0.727	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.304	0.000	0.000	0.696	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.396	0.000	0.000	0.604	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.331	0.000	0.000	0.669	1.00

Table 3G-2.4h Composition of the waste category "Ash & Slag" according to waste types

Waste type	Food waste	Card board	Paper	Wet cardboard and paper	Plastics	Other combust.	Glass	Metal	Other not combust.	Total
Carbon content	15%	40%	40%	20%	-	0%	-	-	-	-
Emission fact. kg CH_4/Mg	50.00	133.33	133.33	66.67	0.00	0.00	0.00	0.00	0.00	-
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.00

The following Table 3G-2.5 presents the methane generation potential for solid waste disposal on land for the eight waste categories, 1990-2010.

Table 3G-2.5 Methane generation potential for the individual waste categories, Gg CH_4 per Gg waste.

$L_{o,j}/W_j$	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Domestic Waste	0.0574	0.0573	0.0572	0.0570	0.0569	0.0606	0.0616	0.0627	0.0595	0.0641
Bulky Waste	0.0755	0.0702	0.0648	0.0594	0.0541	0.0588	0.0610	0.0543	0.0581	0.0550
Garden Waste	0.0566	0.0552	0.0539	0.0525	0.0512	0.0306	0.0237	0.0167	0.0061	0.0472
Commercial & office Waste	0.0585	0.0543	0.0502	0.0460	0.0419	0.0461	0.0526	0.0343	0.0509	0.0722
Industrial Waste	0.0210	0.0207	0.0204	0.0201	0.0197	0.0228	0.0221	0.0233	0.0232	0.0032
Building & constr. Waste	0.0093	0.0093	0.0093	0.0093	0.0094	0.0112	0.0185	0.0108	0.0092	0.0080
Sludge	0.1496	0.1481	0.1466	0.1450	0.1435	0.1373	0.1351	0.1438	0.1391	0.1509
Ash & slag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Domestic Waste	0.0632	0.0601	0.0525	0.0453	0.0156	0.0185	0.0243	0.0140	0.0063	0.0063
Bulky Waste	0.0588	0.0282	0.0107	0.0047	0.0022	0.0023	0.0042	0.0118	0.0032	0.0032
Garden Waste	0.0225	0.0504	0.0424	0.0003	0.0004	0.0002	0.0032	0.0063	0.0038	0.0038
Commercial & office Waste	0.0588	0.0164	0.0234	0.0119	0.0115	0.0094	0.0109	0.0210	0.0099	0.0099
Industrial Waste	0.0179	0.0111	0.0056	0.0053	0.0038	0.0041	0.0047	0.0062	0.0043	0.0043
Building & constr. Waste	0.0092	0.0103	0.0066	0.0062	0.0034	0.0034	0.0061	0.0043	0.0032	0.0032
Sludge	0.1469	0.1273	0.1077	0.1073	0.0733	0.0519	0.0578	0.0753	0.0628	0.0628
Ash & slag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Continued	2010
Domestic Waste	0.0063
Bulky Waste	0.0032
Garden Waste	0.0038
Commercial & office Waste	0.0099
Industrial Waste	0.0043
Building & constr. Waste	0.0032
Sludge	0.0628
Ash & slag	0.0000

Annex 3G-3 Wastewater Handling, 6B

Table 3G-3.1 presents the methane produced in anaerobic digester tanks, recovered for energy production, emitted from sewer system and WWTPs, primary settling tanks and biological N and P removal processes, fugitive emissions from anaerobic processes and net CH_4 emission from the 6 B. Wastewater handling in Denmark, 1990-2010.

Table 3G-3.1 Produced, recovered and emitted CH_4 from wastewater treatment, Gg, 1990-2010

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4 produced	16.64	16.60	16.66	17.13	18.60	20.08	24.34	28.77	26.85	25.01
CH_4 recovered	16.48	16.44	16.49	16.95	18.41	19.88	24.10	28.48	26.58	24.76
CH_4 emitted from sewer system	0.17	0.17	0.17	0.18	0.19	0.21	0.23	0.24	0.26	0.25
CH_4 emitted from septic tanks	2.81	2.82	2.83	2.84	2.85	2.86	2.87	2.88	2.89	2.90
CH_4 emission from anaerobic treatment	0.17	0.17	0.17	0.17	0.19	0.20	0.24	0.29	0.27	0.25
Net CH_4 emission	3.15	3.16	3.17	3.19	3.23	3.27	3.34	3.41	3.42	3.41
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 produced	34.58	35.14	26.73	32.31	28.28	30.50	29.84	30.30	29.53	30.21
CH_4 recovered	34.24	34.78	26.47	31.99	28.00	30.19	29.54	30.00	29.24	29.90
CH_4 emitted from sewer system	0.25	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.25	0.25
CH_4 emitted from septic tanks	2.91	2.92	2.93	2.95	2.96	2.96	2.97	2.98	3.00	3.00
CH_4 emission from anaerobic treatment	0.35	0.35	0.27	0.32	0.28	0.30	0.30	0.30	0.30	0.30
Net CH_4 emission	3.51	3.53	3.48	3.56	3.51	3.54	3.53	3.55	3.55	3.57
Continued	2010									
CH_4 produced	29,76									
CH_4 recovered	29,47									
CH_4 emitted from sewer system	0,26									
CH_4 emitted from septic tanks	3,03									
CH_4 emission from anaerobic treatment	0,30									
Net CH_4 emission	3,59									

Table 3G-3.2 shows the total N_2O emission originating from treatment processes at the Danish WWTPs (direct emissions) and effluents to the Danish surface waters (indirect emissions).

Table 3G-3.2 N_2O emissions from wastewater, Mg, 1990-2010

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O, indirect	265	252	219	273	268	238	180	158	154	147
N_2O, direct	88	92	87	90	119	134	135	139	152	148
N_2O, total	353	344	306	363	387	372	315	297	306	295
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N_2O, indirect	157	134	137	109	119	111	109	116	103	108
N_2O, direct	161	165	211	168	150	193	152	185	256	153
N_2O, total	318	299	348	277	269	304	261	301	359	261
Continued	2010									
N_2O, indirect	104									
N_2O, direct	165									
N_2O, total	269									

Table 3G-3.3 presents the total degradable organic waste (TOW) calculated by use of the default IPCC method corrected for contribution from industry to the influent TOW (1990-1998) and country-specific data (1999-2010).

Table 3G-3.3 Calculated total degradable organic waste (TOW), 1990-2010.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Contribution from industrial inlet BOD	2.5	2.5	2.5	5.0	13.6	22.2	30.8	39.4	48.0	41.0
Population (1000)	5140	5153	5170	5188	5208	5228	5248	5268	5287	5305
TOW [Gg] corrected IPCC method	96.62	96.39	96.71	99.42	107.97	116.59	125.28	134.02	142.80	
TOW [Gg]; country-specific data										140.25
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Contribution from industrial inlet BOD	42	38	38	37	40.5	40.5	40.5	40.5	40.5	40.5
Population (1000)	5322	5338	5351	5384	5398	5411	5427	5447	5476	5511
TOW [Gg]; corrected IPPC method										
TOW [Gg]; country-specific data	141.49	144.36	156.18	160.21	153.06	149.83	146.59	148.88	145.11	148.41
Continued	2010									
Contribution from industrial inlet BOD	40									
Population (1000)	5535									
TOW [Gg] corrected IPCC method										
TOW [Gg]; country-specific data	145.64									

*TOW = (1+I/100) x (P x D_{dom}), where P is the Population number, D_{dom}= 18 250 kg BOD per 1000 persons per year and I is the per cent contribution from industry to the influent wastewater TOW content.

Table 3G-3.4 shows the country-specific emission factor for estimating the methane generated during anaerobic treatment processes.

Table 3G-3.4 Emission factor for estimating the methane generation, kg CH_4/kg BOD.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fraction of wet weight sludge treated in anaerobic processes , F_{AD}	0.29	0.29	0.29	0.29	0.29	0.29	0.32	0.36	0.31	0.30
EF =MCF*f_{AD}*B_o	0.17	0.17	0.17	0.17	0.17	0.17	0.19	0.21	0.19	0.18
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fraction of wet weight sludge treated in anaerobic processes, F_{AD}	0.41	0.41	0.29	0.34	0.31	0.34	0.34	0.34	0.34	0.34
EF =MCF*f_{AD}*B_o	0.24	0.24	0.17	0.20	0.18	0.20	0.20	0.20	0.20	0.20
Continued	2010									
Fraction of wet weight sludge treated in anaerobic processes, F_{AD}	0.34									
EF =MCF*f_{AD}*B_o	0.20									

Table 3G-3.5 presents the nitrogen content in the influent and effluent wastewater.

Table 3G-3.5 Nitrogen content in the influent and effluent wastewater, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Influent wastewater from municipal WWTPs*	17 614	18 477	17 391	18 012	23 866	26 808	27 096	27 891	30 394	29 686
Effluent wastewater, total**	16 884	16 032	13 953	17 403	17 079	15 152	11 431	10 068	9 796	9 363
% N reduction in effluent N	4	18	25	40	57	67	76	83	83	83
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Influent wastewater from municipal WWTPs	32 342	32 999	42 224	33 645	29 989	38 746	30 481	37 079	51 370	30 623
Effluent wastewater, total	10 005	8 553	8 740	6 927	7 589	7 038	6 935	7 382	6 589	6 899
% N reduction in effluent N	86	87	89	89	87	90	88	88	93	87
Continued	2010									
Influent wastewater from municipal WWTPs	33 138									
Effluent wastewater, total	6 600									
% N reduction in effluent N	89									

*Data on the influent wastewater N load from municipal WWTPs are available from the Danish Water Quality Parameter Database held by the Agency for Spatial and Environmental Planning ** Effluent wastewater, total includes separate industrial discharges, rainwater conditioned effluent, scattered houses, mariculture and fish farming and effluents from WWTPs (DEPA. 1994, 1996a, 1997, 1998, 1999a, 2000, 2001a, 2002, 2003a, 2004b, 2005a, 2005b and ASEP 2007, 2009, 2010.

Table 3G-3.6 presents the per cent uncertainties on the individual parameters used for calculating the uncertainties associated with activity data and emission factors used for estimating the methane and nitrous oxide emissions from category 6.B Wastewater Handling. References are given to the equations presented in Chapter 8.6.1.

Table 3G-3.6 Input parameter uncertainties, %.

Input parameters and equations	Uncertainty, %*	Reference
CH_4 (sewer+MB)		Eq. 8.3.2
$EF_{sewer+MB}=B_o*MCF_{sewer+MB}$	**32**	
B_o	30	IPCC, 2006
$MCF_{sewer+MB}$	10	IPCC, 2006
$Ac_{sewer+MB}$	**33**	
TOW	33	Table 3G.3
$CH_{4, AD}$		Eq. 8.3.3
$EF_{AD}=B_o*MCF_{AD}*f_{AD}$	**34**	
B_o	30	IPCC, 2000
MCF_{AD}	10	IPCC, 2006
F_{AD}	12	Table 3G.4
Ac_{AD}	**33**	
TOW	33	Table 3G.3
$CH_{4, st}$		Eq. 8.3.4
$EF_{st}=MCF_{st}*B_o$	**36**	
MCF_{st}	10	IPCC, 2006
B_o	30	IPCC, 2000
$Ac_{st}=f_{nc}*P*DOC_{st}$	**31**	
f_{nc}	5	IPCC, 2000
DOC_{st}	30	IPCC, 2006
P	5	IPCC, 2000
N_2O,direct		Eq. 8.3.6
$EF_{N2O,direct}$	27	Table 3G.5
$Ac_{N2O,direct}$	39/5	Table 3G.5
$m_{N,influent}$	39/5	Table 3G.5
N_2O,indirect		Eq. 8.3.7
$EF_{N2Oindirect}$	17	Table 3G.5
$D_{N,WWTP}$	39/5	Table 3G.5

*Numbers given as x/y represents different uncertainty levels for 1990 and 2010, respectively.

Table 3G-3.7 presents activity data on the total degradable organic matter (TOW) in the influent wastewater at the Danish WWTPs. The average uncertainty throughout the time series is 33 %; the value that has been used as approximation for the input parameter uncertainty on TOW data for the Tier 2 uncertainty model.

Table 3G-3.7 TOW data derived based on monitoring of the chemical (COD) and biological oxygen demand (BOD) in the influent wastewater at the Danish WWTPs, Gg and resulting uncertainties, %.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TOW data derived from reported BOD data, DEPA reports*				100.00						132.00
TOW data derived from reported COD data, DEPA reports*										148.50
TOW time series, IPCC default methodology*	96.62	96.39	96.71	99.42	107.97	116.59	125.28	134.02	142.80	136.51
TOW data derived from reported BOD data in the DWQPD	96.21	109.01	109.30	93.50	124.53	123.79	136.16	134.05	143.07	137.22
TOW data derived from reported COD data in the DWQPD	78.77	87.22	84.61	80.69	203.16	121.03	123.61	128.48	131.29	137.78
Uncertainty, %	52	56	56	43	81	57	56	54	53	4
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TOW data derived from reported COD data, DEPA reports	144.38	144.38	144.38	144.38	144.38	144.38	144.38	144.38	144.38	144.38
TOW time series, IPCC defalt methodology*	138.60	138.60	138.60	138.60	138.60	138.60	138.60	138.60	138.60	138.60
TOW data derived from reported BOD data in the DWQPD	151.15	151.15	151.15	151.15	151.15	151.15	151.15	151.15	151.15	151.15
TOW data derived from reported COD data in the DWQPD	150.94	150.94	150.94	150.94	150.94	150.94	150.94	150.94	150.94	150.94
Uncertainty, %	5	5	29	9	16	13	18	12	21	16

*The default IPCCC methodology corrected for the contribution from industries to the influent TOW have been used in the inventory for the years 1990-1998. The average of the BOD and COD derived TOW data have been used in the inventory for the years 1999-2009. Data are reported in Chapter 8.3, Table 8.3.3.

The national TOW data calculated based on data extracted from the Danish Waste water Quality Parameter Database (DWQPD) represents 100% completeness, but the calculation procedures still need verification by purpose of obtaining better agreement with the data reported by the Danish EPA.

Table 3G-3.8 Data on amount of sludge treated in anaerobic processes for approximation of the input parameter f_{AD} which is the fraction of sludge treated in anaerobic closed systems (cf. Eq. 8.3.3, Chapter 8.3.2).

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
% treated anaerobically (WW)	29	29	29	29	29	29	32	36	31	30
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
% treated anaerobically (WW)	41	41	29	34	31	34	34	34	34	34

Based on the data presented in Table 3G-3.7, the average per cent uncertainty of the fraction of sludge treated in anaerobic closed systems is estimated to be 12%.

Data have been estimated based on reported data in the Danish Sludge database. For the years 2006-2009 the per cent wet weight sludge treated in anaerobic processes has been set equal to the value for 2005 due to low reporting frequencies in the years 2006-2009.

Table 3G-3.9 Estimated direct N_2O emissions, population number and derived emission factors in units of g N_2O/ person.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O, direct emission, Mg	88	92	87	90	88	88	88	88	88	88
Population, per 1000	5 135	5 135	5 135	5 135	5 135	5 135	5 135	5 135	5 135	5 135
EF, g N_2O/person	17	18	17	17	23	26	26	26	29	28
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N_2O, direct emission, Mg	161	165	211	168	150	193	152	185	256	153
Population, per 1000	5 330	5 349	5 368	5 384	5 398	5 411	5 427	5 447	5 476	5 482
EF, g N_2O/person	30	31	39	31	28	36	28	34	47	28

Based on the time trend emission data for the direct N_2O emission an average uncertainty of the EF has been derived calculated as the standard deviation on EF values across the whole time series divided by the time trend average EF value and multiplied by 100%. A resulting uncertainty of 27 % has been used as approximation for the uncertainty of EF for the direct N_2O emissions.

Table 3G-3.10 Uncertainties on the effluent amount of N derived from reported tonnes N in effluent waste water from WWTPs. Data extracted from the Danish Waste water Quality Parameter Database (DWQPD) and form DEPA reports, respectively.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Effluent N, DEPA reports	16 884	15 111	13 071	10 787	10 241	8 938	6 387	4 851	5 162	5 135
Effluent N, DWQPD	7 499	6 882	5 365	4 176	4 853	5 152	4 074	3 947	4 516	4 220
% uncertainty effluents	39	39	42	43	37	30	26	13	9	13
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Effluent N, DEPA reports	4 653	4 221	4 528	3 614	4 027	3 831	3 634	4 358	3 575	4 025
Effluent N, DWQPD	3 996	4 360	4 993	3 644	3 688	3 517	3 648	4 407	3 771	3 765
% uncertainty effluents	10	2	7	1	6	6	0	1	4	5

Similar uncertainty levels has been used for the activity data on the amount of influent N as no other data sources are available then the DWQPD.

The uncertainty of the emission factor for effluent N is based on average of the range provided in the IPCC guidelines (IPCC, 2000 and 2006).

Annex 3G-4 Waste Incineration, 6C

Table 3G-4.1 presents the greenhouse gas emissions from 6.C Waste Incineration for 1990-2010.

