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Danish emission inventories for stationary combustion plants

Inventories until year 2003

Research Notes from NERI No. 229

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Data sheet

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Abstract: Emission inventories for stationary combustion plants are presented and the methodologies and assumptions used for the inventories are described. The pollutants considered are SO_2, NO_X, NMVOC, CH_4, CO, CO_2, N_2O, particulate matter, heavy metals, dioxins and PAH. Since 1990 the fuel consumption in stationary combustion has increased by 25% - the fossil fuel consumption, however, only by 18%. Despite the increased fuel consumption the emission of several pollutants has decreased due to the improved flue gas cleaning technology, improved burner technology and the change of fuel type used. A considerable decrease of the SO_2, NO_X and heavy metal emissions is mainly a result of decreased emissions from large power plants and waste incineration plants. The greenhouse gas emission has increased by 11% since 1990 mainly due to increasing export of electricity. The emission of CH_4 has increased due to increased use of lean-burn gas engines in CHP plants. The emission of PAH increased as a result of the increased combustion of wood in residential boilers and stoves. Uncertainties for the emissions and trends have been estimated

Keywords:	Emission, combustion, power plants, district heating, CHP, co-generation, incineration, MSW, SO_2, NO_X, NMVOC, CH_4, CO, CO_2, N_2O, PM, heavy metals, dioxin, PAH, greenhouse gas
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Contents

Preface

The Danish National Environmental Research Institute (NERI) prepares the Danish atmospheric emission inventories and reports the results on an annual basis to the Climate Convention and to the UN-ECE Convention on Long-Range Transboundary Air Pollution. This report forms part of the documentation for the inventories and covers emissions from stationary combustion plants. The results of inventories up to 2003 are included and this report is an update of the 2004 report "Danish emission inventories for stationary combustion plants".

Last year the report was externally reviewed by Jan Erik Johnsson from the Technical University of Denmark. The changes of *emission factors* suggested by Jan Erik Johnsson have been included in the 2005 reporting, as the review was performed after the 2004 reporting to the Climate Convention and the LRTAP Convention.

This year the report has been externally reviewed by Bo Sander from Elsam Engeneering. The changes of *emission factors* suggested by the reviewer will not be included until the 2006 reporting, because the review was performed after the 2005 reporting to the Climate Convention and the LRTAP Convention.

Sammendrag

Opgørelser over de samlede danske luftemissioner rapporteres årligt til Klimakonventionen (*UN Framework Convention on Climate Change, UNFCCC*) og til UNECE Konventionen om langtransporteret grænseoverskridende luftforurening (*UNECE Convention on Long-Range Transboundary Air Pollution* der forkortes LRTAP Convention). Endvidere rapporteres drivhusgasemissionen til EU fordi EU – såvel som de enkelte medlemslande – har ratificeret klimakonventionen. De danske emissioner opgøres og rapporteres af Danmarks Miljøundersøgelser (DMU). Emissionsopgørelserne omfatter følgende stoffer af relevans for stationær forbrænding: CO_2, CH_4, N_2O, SO_2, NO_X, NMVOC, CO, partikler, tungmetaller, dioxin og PAH. Foruden de årlige opgørelser over total emission rapporteres også sektoropdelt emission og usikkerhed på opgørelserne. Hvert femte år rapporteres endvidere geografisk fordeling af emissionerne, fremskrivning af emissionerne samt de aktivitetsdata – fx brændselsforbrug – der ligger til grund for opgørelserne.

Emissionsopgørelserne for stationære forbrændingsanlæg (ikke mobile kilder) er baseret på den danske energistatistik og på et sæt af emissionsfaktorer for forskellige sektorer, teknologier og brændsler. Anlægsspecifikke emissionsdata for store anlæg, som fx kraftværker, indarbejdes i opgørelserne. Denne rapport giver detaljeret baggrundsinformation om den anvendte metode samt referencer for de data der ligger til grund for opgørelsen – energistatistikken og emissionsfaktorerne.

Emissionsfaktorerne stammer enten fra danske referencer eller fra internationale guidebøger (EMEP/Corinair 2004 og IPCC 1996) udarbejdet til brug for denne type emissionsopgørelser. De danske referencer omfatter miljølovgivning, danske rapporter samt middelværdier baseret på anlægsspecifikke emissionsdata fra et betydeligt antal større værker. Anlægsspecifikke emissionsfaktorer oplyses af anlægsejere, bl.a. i grønne regnskaber.

I emissionsopgørelsen for 2003 er 70 stationære forbrændingsanlæg defineret som punktkilder. Punktkilderne omfatter: kraftværker, decentrale kraftvarmeværker, affaldsforbrændingsanlæg, industrielle forbrændingsanlæg samt raffinaderier. Brændselsforbruget for disse anlæg svarer til 67% af det samlede brændselsforbrug for alle stationære forbrændingsanlæg.

Variationen i årlig import/eksport af el medfører at det totale danske brændselsforbrug varierer. Siden 1990 er brændselsforbruget steget med 25%, mens forbruget af fossile brændsler er steget med 18%. Forbruget af kul er faldet, mens forbruget af naturgas og af biobrændsler er steget.

For følgende stoffer udgør emissionen fra stationær forbrænding over 50% af den samlede danske emission: SO_2, CO_2, tungmetaller (dog ikke Cu), $PM_{2.5}$ og PAH. Endvidere udgør emissionen over 10% for

NO_X, CO, NMVOC, TSP, PM_{10} og Cu. Stationær forbrænding bidrager med mindre end 10% af den samlede danske emission af CH_4 og N_2O.

Inden for de stationære forbrændingsanlæg er kraftværker og decentrale kraftvarmeværker den betydeligste emissionskilde for SO_2, CO_2, NO_X, og tungmetaller. Gasmotorer installeret på decentrale kraftvarmeværker er den største CH_4 emissionskilde. Endvidere har gasmotorer en betydelig emission af NMVOC.

Emissioner fra kedler, brændeovne mv. i forbindelse med beboelse er den betydeligste emissionskilde for CO, NMVOC, partikler og PAH. Det er især forbrænding af træ, som bidrager til disse emissioner.

I rapporten vises tidsserier for emissioner fra stationær forbrænding.

Udviklingen i emissionen af drivhusgasser følger udviklingen i CO_2-emissionen ganske tæt. Både CO_2-emissionen og den samlede drivhusgas-emission fra stationær forbrænding er højere i 2003 end i basisåret 1990 – CO_2 er 10% højere og drivhusgasemissionen er 11% højere. Emissionerne fluktuerer dog betydeligt pga. variationerne i import/eksport af el samt varierende udetemperatur.

CH_4-emissionen fra stationær forbrænding er steget med en faktor 4,3 siden 1990. Denne stigning skyldes, at der i perioden er installeret et betydeligt antal gasmotorer på decentrale kraftvarmeværker.

SO_2-emissionen fra stationær forbrænding er faldet med 94% siden 1980 og 78% siden 1995. Den store reduktion skyldes primært, at emissionen fra el- og fjernvarmeproducerende anlæg er faldet, som følge af installering af afsvovlningsanlæg samt brug af brændsler med lavere svovlindhold.

NO_X-emissionen fra stationær forbrænding er faldet med 43% siden 1985 og 23% siden 1995. Reduktionen skyldes primært at emissionen fra el og fjernvarmeproducerende anlæg er faldet som følge af at der benyttes lav-NO_X-brændere på flere anlæg og at der er idriftsat NO_X-røggasrensning på flere store kraftværker. Variationen i NO_X-emissionen følger variationen i import/eksport af el.

Forbrænding af træ i villakedler og brændeovne er forøget med 68% siden 1990 og dette har medført en stigning i CO-emissionen. Stigningen i CO-emissionen er dog ikke helt så stor, idet CO-emissionen fra halmfyrede gård-anlæg samtidig er faldet betydeligt.

Emissionen af NMVOC fra stationær forbrænding er øget med 43% siden 1985 og 15% siden 1995. Stigningen skyldes primært idriftsættelsen af gasmotorer på decentrale kraftvarmeværker.

Tungmetalemissionerne er faldet betydeligt siden 1990. Emissionen af de enkelte tungmetaller er reduceret mellem 7% og 84%. Faldet skyldes den forbedrede røggasrensing på affaldsforbrændingsanlæg og på kraftværker.