Table 3G-4.1 Overall emission of greenhouse gases from the incineration of human bodies and animal carcasses

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emission from											
Human cremation	Gg	2.05	2.04	2.07	2.16	2.14	2.19	2.17	2.15	2.09	2.12
Animal cremation	Gg	0.12	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.28
Total biogenic	Gg	2.17	2.16	2.21	2.30	2.29	2.35	2.33	2.32	2.27	2.40
CH_4 emission from											
Human cremation	Mg	0.48	0.48	0.49	0.51	0.50	0.52	0.51	0.50	0.49	0.50
Animal cremation	Mg	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.07
Total	Mg	0.51	0.51	0.52	0.54	0.54	0.55	0.55	0.54	0.53	0.56
N_2O emission from											
Human cremation	Mg	0.60	0.60	0.61	0.63	0.63	0.64	0.64	0.63	0.61	0.62
Animal cremation	Mg	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.08
Total	Mg	0.64	0.63	0.65	0.68	0.67	0.69	0.68	0.68	0.67	0.71
6C. Waste incineration											
Non-biogenic CO_2-eqvivalents	Gg	0.21	0.21	0.21	0.22	0.22	0.23	0.22	0.22	0.22	0.23

Continued

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 emission from											
Human cremation	Gg	2.08	2.09	2.13	2.10	2.08	2.04	2.06	2.09	2.09	2.12
Animal cremation	Gg	0.34	0.35	0.35	0.36	0.44	0.59	0.86	0.99	1.03	1.03
Total biogenic	Gg	2.43	2.44	2.48	2.46	2.52	2.63	2.92	3.08	3.12	3.15
CH_4 emission from											
Human cremation	Mg	0.49	0.49	0.50	0.49	0.49	0.48	0.48	0.49	0.49	0.50
Animal cremation	Mg	0.08	0.08	0.08	0.08	0.10	0.14	0.20	0.23	0.24	0.24
Total	Mg	0.57	0.57	0.58	0.58	0.59	0.62	0.69	0.72	0.73	0.74
N_2O emission from											
Human cremation	Mg	0.61	0.61	0.63	0.62	0.61	0.60	0.61	0.61	0.61	0.62
Animal cremation	Mg	0.10	0.10	0.10	0.10	0.13	0.17	0.25	0.29	0.30	0.30
Total	Mg	0.71	0.72	0.73	0.72	0.74	0.77	0.86	0.90	0.92	0.93
6C. Waste incineration											
Non-biogenic CO_2-eqvivalents	Gg	0.23	0.23	0.24	0.24	0.24	0.25	0.28	0.30	0.30	0.30

Continued

		2010
CO_2 emission from		
Human cremation	Gg	2.10
Animal cremation	Gg	1.12
Total biogenic	Gg	3.22
CH_4 emission from		
Human cremation	Mg	0.49
Animal cremation	Mg	0.26
Total	Mg	0.76
N_2O emission from		
Human cremation	Mg	0.62
Animal cremation	Mg	0.33
Total	Mg	0.95
6C. Waste incineration		
Non-biogenic CO_2-eqvivalents	Gg	0.31

Table 3G-4.2 presents the activity data for human cremation for 1990-2010.

Table 3G-4.2 Data human cremations.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nationally deceased	60926	59581	60821	62809	61099	63127	61043	59898	58453	59179
Cremations	40991	40666	41455	43194	42762	43847	43262	42891	41660	42299
Cremation fraction, %	67.3	68.3	68.2	68.8	70.0	69.5	70.8	71.6	69.1	74.4
Continued										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Nationally deceased	57998	58355	58610	57574	55806	54962	55477	55604	54591	54872
Cremations	41651	41707	42539	41997	41555	40758	41233	41766	41788	42408
Cremation fraction, %	71.8	71.5	72.6	72.9	74.5	74.2	74.3	75.1	76.6	77.3
Continued										
	2010									
Nationally deceased	54368									
Cremations	42050									
Cremation fraction, %	77.3									

Table 3G-4.3 presents the activity data for animal cremation for 1990-2010.

Table 3G-4.3 Activity data, (direct contact with all Danish pet crematoria).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Crematorium A, Mg	-	-	-	-	-	-	-	-	-	-
Crematorium B, Mg	150	160	170	180	190	200	210	220	235	368
Crematorium C, Mg	-	-	-	-	-	-	-	-	-	-
Total, Mg	150	160	170	180	190	200	210	220	235	368
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Crematorium A, Mg	-	-	-	-	-	-	300	450	450	450
Crematorium B, Mg	443	452	451	462	571	762	798	802	848	853
Crematorium C, Mg	-	-	-	-	-	-	18	32	40	36
Total, Mg	443	452	451	462	571	762	1116	1284	1338	1339
Continued	2010									
Crematorium A, Mg	475									
Crematorium B, Mg	934									
Crematorium C, Mg	40									
Total, Mg	1449									

Annex 3G-5 Waste Other, 6D

Table 3G-5.1a-c presents the national emissions for source category 6D 1990-2010.

Table 3G-5.1a Overall emission of greenhouse gasses from accidental fires and composting, 1990-1999.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emission from											
Accidental building fires	Gg	63.18	65.19	70.81	62.27	62.64	72.31	73.07	67.55	60.42	64.98
- of which non-biogenic	Gg	11.46	11.82	12.84	11.29	11.36	13.11	13.25	12.25	10.96	11.79
Accidental vehicle fires	Gg	6.88	6.88	6.87	7.02	6.98	7.06	7.18	7.10	7.18	7.18
Total, non-biogenic	Gg	18.34	18.71	19.71	18.31	18.34	20.17	20.43	19.35	18.14	18.97
CH_4 emission from											
Compost production	Mg	1268.8	1397.3	1525.4	1653.6	1781.6	1632.0	1936.1	2213.7	2303.5	2717.7
Accidental building fires	Mg	64.16	66.18	71.85	63.20	63.56	73.36	74.12	68.56	61.32	65.96
Accidental vehicle fires	Mg	14.34	14.34	14.31	14.62	14.55	14.70	14.95	14.80	14.96	14.96
Total	Mg	1347.3	1477.9	1611.5	1731.5	1859.7	1720.0	2025.1	2297.1	2379.8	2798.6
N_2O emission from											
Compost production	Mg	36.17	40.04	43.90	47.76	51.61	49.53	57.87	66.58	79.61	108.32
Accidental building fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Accidental vehicle fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Total	Mg	36.17	40.04	43.90	47.76	51.61	49.53	57.87	66.58	79.61	108.32
6D. Waste other											
CO_2-eqvivalents	Gg	57.85	62.15	67.16	69.47	73.40	71.64	80.90	88.23	92.80	111.31

Table 3G-5.1b Overall emission of greenhouse gasses from accidental fires and composting, 2000-2009.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 emission from											
Accidental building fires	Gg	63.86	63.34	61.56	69.58	60.20	62.48	64.24	76.38	72.67	69.72
- of which non-biogenic	Gg	11.58	11.49	11.17	12.62	10.92	11.34	11.66	13.71	13.41	12.65
Accidental vehicle fires	Gg	7.24	7.18	7.08	6.96	6.85	6.92	7.12	5.61	8.09	8.43
Total, non-biogenic	Gg	18.82	18.67	18.25	19.58	17.78	18.26	18.77	19.32	21.50	21.08
CH_4 emission from											
Compost production	Mg	2882.6	2951.1	2893.0	3018.1	2867.8	3086.7	3269.4	3646.1	3323.4	3539.3
Accidental building fires	Mg	64.88	64.52	62.78	71.01	61.47	63.78	65.63	75.18	74.64	71.35
Accidental vehicle fires	Mg	15.08	14.96	14.76	14.50	14.28	14.42	14.82	11.70	16.85	17.56
Total	Mg	2962.6	3030.5	2970.6	3103.6	2943.6	3164.9	3349.9	3733.0	3414.9	3628.2
N_2O emission from											
Compost production	Mg	130.90	131.67	160.07	161.25	95.47	100.56	109.60	125.24	116.79	127.27
Accidental building fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Accidental vehicle fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Total	Mg	130.90	131.67	160.07	161.25	95.47	100.56	109.60	125.24	116.79	127.27
6D. Waste other											
CO_2-eqvivalents	Gg	121.61	123.13	130.26	134.75	109.19	115.89	123.09	136.54	129.42	136.73

Table 3G-5.1c Overall emission of greenhouse gasses from accidental fires and composting, 2010.

		2010
CO_2 emission from		
Accidental building fires	Gg	61.73
- of which non-biogenic	Gg	11.14
Accidental vehicle fires	Gg	7.11
Total, non-biogenic	Gg	18.24
CH_4 emission from		
Compost production	Mg	3829.5
Accidental building fires	Mg	64.62
Accidental vehicle fires	Mg	14.80
Total	Mg	3909.0
N_2O emission from		
Compost production	Mg	137.57
Accidental building fires	Mg	NAV
Accidental vehicle fires	Mg	NAV
Total	Mg	137.57
6D. Waste other		
CO_2-eqvivalents	Gg	142.98

Table 3G-5.2 presents the activity data for composting 1990-2010.

Table 3G-5.2 Activity data composting, Gg, 1990-2010.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Composting of garden and park waste	274	304	335	365	395	358	431	496	517	614
Composting of organic waste from households and other	16	19	23	26	29	40	38	47	43	49
Composting of sludge	NAV	NAV	NAV	NAV	NAV	7	6	7	57	134
Home composting of garden and vegetable food waste	20	20	20	20	21	21	21	21	21	21
Total	310	344	377	411	444	426	495	571	638	818
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Composting of garden and park waste	653	669	653	682	650	702	745	835	757	807
Composting of organic waste from households and other	47	52	63	66	53	45	48	44	46	70
Composting of sludge	218	211	348	336	53	50	67	91	94	107
Home composting of garden and vegetable food waste	21	21	22	22	22	22	22	22	22	23
Total	939	953	1085	1106	778	819	882	992	920	1007
Continued	2010									
Composting of garden and park waste	877									
Composting of organic waste from households and other	58									
Composting of sludge	120									
Home composting of garden and vegetable food waste	23									
Total	1077									

NAV = Not available.

Table 3G-5.3 presents the occurrence of all accidental fires, building fires and vehicle fires, 1990-2010. Building and vehicle fires do not make up for all the national accidental fires. The total number of registered fires is based on the number of times the fire brigade have been notified of occurring fires.

Table 3G-5.3 Occurrence of accidental fires, 1990-2010.

Year	All fires	Building fires	Vehicle fires	Field
1990	17025	10187	3354	3484
1991	17589	10524	3465	3600
1992	19124	11443	3767	3914
1993	16803	10054	3310	3439
1994	16918	10123	3333	3462
1995	19543	11694	3850	3999
1996	19756	11821	3892	4043
1997	18236	10911	3592	3733
1998	16320	9765	3215	3340
1999	17538	10494	3455	3589
2000	17174	10276	3383	3515
2001	16894	10108	3328	3458
2002	16362	9790	3223	3349
2003	18443	11035	3633	3775
2004	15927	9530	3137	3260
2005	16551	9903	3260	3388
2006	16965	10151	3342	3472
2007	18263	12527	3223	2513
2008	20643	12124	4068	4451
2009	18930	10652	3930	4348
2010	16728	9325	3459	3944

Table 3G-5.4 presents the full scale equivalent activity data of accidental building fires.

Table 3G-5.4 Accidental building fires full scale equivalent activity data.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Container fires	781	807	878	771	776	897	907	837	749	805
Detached house fires	777	802	873	767	772	892	901	832	745	800
Undetached house fires	231	238	259	228	229	265	268	247	221	237
Apartment building fires	367	379	412	362	365	421	426	393	352	378
Industry building fire	320	331	360	316	318	368	372	343	307	330
Additional building fires	437	451	490	431	434	501	507	468	418	450
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Container fires	788	775	751	846	731	759	778	979	1004	841
Detached house fires	784	771	747	841	727	755	774	757	886	876
Undetached house fires	233	229	222	250	216	224	230	343	278	208
Apartment building fires	370	364	353	398	343	357	366	405	433	413
Industry building fire	323	318	308	347	300	311	319	435	346	344
Additional building fires	440	433	420	473	408	424	435	483	523	466
Continued	2010									
Container fires	623									
Detached house fires	833									
Undetached house fires	194									
Apartment building fires	348									
Industry building fire	281									
Additional building fires	429									

Table 3G-5.5a-c presents emission factors for 1990-2010 for accidental fires in detached houses, undetached houses and apartment buildings respectively.

Table 3G-5.5a Emission factors for accidental detached building fires, 1990-2010.

Detached houses		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 - total	Mg	30.6	30.5	30.5	30.5	30.5	30.4	30.3	30.4	30.4	30.4
CO_2 - biogenic	Mg	25.0	24.9	24.8	24.9	24.8	24.8	24.7	24.8	24.7	24.8
CO_2 - non-biogenic	Mg	5.7	5.7	5.6	5.7	5.6	5.6	5.6	5.6	5.6	5.6
CH_4	kg	40.6	40.4	40.3	40.4	40.3	40.2	40.2	40.3	40.2	40.3
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 - total	Mg	30.7	31.3	31.6	31.8	31.9	31.8	32.0	31.4	31.6	31.7
CO_2 - biogenic	Mg	25.0	25.5	25.7	25.9	26.0	25.9	26.1	25.6	25.7	25.9
CO_2 - non-biogenic	Mg	5.7	5.8	5.9	5.9	5.9	5.9	5.9	5.8	5.8	5.9
CH_4	kg	40.6	41.5	41.8	42.1	42.3	42.1	42.4	41.6	41.8	42.0
Continued		2010									
CO_2 - total	Mg	32.0									
CO_2 - biogenic	Mg	26.1									
CO_2 - non-biogenic	Mg	5.9									
CH_4	kg	42.3									

Table 3G-5.5b Emission factors for accidental undetached building fires, 1990-2010.

Undetached houses		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 - total	Mg	25.3	25.2	25.2	25.2	25.2	25.2	25.3	25.4	25.5	25.6
CO_2 - biogenic	Mg	20.6	20.6	20.5	20.5	20.5	20.6	20.6	20.7	20.7	20.8
CO_2 - non-biogenic	Mg	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
CH_4	kg	33.5	33.4	33.4	33.4	33.4	33.4	33.5	33.6	33.7	33.8
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 - total	Mg	25.7	25.7	25.7	25.8	25.8	25.7	25.8	25.9	26.0	26.1
CO_2 - biogenic	Mg	20.9	20.9	21.0	21.0	21.0	21.0	21.0	21.1	21.2	21.3
CO_2 - non-biogenic	Mg	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
CH_4	kg	34.0	34.0	34.1	34.1	34.2	34.1	34.2	34.3	34.5	34.6
Continued		2010									
CO_2 - total	Mg	26.2									
CO_2 - biogenic	Mg	21.4									
CO_2 - non-biogenic	Mg	4.9									
CH_4	kg	34.7									

Table 3G-5.5c Emission factors for accidental apartment building fires, 1990-2010.

Apartment buildings		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 - total	Mg	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
CO_2 - biogenic	Mg	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
CO_2 - non-biogenic	Mg	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
CH_4	kg	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 - total	Mg	14.7	14.7	14.8	14.8	14.8	14.8	14.9	15.0	15.0	15.1
CO_2 - biogenic	Mg	12.0	12.0	12.0	12.0	12.1	12.1	12.1	12.2	12.2	12.3
CO_2 - non-biogenic	Mg	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8
CH_4	kg	19.5	19.5	19.5	19.6	19.6	19.7	19.7	19.8	19.9	20.0
Continued		2010									
CO_2 - total	Mg	15.1									
CO_2 - biogenic	Mg	12.3									
CO_2 - non-biogenic	Mg	2.8									
CH_4	kg	20.0									

Table 3G-5.6 stated the average building floor space, 1990-2010.

Table 3G-5.6 Average floor space in building types.

Year	Detached	Undetached	Apartment
1990	156	129	75
1991	156	128	75
1992	155	128	75
1993	155	128	75
1994	155	128	75
1995	155	129	75
1996	155	129	75
1997	155	129	75
1998	155	130	75
1999	155	130	75
2000	156	131	75
2001	160	131	75
2002	161	131	75
2003	162	131	75
2004	163	132	75
2005	162	131	76
2006	163	132	76
2007	160	132	76
2008	161	133	77
2009	162	133	77
2010	163	134	77

Table 3G-5.7a-c presents the number of nationally registered vehicles and the number of full scale equivalent accidental vehicle fires, 1990-2010.