Emissionen af de forskellige PAH'er er steget 37-60% siden 1990, hvilket hænger sammen med den øgede mængde træ, der forbrændes i brændeovne eller små villakedler.

Summary

Danish emission inventories are prepared on an annual basis and are reported to the *UNECE Framework Convention on Climate Change* (UNFCCC or Climate Convention) and to the UNECE *Convention on Long-Range Transboundary Air Pollution* (LRTAP Convention). Furthermore, a greenhouse gas emission inventory is reported to the EU, due to the EU – as well as the individual member states – being party to the Climate Convention. The annual Danish emission inventories are prepared by the Danish National Environmental Research Institute (NERI). The inventories include the pollutants: CO_2, CH_4, N_2O, SO_2, NO_X, NMVOC, CO, particulate matter, heavy metals, dioxins and PAH. In addition to annual total emissions, the report includes sector specific emissions and uncertainty estimates. Every 5 years the reporting includes data on the geographical distribution of the emissions, a projection of emissions data and details of the activity data – e.g. fuel consumption – on which the inventories are based.

The inventories are based on the Danish energy statistics and on a set of emission factors for various sectors, technologies and fuels. Plant specific emissions for large combustion sources are incorporated into the inventories. This report provides detailed background information on the methodology and references for the input data in the inventory - energy statistics and emission factors.

The emission factors are based either on national references or on international guidebooks (EMEP/Corinair 2004 and IPCC 1996). The majority of the country-specific emission factors refer to: Danish legislation, Danish research reports or calculations based on plant-specific emissions from a considerable number of large point sources. The plant-specific emission factors are provided by plant operators, e.g. in annual environmental reports.

In the inventory for the year 2003, 70 stationary combustion plants are specified as large point sources. The point sources include large power plants, municipal waste incineration plants, industrial combustion plants and petroleum refining plants. The fuel consumption of these large point sources corresponds to 67% of the overall fuel consumption of stationary combustion.

The Danish fuel consumption rate fluctuates due to the import/export of electricity. Since 1990 fuel consumption has increased by 25%, fossil fuel consumption, however, has only increased by 18%. The use of coal has decreased whereas the use of natural gas and renewable fuels has increased.

Stationary combustion plants account for more than 50% of the total Danish emission for the following pollutants: SO_2, CO_2, heavy metals (except Cu) $PM_{2.5}$ and PAH. Furthermore, emissions from stationary combustion plants account for more than 10% of the total Danish emission for the following pollutants: NO_X, CO, NMVOC, TSP, PM_{10} and Cu. Stationary combustion plants account for less than 10% of the total Danish CH_4 and N_2O emission.

Public power plants represent the most important stationary combustion emission source for SO_2, CO_2, NO_X and heavy metals.

Lean-burn gas engines installed in decentralised CHP plants are the largest emission source for CH_4. Furthermore, these plants also represent a considerable emission source for NMVOC.

Residential plants are the most important stationary combustion source for CO, NMVOC, particulate matter and PAH. Wood combustion in residential plants is the predominant emission source.

The report in hand includes time-series for stationary combustion plants for the range of pollutants.

The development in greenhouse gas (GHG) emission follows that of CO_2 emission very closely. Both the CO_2 emission and the total GHG emissions were higher in 2003 than in 1990: The CO_2 emission increased by 10% and the GHG emission by 11%. However, fluctuations in the GHG emission level are significant, the fluctuations in the time-series arising from electricity import/export and outdoor temperature variations from year to year.

The CH_4 emission from stationary combustion has increased by a factor of 4,3 since 1990. This is a result of the considerable number of lean-burn gas engines installed in CHP plants in Denmark during this period.

SO_2 emission from stationary combustion plants has decreased by 94% from 1980 and 78% from 1995. The large emission decrease is mainly a result of the reduced emission from electricity and district heat production made possible by installation of desulphurisation plants and due to the use of fuels with lower sulphur content.

The NO_X emission from stationary combustion plants has decreased by 43% since 1985 and 23% since 1995. The reduced emission is mainly a result of the reduced emission from electricity and district heat production plants in which the use of low NO_X burners has increased. Also, de-NO_X flue gas cleaning units have been put into operation in a greater number of the larger power plants. The fluctuations in the time-series follow fluctuations in fuel consumption in power plants, these occurring due to electricity import/export.

Wood consumption in residential plants has increased by 68% since 1990 causing an increase in the CO emission. The increase in CO from residential plants is less steep than the increase in wood consumption as the CO emission from straw-fired farmhouse boilers has decreased considerably.

The NMVOC emission from stationary combustion plants has increased by 43% from 1985 and 15% from 1995. The increased NMVOC emission results mainly from the increased use of lean-burn gas engines.

All heavy metal emissions have decreased considerably since 1990 – between 7% and 84%. The decreases result from improvements in

flue gas cleaning systems installed in municipal waste incineration plants and in power plants.

The PAH emission has increased since 1990 due to increased combustion of wood in residential plants.

1 Introduction

The Danish atmospheric emission inventories are prepared on an annual basis and the results are reported to the *UN Framework Convention on Climate Change* (UNFCCC or Climate Convention) and to the UNECE *Convention on Long-Range Transboundary Air Pollution* (LRTAP Convention). Furthermore, a greenhouse gas emission inventory is reported to the EU, due to the EU – as well as the individual member states – being party to the Climate Convention. The Danish atmospheric emission inventories are calculated by the Danish National Environmental Research Institute (NERI).

This report provides a summary of the emission inventories for stationary combustion and background documentation for the estimates. Stationary combustion plants include power plants, district heating plants, non-industrial and industrial combustion plants, industrial process burners, petroleum-refining plants, as well as combustion in oil/gas extraction and in pipeline compressors. Emissions from flaring in oil/gas production and from flaring carried out in refineries are not covered by this report.

This report presents detailed emission inventories and time-series for emissions from stationary combustion plants. Furthermore, emissions from stationary combustion plants are compared with total Danish emissions.

The methodology and references for the emission inventories for stationary combustion plants are described. Furthermore, uncertainty estimates are provided.

2 Total Danish emissions, international conventions and reduction targets

2.1 Total Danish emissions

An overview of the Danish emission inventories for 2003 including all sectors is shown in Table 1-Table 4. The emission inventories reported to the LRTAP Convention and to the Climate Convention are organised in 6 main source categories and a number of sub categories. The emission source *1 Energy* covers combustion in stationary and mobile sources as well as fugitive emissions from the energy sector. Emissions from incineration of municipal waste in power plants or district heating plants are included in the source category *1 Energy*, rather than in the source category *6 Waste*.

Links to the latest emission inventories can be found on the NERI home page: *http://www2.dmu.dk/1_Viden/2_Miljoe-tilstand/3_luft/4_adaei/default_en.asp* or via www.dmu.dk. Surveys of the latest inventories and the updated emission factors are also available on the NERI homepage.

Note that according to convention decisions emissions from certain specific sources are not included in the inventory totals. These emissions are reported as memo items and are thus estimated, but not included in the totals. The data for the total Danish emission included in this report does not include memo items.

- CO_2 emission from renewable fuels is not included in national totals, but reported as a memo item.
- Emissions from international bunkers and from international aviation are not included in national totals.

Further emission data for stationary combustion plants are provided in Chapters 5-9.

Table 1 Greenhouse gas emission for the year 2003 (Illerup et al. 2005a).

Pollutant	CO_2	CH_4	N_2O	HFCs, PFCs and SF6
Unit		Gg CO_2 equivalent		
1. Energy	57.635	771	912	-
2. Industrial Processes	1.488	-	895	746
3. Solvent and Other Product Use	206	-	-	-
4. Agriculture	-	3.706	6.192	-
5. Land-Use Change and Forestry	-1.204	-	-	-
6. Waste	-	1.397	61	-
Total Danish emission (gross)[1)]		**74.008**		
Total Danish emission (net) [2)]		**72.804**		

1) Not including Land-Use Change and Forestry
2) Including Land-Use Change and Forestry

Table 2 Emissions 2003 reported to the LRTAP Convention (Illerup et al. 2005b).