Table 3G-5.7a Number of nationally registered vehicles and full scale equivalent vehicle fires

	Passenger Cars		Buses		Light Duty Vehicles		Heavy Duty Vehicles	
	Registered	FSE fires	Registered	FSE fires	Regis-	FSE fires	Registered	FSE fires
1990	1645587	479	8109	12	192321	19	45664	58
1991	1649301	480	9989	14	197439	19	45494	58
1992	1659929	483	11259	16	202806	20	45510	58
1993	1679055	489	13513	19	211759	20	46228	59
1994	1672177	487	14261	21	219642	21	47329	60
1995	1733405	505	14371	21	228076	22	48077	61
1996	1793158	522	14594	21	234406	23	48319	61
1997	1841075	536	14690	21	240763	23	48785	62
1998	1878032	547	14894	21	249463	24	49697	63
1999	1906153	555	14953	21	259215	25	50443	64
2000	1916686	558	15051	22	272387	26	50227	64
2001	1932741	563	15005	22	283031	27	49885	63
2002	1946353	567	14971	22	295581	29	49208	62
2003	1948967	568	14989	22	309614	30	48653	62
2004	1967643	573	14997	22	336038	32	48318	61
2005	2012399	586	15131	22	372674	36	49311	63
2006	2064005	601	15180	22	414454	40	50691	64
2007	2151344	518	15013	16	402464	19	51758	46
2008	2182235	666	14830	24	398552	44	50528	71
2009	2199453	729	14752	23	383148	48	46510	67
2010	2247021	646	14577	23	362389	38	44812	60

Table 3G-5.7b Number of nationally registered vehicles and full scale equivalent vehicle fires

	Motorcycles/Mopeds		Caravans		Train		Ship	
	Registered	FSE fires	Registered	FSE fires	Regis-	FSE fires	Registered	FSE fires
1990	164111	58	86257	24	7156	9	2324	26
1991	163362	58	88278	24	7212	9	2312	26
1992	159024	56	90299	25	7438	9	2307	26
1993	156405	55	93150	26	7496	9	2140	24
1994	154376	55	94551	26	7117	8	2027	22
1995	165313	58	95831	26	6854	8	1911	21
1996	178096	63	97592	27	6631	8	1841	20
1997	192364	68	99931	27	6428	8	1761	19
1998	205654	73	102302	28	5861	7	1696	19
1999	220064	78	104852	29	5525	7	1695	19
2000	233695	83	106935	29	4907	6	1759	19
2001	243390	86	108924	30	4561	5	1797	20
2002	253731	90	110995	30	4169	5	1878	21
2003	256779	91	113338	31	4048	5	1838	20
2004	263815	93	116930	32	3273	4	1783	20
2005	274264	97	121350	33	3195	4	1792	20
2006	287672	102	126011	35	3002	4	1789	20
2007	302914	99	131708	36	2617	2	1755	20
2008	308546	122	136905	45	2588	3	1728	20
2009	307373	128	140366	34	2489	5	1742	22
2010	301766	83	142354	37	2740	2	1773	16

Table 3G-5.7c Number of nationally registered vehicles and full scale equivalent vehicle fires

	Airplane		Tractor		Combined Harvester		Bicycle	Other Transport	Machine
	Registered	FSE fires	Registered	FSE fires	Registered	FSE fires	FSE fires	FSE fires	FSE fires
1990	1055	1	135980	82	35118	57			
1991	1059	1	135887	82	34066	55			
1992	1066	1	132136	80	32923	53			
1993	1059	1	133891	81	32777	53			
1994	1063	1	127764	77	31022	50			
1995	1058	1	134277	81	29291	47			
1996	1088	1	124708	75	29736	48			
1997	1094	1	128391	77	26576	43			
1998	1091	1	119719	72	26484	43			
1999	1087	1	120314	72	23853	39			
2000	1070	1	115692	70	24128	39			
2001	1089	1	114369	69	23589	38			
2002	1149	1	112742	68	23065	37			
2003	1083	1	111023	67	22537	37			
2004	1055	1	109610	66	22076	36			
2005	1073	1	107867	65	21436	35			
2006	1039	1	105865	64	20976	34			
2007	1058	1	106025	52	20507	19	2	85	75
2008	1077	1	106025	62	20046	34	4	97	135
2009	1122	1	106025	64	19584	43	3	93	111
2010	1152	1	106025	77	19354	32	4	58	94

Table 3G-5.8 presents the average weight of passenger cars, buses, vans, trucks and motorcycles/mopeds in 1990-2010.

Table 3G-5.8 Average weight of different vehicle categories, kg, 1990-2010.

	Cars	Buses	Vans	Trucks	Motorcycles/ Mopeds
1990	850	10000	2000	15000	80
1991	850	10000	2000	15000	80
1992	850	10000	2000	15000	80
1993	901	10068	2297	14732	107
1994	908	10512	2382	14674	108
1995	923	10807	2492	14801	107
1996	935	10899	2638	14928	107
1997	948	10950	2746	14987	107
1998	964	10960	2848	15111	107
1999	982	11140	2964	15223	107
2000	999	11195	3103	15214	107
2001	1012	11312	3238	14888	108
2002	1024	11387	3333	14486	108
2003	1039	11479	3442	14026	109
2004	1052	11572	3561	13599	110
2005	1068	11560	3793	13258	111
2006	1086	11684	4120	13179	113
2007	1105	11753	4505	13268	114
2008	1122	11700	4710	13246	116
2009	1134	11642	4682	12802	116
2010	1144	11804	4498	11883	117

The following Table 3G-5.9 shows the annual amount of combusted vehicle in accidental fires.

Table 3G-5.9 Burnt mass of different vehicle and machine categories, Mg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger cars	407	408	411	441	442	466	488	509	527	545
Buses	117	144	162	196	215	223	229	231	235	239
Light duty vehicles	37	38	39	47	51	55	60	64	69	74
Heavy duty vehicles	870	866	867	865	882	903	916	928	953	975
Motorcycle, moped	5	5	4	6	6	6	7	7	8	8
Other transport	-	-	-	-	-	-	-	-	-	-
Caravan	18	19	19	21	21	22	23	23	24	25
Train	128	129	133	132	125	121	118	115	106	100
Ship	257	256	255	238	236	228	222	213	205	209
Airplane	12	12	12	11	11	11	12	12	12	12
Bicycle	-	-	-	-	-	-	-	-	-	-
Tractor	164	164	159	185	183	201	198	212	205	215
Combined harvester	854	828	800	782	738	702	719	645	648	588
Machine	-	-	-	-	-	-	-	-	-	-
Total	2867	2867	2861	2923	2909	2940	2991	2960	2993	2992

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Passenger cars	557	570	581	590	603	626	653	572	748	827
Buses	242	244	245	247	249	251	255	182	283	264
Light duty vehicles	82	89	95	103	116	137	165	86	207	223
Heavy duty vehicles	970	943	905	866	834	830	848	608	936	863
Motorcycle, moped	9	9	10	10	10	11	11	11	14	15
Other transport	-	-	-	-	-	-	-	47	54	53
Caravan	26	27	28	29	30	32	34	36	45	34
Train	89	81	72	68	53	51	47	33	39	63
Ship	218	225	236	233	228	229	231	234	230	253
Airplane	12	12	12	11	10	10	10	8	13	13
Bicycle	-	-	-	-	-	-	-	0	0	0
Tractor	216	223	226	230	235	246	263	235	290	301
Combined harvester	595	569	541	512	486	460	448	255	450	552
Machine	-	-	-	-	-	-	-	33	61	50
Total	3016	2991	2952	2899	2856	2884	2965	2339	3371	3512

Continued	2010
Passenger cars	739
Buses	266
Light duty vehicles	171
Heavy duty vehicles	715
Motorcycle, moped	10
Other transport	33
Caravan	38
Train	24
Ship	189
Airplane	7
Bicycle	0
Tractor	347
Combined harvester	378
Machine	43
Total	2960

Annex 3G-6 Recalculations to the waste sector

Table 3G-6.1 Changes in emissions from Solid Waste Disposal on Land compared with the CRF reported last year.

SWDS	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4, previous inventory	Gg	52.9	54.2	54.9	55.8	54.2	52.6	52.5	50.3	48.7	50.4
CH_4, recalculated	Gg	72.8	73.1	72.4	71.7	68.0	64.5	63.0	59.2	56.4	56.8
Change, CO_2-equivalents	Gg	418.9	397.0	368.0	333.8	289.9	250.2	220.0	186.9	160.6	132.7
Change	%	37.7	34.9	31.9	28.5	25.5	22.7	19.9	17.7	15.7	12.5
Continued	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4, previous inventory	Gg	50.9	51.8	50.2	52.3	48.4	48.5	51.4	50.6	50.3	49.5
CH_4, recalculated	Gg	56.4	55.4	51.7	52.1	46.3	44.9	46.5	44.3	42.6	40.5
Change, CO_2-equivalents	Gg	114.5	75.5	31.9	-2.6	-43.3	-76.9	-104.5	-133.0	-162.6	-188.0
Change	%	10.7	6.9	3.0	-0.2	-4.3	-7.5	-9.7	-12.5	-15.4	-18.1

Table 3G-6.2 Changes in emissions from Wastewater Handling compared with the CRF reported last year.

Wastewater Handling	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4, previous inventory	Gg	3.15	3.16	3.17	3.19	3.23	3.27	3.34	3.41	3.42	3.40
CH_4, recalculated	Gg	3.15	3.16	3.17	3.19	3.23	3.27	3.34	3.41	3.42	3.41
N_2O, previous inventory	Gg	0.35	0.34	0.31	0.36	0.39	0.37	0.31	0.30	0.31	0.30
N_2O, recalculated	Gg	0.35	0.34	0.31	0.36	0.39	0.37	0.31	0.30	0.31	0.30
Change, CO_2-equivalents	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Change	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
Continued	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4, previous inventory	Gg	3.51	3.52	3.44	3.51	3.49	3.52	3.52	3.54	3.55	3.56
CH_4, recalculated	Gg	3.51	3.53	3.48	3.56	3.51	3.54	3.53	3.55	3.55	3.57
N_2O, previous inventory	Gg	0.32	0.30	0.35	0.28	0.27	0.30	0.26	0.30	0.36	0.26
N_2O, recalculated	Gg	0.32	0.30	0.35	0.28	0.27	0.30	0.26	0.30	0.36	0.26
Change, CO_2-equivalents	Gg	0.13	0.38	0.81	0.97	0.55	0.42	0.28	0.35	0.18	0.30
Change	%	0.08	0.23	0.45	0.61	0.35	0.25	0.18	0.21	0.10	0.19

Table 3G-6.3 Changes in emissions from Waste Incineration compared with the CRF reported last year.

Waste Incineration	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4, previous inventory	Mg	0.51	0.51	0.52	0.54	0.54	0.55	0.55	0.54	0.53	0.56
CH_4, recalculated	Mg	0.51	0.51	0.52	0.54	0.54	0.55	0.55	0.54	0.53	0.56
N_2O, previous inventory	Mg	0.64	0.63	0.65	0.68	0.67	0.69	0.68	0.68	0.67	0.71
N_2O, recalculated	Mg	0.64	0.63	0.65	0.68	0.67	0.69	0.68	0.68	0.67	0.71
Change, CO_2-equivalents	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Continued	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4, previous inventory	Mg	0.57	0.57	0.58	0.58	0.59	0.62	0.69	0.72	0.73	0.74
CH_4, recalculated	Mg	0.57	0.57	0.58	0.58	0.59	0.62	0.69	0.72	0.73	0.74
N_2O, previous inventory	Mg	0.71	0.72	0.73	0.72	0.74	0.77	0.86	0.90	0.92	0.93
N_2O, recalculated	Mg	0.71	0.72	0.73	0.72	0.74	0.77	0.86	0.90	0.92	0.93
Change, CO_2-equivalents	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change	%	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01

Table 3G-6.4 Changes in emissions from Waste Other compared with the CRF reported last year.

Waste Other	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, previous inventory	Gg	22.02	22.66	24.17	22.43	22.75	25.41	25.82	24.66	23.19	24.54
CO_2, recalculated	Gg	18.34	18.71	19.71	18.31	18.34	20.17	20.43	19.35	18.14	18.97
CH_4, previous inventory	Gg	1.40	1.53	1.67	1.78	1.92	1.78	2.09	2.36	2.43	2.86
CH_4, recalculated	Gg	1.35	1.47	1.61	1.73	1.86	1.72	2.03	2.30	2.38	2.80
N_2O, previous inventory	Gg	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.08	0.11
N_2O, recalculated	Gg	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.08	0.11
Change, CO_2-equivalents	Gg	-4.80	-5.12	-5.73	-5.25	-5.55	-6.57	-6.74	-6.57	-6.19	-6.81
Change	%	-7.67	-7.62	-7.86	-7.03	-7.02	-8.39	-7.69	-6.93	-6.25	-5.77
Continued	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2, previous inventory	Gg	24.33	24.08	23.56	25.38	23.14	23.96	25.05	25.99	28.48	27.67
CO_2, recalculated	Gg	18.82	18.67	18.25	19.58	17.78	18.26	18.77	19.32	21.50	21.08
CH_4, previous inventory	Gg	3.02	3.09	3.03	3.17	3.00	3.22	3.41	3.80	3.48	3.86
CH_4, recalculated	Gg	2.96	3.03	2.98	3.11	2.95	3.16	3.35	3.73	3.41	3.63
N_2O, previous inventory	Gg	0.13	0.13	0.16	0.16	0.10	0.10	0.11	0.13	0.12	0.13
N_2O, recalculated	Gg	0.13	0.13	0.16	0.16	0.10	0.10	0.11	0.13	0.12	0.13
Change, CO_2-equivalents	Gg	-6.71	-6.58	-6.44	-7.06	-6.47	-6.86	-7.52	-8.05	-8.26	-12.41
Change	%	-5.23	-5.08	-4.71	-4.98	-5.59	-5.59	-5.76	-5.57	-6.00	-8.32

Table 3G-6.5 Changes in emissions from the waste sector compared with the CRF reported last year.

Waste	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, previous inventory	Gg	22.0	22.7	24.2	22.4	22.7	25.4	25.8	24.7	23.2	24.5
CO_2, recalculated	Gg	18.3	18.7	19.7	18.3	18.3	20.2	20.4	19.4	18.1	19.0
CH_4, previous inventory	Gg	57.5	58.9	59.7	60.8	59.4	57.6	58.0	56.1	54.6	56.7
CH_4, recalculated	Gg	77.3	77.8	77.2	76.6	73.1	69.5	68.4	64.9	62.2	63.0
N_2O, previous inventory	Gg	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
N_2O, recalculated	Gg	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Change, CO_2-equivalents	Gg	414.1	391.9	362.3	328.5	284.4	243.7	213.3	180.3	154.4	126.0
Change	%	30.7	28.4	26.1	23.0	20.2	17.8	15.7	13.7	12.0	9.4
Continued	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2, previous inventory	Gg	24.3	24.1	23.6	25.4	23.1	24.0	25.1	26.0	28.5	27.7
CO_2, recalculated	Gg	18.8	18.7	18.3	19.6	17.8	18.3	18.8	19.3	21.5	21.1
CH_4, previous inventory	Gg	57.4	58.4	56.6	58.9	54.9	55.3	58.4	58.0	57.3	56.9
CH_4, recalculated	Gg	62.8	62.0	58.1	58.8	52.8	51.6	53.3	51.6	49.5	47.7
N_2O, previous inventory	Gg	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.4
N_2O, recalculated	Gg	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.4
Change, CO_2-equivalents	Gg	107.9	69.2	26.3	-8.7	-49.2	-83.3	-	-140.7	-170.7	-200.1
Change	%	7.9	5.0	1.9	-0.6	-3.8	-6.4	-8.2	-10.2	-12.4	-14.9

Annex 4 - CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

Please refer to Chapter 3.4 and Annex 3A.

Annex 5 - Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

GHG inventory

The Danish greenhouse gas emission inventories for 1990-2009 include all sources identified by the Revised 1996 IPCC Guidelines and the 2000 IPCC Good Practice Guidance. Some very minor sources have not been estimated due to lack of methodology, activity data or emission factors, i.e.:

In the Solvent and other product use sector currently only N_2O emissions from anaesthesia and some other minor uses are included in CRF category 3D, Denmark will try to obtain activity data for use of N_2O in aerosol cans. N_2O emissions from anaesthesia are only included from 2005 onwards.

Direct and indirect CH_4 emissions from agricultural soils are not estimated. Direct and indirect soil emissions are considered of minor importance for CH_4. No methodology is available in the IPCC Guidelines.

Emissions from harvested wood products are not reported due to lack of data. Several possible sources of CH_4 in the LULUCF sector are also reported as not estimated. For more detail please see chapter 7.

In the Waste sector CO_2 emissions from managed waste disposal on land are not estimated. According to the 1996 IPCC Guidelines: "Decomposition of organic material derived from biomass sources (e.g., crops, forests), which are regrown on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology."

Emissions of N_2O from accidental fires are reported as not estimated due to lack of emission factors.

KP-LULUCF inventory

The KP-LULUCF inventory is considered complete. Please see Chapter 11 for further documentation.

Annex 6 - Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

Tables A6.1 to A6.5 below contain the information publically available in this report. Table A6.6 includes the list of discrepancies identified by the ITL.

Table A6.1 Total quantities of Kyoto Protocol units by account type at beginning of reported year.

	Unit type					
Account type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	207 147 842	4 108 696	NO	447 341	NO	NO
Entity holding accounts	23 685 544	184 668	NO	1306 555	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	149 207	13 374	NO	72	NO	NO
Retirement account	51 493 378	NO	NO	537 973	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	282 475 971	4 306 738	NO	2 291 941	NO	NO

Table A6.2a Annual internal transactions.

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	ICERs	AAUs	ERUs	RMUs	CERs	tCERs	ICERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verified projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	47 875	NO		
3.3 Deforestation			NO				NO	NO	23 297	NO		
3.4 Forest management			NO				NO	NO	264 692	NO		
3.4 Cropland management			618 231				NO	NO	NO	NO		
3.4 Grazing land management			5878				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired ICERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							7657	NO	NO	1917	NO	NO
Sub-total		NO	624 109				7657	NO	335 864	1917	NO	NO

Table A6.2a Annual internal transactions.

Transaction type	Retirement - Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	ICERs
Retirement	24 446 840	1766	NO	822 623	NO	NO

Table A6.2b Annual external transactions.