Pollutant	NO_x Gg	CO Gg	NMVOC Gg	SO_2 Gg	TSP Mg	PM_{10} Mg	$PM_{2.5}$ Mg
1. Energy	209	593	89	31	25950	22853	20408
2. Industrial Processes	0	-	1	-	323	258	194
3. Solvent and Other Product Use	-	-	67	-	-	-	-
4. Agriculture	-	-	2	-	16412	7386	1641
5. Land-Use Change and Forestry	-	-	-	-	-	-	-
6. Waste	0	0	0	0	0	0	0
Total Danish emission	**209**	**593**	**158**	**31**	**42685**	**30497**	**22243**

Table 3 Emissions 2003 reported to the LRTAP Convention (Illerup et al. 2005b).

Pollutant	Pb Mg	Cd Mg	Hg Mg	As Mg	Cr Mg	Cu Mg	Ni Mg	Se Mg	Zn Mg
1. Energy	4,59	0,58	1,24	0,76	1,23	8,76	10,57	2,11	22,63
2. Industrial Processes	0,07	0,00	-	-	-	0,05	-	-	0,63
3. Solvent and Other Product Use	-	-	-	-	-	-	-	-	-
4. Agriculture	-	-	-	-	-	-	-	-	-
5. Land-Use Change and Forestry	-	-	-	-	-	-	-	-	-
6. Waste	-	-	-	-	-	-	-	-	-
Total Danish emission	**4,66**	**0,58**	**1,24**	**0,76**	**1,23**	**8,80**	**10,57**	**2,11**	**23,27**

Table 4 Emissions 2003 reported to the LRTAP Convention (Illerup et al. 2005b).

Pollutant	Benzo(a)-pyrene Mg	Benzo(b)fluo-ranthene Mg	Benzo(k)-fluoranthene Mg	Indeno(1,2,3-c,d)pyrene Mg	Dioxin [1] g I-teq
1. Energy	2,97	3,95	1,34	2,22	30,29
2. Industrial Processes	-	-	-	-	1,00
3. Solvent and Other Product Use	-	-	-	-	13,25
4. Agriculture	-	-	-	-	-
5. Land-Use Change and Forestry	-	-	-	-	-
6. Waste	-	-	-	-	22,85
7. Other	-	-	-	-	10,25
Total Danish emission	**2,97**	**3,95**	**1,34**	**2,22**	**77,64**

1) Dioxin emission inventories are estimated by the Danish Environmental Protection Agency

2.2 International conventions and reduction targets

Denmark is a party to two international conventions relevant with regard to emissions from stationary combustion plants:

- The UNECE Convention on Long Range Transboundary Air Pollution (LRTAP Convention or the Geneva Convention)
- The UN Framework Convention on Climate Change under the Intergovernmental Panel on Climate Change (IPCC). The convention is also called UNFCCC or the Climate Convention.

The LRTAP Convention is a framework convention and has expanded to cover 8 protocols:

- *EMEP Protocol*, 1984 (Geneva).
- *Protocol on Reduction of Sulphur Emissions*, 1985 (Helsinki).
- *Protocol concerning the Control of Emissions of Nitrogen Oxides*, 1988 (Sofia).
- *Protocol concerning the Control of Emissions of Volatile Organic Compounds*, 1991 (Geneva).
- *Protocol on Further Reduction of Sulphur Emissions*, 1994 (Oslo).
- *Protocol on Heavy Metals*, 1988 (Aarhus).
- *Protocol on Persistent Organic Pollutants (POPs)*, 1998 (Aarhus).
- *Protocol to Abate Acidification, Eutrophication and Ground-level Ozone*, 1999 (Gothenburg).

The reduction targets/emission ceilings included in the protocols of the LRTAP Convention are stated in Table 5.

Table 5 Danish reduction targets / emission ceiling, LRTAP Convention.

Pollutant	Reduction / emission ceiling	Reference	Comment
SO_2	55 Gg in 2010	Gothenburg protocol	The ceiling equals 177% of the 2003 emission
NO_X	127 Gg in 2010	Gothenburg protocol	The ceiling equals 61% of the 2003 emission
NMVOC	85 Gg in 2010	Gothenburg protocol	The ceiling equals 54% of the 2003 emission

The Climate Convention is a framework convention from 1992. The Kyoto protocol is a protocol to the Climate Convention.

The Kyoto protocol sets legally-binding emission targets and timetables for 6 greenhouse gases: CO_2, CH_4, N_2O, HFC, PFC and SF_6. The greenhouse gas emission of each of the 6 pollutants is translated to CO_2 equivalents, which can be totalled to produce total greenhouse gas (GHG) emission in CO_2 equivalent. Denmark is obliged to reduce the average 2008-2010 GHG emission by 21% compared to the 1990 emission level.

EU is a party to the Climate Convention and, thereby, EU countries are obliged to submit emission data to the EU Monitoring Mechanism for CO_2 and other Greenhouse Gases.

3 Methodology and references

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 3rd edition, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (EMEP/Corinair 2004). Emission data are stored in an Access database, from which data are transferred to the reporting formats.

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 emission inventory for dioxin is reported by the Danish Environmental Protection Agency (Hansen & Hansen 2003). Dioxin emission data are presented, but not further discussed in this report.

3.1 Emission source categories

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 sectors. Aggregation to the sector codes used for both the Climate Convention and the LRTAP Convention is based on a correspondence list between SNAP and IPCC enclosed in Appendix 3.

The sector codes applied in the reporting activity will be referred to as IPCC sectors. The IPCC sectors define 6 main source categories, listed in Table 6, and a number of subcategories. Stationary combustion is part of the IPCC sector 1, *Energy*. Table 7 presents subsectors in the IPCC energy sector. The table also presents the sector in which the NERI documentation is included. Though industrial combustion is part of the stationary combustion detailed documentation for some of the specific industries is discussed in the industry chapters/reports. Stationary combustion is defined as combustion activities in the SNAP sectors 01-03.

Table 6 IPCC main sectors.

1. Energy
2. Industrial Processes
3. Solvent and Other Product Use
4. Agriculture
5. Land-Use Change and Forestry
6. Waste

Table 7 IPCC source categories for the energy sector.

IPCC id	IPCC sector name	NERI documentation
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
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

Stationary combustion plants are included in the emission source subcategories:

- *1A1 Energy, Fuel consumption, Energy Industries*
- *1A2 Energy, Fuel consumption, Manufacturing Industries and Construction*
- *1A4 Energy, Fuel consumption, Other Sectors*

The emission sources *1A2* and *1A4,* however also include emission from transport subsectors. The emission source *1A2* includes emissions from some off-road machinery in the industry. The emission source *1A4* includes off-road machinery in agriculture, forestry and household/gardening. Further emissions from national fishing are included in subsector *1A4*.

The emission and fuel consumption data included in tables and figures in this report only include emissions originating from stationary combustion plants of a given IPCC sector. The IPCC sector codes

have been applied unchanged, but some sector names have been changed to reflect the stationary combustion element of the source.

The CO_2 from calcination is not part of the energy sector. This emission is included in the IPCC sector 2 Industrial processes.

3.2 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 2003, 70 stationary combustion plants are specified as large point sources. These point sources include:

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

The fuel consumption of stationary combustion plants registered as large point sources is 414 PJ (2003). This corresponds to 67% of the overall fuel consumption for stationary combustion.

A list of the large point sources for 2003 and the fuel consumption rates is provided in Appendix 8. The number of large point sources registered in the databases increased from 1990 to 2003. In the emission database for the years before 1990 only one large point source have been registered.

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. Appendix 8 shows which of the emission data for large point sources are plant-specific and which are based on emission factors.

SO_2 and NO_X emissions from large point sources are often plant-specific based on emission measurements. Emissions of CO, NMVOC, PM and metals are also plant-specific for some plants. Plant-specific emission data are obtained from:

- Annual environmental reports
- Annual plant-specific reporting of SO_2 and NO_X from power plants >25MW_e prepared for the Danish Energy Authority due to Danish legislatory requirement
- Emission data reported by Elsam and E2, the two major electricity suppliers
- Emission data reported from industrial plants

Annual environmental reports for the plants include a considerable number of emission data sets. Emission data from annual environ-

mental 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 (CO_2, CH_4 and N_2O) from the large point sources are all based on the area source emission factors.

3.3 Area sources

Fuels not combusted in large point sources are included as sector 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.

3.4 Activity rates, fuel consumption

The fuel consumption rates are based on the official Danish energy statistics prepared by the Danish Energy Authority. The Danish Energy Authority aggregates fuel consumption rates to SNAP sector categories (DEA 2004a). Some fuel types in the official Danish energy statistics are added to obtain a less detailed fuel aggregation level, see Appendix 10. The calorific values on which the energy statistics are based are also enclosed in Appendix 10.