	Additions - Unit type						Subtractions - Unit type					
Transfers and acquisitions	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
AT	NO	NO	NO	NO	NO	NO	8856	NO	NO	NO	NO	NO
BE	438 747	197 093	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
BG	NO	1 046 034	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CDM	NO	NO	NO	1 533 737	NO	NO	NO	NO	NO	NO	NO	NO
CH	NO	NO	NO	108 875	NO	NO	NO	NO	NO	NO	NO	NO
CZ	NO	33 151	NO	NO	NO	NO	70 000	NO	NO	NO	NO	NO
DE	1 329 000	NO	NO	NO	NO	NO	415 767	NO	NO	9752	NO	NO
EU	5 000 000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FI	30 000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FR	3600	NO	NO	20 371	NO	NO	65 439	NO	NO	NO	NO	NO
GB	1 606 329	6000	NO	961 902	NO	NO	2 933 331	NO	NO	75 000	NO	NO
IT	NO	NO	NO	NO	NO	NO	150 000	NO	NO	NO	NO	NO
NL	130 000	NO	NO	277 789	NO	NO	300 200	NO	NO	NO	NO	NO
NO	30 845	NO	NO	54 598	NO	NO	15 000	NO	NO	NO	NO	NO
PL	5950	519 935	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
PT	NO	NO	NO	NO	NO	NO	2 188 000	NO	NO	NO	NO	NO
RO	NO	177 953	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SE	19 430	62 674	NO	65 467	NO	NO	6500	NO	NO	NO	NO	NO
UA	NO	207 000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	8 593 901	2 249 840	NO	3 022 739	NO	NO	6 153 093	NO	NO	84 752	NO	NO
Additional information												
Independently verified ERUs								NO				

Table A6.2c Total annual transactions.

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Total (Sum of tables 2a and 2b)	8 593 901	2 249 840	624 109	3 022 739	NO	NO	6 160 750	NO	335 864	86 669	NO	NO

Table A6.3 Expiry, cancellation and replacement.

	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
Transaction or event type	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Table A6.4 Total quantities of Kyoto Protocol units by account type at end of reported year.

Account type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
	Unit type					
Party holding accounts	189 089 822	6 265 538	288 245	753 610	NO	NO
Entity holding accounts	19 729 875	275 900	NO	3 113 733	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	335 864	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	156 864	13 374	NO	1989	NO	NO
Retirement account	75 940 218	1766	NO	1 360 596	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	284 916 779	6 556 578	624 109	5 229 928	NO	NO

Table A6.5 (a). Summary information on additions and subtractions.

	Additions - Unit type						Subtractions – Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and 3.8	276 838 955											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	276 838 955	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	191 772 275	NO	NO	27 439 229	NO	NO	174 391 031	NO	NO	23 971 973	NO	NO
Year 2 (2009)	881 590 260	524 201	NO	32 057 896	NO	NO	874 991 940	185 735	NO	33 349 553	NO	NO
Year 3 (2010)	233 919 660	5 344 875	NO	28 125 141	NO	NO	252 411 415	1 389 977	NO	28 008 871	NO	NO
Year 4 (2011)	8 593 901	2 249 840	624 109	3 022 739	NO	NO	6 160 750	NO	335 864	86 669	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	1 315 876 096	8 118 916	624 109	90 645 005	NO	NO	1 307 955 136	1 575 712	335 864	85 417 066	NO	NO
Total	1 592 715 051	8 118 916	624 109	90 645 005	NO	NO	1 307 955 136	1 575 712	335 864	85 417 066	NO	NO

Table A6.5 (b). Summary information on replacement.

	Requirement for Replacement – Unit type		Replacement – Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table A6.5 (c). Summary information on retirement.

	Retirement – Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	26 171 207	NO	NO	375 230	NO	NO
Year 3 (2010)	25 322 171	NO	NO	162 743	NO	NO
Year 4 (2011)	24 446 840	1766	NO	822 623	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	75 940 218	1766	NO	1 360 596	NO	NO

Table A.6.6 List of discrepancies.										
DES Response Code	Average number of occurrences per transaction (x 100.000)		Transaction Number	Proposal Date Time	Transaction Type	Final State	Explanation	Units Involved abbreviated		
	Reported Year	Prior to the Reported Year						Serial Number	Unit Type	Quantity
4003	39,11	640,09	DK585983	21/12/2011 13:06:55	Internal Transfer	Terminated	The registry still implements the old message flow and thus it completes directly the received external transfer on reception of the acceptProposal message. Consequently, the registry attempted to transfer units received from Great Britain while the ITL considered the units to be still blocked by an ongoing transaction.	CN-333575107-333592706	CER	17600
4010	39,11	1135,41	DK585983	21/12/2011 13:06:55	Internal Transfer	Terminated	This response code is already returned along with response code 4003	CN-333575107-333592706	CER	17600
5009	117,32	0	DK581682	08/04/2011 15:37:37	Issuance	Terminated	Administrative error when setting issuance limits in the registry and attempting to issue RMUs	DK-4084586185-4084850876	RMU	264692
			DK581683	08/04/2011 15:43:19	Issuance	Terminated		DK-4084850877-4084874173	RMU	23297
			DK581684	08/04/2011 15:43:36	Issuance	Terminated		DK-4084874174-4084922048	RMU	47875
5018	39,11	0	DK581684	08/04/2011 15:43:36	Issuance	Terminated	Administrative error when setting issuance limits in the registry and attempting to issue RMUs	DK-4084874174-4084922048	RMU	47875

Annex 7 - Tables 6.1 and 6.2 of the IPCC good practice guidance

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO_2 eqv	Gg CO_2 eqv	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	23 834	15 224	1	1	1.030	0.266	-0.053	0.208	-0.027	0.264	0.266
Stationary Combustion, BKB	CO_2	11	3	3	5	5.831	0.000	0.000	0.000	0.000	0.000	0.000
Stationary Combustion, Coke	CO_2	138	84	2	5	5.340	0.008	0.000	0.001	-0.002	0.003	0.004
Stationary Combustion, Fossil waste	CO_2	573	1410	5	10	11.180	0.268	0.013	0.019	0.129	0.136	0.188
Stationary Combustion, Petroleum coke	CO_2	410	477	5	5	7.068	0.057	0.002	0.007	0.010	0.046	0.047
Stationary Combustion, Residual oil	CO_2	2 440	880	1	2	2.224	0.033	-0.015	0.012	-0.029	0.016	0.034
Stationary Combustion, Gas oil	CO_2	4 547	1 577	2	4	4.688	0.126	-0.028	0.022	-0.113	0.074	0.135
Stationary Combustion, Kerosene	CO_2	366	4	3	5	5.706	0.000	-0.004	0.000	-0.020	0.000	0.020
Stationary Combustion, LPG	CO_2	164	89	2	5	5.477	0.008	-0.001	0.001	-0.003	0.004	0.005
Stationary Combustion, Refinery gas	CO_2	816	817	1	2	2.236	0.031	0.002	0.011	0.004	0.016	0.016
Stationary Combustion, Natural gas	CO_2	4 335	10 607	1	0	1.100	0.198	0.097	0.145	0.039	0.210	0.213
Stationary Combustion, SOLID	CH_4	13	4	1	100	100.005	0.007	0.000	0.000	-0.008	0.000	0.008
Stationary Combustion, LIQUID	CH_4	3	1	1	100	100.007	0.002	0.000	0.000	-0.001	0.000	0.001
Stationary Combustion, GAS	CH_4	3	7	1	100	100.005	0.011	0.000	0.000	0.006	0.000	0.006
Natural gas fuelled engines, GAS	CH_4	5	234	1	2	2.236	0.009	0.003	0.003	0.006	0.005	0.008
Stationary Combustion, WASTE	CH_4	1	1	5	100	100.125	0.002	0.000	0.000	0.001	0.000	0.001
Stationary Combustion, BIOMASS	CH_4	97	133	13	100	100.822	0.227	0.001	0.002	0.075	0.033	0.082
Biogas fuelled engines, BIOMASS	CH_4	1	28	4	10	10.703	0.005	0.000	0.000	0.004	0.002	0.004
Stationary Combustion, SOLID, N_2O	N_2O	68	42	1	400	400.001	0.282	0.000	0.001	-0.072	0.001	0.072
Stationary Combustion, LIQUID, N_2O	N_2O	43	14	1	1000	1000.001	0.233	0.000	0.000	-0.282	0.000	0.282
Stationary Combustion, GAS, N_2O	N_2O	16	36	1	750	750.001	0.454	0.000	0.000	0.230	0.001	0.230
Stationary Combustion, WASTE, N_2O	N_2O	7	16	5	400	400.031	0.107	0.000	0.000	0.057	0.002	0.057
Stationary Combustion, BIOMASS, N_2O	N_2O	38	93	2	1000	1000.002	1.585	0.001	0.001	0.857	0.004	0.857
Transport, Road transport	CO_2	9 282	12 108	2	5	5.385	1.107	0.063	0.165	0.317	0.467	0.564
Transport, Military	CO_2	119	107	2	5	5.385	0.010	0.000	0.001	0.001	0.004	0.004
Transport, Railways	CO_2	297	242	2	5	5.385	0.022	0.000	0.003	0.000	0.009	0.009
Transport, Navigation (small boats)	CO_2	48	99	41	5	41.304	0.070	0.001	0.001	0.004	0.079	0.079
Transport, Navigation (large vessels)	CO_2	748	494	11	5	12.083	0.101	-0.001	0.007	-0.007	0.105	0.105

Continued

Transport, Fisheries	CO_2	591	575	2	5	5.385	0.053	0.001	0.008	0.007	0.022	0.023
Transport, Agriculture	CO_2	1 272	1 273	24	5	24.515	0.530	0.003	0.017	0.017	0.589	0.590
Transport, Forestry	CO_2	36	17	30	5	30.414	0.009	0.000	0.000	-0.001	0.010	0.010
Transport, Industry (mobile)	CO_2	839	1 037	41	5	41.304	0.727	0.005	0.014	0.025	0.820	0.820
Transport, Residential	CO_2	39	63	35	5	35.355	0.038	0.000	0.001	0.002	0.042	0.042
Transport, Commercial/institutional	CO_2	74	173	35	5	35.355	0.104	0.002	0.002	0.008	0.117	0.117
Transport, Civil aviation	CO_2	243	156	10	5	11.180	0.030	-0.001	0.002	-0.003	0.030	0.030
Transport, Road transport	CH_4	53	14	2	40	40.050	0.009	0.000	0.000	-0.016	0.001	0.016
Transport, Military	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Railways	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Navigation (small boats)	CH_4	0	1	41	100	108.079	0.001	0.000	0.000	0.000	0.000	0.001
Transport, Navigation (large vessels)	CH_4	0	0	11	100	100.603	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Fisheries	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Agriculture	CH_4	2	2	24	100	102.840	0.004	0.000	0.000	0.000	0.001	0.001
Transport, Forestry	CH_4	0	0	30	100	104.403	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Industry (mobile)	CH_4	1	1	41	100	108.079	0.001	0.000	0.000	0.000	0.001	0.001
Transport, Residential	CH_4	1	1	35	100	105.948	0.002	0.000	0.000	0.001	0.001	0.001
Transport, Commercial/institutional	CH_4	2	3	35	100	105.948	0.006	0.000	0.000	0.002	0.002	0.003
Transport, Civil aviation	CH_4	0	0	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Road transport	N_2O	93	119	2	50	50.040	0.102	0.001	0.002	0.031	0.005	0.031
Transport, Military	N_2O	1	1	2	1000	1000.002	0.019	0.000	0.000	0.003	0.000	0.003
Transport, Railways	N_2O	3	2	2	1000	1000.002	0.035	0.000	0.000	0.000	0.000	0.000
Transport, Navigation (small boats)	N_2O	0	1	41	1000	1000.840	0.018	0.000	0.000	0.010	0.001	0.010
Transport, Navigation (large vessels)	N_2O	15	10	11	1000	1000.060	0.164	0.000	0.000	-0.029	0.002	0.029
Transport, Fisheries	N_2O	11	11	2	1000	1000.002	0.192	0.000	0.000	0.028	0.000	0.028
Transport, Agriculture	N_2O	15	17	24	1000	1000.288	0.284	0.000	0.000	0.061	0.008	0.061
Transport, Forestry	N_2O	0	0	30	1000	1000.450	0.003	0.000	0.000	0.000	0.000	0.000
Transport, Industry (mobile)	N_2O	11	14	41	1000	1000.840	0.232	0.000	0.000	0.070	0.011	0.070
Transport, Residential	N_2O	0	0	35	1000	1000.612	0.006	0.000	0.000	0.002	0.000	0.002
Transport, Commercial/institutional	N_2O	0	1	35	1000	1000.612	0.014	0.000	0.000	0.007	0.001	0.008
Transport, Civil aviation	N_2O	3	3	10	1000	1000.050	0.045	0.000	0.000	0.001	0.001	0.001
1.B.2 Flaring in refinery	CO_2	23	19	11	2	11.180	0.004	0.000	0.000	0.000	0.004	0.004
1.B.2 Flaring off-shore	CO_2	300	333	8	2	7.762	0.044	0.001	0.005	0.003	0.048	0.048
1.B.2 Land based activities	CO_2	0	0	2	40	40.050	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Off-shore activities	CO_2	2	5	2	30	30.067	0.002	0.000	0.000	0.001	0.000	0.001
1.B.2 Transmission of natural gas	CO_2	0	0	15	2	15.133	0.000	0.000	0.000	0.000	0.000	0.000

Continued

1.B.2 Distribution of natural gas	CO_2	0	0	25	10	26.926	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Venting in gas storage	CO_2	0	0	15	2	15.133	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Flaring in refinery	CH_4	1	0	11	15	18.601	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Flaring off-shore	CH_4	0	1	8	125	125.225	0.001	0.000	0.000	0.000	0.000	0.000
1.B.2 Refinery processes	CH_4	1	47	1	125	125.004	0.099	0.001	0.001	0.078	0.001	0.078
1.B.2 Land based activities	CH_4	17	18	2	40	40.050	0.012	0.000	0.000	0.002	0.001	0.002
1.B.2 Off-shore activities	CH_4	15	37	2	30	30.067	0.019	0.000	0.001	0.010	0.001	0.011
1.B.2 Transmission of natural gas	CH_4	4	1	15	2	15.133	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Distribution of natural gas	CH_4	5	3	25	10	26.926	0.001	0.000	0.000	0.000	0.001	0.001
1.B.2 Venting in gas storage	CH_4	0	1	15	2	15.133	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2 Flaring in refinery	N_2O	0	0	11	1000	1000.060	0.001	0.000	0.000	-0.001	0.000	0.001
1.B.2 Flaring off-shore	N_2O	1	1	8	1000	1000.028	0.013	0.000	0.000	0.003	0.000	0.003
2A1 Cement production	CO_2	882	672	1	2	2.236	0.026	-0.001	0.009	-0.001	0.013	0.013
2A2 Lime production	CO_2	116	46	5	5	7.071	0.005	-0.001	0.001	-0.003	0.004	0.005
2A3 Limestone and dolomite use	CO_2	14	46	5	5	7.071	0.005	0.000	0.001	0.002	0.004	0.005
2A5 Asphalt roofing	CO_2	0	0	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2A6 Road paving with asphalt	CO_2	2	2	5	25	25.495	0.001	0.000	0.000	0.000	0.000	0.000
2A7 Glass and Glass wool	CO_2	55	31	5	2	5.385	0.003	0.000	0.000	0.000	0.003	0.003
2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	1	2	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
2C1 Iron and steel production	CO_2	28	0	5	5	7.071	0.000	0.000	0.000	-0.002	0.000	0.002
2D2 Food and Drink	CO_2	4	2	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
2G Lubricants	CO_2	50	33	2	5	5.385	0.003	0.000	0.000	0.000	0.001	0.001
2B2 Nitric acid production	N_2O	1 043	0	2	25	25.080	0.000	-0.011	0.000	-0.286	0.000	0.286
2F Consumption of HFC	HFC	218	800	10	50	50.990	0.693	0.009	0.011	0.426	0.154	0.454
2F Consumption of PFC	PFC	1	13	10	50	50.990	0.011	0.000	0.000	0.009	0.003	0.009
2F Consumption of SF_6	SF_6	107	38	10	50	50.990	0.033	-0.001	0.001	-0.033	0.007	0.034
3A Paint application	CO_2	16	7.96	10	15	18.028	0.002	0.000	0.000	-0.001	0.002	0.002
3B Degreasing and dry cleaning	CO_2	0	0.00	10	15	18.028	0.000	0.000	0.000	0.000	0.000	0.000
3C Chemical products, manufacturing and processing	CO_2	19	12.31	10	15	18.028	0.004	0.000	0.000	-0.001	0.002	0.002
3D5 Other	CO_2	57	41.75	10	20	22.361	0.016	0.000	0.001	-0.001	0.008	0.008
3D5 Consumption of fireworks	CO_2	0	0.23	8	100	100.319	0.000	0.000	0.000	0.000	0.000	0.000
3D1 Other - Use of N_2O for Anaesthesia	N_2O	0	10.66	5	5	7.071	0.001	0.000	0.000	0.001	0.001	0.001
3D3 Use of tobacco	N_2O	0	0.17	20	30	36.056	0.000	0.000	0.000	0.000	0.000	0.000
3D3 Use of charcoal for BBQ	N_2O	0	0.08	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
3D3 Consumption of fireworks	N_2O	1	3.25	8	100	100.319	0.006	0.000	0.000	0.004	0.001	0.004