The fuel consumption of the IPCC sector *1A2 Manufacturing industries and construction* (corresponding to SNAP sector *03 Combustion in manufacturing industries)* is not disaggregated into specific industries in the NERI emission database. So far disaggregation into specific industries is only estimated for the reportings to the Climate Convention. The disaggregation of fuel consumption and emissions from the industrial sector is discussed in Chapter 3.6.

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 251 TJ) is added to the apparent consumption of petroleum coke and the emissions are included in the inventory.

The Danish Energy Authority (DEA) compiles a database for the fuel consumption of each district heating and power-producing plant, based on data reported by plant operators. The fuel consumption of large point sources specified in the Danish emission database refers to the DEA database (DEA 2004c).

The fuel consumption of area sources is calculated as total fuel consumption minus fuel consumption of large point sources.

Emissions from non-energy use of fuels have not been included in the Danish inventory, to date, but the non-energy use of fuels is, however, included in the reference approach for Climate Convention reporting. The Danish energy statistics include three fuels used for non-energy purposes: Bitumen, white spirit and lube oil. The fuels used for non-energy purposes add up to less than 2% of the total fuel consumption in Denmark.

In Denmark all municipal waste incineration is utilised for heat and power production. Thus, incineration of waste is included as stationary combustion in the IPCC Energy sector (source categories *1A1*, *1A2* and *1A4)*.

Fuel consumption data are presented in Chapter 4.

3.5 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/Corinair Guidebook (EMEP/Corinair 2004) and IPCC Reference Manual (IPCC 1996).

A complete list of emission factors including time-series and references is provided in Appendix 6.

A considerable part of the emission data for municipal waste incineration plants and large power plants are plant-specific. The area source emission factors do not, therefore, necessarily represent average values for these plant categories. To attain a set of emission factors that expresses the average emission for power plants combusting coal and for municipal waste incineration plants, implied emission factors have been calculated for these two plant categories. The implied emission factors are presented in Appendix 7. The implied emission factors are calculated as total emission divided by total fuel consumption.

3.5.1 CO_2

The CO_2 emission factors applied for 2003 are presented in Table 8. For municipal waste and natural gas, time-series have been estimated. For all other fuels the same emission factor is applied for 1990-2003.

In reporting for the Climate Convention, the CO_2 emission is aggregated to five fuel types: Solid fuel, Liquid fuel, Gas, Biomass and Other fuels. The correspondence list between the NERI fuel categories and the IPCC fuel categories is also provided in Table 8.

Only emissions from fossil fuels are included in the national total CO_2 emission. The biomass emission factors are also included in the table, because emissions from biomass are reported to the Climate Convention as a memo item.

The CO_2 emission from incineration of municipal waste (94,5 + 17,6 kg/GJ) is divided into two parts: The emission from combustion of the plastic 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 CO_2 emission from combustion of the plastic content of the waste is reported in the fuel category, *Other fuels*. However, this split is not applied in either fuel consumption or other emissions, because it is only relevant for CO_2. Thus, the full consumption of municipal waste is included in the fuel category, *Biomass,* and the full amount of non-CO_2 emissions from municipal waste combustion is also included in the *Biomass*-category.

The CO_2 emission factors have been confirmed by the two major power plant operators, both directly (Christiansen, 1996 and Andersen, 1996) and indirectly, by applying the NERI emission factors in the annual environmental reports for the large power plants and by accepting use of the NERI factors in Danish legislation.

The current Danish legislation concerning CO_2 emission from power plants in 2003 and 2004 (Lov 376 1999) is based on standard CO_2 emission factors for each fuel. Thus, so far power plant operators have not been encouraged to estimate CO_2 emission factors based on their own fuel analysis. In future legislation (Lov 493 2004) operators of large power plants are obliged to verify the applied emission factors, which will lead to the availability of improved emission factors for national emission inventories in future. The plants will report CO_2 emissions for 2005 according to this legislation.

Table 8 CO_2 emission factors 2003.

Fuel	Emission factor		Unit	Reference type	IPCC fuel
	Biomass	Fossil fuel			Category
Coal		95	kg/GJ	Country specific	Solid
Brown coal briquettes		94,6	kg/GJ	IPCC reference manual	Solid
Coke oven coke		108	kg/GJ	IPCC reference manual	Solid
Petroleum coke		92	kg/GJ	Country specific	Liquid
Wood	102		kg/GJ	Corinair	Biomass
Municipal waste	94,5	17,6	kg/GJ	Country specific	Biomass / Other fuels
Straw	102		kg/GJ	Country specific	Biomass
Residual oil		78	kg/GJ	Corinair	Liquid
Gas oil		74	kg/GJ	Corinair	Liquid
Kerosene		72	kg/GJ	Corinair	Liquid
Fish & rape oil	74		kg/GJ	Country specific	Biomass
Orimulsion		80	kg/GJ	Country specific	Liquid
Natural gas		57,19	kg/GJ	Country specific	Gas
LPG		65	kg/GJ	Corinair	Liquid
Refinery gas		56,9	kg/GJ	Country specific	Liquid
Biogas	83,6		kg/GJ	Country specific	Biomass

Coal

The emission factor 95 kg/GJ is based on Fenhann & Kilde 1994. The CO_2 emission factors have been confirmed by the two major power

plant operators in 1996 (Christiansen 1996 and Andersen 1996). Elsam reconfirmed the factor in 2001 (Christiansen 2001). The same emission factor is applied for 1990-2003.

Brown coal briquettes

The emission factor 94,6 kg/GJ is based on a default value from the IPCC guidelines assuming full oxidation. The default value in the IPCC guidelines is 25,8 t C/TJ, corresponding to 25,8·(12+2·16)/12 = 94,6 kg CO_2/GJ assuming full oxidation.

Coke oven coke

The emission factor 108 kg/GJ is based on a default value from the IPCC guidelines assuming full oxidation. The default value in the IPCC guidelines is 29,5 t C/TJ, corresponding to 29,5·(12+2·16)/12 = 108 kg CO_2/GJ assuming full oxidation.

Petroleum coke

The emission factor 92 kg/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 is applied for 1990-2003.

Wood

The emission factor for wood, 102 kg/GJ, refers to Fenhann & Kilde 1994. The factor is based on the interval stated in a former edition of the EMEP/Corinair Guidebook and the actual value is the default value from the Collector database. The same emission factor is applied for 1990-2003.

Municipal waste

The CO_2 emission from incineration of municipal waste is divided into two parts: The emission from combustion of the plastic 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 plastic content of waste was estimated to be 6,6 w/w% in 2003 (Hulgaard 2003). The weight share, lower heating values and CO_2 emission factors for different plastic types are estimated by Hulgaard in 2003 (Table 9). The total weight share for plastic and for the various plastic types is assumed to be the same for all years (NERI assumption).

Table 9 Data for plastic waste in Danish municipal waste (Hulgaard 2003)[1)2)].

Plastic type	Mass share of plastic in municipal waste in Denmark		Lower heating value of plastic	Energy content of plastic	CO_2 emission factor for plastic	CO_2 emission factor
	kg plastic/ kg municipal waste	% of plastic	MJ/kg plastic	MJ/kg municipal waste	g/MJ plastic	g/kg municipal waste
PE	0,032	48	41	1,312	72,5	95
PS/EPS	0,02	30	37	0,74	86	64
PVC	0,007	11	18	0,126	79	10
Other (PET, PUR, PC, POM, ABS, PA etc.)	0,007	11	24	0,168	95	16
Total	0,066	100	35,5	2,346	78,7	185

Hulgaard 2003 refers to:

1) TNO report 2000/119, Eco-efficiency of recovery scenarios of plastic packaging, Appendices, July 2001 by P.G. Eggels, A.M.M. Ansems, B.L. van der Ven, for Association of Plastic Manufacturers in Europe

2) Kost, Thomas, Brennstofftechnische Charakterisierung von Haushaltabfällen, Technische Universität Dresden, Eigenverlag des Forums für Abfallwirtschaft und Altlasten e.V., 2001

Based on emission measurements on 5 municipal waste incineration plants (Jørgensen & Johansen, 2003) the total CO_2 emission factor for municipal waste incineration has been determined to be 112,1 kg/GJ. The CO_2 emission from the biomass part is the total CO_2 emission minus the CO_2 emission from the plastic part.

Thus, in 2003 the CO_2 emission factor for the plastic content of waste was estimated to be 185g/kg municipal waste (Table 9). The CO_2 emission per GJ of waste is calculated based on the lower heating values for waste listed in Table 10 (DEA 2004b). It has been assumed that the plastic content in weight per cent is constant, resulting in a decreasing energy per cent since the lower heating value (LHV) is increasing. However, the increasing LHV may be a result of increasing plastic content in the municipal waste. Time-series for the CO_2 emission factor for plastic content in waste are included in Table 10.

Emission data from four waste incineration plants (Jørgensen & Johansen 2003) demonstrate the fraction of the carbon content of the waste not oxidised to be approximately 0,3%. The unoxidised fraction of the carbon content is assumed to originate from the biomass content, and all carbon originating from plastic are assumed to be oxidised.

Table 10 CO_2 emission factor for municipal waste, plastic content and biomass content.

Year	Lower heating value of municipal waste [1]	Plastic content	CO_2 emission factor for plastic [3]	CO_2 emission factor for plastic	CO_2 emission factor for municipal waste, total [2]	CO_2 emission factor for biomass content of waste
	[GJ/Mg]	[% of energy]	[g/kg waste]	[kg/GJ waste]	[kg/GJ waste]	[kg/GJ waste]
1990	8,20	28,6	185	22,5	112,1	89,6
1991	8,20	28,6	185	22,5	112,1	89,6
1992	9,00	26,1	185	20,5	112,1	91,6
1993	9,40	25,0	185	19,6	112,1	92,5
1994	9,40	25,0	185	19,6	112,1	92,5
1995	10,00	23,5	185	18,5	112,1	93,6
1996	10,50	22,3	185	17,6	112,1	94,5
1997	10,50	22,3	185	17,6	112,1	94,5
1998	10,50	22,3	185	17,6	112,1	94,5
1999	10,50	22,3	185	17,6	112,1	94,5
2000	10,50	22,3	185	17,6	112,1	94,5
2001	10,50	22,3	185	17,6	112,1	94,5
2002	10,50	22,3	185	17,6	112,1	94,5
2003	10,50	22,3	185	17,6	112,1	94,5

1) DEA 2004b
2) Based on data from Jørgensen & Johansen 2003
3) From Table 9

Straw

The emission factor for straw, 102 kg/GJ refers to Fenhann & Kilde 1994. The factor is based on the interval stated in the EMEP/Corinair Guidebook (EMEP/Corinair 2004) and the actual value is the default value from the Collecter database. The same emission factor is applied for 1990-2003.

Residual oil

The emission factor 78 kg/GJ refers to Fenhann & Kilde 1994. The factor is based on the interval stated in the EMEP/Corinair Guidebook (EMEP/Corinair 2004). The factor is slightly higher than the IPCC default emission factor for residual fuel oil (77,4 kg/GJ assuming full oxidation). The CO_2 emission factors have been confirmed by the two major power plant operators in 1996 (Christiansen 1996 and Andersen 1996). The same emission factor is applied for 1990-2003.

Gas oil

The emission factor 74 kg/GJ refers to Fenhann & Kilde 1994. The factor is based on the interval stated in the EMEP/Corinair Guidebook (EMEP/Corinair 2004). The factor agrees with the IPCC default emission factor for gas oil (74,1 kg/GJ assuming full oxidation). The CO_2 emission factors have been confirmed by the two major power plant operators in 1996 (Christiansen 1996 and Andersen 1996). The same emission factor is applied for 1990-2003.

Kerosene

The emission factor 72 kg/GJ refers to Fenhann & Kilde 1994. The factor agrees with the IPCC default emission factor for other kerosene (71,9 kg/GJ assuming full oxidation). The same emission factor is applied for 1990-2003.

Fish & rape oil

The emission factor is assumed to be the same as for gas oil – 74 kg/GJ. The consumption of fish and rape oil is relatively low.

Orimulsion

The emission factor 80 kg/GJ refers to the Danish Energy Authority (DEA 2004). The IPCC default emission factor is almost the same: 80,7 kg/GJ assuming full oxidation. The CO_2 emission factors have been confirmed by the only major power plant operator using orimulsion (Andersen 1996). The same emission factor is applied for 1990-2003.

Natural gas

The emission factor for natural gas is estimated by the Danish gas transmission company, Gastra[1] (Lindgren 2004). Only natural gas from the Danish gas fields is utilised in Denmark. The calculation is based on gas analysis carried out daily by Gastra. Gastra and the Danish Gas Technology Centre have calculated emission factors for 2000-2003. 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). Time-series for the CO_2 emission factors is provided in Table 11.

Table 11 CO_2 emission factor for natural gas.

Year	CO_2 emission factor
1990-1999	56,9 kg/GJ
2000	57,1 kg/GJ
2001	57,25 kg/GJ
2002	57,28 kg/GJ
2003	57,19 kg/GJ

LPG

The emission factor 65 kg/GJ refers to Fenhann & Kilde 1994. The emission factor is based on the EMEP/Corinair Guidebook (EMEP/Corinair 2004). The emission factor is somewhat higher than the IPCC default emission factor (63 kg/GJ assuming full oxidation). The same emission factor is applied for 1990-2003.

Refinery gas

The emission factor applied for refinery gas is the same as the emission factor for natural gas 1990-1999. The emission factor is within the interval of the emission factor for refinery gas stated in the EMEP/Corinair Guidebook (EMEP/Corinair 2004). The same emission factor is applied for 1990-2003.

Biogas

The emission factor 83,6 kg/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).

[1] Former part of DONG. From 2005 part of the new national electricity and gas transmission company Energinet.dk

3.5.2 CH_4

The CH_4 emission factors applied for 2003 are presented in Table 12. In general, the same emission factors have been applied for 1990-2003. However, time-series have been estimated for both natural gas fuelled engines and biogas fuelled engines.

Emission factors for gas engines, gas turbines and CHP plants combusting wood, straw or municipal waste all refer to emission measurements carried out on Danish plants (Nielsen & Illerup 2003). Other emission factors refer to the EMEP/Corinair Guidebook (EMEP/Corinair 2004).

Gas engines combusting natural gas or biogas contribute much more to the total CH_4 emission than other stationary combustion plants. The relatively high emission factor for gas engines is well-documented and further discussed below.

Table 12 CH_4 emission factors 1990-2003.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	1A1a	010101, 010102, 010103	1,5	EMEP/Corinair 2004
COAL	1A1a, 1A2f, 1A4b, 1A4c	010202, 010203, 0301, 0202, 0203	15	EMEP/Corinair 2004
BROWN COAL BRI.	all	all	15	EMEP/Corinair 2004, assuming same emission factor as for coal
COKE OVEN COKE	all	all	15	EMEP/Corinair 2004, assuming same emission factor as for coal
PETROLEUM COKE	all	all	15	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	2	Nielsen & Illerup 2003
WOOD AND SIMIL.	1A4a, 1A4b, 1A4c	0201, 0202, 0203	200	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a, 1A2f	010105, 010202, 010203, 0301, 030102, 030103	32	EMEP/Corinair 2004
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	0,59	Nielsen & Illerup 2003
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	all other	6	EMEP/Corinair 2004
STRAW	1A1a	010102, 010103	0,5	Nielsen & Illerup 2003
STRAW	1A1a, 1A2f, 1A4c	010202, 010203, 020302, 030105	32	EMEP/Corinair 2004
STRAW	1A4b, 1A4c	0202, 0203	200	EMEP/Corinair 2004
RESIDUAL OIL	all	all	3	EMEP/Corinair 2004
GAS OIL	all	all	1,5	EMEP/Corinair 2004
KEROSENE	all	all	7	EMEP/Corinair 2004
FISH & RAPE OIL	all	all	1,5	EMEP/Corinair 2004, assuming same emission factor as gas oil
ORIMULSION	1A1a	010101	3	EMEP/Corinair 2004, assuming same emission factor as residual oil
NATURAL GAS	1A1a	0101, 010101, 010102, 010202	6	DGC 2001
NATURAL GAS	1A1a	010103, 010203	15	Gruijthuijsen & Jensen 2000
NATURAL GAS	1A1a, 1Ac, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	1,5	Nielsen & Illerup 2003
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	1) 520	Nielsen & Illerup 2003
NATURAL GAS	1A1c, 1A2f, 1A4a, 1A4b, 1A4c	010502, 0301, 0201, 0202, 0203	6	DGC 2001
NATURAL GAS	1A2f, 1A4a, 1A4b	030103, 030106, 020103, 020202	15	Gruijthuijsen & Jensen 2000
LPG	all	all	1	EMEP/Corinair 2004
REFINERY GAS	1A1b	010304	1,5	EMEP/Corinair 2004
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	1) 323	Nielsen & Illerup 2003
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	all other	4	EMEP/Corinair 2004

1) 2003 emission factor. Time-series is shown below

3.5.2.1 CHP plants

A considerable portion 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 in Western Denmark, Eltra, emission factors for CHP plants <25MW_e have been estimated. The work was reported in 2003 (Nielsen & Illerup 2003) and

the results have been fully implemented in the inventory reported in 2004.