Continued

4A Enteric Fermentation	CH_4	3 247	2 856	2	20	20.100	0.975	0.003	0.039	0.068	0.110	0.129
4B Manure Management	CH_4	993	1 288	5	20	20.616	0.451	0.007	0.018	0.134	0.124	0.182
4F Field burning of agricultural residues	CH_4	2	2	25	50	55.902	0.002	0.000	0.000	0.000	0.001	0.001
4.B Manure Management	N_2O	600	421	22	50	54.772	0.392	-0.001	0.006	-0.041	0.182	0.186
4.D1.1 Synthetic Fertilizer	N_2O	2 405	1 139	25	100	103.121	1.995	-0.011	0.016	-1.081	0.553	1.215
4.D1.2 Animal waste applied to soils	N_2O	1 112	1 154	30	100	104.403	2.046	0.004	0.016	0.356	0.668	0.757
4.D1.3 N-fixing crops	N_2O	269	238	20	100	101.980	0.412	0.000	0.003	0.029	0.092	0.096
4.D1.4 Crop Residue	N_2O	361	315	20	100	101.980	0.545	0.000	0.004	0.033	0.121	0.126
4.D1.5 Cultivation of histosols	N_2O	226	163	20	100	101.980	0.282	0.000	0.002	-0.025	0.063	0.068
4.D.2 Grassing animals	N_2O	311	197	25	100	103.199	0.346	-0.001	0.003	-0.071	0.097	0.121
4.D3 Atmospheric deposition	N_2O	455	288	19	100	101.736	0.497	-0.001	0.004	-0.106	0.104	0.149
4.D3 Leaching	N_2O	2 452	1 415	20	100	101.980	2.451	-0.008	0.019	-0.756	0.546	0.933
4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	28	41	20	100	101.980	0.072	0.000	0.001	0.026	0.016	0.030
4.F Field Burning of Agricultural Residues	N_2O	1	1	25	50	55.902	0.001	0.000	0.000	0.000	0.000	0.000
5.A.1 Broadleaves	CO_2	-708	-3 752	15	50	52.202	-3.326	-0.043	-0.051	-2.172	-1.086	2.428
5.A.1 Conifers	CO_2	-136	-1 937	15	50	52.202	-1.717	-0.025	-0.026	-1.246	-0.561	1.367
5.A.2 Broadleaves	CO_2	3	178	15	50	52.202	0.158	0.002	0.002	0.120	0.051	0.130
5.A.2 Conifers	CO_2	6	-177	15	50	52.202	-0.157	-0.002	-0.002	-0.124	-0.051	0.134
5(II) Forest Land.	N_2O	16	12	30	75	80.777	0.017	0.000	0.000	-0.001	0.007	0.007
5.B Cropland, Living biomass	CO_2	177	102	10	50	50.990	0.088	-0.001	0.001	-0.027	0.020	0.034
5.B Cropland, Dead organic matter	CO_2	7	1	10	50	50.990	0.001	0.000	0.000	-0.003	0.000	0.003
5.B Cropland, Mineral soils	CO_2	1 415	1 152	10	75	75.664	1.480	0.000	0.016	0.015	0.222	0.223
5.B Cropland, Organic soils	CO_2	2 420	1 745	10	90	90.554	2.683	-0.003	0.024	-0.244	0.337	0.416
5(III) Disturbance, Land converted to cropland	N_2O	3	1	50	75	90.139	0.001	0.000	0.000	-0.002	0.001	0.002
5.C Grassland, Living biomass	CO_2	186	34	10	50	50.990	0.029	-0.002	0.000	-0.079	0.006	0.079
5.C Grassland, Dead organic matter	CO_2	37	2	10	50	50.990	0.002	0.000	0.000	-0.018	0.000	0.018
5.C Grassland, Mineral soils	CO_2	0	5	10	75	75.664	0.006	0.000	0.000	0.005	0.001	0.005
5.C Grassland, Organic soils	CO_2	183	145	10	90	90.554	0.223	0.000	0.002	-0.003	0.028	0.028
5.D Wetlands, Living biomass	CO_2	0	-5	10	50	50.990	-0.005	0.000	0.000	-0.004	-0.001	0.004
5.D Wetlands, Dead organic matter	CO_2	0	0	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
5.D Wetlands, Soils	CO_2	86	5	10	100	100.499	0.009	-0.001	0.000	-0.087	0.001	0.087
5(II) Wetlands	N_2O	0	0	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
5.E Settlements, Living biomass	CO_2	104	134	10	50	50.990	0.116	0.001	0.002	0.034	0.026	0.043
5(IV) Cropland Limestone	CO_2	623	185	5	50	50.249	0.158	-0.004	0.003	-0.215	0.018	0.216
5(V) Biomass Burning	CH_4	1	0	50	30	58.310	0.000	0.000	0.000	0.000	0.000	0.000

Continued

5(V) Biomass Burning	N_2O	0	0	50	30	58.310	0.000	0.000	0.000	0.000	0.000	0.000
6 A. Solid Waste Disposal on Land	CH_4	1477	693	10	118	118.323	1.392	-0.007	0.009	-0.794	0.134	0.805
6 B. Wastewater Handling	CH_4	66	75	44	78	89.554	0.115	0.000	0.001	0.024	0.064	0.068
6 B. Wastewater Handling - Direct	N_2O	27	51	37	98	104.752	0.091	0.000	0.001	0.039	0.037	0.054
6 B. Wastewater Handling - Indirect	N_2O	82	33	59	39	70.725	0.039	0.000	0.000	-0.018	0.037	0.041
6.D Accidental fires, buildings	CO_2	11	11	10	300	300.167	0.057	0.000	0.000	0.008	0.002	0.008
6.D Accidental fires, vehicles	CO_2	7	7	10	500	500.100	0.060	0.000	0.000	0.011	0.001	0.011
6.C Incineration of corpses	CH_4	0	0	1	150	150.003	0.000	0.000	0.000	0.000	0.000	0.000
6.C Incineration of carcasses	CH_4	0	0	40	150	155.242	0.000	0.000	0.000	0.000	0.000	0.000
6.D Compost production	CH_4	27	80	40	100	107.703	0.147	0.001	0.001	0.081	0.062	0.102
6.D Accidental fires, buildings	CH_4	1	1	10	500	500.100	0.012	0.000	0.000	0.002	0.000	0.002
6.D Accidental fires, vehicles	CH_4	0	0	10	700	700.071	0.004	0.000	0.000	0.001	0.000	0.001
6.C Incineration of corpses	N_2O	0	0	1	150	150.003	0.000	0.000	0.000	0.000	0.000	0.000
6.C Incineration of carcasses	N_2O	0	0	40	150	155.242	0.000	0.000	0.000	0.000	0.000	0.000
6.D Compost production	N_2O	11	43	40	100	107.703	0.078	0.000	0.001	0.046	0.033	0.056
Total		73 309	58 895			47.829						14.566
Total uncertainties			Overall uncertainty in the year (%):			6.916					Trend uncertainty (%):	3.817

Annex 8 Methodology applied for the greenhouse gas inventory for the Faroe Islands

Introduction

This report covers the Faroese part of the National Inventory Report for the Kingdom of Denmark.

This report is made by the Faroese Environment Agency FEA.

Background information on greenhouse gas inventories and climate change

Each year the Faroe Islands is obligated to report its emission of greenhouse gases (GHG), according to the requirements of the United Nations Framework Convention on Climate Change (UNFCCC). The Kingdom of Denmark (which includes Denmark, Greenland and the Faroe Islands as geographical areas) has signed the UNCCC.

When Denmark ratified the Kyoto Protocol, it was with territorial reservation for the Faroe Islands. Since the reservation has not been lifted, the requirements for reporting are only those related to the UNFCCC convention.

The Faroese emission figures are part of the emission total for the Kingdom of Denmark, and emission data are subsequently submitted to the UNFCCC.

The first emission inventories for the Faroe Islands were made using an average method based upon the total use of fossil fuels in the Faroe Islands and consequently the inventories have only included total estimates of CO_2 emissions. Later, the inventories were done according to IPCC guidelines. The FEA has since 2008 yearly reported GHG emissions to NERI.

The GHGs reported are:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexaflouride SF_6

A description of the institutional arrangement for inventory preparation

FEA, a subsidiary of the Ministry of the Interior, is responsible for the annual preparation and submission to the UNFCCC of the Faroe Islands' contribution to the Kingdom of Denmark National Inventory Report and the GHG inventories in the Common Reporting Format in accordance with the UNFCCC Guidelines. The inventory is done with guidance from and in co-operation with NERI.

The work concerning the annual greenhouse gas emission inventory is carried out in co-operation with other Faroese ministries, research institutes, organisations and companies:

- *Statistics Faroe Islands (Ministry of Finance)* Annual statistics on liquid fuel sale, fuel usage for electricity and heat production, and statistics on livestock (sheep and cows).
- *Municipal Waste Plants* Data on amount of incinerated waste.
- *Electricity producing company* Data on import of F-gases (SF_6).
- *Airline Company* Data for fuel usage for domestic flights and international flights to and from the Faroe Islands.
- *Refrigeration companies* Data on import of F-gases (HFCs).
- *Oil companies – licence holders* Data on use of fuel oil in connection with exploration (deep water) drilling in Faroese territorial waters.

In January 2010, NERI and FEA made a formal agreement about data delivery.

Brief description of the process of inventory preparation. Data collection and processing, data storage and archiving

The activity data for fuel sale and for fuel usage by large combustion plants, as well as for the number of livestock (sheep and cows) are collected and stored at Statistics Faroe Islands. Each year, FEA receives new data for fuel sale and fuel usage for the previous year. Numbers of livestock is accessible on the homepage of Statistics Faroe Islands, www.hagstova.fo.

Other activity data are delivered by plants owned by municipalities or private companies.

After receiving the data, the material is placed on servers at FEA. The servers are subject to routine backup services. Material that has been backed up is archived safely. All data is archived in the electronic journal of the agency.

The emission factors are yearly received from NERI Denmark, sent by email to the FEA as Excel files. In addition to copying the factors to spreadsheet files, the e-mails are archived in the electronic journal.

The 1990-2008 submission was the first time activity data and emissions were reported in the CRF format. This improvement has meant higher data security and limited the potential for errors in the reporting. The emission inventory is both reported in the form of an xml file and as CRF Excel tables.

Brief general description of methodologies and data sources used

The GHG inventory for the Faroe Islands includes the following sectors:

- Energy sector (CRF sector 1)
- Industrial processes (CRF sector 2)
- Agriculture (CRF sector 4)
- Waste (CRF sector 5) (all emissions allocated to the Energy sector)

The applied methodologies follow the IPCC Guidelines and IPCC Good Practice Guidance, and generally the Tier 1 method is applied. A brief general description of methodologies is included below for the different sectors.

The methods and the emission factors used in the inventory are shown in Table 1 (emission factors for CO_2, CH_4 and N_2O in the Energy and Agriculture sector) and in Table 2 (emission factors for HFCs and SF_6 in the sector for Industrial Processes).

Table 1 Methods applied and emission factors used for calculating CO_2, CH_4 and N_2O emissions in the Energy and Agriculture sectors.

	CO_2		CH_4		N_2O	
GHG CATEGORIES	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	T1	CS	T1	CS	T1	CS
A. Fuel Combustion	T1	CS	T1	CS	T1	CS
1. Energy Industries	T1	CS	T1	CS	T1	CS
2. Manufacturing Industries and Construction	T1	CS	T1	CS	T1	CS
3. Transport	T1	CS	T1	CS	T1	CS
4. Other Sectors	T1	CS	T1	CS	T1	CS
4. Agriculture			T1	D	T1	D
A. Enteric Fermentation			T1	D		
B. Manure Management			T1	D	T1	D

Table 2 Methods and Emission factors used for calculating HFCs and SF6 emissions in the Industrial Processes sector.

	HFCs		SF_6	
GHG CATEGORIES	Method applied	Emission factor	Method applied	Emission factor
2. Industrial Processes	T1	D	T1	D
F. Consumption of Halocarbons and SF_6	T1	D	T1	D

Energy sector

All emissions in the Energy sector are from Fuel combustion (1.A.1), and in these categories:

- 1A1a Main Activity Electricity and Heat Production (incl. Waste)
- 1A1c Manufacture of Solid fuels and Other Energy Industries
- 1A2 Manufacturing Industry and Construction
- 1A3a Civil aviation

- 1A3b Road transport
- 1A3d Navigation
- 1A4a Commercial/Institutional
- 1A4b Residential
- 1A4c Agriculture, Forestry and Fishing

Statistics Faroe Islands provides the information on fuel sales by fuel type (in m^3) and divided into eight main groups (original titles: Fishing vessels, Other ships, Transportation, Industry, Trading and Service, Residential and Communities, Institutions and Public power), each group again divided into subgroups.

The fuel data delivered by Statistics Faroe Islands originate from several sources. The main data sources are the two oil companies in the Faroe Islands. Fuel data not included in sales information from the companies are provided directly by the industry.

Since the data on fuel sale are not fully arranged according to IPCC guidelines, the FEA rearranges the data to comply with the guidelines.

In some cases, it is not possible to rearrange the data to fully comply with the IPCC guidelines. This is the case for foreign fishing vessels. According to the guidelines all emissions resulting from fuel used in coastal and deep sea fishing should be allocated to the country delivering the fuel. The oil companies selling fuel to foreign fishing vessels do not all have a system to register the vessel type. Thus, in the inventory, emissions from foreign fishing vessels are partly allocated to International bunkers. This means that the emission from fishing vessels in reality is higher than in the inventory and emission from International bunkering is lower. In accordance with a new Executive Order from December 2010 on reporting of fuels, etc., FEA can obtain more detailed information from oil companies on sale of fuel to fishing vessels. This has already resulted in more detailed in formation about sale of oil to ships in 2010.

The inventory includes all oil bunkered on Faroese territory, excluding oil bunkered at open sea by international companies, i.e., from foreign supplier to foreign customer.

Emission factors

Emissions from fuel combustion come from two main sources: stationary and mobile combustion. Stationary combustion means fuel combustion related to industrial processes, house heating and oil exploration. Mobile combustion includes the combustion in engines used for propulsion in the various modes of transport such as road transport, marine activities and aviation. The emission factors used for stationary, transport, waste and aviation are country specific and provided by NERI.

Emissions are calculated by multiplying fuel consumption data with an emission factor (e.g. in tonnes emission per GJ fuel).

Road transport

The emission factors for road traffic are calculated by NERI. The Danish results are modified for Faroese traffic conditions such as other gross vehicle weights for heavy-duty vehicles and no highway driving conditions. The emissions factors are also modified because biofuel is not used in the Faroe Islands, unlike in Denmark. The emission factors are shown in Table 3.

Table 3 Emission factors for road transport, 1990-2010.

	Diesel			Gasoline		
	CH_4	CO_2	N_2O	CH_4	CO_2	N_2O
1990	7,388	74	1,687	31,271	73	2,988
1991	7,335	74	1,683	30,504	73	3,049
1992	7,309	74	1,678	28,916	73	3,199
1993	7,242	74	1,643	27,605	73	3,323
1994	7,262	74	1,661	25,581	73	3,500
1995	7,305	74	1,739	23,603	73	3,664
1996	7,284	74	1,807	21,822	73	3,802
1997	7,154	74	1,886	20,117	73	3,858
1998	6,898	74	1,972	18,658	73	3,753
1999	6,582	74	2,063	17,290	73	3,683
2000	6,167	74	2,116	16,277	73	3,637
2001	5,871	74	2,217	15,241	73	3,511
2002	5,464	74	2,291	14,057	73	3,321
2003	5,090	74	2,369	13,001	73	3,114
2004	4,741	74	2,446	11,907	73	2,926
2005	4,381	74	2,505	10,925	73	2,653
2006	4,052	74	2,570	9,891	73	2,388
2007	3,382	74	2,639	8,912	73	2,120
2008	2,631	74	2,700	8,224	73	1,904
2009	2,064	74	2,744	7,680	73	1,749
2010	1,756	74	2,797	7,282	73	1,580

Aviation

As the Faroe Islands has accepted the United Nations Climate Convention as a part of the Kingdom of Denmark, aviation between Denmark and the Faroe Islands is to be reported as domestic aviation.

The Faroese airline company, Atlantic Airways, delivers data for use of jet fuel bunkered in the Faroe Islands. The data is divided by destination: flights to destinations inside the Kingdom of Denmark, i.e., Denmark and Greenland (Domestic Aviation), and outside the Danish Kingdom, e.g., Iceland, Norway and Great Britain (International Aviation). Fuel refuelled outside the Faroe Islands is not included in the Faroese inventory.

The emission factors for aviation are made by NERI, see Table 4.

Table 4 Emission factors for aviation, 1990-2010

	CH_4	CO_2	N_2O
	G pr GJ	Kg pr GJ	G pr GJ
1990	465,9	72,0	2,68
1991	465,9	72,0	2,68
1992	465,9	72,0	2,68
1993	465,9	72,0	2,68
1994	465,9	72,0	2,68
1995	465,9	72,0	2,68
1996	465,9	72,0	2,68
1997	465,9	72,0	2,68
1998	465,9	72,0	2,68
1999	465,9	72,0	2,68
2000	465,9	72,0	2,68
2001	465,9	72,0	2,61
2002	473,7	72,0	2,61
2003	475,0	72,0	2,61
2004	523,3	72,0	2,62
2005	718,0	72,0	2,67
2006	716,6	72,0	2,67
2007	719,3	72,0	2,67
2008	716,6	72,0	2,67
2009	716,6	72,0	2,67
2010	720,2	72,0	2,67

Industrial processes

Emissions from Industrial processes are allocated to these categories:

- 2F1 Refrigeration and Air Conditioning
- 2G1 Electrical equipment

The inventory follows the principles in the IPCC Guidelines and the IPCC Good Practice Guidance, with at Tier 1 methodology. The emissions factors are IPPC default.

FEA conducts annual surveys on the consumption (import) of HFCs and SF_6 (since 2003). An estimate of the consumption has been done for the years 1990-2002.

There has been no consumption of PFCs in the Faroe Islands.

Solvent and other product use

Since no data are available, emissions from solvent and other product use are not calculated.

Agriculture

GHG emissions from agriculture are calculated for following categories:

- 4A Enteric fermentation

- 4B Manure management
- 4D2 Agricultural Soil - Grassing animals

The inventory follows the principles in the IPCC Guidelines and the IPCC Good Practice Guidance. Method: Tier 1. All emission factors used for agriculture are IPCC standard values. The emissions are calculated with support from NERI. Activity data is accessible on the homepage of Statistics Faroe Islands.

Waste

The GHG emission from waste incineration is calculated using country specific methodology. Emission factors relative to emissions of CO_2, N_2O and CH_4 from waste incineration in 1990-2010 are listed in Table 5 and heating values for waste incineration are listed in Table 6

Table 5 Emission factors for waste incineration.

Year	Fossil waste	CO_2 EMF - fossil	CO_2 EMF - biogen	CH_4 EMF - tot	N_2O EMF - tot
	%	Kg pr GJ	Kg pr GJ	g pr GJ	g pr GJ
1990	32,2	37	86,7	6	4
1991	32,2	37	86,7	6	4
1992	35,4	37	84,2	6	4
1993	36,9	37	83,0	6	4
1994	36,9	37	83,0	6	4
1995	39,3	37	81,1	6	4
1996-2010	41,2	37	79,6	6	4

Table 6 Heating values (GJ pr t) for waste.

Year	Heating values GJ pr t
1990-91	8,2
1992	9,0
1993-94	9,4
1995	10,0
1996-2010	10,5

Brief description of key categories

No key category analysis (KCA) has been carried out for the Faroe Islands inventory.

Information on QA/QC plan including verification and treatment of confidential issues where relevant

A number of measures are in place to ensure the quality of the greenhouse gas inventory for the Faroe Islands.

The general QC activities include:

- Check that data from Statistics Faroe Islands and other data deliverers are correctly transferred to emissions spreadsheets.

- Check that data are correctly moved between data processing steps, e.g., it is ensured that the data are imported correctly from the emission spreadsheets /databases to the CRF Reporter.
- The time series are analysed. Any large fluctuations are investigated and explained /corrected.
- The completeness of the inventory is checked utilising the completeness checker incorporated in the CRF Reporter.

These types of QC checks are recommended as Tier 1 QC checks in the IPCC Good Practice Guidance (IPCC, 2000).

No confidential issues are relevant.

General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

No uncertainty evaluation has been made for the Faroese inventory.

General assessment of the completeness

In general, the inventory is complete. However, recalculation in the 2009 and the 2010 inventory in water-born navigation and in International bunkers for the years 2001-2009 implied incompleteness, since it was not possible at the time of delivery to complete the recalculation back to 1990. Data for 1990-2000 in these categories will be recalculated before the next inventory reporting in 2013.

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Lastein, L. & Winther, M. 2003: Emissions of greenhouse gases and long-range transboundary air pollutants in the Faroe Islands 1990-2001. National Environmental Research Institute, Denmark. 62 p. – NERI Technical Report no. 477. Available at: http://technicalreports.dmu.dk

Winther, M. 2001: 1998 Fuel Use and Emissions for Danish IFR Flights. Environmental Project no. 628, 2001. 112 p. Danish EPA. Prepared by the National Environmental Research Institute, Denmark. Electronic report at homepage of Danish EPA. Available at: http://www.mst.dk/udgiv/Publications/2001/87-7944-661-2/html/

Trends in Greenhouse Gas Emissions

The trends present in this Chapter cover the emissions from the Faroe Islands.

The trend tables 1990-2010 for CO_2, CH_4, N_2O, F-gases and CO_2 equivalents (CRF: Table10) are presented in Annex 1.

Description and interpretation of emission trends for aggregated greenhouse gas emissions

The greenhouse gas emissions are estimated according to the IPCC guidelines and are aggregated into four main sectors: Energy, Agriculture, Waste and Industrial Processes. All emissions from the Waste sector are allocated to the Energy sector. The greenhouse gases include CO_2, CH_4, N_2O, HFCs and SF_6. Figure 1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2010. The total greenhouse gas emission in CO_2 equivalents has increased by 19.1 % from 1990 to 2010. Comments on the overall trends etc are given in the sections below.

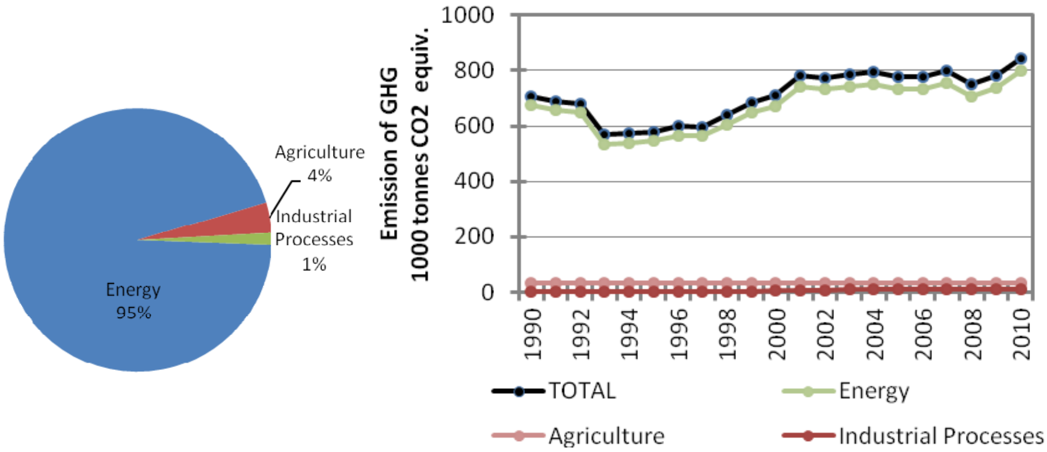

Figure 1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors for 2010 and time series for 1990 to 2010.

Figure 2 shows the composition of greenhouse gas emissions (CO_2, N_2O, CH_4 and F-gases) in 2010, calculated in GWP values. CO_2 is the most important greenhouse gas contributing in 2010 with 94 %, followed by N_2O with 3 %, CH_4 2 % and F-gases (HFCs and SF_6) with 1 %.

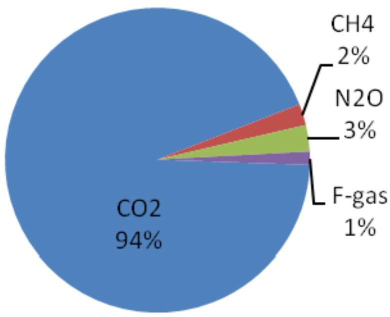

Figure 2 Emissions of GHG in CO_2 equivalents in 2010, distributed on type of gas.

Figure 3 shows the total emissions of greenhouse gases (in CO_2 equivalents) in the time period 1990-2010. The total emission has increased by 19.1 % from 1990-2010. From 1990 to 1993 a decrease is observed, due to the economic crisis in the Faroe Islands. From 2001 to 2006, the emissions were rather stabile. In 2008 and 2009 the emissions from Faroese fishing ship decreased significantly. But because of a new bunkering activity from 2009 and onward, has lead to a substantial increase in the number of foreign fishing vessels bunkering in the Faroe Island, the total emission from fishing has increased. In 2010, the emissions were 19.1 % above the base year.

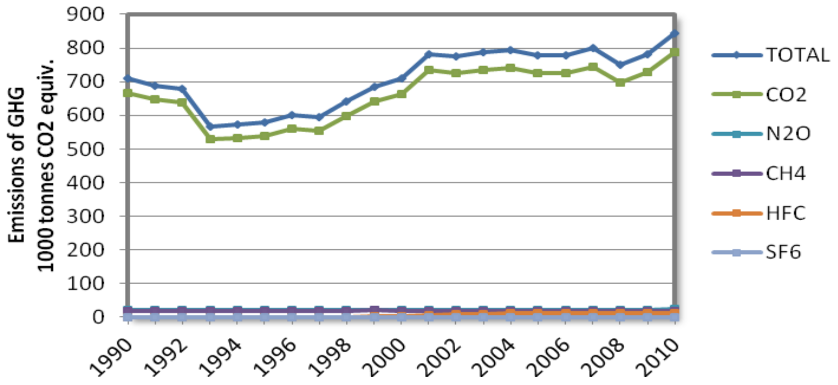

Figure 3 GHG emission in CO_2 equivalents, time series 1990-2010.

Description and interpretation of emission trends by gas

Carbon dioxide

The emission of CO_2 is from fuel consumption only. The trend in the emission of CO_2 (Figure 4) is nearly identical with the total emission of GHG in the Faroe Islands (Figure 3) showing the trends in CO_2 emissions in the period from 1990 to 2010. After the economic decline in the 1990s the emissions rose and were rather constant until 2007. From 2008 to 2010 the effort in the Faroese fishing fleet was significantly lower than previous years, also meaning a significant reduction in oil consumption. The reduction in the emissions for fisheries in 2009 and 2010 is hidden because a new oil bunkering activity most used by foreign fishing vessel started up in 2009, increasing the emissions even more than before the decline in the fisheries sector in 2008-2010.

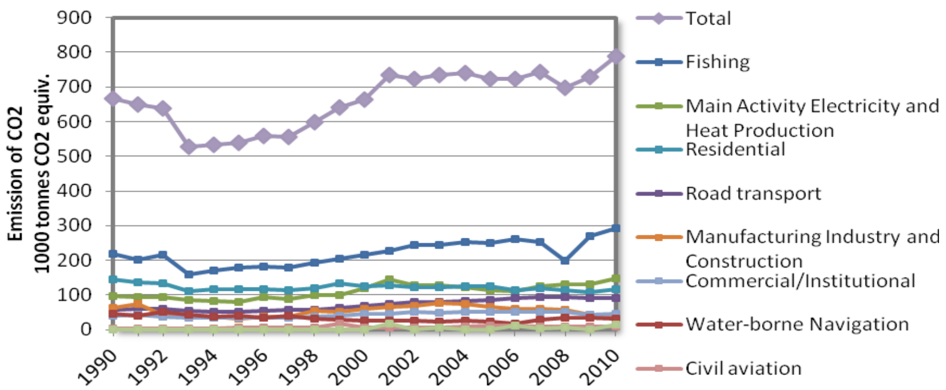

Figure 4 Total CO_2 emissions, time series for 1990-2010.

Figure 5 shows how the emissions are distributed between categories. In 2010 37 % of the CO_2 emissions came from fishing vessels. Public electricity and heat production accounted for 19 %, households for 15 % and road transport for 11 % of the total CO_2 emission.

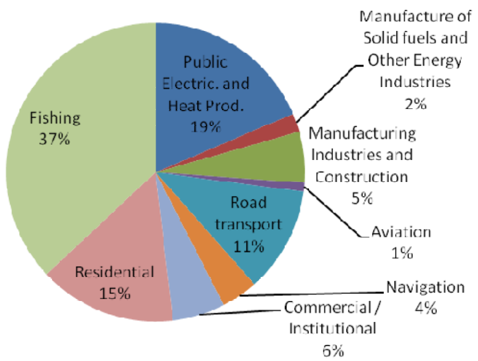

Figure 5 Emissions of CO_2 in the Energy sector, divided in fuel consumption categories, 2010.

Nitrous oxide

Figure 6 shows the emissions of nitrous oxide in the Faroe Islands 1990-2010. Most of the N_2O is from the agriculture sector, especially from animals grazing on agricultural soils.

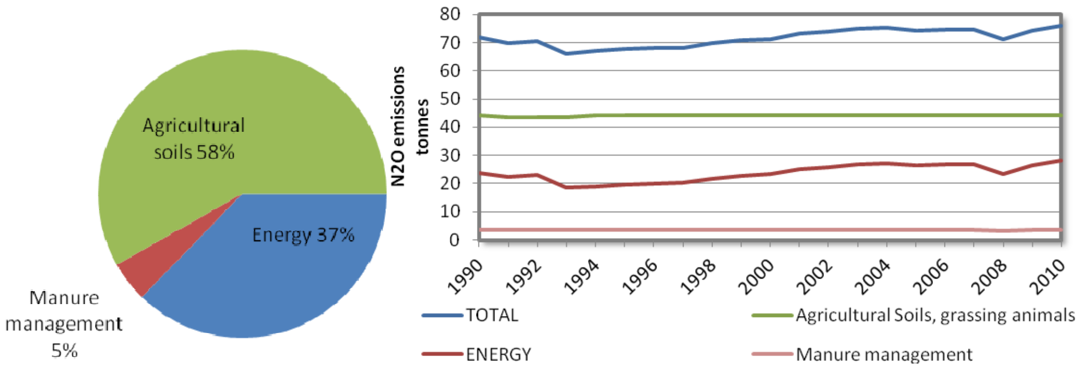

Figure 6 N_2O emissions in tonnes distributed on sector and time series for 1990-2010.

Methane

Figure 7 shows the emissions of methane in the Faroe Islands 1990-2010. Most of the methane emission is from the agriculture sector, especially from enteric fermentation (86 %). Most of the emission of CH_4 in the energy sector is due to aviation activity.

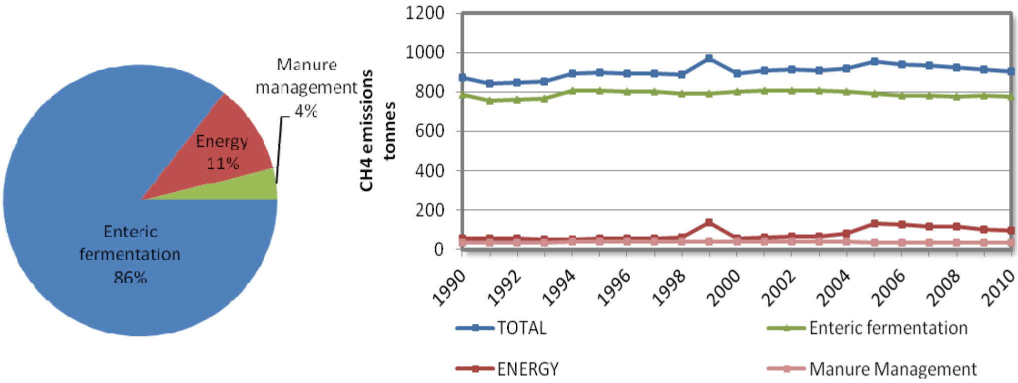

Figure 7 CH_4 emissions in tonnes distributed on sectors and time series for 1990-2010.

HFCs, PFCs and SF_6

Figure 8 shows the emissions of F-gases, HFCs and SF_6 respectively in the years 1990-2010. Most of the emission is HFCs, which are used for refrigeration purposes, as substitutes for HCFCs. After the emissions increased in the period 1996-2005, the emissions have been rather stabile at around 12,000 tonnes of CO_2 equivalents pr year.

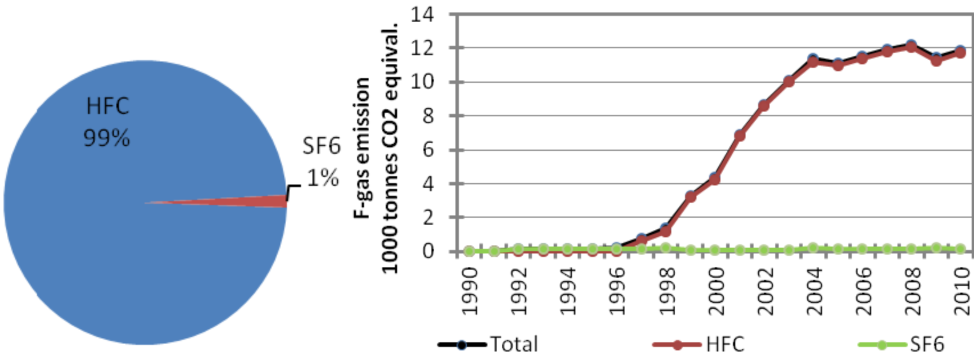

Figure 8 F-gas emissions in CO_2 equivalents, contribution from type of F-gas and time series for 1990-2010.

In 2010 the actual emission of SF_6 was 170 tonnes CO_2 equivalents.

PFC has never been in use in the Faroe Islands.

Description and interpretation of emission trends by source

In 2010, 95 % of all GHG emissions were from the Energy sector, including waste-incineration. 4 % were from agriculture and 1 % from Industrial processes, see Figure 9.

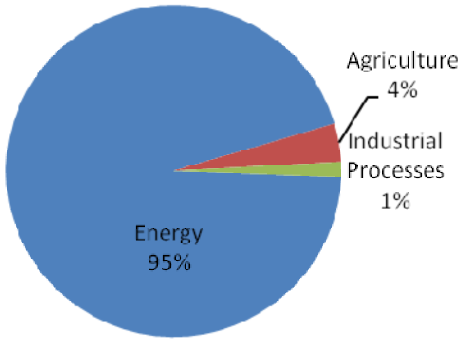

Figure 9 Emissions of GHG in CO_2 equivalents distributed by main sectors, 2010.

The fluctuations in the GHG emissions in the Energy sector are decisive for the fluctuations in the total GHG emissions, see Figure 10. The emissions from the Agriculture sector and from Industrial processes are relative small and constant.