The work included municipal waste incineration plants, CHP plants combusting wood and straw, natural gas and biogas-fuelled (reciprocating) engines, and natural gas fuelled gas turbines. CH_4 emission factors for these plants all refer to Nielsen & Illerup 2003. 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.

Gas engines, natural gas

SNAP 010105, 010205, 010505, 030105, 020105, 020204 and 020304

The emission factor for natural gas engines was determined as 520 g/GJ in 2000 and the same emission factor has been applied for 2001 - 2003. The emission factor for natural gas engines was based on 291 emission measurements on 114 different plants. The plants, from which emission measurements were available, represented 44% of the total gas consumption in gas engines. The emission factor was estimated based on fuel consumption of 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 emission of total unburned hydrocarbon (CH_4 + NMVOC). A constant disaggregation factor was estimated based on a number of emission measurements including both CH_4 and NMVOC.

The emission factor for lean-burn gas engines is relatively high, especially for prechamber engines, which account for more than half the gas consumption in Danish gas engines. However, the emission factors for different prechamber 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 and in later years mainly prechamber engines were installed. As mentioned above, prechamber engines have a higher emission factor than open-chamber engines, therefore, the emission factor has changed during the period 1990-2003. A time-series for the emission factor has been estimated and is presented below (Nielsen & Illerup 2003). The time-series was based on:

- Emission factors for different engine types
- Data for year of installation for each engine and fuel consumption of each engine 1994-2003 from the Danish Energy Authority (DEA 2004c)
- Research concerning the CH_4 emission from gas engines carried out in 1997 (Nielsen & Wit 1997)

Table 13 Time-series for the CH_4 emission factor for natural gas fuelled engines.

Year	Emission factor [g/GJ]
1990	257
1991	299
1992	347
1993	545
1994	604
1995	612
1996	596
1997	534
1998	525
1999	524
2000	520
2001	520
2002	520
2003	520

Gas engines, biogas

SNAP 010105, 010505, 020105, 020304 and 030105

The emission factor for biogas engines was estimated to 323 g/GJ in 2000 and the same emission factor has been applied for 2001 - 2003. The emission factor for biogas engines was based on 18 emission measurements on 13 different plants. The plants, from which emission measurements were available, represented 18% of the total gas consumption in gas engines.

The emission factor is lower than the factor for natural gas, mainly because most engines are lean-burn open-chamber engines - not pre-chamber engines. A time-series for the emission factor has been estimated (Nielsen & Illerup 2003).

Table 14 Time-series for the CH_4 emission factor for biogas fuelled engines.

Year	Emission factor [g/GJ]
1990	239
1991	251
1992	264
1993	276
1994	289
1995	301
1996	305
1997	310
1998	314
1999	318
2000	323
2001	323
2002	323
2003	323

Gas turbines, natural gas

SNAP 010104, 010504, 020104, 020303 and 030104

The emission factor for gas turbines was estimated to be below 1,5g/GJ and the emission factor 1,5 g/GJ has been applied for all years. The emission factor was based on emission measurements on 9 plants.

CHP, wood

SNAP 010102 and, 010103 and 010104

The emission factor for CHP plants combusting wood was estimated to be below 2,1 g/GJ and the emission factor 2 g/GJ has been applied for all years. The emission factor was based on emission measurements on 3 plants.

CHP, straw

SNAP 010102 and 010103

The emission factor for CHP plants combusting straw was estimated to be below 0,5g/GJ and the emission factor 0,5g/GJ has been applied for all years. The emission factor was based on emission measurements on 4 plants.

CHP, municipal waste

SNAP 010102, 010103, 010104 and 010105

The emission factor for CHP plants combusting municipal waste was estimated to be below 0,59g/GJ and the emission factor 0,59g/GJ has been applied for all years. The emission factor was based on emission measurements on 16 plants.

3.5.2.2 Other stationary combustion plants

Emission factors for other plants refer to the EMEP/Corinair Guidebook (EMEP/Corinair 2004), the Danish Gas Technology Centre (DGC 2001) or Gruijthuijsen & Jensen 2000. The same emission factors are applied for 1990-2003.

3.5.3 N_2O

The N_2O emission factors applied for the 2003 inventory are listed in Table 15. The same emission factors have been applied for 1990-2003.

Emission factors for gas engines, gas turbines and CHP plants combusting wood, straw or municipal waste all refer to emission measurements carried out on Danish plants (Nielsen & Illerup 2003). Other emission factors refer to the EMEP/Corinair Guidebook (EMEP/Corinair 2004).

Table 15 N_2O emission factors 1990-2003.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	all	all	3	EMEP/Corinair 2004
BROWN COAL BRI.	all	all	3	EMEP/Corinair 2004
COKE OVEN COKE	all	all	3	EMEP/Corinair 2004
PETROLEUM COKE	all	all	3	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	0,8	Nielsen & Illerup 2003
WOOD AND SIMIL.	1A1a	010105, 010202, 010203	4	EMEP/Corinair 2004
WOOD AND SIMIL.	1A2f, 1A4a, 1A4b, 1A4c	all	4	EMEP/Corinair 2004
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	1,2	Nielsen & Illerup 2003
MUNICIP. WASTES	1A1a	010203	4	EMEP/Corinair 2004
MUNICIP. WASTES	1A2f, 1A4a	030102, 0201, 020103	4	EMEP/Corinair 2004
STRAW	1A1a	010102, 010103	1,4	Nielsen & Illerup 2003
STRAW	1A1a	010202, 010203	4	EMEP/Corinair 2004
STRAW	1A2f, 1A4b, 1A4c	all	4	EMEP/Corinair 2004
RESIDUAL OIL	all	all	2	EMEP/Corinair 2004
GAS OIL	all	all	2	EMEP/Corinair 2004
KEROSENE	all	all	2	EMEP/Corinair 2004
FISH & RAPE OIL	all	all	2	EMEP/Corinair 2004, assuming same emission factor as gas oil
ORIMULSION	1A1a	010101	2	EMEP/Corinair 2004, assuming same emission factor as residual oil
NATURAL GAS	1A1a	0101, 010101, 010102, 010103, 010202, 010203	1	EMEP/Corinair 2004
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	2,2	Nielsen & Illerup 2003
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	1,3	Nielsen & Illerup 2003
NATURAL GAS	1A1c, 1A2f, 1A4a, 1A4b, 1A4c	010502, 0301, 030103, 030106, 0201, 020103, 0202, 020202, 0203	1	EMEP/Corinair 2004
LPG	all	all	2	EMEP/Corinair 2004
REFINERY GAS	all	all	2,2	EMEP/Corinair 2004
BIOGAS	1A1a	010102, 010103, 010203	2	EMEP/Corinair 2004
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	0,5	Nielsen & Illerup 2003
BIOGAS	1A2f, 1A4a, 1A4c	0301, 030102, 0201, 020103, 0203	2	EMEP/Corinair 2004

3.5.4 SO_2, NO_X, NMVOC and CO

Emission factors for SO_2, NO_X, NMVOC and CO are listed in Appendix 6. The appendix includes references and time-series.

The emission factors refer to:

- The EMEP/Corinair Guidebook (EMEP/Corinair 2004)
- The IPCC Guidelines, Reference Manual (IPCC 1996)
- Danish legislation:
  - Luftvejledningen 2001 (legislation from Danish Environmental Protection Agency)
  - Bek. 689 1990 (legislation from Danish Environmental Protection Agency)
  - Bek. 698 1998 (legislation from Danish Environmental Protection Agency)
- Danish research reports including:
  - An emission measurement program for decentralised CHP plants (Nielsen & Illerup 2003)
  - Research and emission measurements programs for biomass fuels:
    - Nikolaisen et al., 1998

  - Jensen & Nielsen, 1990
  - Dyrnum et al., 1990
  - Hansen et al., 1994
  - Serup et al., 1999
- Research and environmental data from the gas sector:
  - Gruijthuijsen & Jensen 2000
  - Danish Gas Technology Centre 2001

- Calculations based on plant-specific emissions from a considerable number of power plants (Nielsen & Illerup, 2003).
- Calculations based on plant-specific emission data from a considerable number of municipal 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.
- Additional personal communication.

Emission factor time-series have been estimated for a considerable number of the emission factors. These are provided in Appendix 6.

A detailed documentation for the SO_2 and NO_X emission factors is given in Appendix 4.

3.5.5 Particulate matter (PM)

Emission factors for PM and references for the emission factors are listed in Appendix 6. The appendix includes references. The emission factors are based on:

- The TNO/CEPMEIP emission factor database (CEPMEIP 2001)
- A Nordic project where improved emission factors for residential wood combustion was estimated (Sternhufvud et al. 2004))

- An improved PM emission inventory for residential wood combustion (Illerup & Nielsen, 2004)

and a considerable number of country-specific factors (Nielsen et al. 2003) referring to:

- Danish legislation:
  - Luftvejledningen 2001 (legislation from Danish Environmental Protection Agency).
  - Bek. 689 1990 (legislation from Danish Environmental Protection Agency).
- Calculations based on plant-specific emission data from a considerable number of municipal waste incineration plants.
- Danish research reports including:
  - An emission measurement program for decentralised CHP plants (Nielsen & Illerup 2003).
  - An emission measurement program for large power plants (Livbjerg et al. 2001).
- Additional personal communication concerning wood and straw combustion in residential plants.

Emission factor time series have been estimated for residential wood combustion. All other emission factors are considered constant in 2000-2003.

3.5.6 Heavy metals

Emission factors for 2003 for heavy metals (HM) are presented in Appendix 6. The appendix includes references and time-series. The emission factors refer to:

- Research concerning heavy metal emission factors representative for Denmark (Illerup et al. 1999).
- Emission measurement program carried out on Danish decentralised CHP plants (Nielsen & Illerup 2003).

Time-series have been estimated for municipal waste incineration. For all other sources the same emission factors have been applied for 1990-2003.

The HM emission factors listed in Appendix 5 are only given for the categories where activity data are available. Missing emission factors for some categories and some years reflect that the aggregation level is different for different years.

3.5.7 PAH

Emission factors 2003 for PAHs are shown in Appendix 6. The appendix includes references. The PAH emission factors refer to:

- Research carried out by TNO (Berdowski et al. 1995).
- Research carried out by Statistics Norway (Finstad et al. 2001).
- An emission measurement program performed on biomass fuelled plants. The project was carried out for the Danish Environmental Protection Agency (Jensen & Nielsen 1996).
- An emission measurement program carried out on Danish decentralised CHP plants (Nielsen & Illerup 2003).
- Additional information from the gas sector and the electricity production sector (Sander 2003 and Jensen 2001).

The same emission factors are applied for all years. In general, emission factors for PAH are uncertain.

3.6 Disaggregation to specific industrial subsectors

The national statistics on which the emission inventories are based do not include a direct disaggregation to specific industrial subsectors. However, separate national statistics from Statistics Denmark include a disaggregation to industrial subsectors. This part of the energy statistics is also included in the official energy statistics from the Danish Energy Authority.

Every other year Statistics Denmark collects fuel consumption data for all industrial companies of a considerable size. The deviation between the total fuel consumption from the Danish Energy Authority and the data collected by Statistics Denmark is rather small. Thus the disaggregation to industrial subsectors available from Statistics Den-

mark can be applied for estimating disaggregation keys for fuel consumption and emissions.

The industrial fuel consumption is considered in three aspects:

- Fuel consumption for transport. This part of the fuel consumption is not disaggregated to subsectors.
- Fuel consumption applied in power or district heating plants. Disaggregation of fuel and emissions is plant specific.
- Fuel consumption for other purposes. The total fuel comsumption and the total emissions are disaggregated to subsectors.

The following emissions from the industrial sector are disaggregated to subsectors this year: CO_2, CH_4, N_2O, SO_2, NO_x, NMVOC and CO. Next year disaggregation of the remaining pollutants will be estimated and the disaggregated data reported to the LRTAP Convention.

4 Fuel consumption data

In 2003 total fuel consumption for stationary combustion plants was 622 PJ of which 537 PJ was fossil fuels. The fuel consumption rates are shown in Appendix 5.

Fuel consumption distributed on the stationary combustion subsectors is shown in Figure 1 and Figure 2. The majority - 64% - of all fuels is combusted in the sector, *Public electricity and heat production.* Other sectors with high fuel consumption are *Residential* and *Industry*.

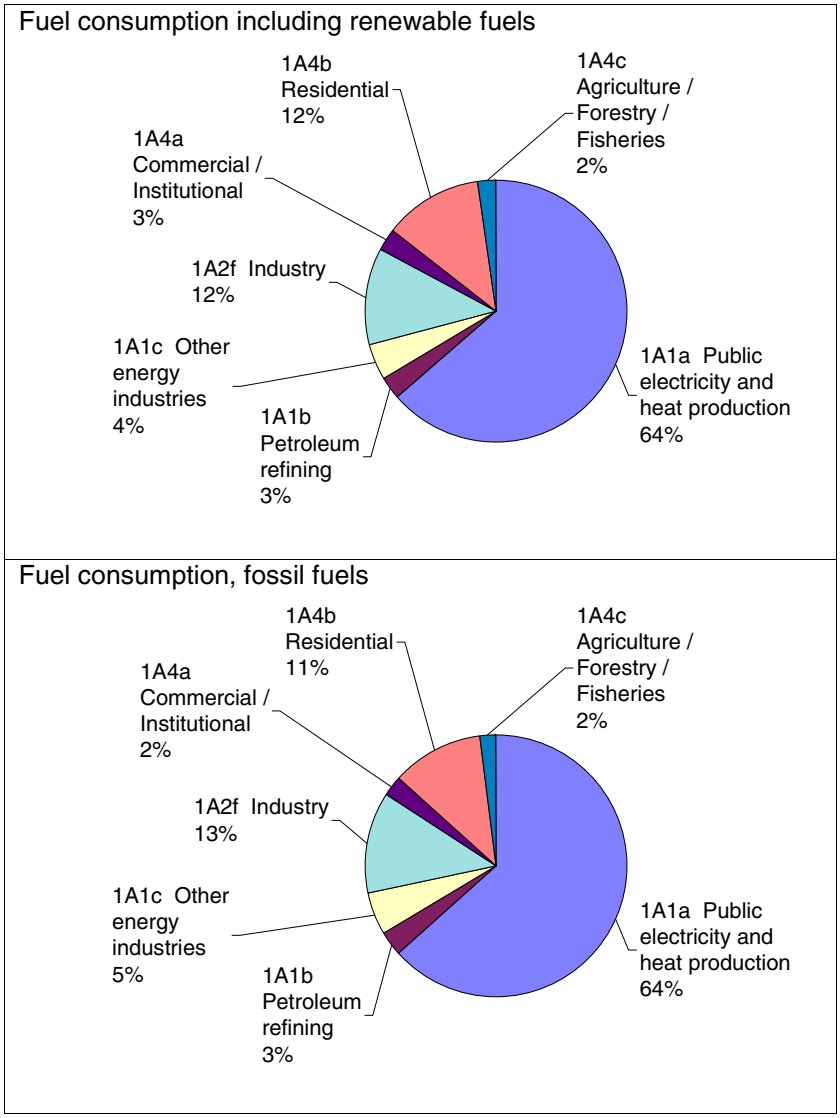


Figure 1 Fuel consumption rate of stationary combustion, 2003 (based on DEA 2004a).

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 CHP plants, as well as in industry, district heating and households.