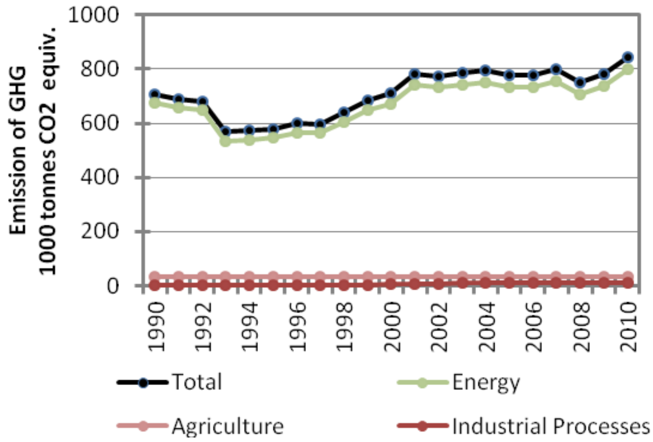

Figure 10 GHG emissions in CO_2 equivalents, main sectors, time series 1990-2010.

Description and interpretation of emission trends for indirect greenhouse gases and SO_2

Emission trends for indirect greenhouse gases and SO_2 have not been made for the Faroe Islands.

Energy (CRF sector 1)

Overview of the sector

Fuel consumption on the Faroe Islands can be seen in Figure 11. Most of the fuel is used by fishing vessels.

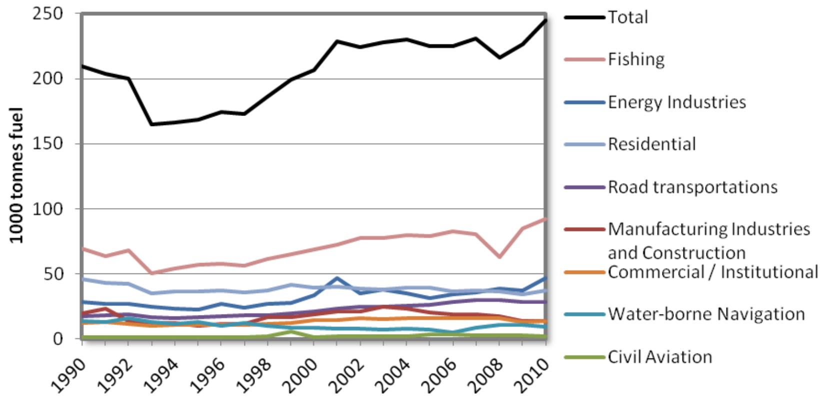

Figure 11 Fuel consumption (tonnes) in the Energy sector, including waste incineration.

The pattern in Figure 11 is also seen in Figure 12, where it can be seen that the trends in the emissions of GHG in the Energy sector is identical to the trends in the fuel consumption.

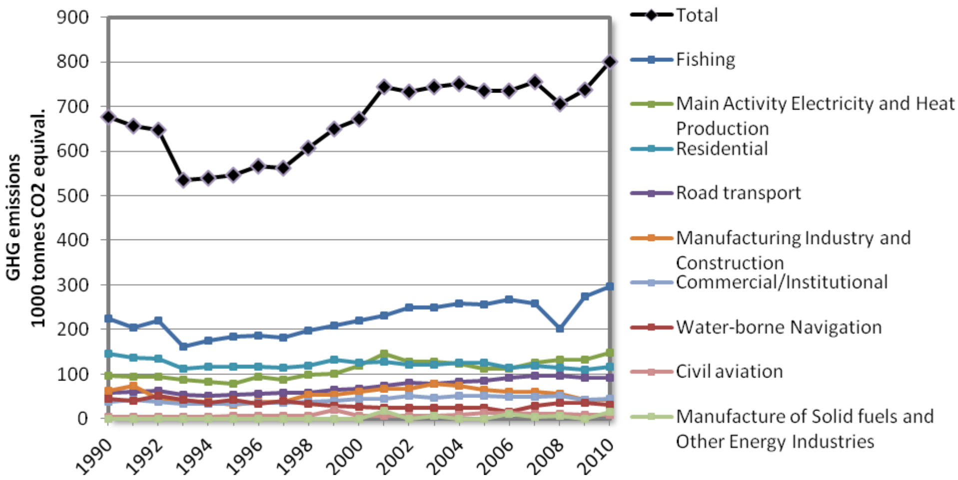

Figure 12 GHG emissions in CO_2 equivalents, categories in the Energy sector, 1990-2010.

Figure 13 shows how the emission of GHG in 2012 was distributed between groups of fuel users. Fishing vessels, Electricity production, Residential and Road transport had 37, 18, 15 and 11 %, respectively, of the emissions in the Energy sector in 2010.

The total emission has increased by 19.1 % from 1990-2010. From 1990 to 1993 a decrease is observed, due to the economic crisis in the Faroe Islands. From 2001 to 2007, the emissions were rather stabile. In 2008 and 2009 the emissions from Faroese fishing ship decreased significantly. But since a new bunkering activity started in 2009, a substantial increase has been in the number of foreign fishing vessels bunkering in the Faroe Island and the total emission from fishing has increased significantly. In 2010, the emissions were 19.1 % above the base year.

Waste incineration has been included under sector 1A1a (Electricity and Heat production).

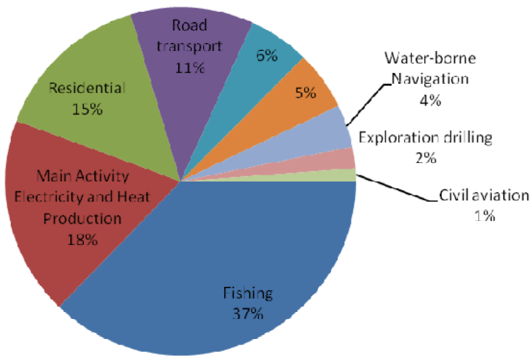

Figure 13 GHG emissions in CO_2 equivalents; Energy sector divided in categories, 2009.

Fugitive emissions (CRF sector 1B)

Fugitive emissions of GHG gases are estimated to be very limited on the Faroe Islands. These emissions have not been estimated.

Industrial Processes (CRF Sector 2)

There is no chemical industry, no metal production, no production of F-gases and no mineral production (other than road paving with asphalt) on the Faroe Islands. The only industrial processes leading to GHG emissions on the Faroe Islands is the use of F-gases. Since no data is available on paving roads with asphalt, the emissions of GHG from road paving are not included in the inventory.

Overview of the sector

Figure 14 shows the GHG emissions from industrial processes on the Faroe Islands. The increase in emissions, starting in 1996 is due to use of HFCs in refrigeration.

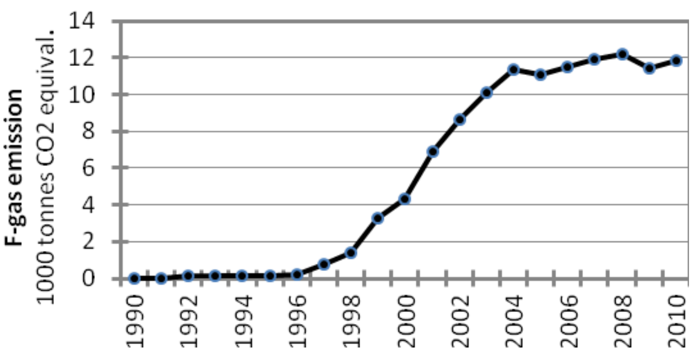

Figure 14 GHG emissions in CO_2 equivalents, Industrial processes, 1990-2010.

Mineral products (2A)

There is no mineral production in the Faroe Islands, other than paving roads with asphalt. No data is available for paving roads with asphalt.

Chemical industry (2B)

No chemical industry with GHG emission is located in the Faroe Islands.

Metal production (2C)

No metal production industry is located in the Faroe Islands.

Production of Halocarbons and SF_6 (2E)

There is no production of halocarbons and SF_6 in the Faroe Islands.

Metal Production (2C) and Consumption of Halocarbons and SF_6 (2F)

Of the total GHG emissions, 1 % is due to emissions of F-gasses, which are potent greenhouse gases. A part of the emission is HFC gasses, which are used for refrigeration purposes and SF_6 used in electrical equipment.

Time series of the emission (tonnes) of HFCs 1990-2010, are seen in Table 7.

Table 7 Emissions of HFCs from Refrigeration and Air Conditioning, 1990-2010 (tonnes).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Domestic refrigeration											
HFC-134a	NO	NO	NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Commercial refrigeration											
HFC-134a	NO	NO	NO	0,00	0,00	0,00	0,00	0,01	0,02	0,03	0,05
HFC-32	NO	NO	NO	0,00	0,00	0,00	0,00	0,00	0,01	0,05	0,09
HFC-125	NO	NO	NO	0,00	0,00	0,00	0,00	0,01	0,03	0,09	0,15
HFC-143a	NO	NO	NO	0,00	0,00	0,00	0,00	0,01	0,02	0,04	0,06
Industrial refrigeration											
HFC-134a	NO	NO	NO	0,00	0,00	0,00	0,00	0,03	0,06	0,11	0,16
HFC-125	NO	NO	NO	0,00	0,00	0,00	0,00	0,07	0,12	0,23	0,33
HFC-143a	NO	NO	NO	0,00	0,00	0,00	0,00	0,08	0,15	0,28	0,39
Mobile Air Conditioning											
HFC-134a	NO	NO	NO	NO	NO	NO	NO	NO	0,01	0,70	0,70

Continued	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Domestic refrigeration										
HFC-134a	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Commercial refrigeration										
HFC-134a	0,07	0,10	0,12	0,13	0,14	0,13	0,13	0,14	0,14	0,17
HFC-32	0,16	0,22	0,28	0,33	0,32	0,31	0,30	0,28	0,26	0,27
HFC-125	0,25	0,35	0,43	0,50	0,51	0,50	0,50	0,57	0,59	0,74
HFC-143a	0,09	0,12	0,15	0,17	0,19	0,19	0,22	0,32	0,35	0,51
Industrial refrigeration										
HFC-134a	0,28	0,36	0,43	0,48	0,45	0,39	0,36	0,34	0,34	0,35
HFC-125	0,59	0,75	0,88	0,99	0,97	1,03	1,06	1,01	0,86	0,77
HFC-143a	0,70	0,89	1,05	1,17	1,15	1,22	1,25	1,19	1,02	0,91
Mobile Air Conditioning										
HFC-134a	0,70	0,70	0,70	0,68	0,59	0,64	0,76	0,83	0,89	0,94

The HFC emissions are reported with the following assumptions:

- Domestic refrigeration is use in freezers and refrigerators.
- Commercial refrigeration is use in landbased units.
- Industrial refrigeration is use on ships.
- Mobile air conditioning is use in cars, buses and trucks.

Recalculations 2010
Due to changes in the division HFC-134a and HFC-404a between K2, K3 and K4, in 2010, the emission of some of these F-gases, especially HFC-134 and HFC-125, are recalculated for 2009. The recalculations implied only minor changes in the emission.

Figure 15 shows the emissions of SF6 and four types of specific HFCs.

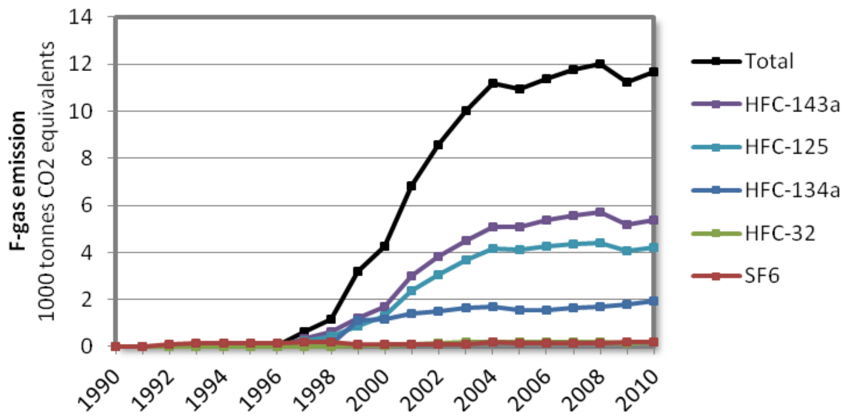

Figure 15 Emission of F-gases (HFCs and SF_6) in CO_2 equivalents, time series for 1990-2010.

Other (2G)

No emissions are in the category "Other".

Uncertainty

Estimations of the uncertainties for Industrial processes have not been done.

Solvents and other product use (CRF Sector 3)

Overview of the sector

Since no data are available for this sector, no emissions are calculated. The expected emissions are low.

Agriculture (CRF Sector 4)

Overview

The emission of greenhouse gases from agricultural activities includes:

- CH_4 emission from manure management and enteric fermentation.
- N_2O emission from manure management and agricultural soil.

4 % of the total GHG emissions on the Faroe Islands are due to agriculture. The sources are cattle and sheep. Figure 16 shows the number of cattle in the Faroe Islands from 1990 to 2010. The number of sheep is 78,940, which is the carrying capacity for sheep on the islands. There are no data on the exact number of sheep.

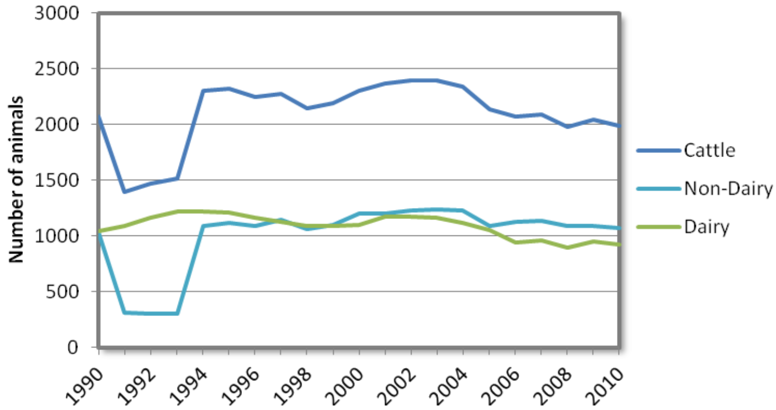

Figure 16 Number of cattle (dairy and non-dairy), time series for 1990-2010.

Figure 17 shows the total emissions from the Agriculture sector.

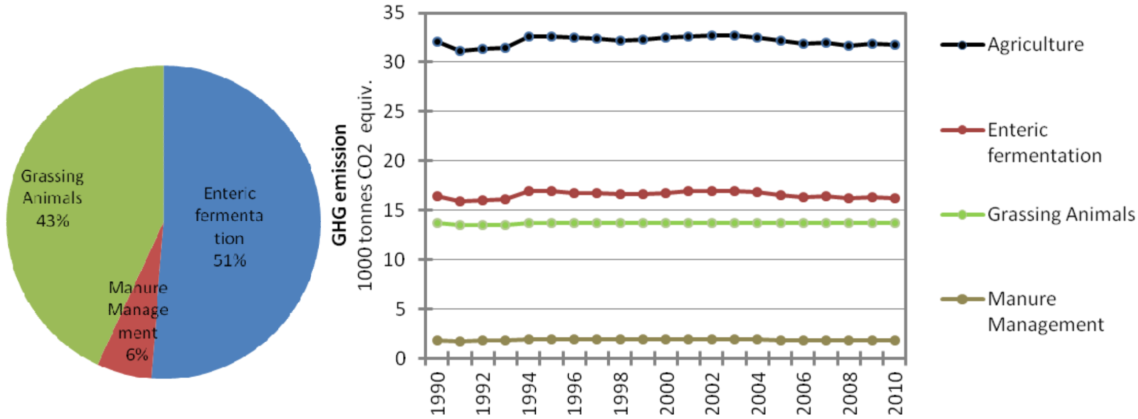

Figure 17 GHG emissions in CO_2 equivalents, in the Agriculture sector, 1990-2010

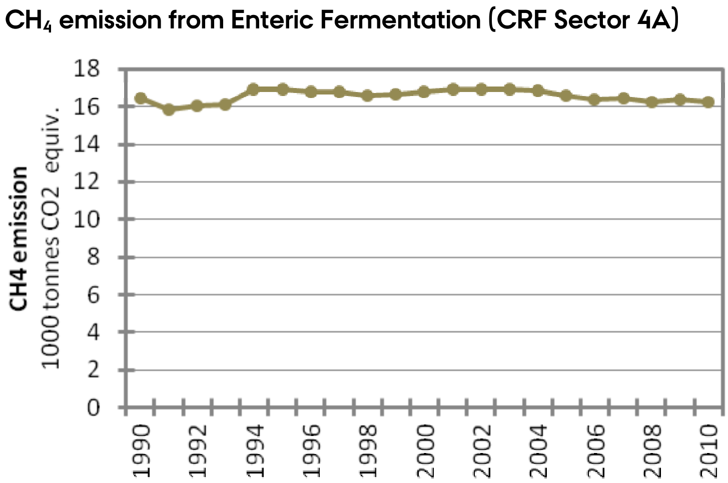

Figure 18 CH_4 emissions in CO_2 equivalents from enteric fermentation, 1990-2010

Figure 18 shows emissions of CH_4 from enteric fermentation on the Faroe Islands, 1990-2010.

CH_4 and N_2O emission from Manure Management (CRF Sector 4B)

Figure 19 shows emissions of N_2O and CH_4 from manure management on the Faroe Islands.

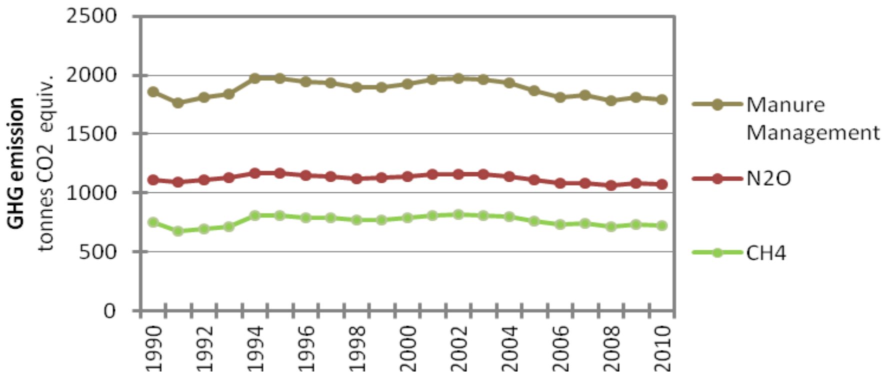

Figure 19 N_2O and CH_4 emission in CO_2 equivalents from Manure management, time series 1990-2010.

N_2O emission from Agricultural Soils (CRF Sector 4D)

The emission from sheep and cows grazing on agricultural soil is 44 tonnes N_2O per year. This corresponds to 13,700 tonnes of CO_2 equivalents. Figure 20 shows the N_2O emissions from agricultural soil. Since the number of sheep is constant over time, the emissions are also constant.

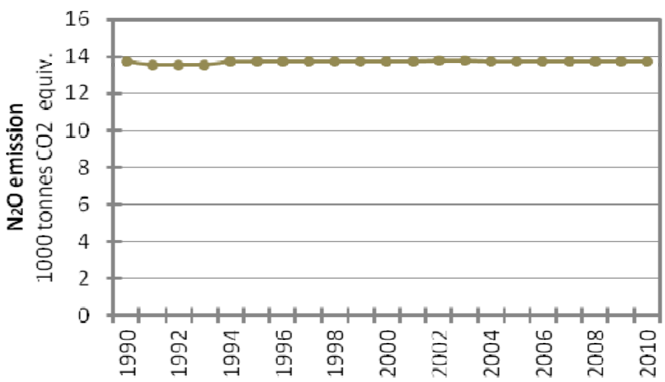

Figure 20 N_2O emissions (tonnes) from Agricultural Soils, grazing animals, time series 1990-2010.

NMVOC emission

The emission of NMVOC is not calculated.

Uncertainties

The uncertainties have not been calculated.

Recalculation

No recalculations were made in the Agriculture sector.

Planned improvements

Include emissions from animal categories other than cattle and sheep.

Land Use, Land Use Change and Forestry (CRF Sector 5)

No emissions are calculated for land use, land-use change and forestry.

Waste Sector (CRF Sector 6)

Overview of the Waste sector

Waste incineration is the only source in the Waste sector with significant emission. The emissions have been allocated to the energy sector in accordance with the IPCC Guidelines.

Solid Waste Disposal on Land (CRF Source Category 6A)

A number of land-based solid waste disposals facilities are located on the Faroe Islands. The GHG emissions from these depots have not been calculated.

Wastewater Handling (CRF Source Category 6B)

In the Faroe Islands, most households have a septic tank. Industrial wastewater, e.g., from the fishing industry, is treated mechanically. Only one wastewater handling plant is treating the water chemically and biologically.

GHG emissions from wastewater handling are not calculated.

Waste Incineration (CRF Source Category 6C)

There are two waste incineration plants on the Faroe Islands, one in Hoyvík and one in Leirvík. Both plants are considered energy recovery operations and therefore the emissions have been allocated to the energy sector in accordance with the IPCC Guidelines.

Figure 21 shows the amounts of waste incinerated on the Faroe Islands 1990-2010.

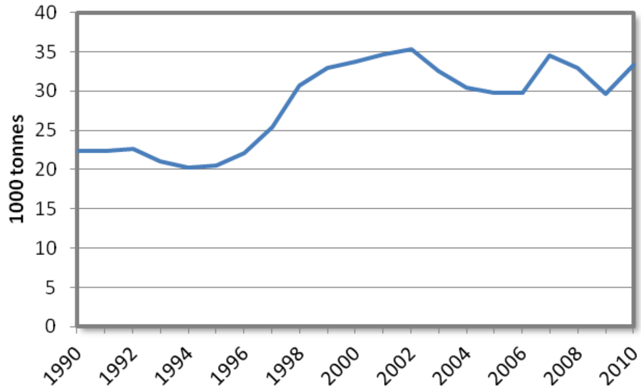

Figure 21 Incineration of municipal waste on the Faroe Islands, 1990-2010.

Emission from waste incineration has been included under sector 1A1a.

Waste Other (CRF Source Category 6D)

There are no activities and emissions in Waste Other.

Other (CRF sector 7)

In CRF sector 7, there are no activities and emissions or removals for the inventory of the Faroe Islands.

Recalculations and improvements

Since the 2011 submission is the second submission in which the Faroe Islands has submitted the data in the CRF format, the 2011 submission is the first submission with recalculations.

Explanations and justifications for recalculations

The following recalculations and improvements to the emission inventories have been made since the reporting in 2011.

Energy

Municipal Waste

Recalculations are made due to updated emission factors for CO_2 for 1990-2009. The change is the same as in the inventory for Denmark.

Road Transport

The recalculations for road transport are due to use of new updated emission factors. The changes are the same as in the inventory for Denmark, i.e.: the total mileage per vehicle category from 1985-2009 have been updated based on new data prepared by DTU Transport (Department of Transport, Technical University of Denmark). Important changes are a different split of total mileage between gasoline and diesel passenger cars based on data for the year 2008 from the Danish vehicle inspection and maintenance programme.

Another recalculation for emission from road transport is due to a correction of an error where the EF for gasoline had been used instead of EF for diesel for CH_4 and vice versa (1990-2009). The same applied for N_2O.

Water-born navigation

Emissions from fuel sold to a few coastal ferries had by mistake been reported as International bunkers. It is now corrected as emission in the water-born navigation category. The error is for the whole time series, 1990-2009. Note that the recalculation was only done for the years 2001-2009. In next submission the recalculation will be done for 1990-2000 as well.

Other sectors

The activity data for fisheries for 2008 was updated with a significant amount of oil. The data was not available at the time of the previous submission.

In addition, the emission of CH_4 and N_2O from use of fuel oil in the fishing fleet has previously not been reported for the years 1990-2009. This has now been included for the years 2001-2010. In next submission the emissions will be added for 1990-2000 as well.

International bunkring

Emissions from a few coastal ferries had been included in the emissions for International bunkering, see text above (water-born navigation).

Industrial Processes – F-gases

Due to changes in the division HFC-134a and HFC-404a between K2, K3 and K4, in 2010, the emission of some of these F-gases, especially HFC-134 and HFC-125, are recalculated for 2010. The recalculations implied only minor changes in the emission.

Implications for emission levels

The recalculations for fisheries (other sectors) implied a significant increase in the emission, also on total emissions.

Implications for emission trends, including time series consistency

The time series for Water-born navigation and for International bunkering are inconsistent over time, since the recalculations were only done for 2001-2009. Emissions 1990-2000 are not comparable with emissions 2001-2009. In the next submission these time series will be corrected and consistent.

Recalculations. Including those in response to the review process, and planned improvements to the inventory (e.g. institutional arrangements. inventory preparations)

This will be completed in the 2013 submission.

Annexes

Annex 1 Trend tables 1990, 1995, 2000, 2005, 2009-2010 for CO_2, CH_4, N_2O, F-gases (CO_2 equivalents) and Trend tables 1990, 1995, 2000, 2005-2010 for Summary (all gases)

The tables are copied from the CRF 2012 spreadsheet file, Tables 10.1-10.5.

TABLE 10 EMISSION TRENDS CO_2 - Inventory 2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990) (Gg)	1995 (Gg)	2000 (Gg)	2005 (Gg)	2009 (Gg)	2010 (Gg)
1. Energy	667,67	539,31	664,33	724,19	727,86	788,88
A. Fuel Combustion (Sectoral Approach)	667,67	539,31	664,33	724,19	727,86	788,88
1. Energy Industries	96,90	79,23	119,26	112,26	130,89	162,68
2. Manufacturing Industries and Construction	61,86	31,89	59,30	65,26	42,92	43,28
3. Transport	105,12	97,89	99,17	119,01	134,08	128,95
4. Other Sectors	403,79	330,30	386,60	427,67	419,96	453,97
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Industrial Processes	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture						
A. Enteric Fermentation						
B. Manure Management						
C. Rice Cultivation						
D. Agricultural Soils						
E. Prescribed Burning of Savannas						
F. Field Burning of Agricultural Residues						
G. Other						
5. Land Use, Land-Use Change and Forestry[(2)]	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
A. Forest Land	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE
G. Other	NA	NA	NA	NA	NA	NA
6. Waste	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
B. Waste-water Handling						
C. Waste Incineration	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA
Total CO_2 emissions including net CO_2 from LULUCF	667,67	539,31	664,33	724,19	727,86	788,88
Total CO_2 emissions excluding net CO_2 from LULUCF	667,67	539,31	664,33	724,19	727,86	788,88
Memo Items:						
International Bunkers	NA,NE,NO	131,72	136,46	135,07	54,44	76,59
Aviation	NE,NO	0,13	0,88	1,21	0,75	0,77
Marine	NA,NE,NO	131,59	135,59	133,87	53,70	75,82
Multilateral Operations	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	15,90	16,65	28,18	24,88	24,74	27,91

TABLE 10 EMISSION TRENDS CH_4 - Inventory2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	2000	2005	2009	2010
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	0,05	0,05	0,06	0,13	0,10	0,10
A. Fuel Combustion (Sectoral Approach)	0,05	0,05	0,06	0,13	0,10	0,10
1. Energy Industries	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport	0,05	0,04	0,05	0,12	0,09	0,08
4. Other Sectors	0,01	0,01	0,01	0,01	0,01	0,01
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Industrial Processes	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
A. Mineral Products	NO	NO	NO	NO	NO	NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use						
4. Agriculture	0,82	0,84	0,84	0,82	0,81	0,81
A. Enteric Fermentation	0,78	0,81	0,80	0,79	0,78	0,77
B. Manure Management	0,04	0,04	0,04	0,04	0,03	0,03
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
A. Forest Land	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
G. Other	NA	NA	NA	NA	NA	NA
6. Waste	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,N
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
D. Other	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA
Total CH_4 emissions including CH_4 from LULUCF	0,87	0,90	0,89	0,95	0,91	0,91
Total CH_4 emissions excluding CH_4 from LULUCF	0,87	0,90	0,89	0,95	0,91	0,91
Memo Items:						
International Bunkers	NA,NE,NO	0,00	0,01	0,02	0,01	0,01
Aviation	NE,NO	0,00	0,01	0,01	0,01	0,01
Marine	NA,NE,NO	0,00	0,00	0,00	0,00	0,00
Multilateral Operations	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass						

TABLE 10 EMISSION TRENDS N_2O - Inventory 2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	2000	2005	2009	2010
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	0,02	0,02	0,02	0,03	0,03	0,03
A. Fuel Combustion (Sectoral Approach)	0,02	0,02	0,02	0,03	0,03	0,03
1. Energy Industries	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport	0,00	0,00	0,00	0,00	0,01	0,01
4. Other Sectors	0,02	0,01	0,01	0,02	0,02	0,02
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Industrial Processes	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
A. Mineral Products	NO	NO	NO	NO	NO	NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO
C. Metal Production	NA	NA	NA	NA	NA	NA
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	0,05	0,05	0,05	0,05	0,05	0,05
A. Enteric Fermentation						
B. Manure Management	0,00	0,00	0,00	0,00	0,00	0,00
C. Rice Cultivation						
D. Agricultural Soils	0,04	0,04	0,04	0,04	0,04	0,04
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
A. Forest Land	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
G. Other	NA	NA	NA	NA	NA	NA
6. Waste	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
A. Solid Waste Disposal on Land						
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
D. Other	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA
Total N_2O emissions including N_2O from LULUCF	0,07	0,07	0,07	0,07	0,07	0,08
Total N_2O emissions excluding N_2O from LULUCF	0,07	0,07	0,07	0,07	0,07	0,08
Memo Items:						
International Bunkers	NA,NE,NO	0,01	0,01	0,01	0,00	0,00
Aviation	NE,NO	0,00	0,00	0,00	0,00	0,00
Marine	NA,NE,NO	0,01	0,01	0,01	0,00	0,00
Multilateral Operations	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass						

TABLE 10 EMISSION TRENDS HFCs, PFCs and SF_6 - Inventory 2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	2000	2005	2009	2010
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	NA,NE,NO	0,02	4,35	11,20	11,61	12,11
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-32	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-43-10mee	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-125	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-134	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-134a	NA,NE,NO	0,00	0,00	0,00	0,00	0,00
HFC-152a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-143	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-143a	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-236fa	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-245ca	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of PFCs[3] - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
CF_4	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_2F_6	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_4F_{10}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
$c-C_4F_8$	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_5F_{12}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_6F_{14}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of SF6[3] - (Gg CO_2 equivalent)	NA,NE,NO	0,15	0,08	0,15	0,21	0,17
SF_6	NA,NE,NO	0,00	0,00	0,00	0,00	0,00

TABLE 10 EMISSION TRENDS, SUMMARY - Inventory 2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS EMISSIONS	Base year (1990)	1995	2000	2001	2005	2008	2009	2010
	CO_2 equivalent (Gg)							
CO_2 emissions including net CO_2 from LULUCF	667,67	539,31	664,33	733,98	724,19	696,89	727,86	788,88
CO_2 emissions excluding net CO_2 from LULUCF	667,67	539,31	664,33	733,98	724,19	696,89	727,86	788,88
CH_4 emissions including CH_4 from LULUCF	18,37	18,84	18,76	19,03	20,03	19,38	19,17	19,03
CH_4 emissions excluding CH_4 from LULUCF	18,37	18,84	18,76	19,03	20,03	19,38	19,17	19,03
N_2O emissions including N_2O from LULUCF	22,22	20,99	22,09	22,68	23,01	22,04	23,00	23,55
N_2O emissions excluding N_2O from LULUCF	22,22	20,99	22,09	22,68	23,01	22,04	23,00	23,55
HFCs	NA,NE,NO	0,02	4,35	6,93	11,20	12,39	11,61	12,11
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
SF_6	NA,NE,NO	0,15	0,08	0,08	0,15	0,16	0,21	0,17
Total (including LULUCF)	708,26	579,32	709,62	782,70	778,59	750,86	781,84	843,74
Total (excluding LULUCF)	708,26	579,32	709,62	782,70	778,59	750,86	781,84	843,74

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	2000	2001	2005	2008	2009	2010
	CO_2 equivalent (Gg)							
1. Energy	676,22	546,52	672,73	743,05	735,09	706,60	738,14	799,70
2. Industrial Processes	NA,NE,NO	0,18	4,43	7,01	11,36	12,55	11,82	12,28
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	32,04	32,62	32,45	32,64	32,14	31,71	31,88	31,76
5. Land Use, Land-Use Change and Forestry(5)	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
6. Waste	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	708,26	579,32	709,62	782,70	778,59	750,86	781,84	843,74

TABLE 10 EMISSION TRENDS, SUMMARY - Inventory 2010 - Submission 2012 v1.1 - FAROE ISLANDS

GREENHOUSE GAS EMISSIONS	Base year (1990)	1995	2000	2001	2005	2006	2007	2008	2009	2010
	CO2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	667,67	539,31	664,33	733,98	724,19	726,73	744,29	696,89	727,86	788,88
CO_2 emissions excluding net CO_2 from LULUCF	667,67	539,31	664,33	733,98	724,19	726,73	744,29	696,89	727,86	788,88
CH_4 emissions including CH_4 from LULUCF	18,37	18,84	18,76	19,03	20,03	19,72	19,63	19,38	19,17	19,03
CH_4 emissions excluding CH_4 from LULUCF	18,37	18,84	18,76	19,03	20,03	19,72	19,63	19,38	19,17	19,03
N_2O emissions including N_2O from LULUCF	22,22	20,99	22,09	22,68	23,01	23,12	23,16	22,04	23,00	23,55
N_2O emissions excluding N_2O from LULUCF	22,22	20,99	22,09	22,68	23,01	23,12	23,16	22,04	23,00	23,55
HFCs	NA,NE,NO	0,02	4,35	6,93	11,20	11,66	12,09	12,39	11,61	12,11
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
SF_6	NA,NE,NO	0,15	0,08	0,08	0,15	0,14	0,13	0,16	0,21	0,17
Total (including LULUCF)	708,26	579,32	709,62	782,70	778,59	781,38	799,31	750,86	781,84	843,74
Total (excluding LULUCF)	708,26	579,32	709,62	782,70	778,59	781,38	799,31	750,86	781,84	843,74

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	2000	2001	2005	2006	2007	2008	2009	2010
	CO2 equivalent (Gg)									
1. Energy	676,22	546,52	672,73	743,05	735,09	737,68	755,13	706,60	738,14	799,70
2. Industrial Processes	NA,NE,NO	0,18	4,43	7,01	11,36	11,80	12,22	12,55	11,82	12,28
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	32,04	32,62	32,45	32,64	32,14	31,90	31,96	31,71	31,88	31,76
5. Land Use, Land-Use Change and Forestry[5]	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
6. Waste	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[5]	708,26	579,32	709,62	782,70	778,59	781,38	799,31	750,86	781,84	843,74

DENMARK'S NATIONAL INVENTORY REPORT 2012

Emission Inventories 1990-2010 - Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

This report is Denmark's National Inventory Report 2012. The report contains information on Denmark's emission inventories for all years' from 1990 to 2010 for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, NO_X, CO, NMVOC, SO_2

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