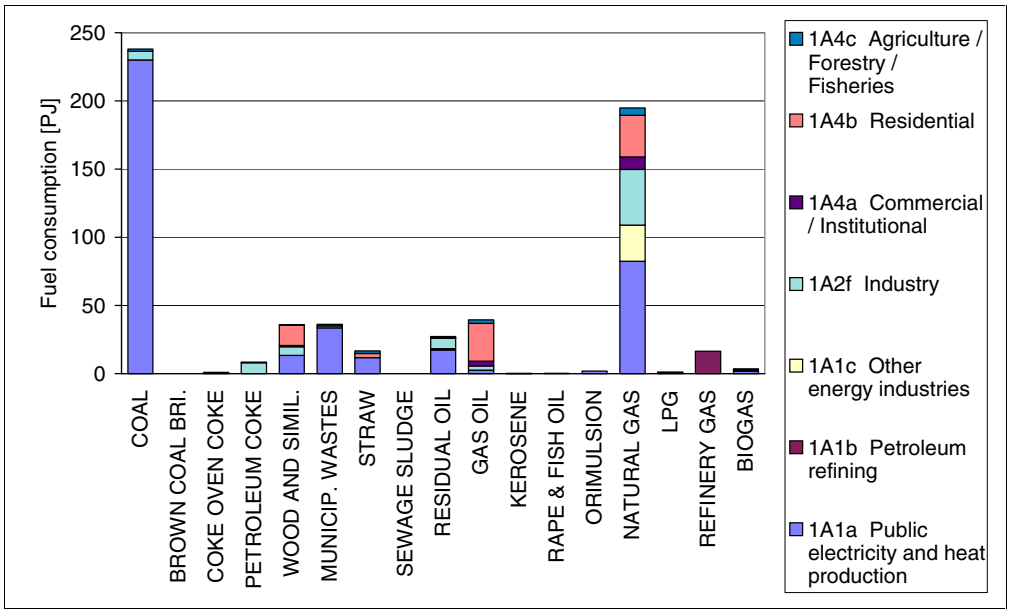


Figure 2 Fuel consumption of stationary combustion plants 2003 (based on DEA 2004a).

Fuel consumption time-series for stationary combustion plants are presented in Figure 3. The total fuel consumption has increased by 25% from 1990 to 2003, while the fossil fuel consumption has only increased by 18%. The consumption of natural gas and renewable fuels has increased since 1990 whereas coal consumption has decreased.

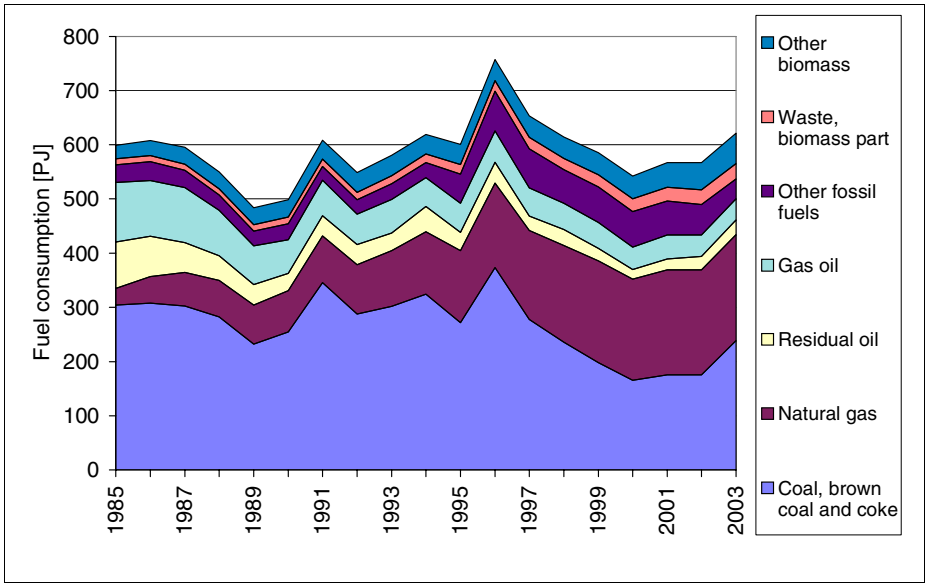


Figure 3 Fuel consumption time-series, stationary combustion (based on DEA 2004a).

The fluctuations in the time-series for fuel consumption are a result mainly of electricity import/export activity, 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 and NO_x emission are illustrated and compared in Figure 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 2003 the net electricity export was 30760 TJ which is much higher than in 2002. The high electricity export in 2003 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 Authority produces a correction of the actual fuel consumption without random variations in electricity imports/exports and ambient temperature. This fuel consumption trend is also illustrated in Figure 4. The corrections are included here to explain the fluctuations in the emission time-series.

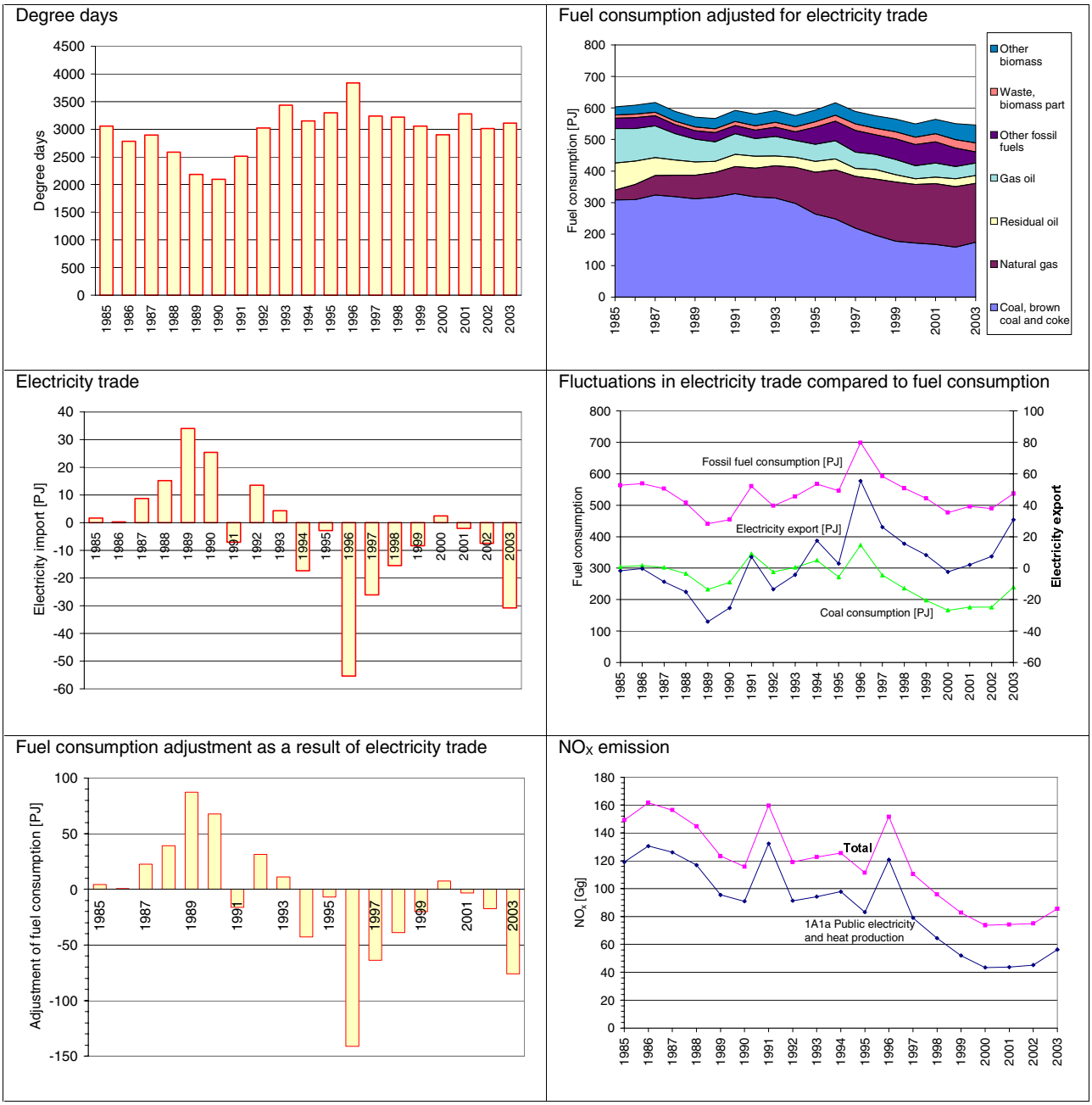


Figure 4 Comparison of time-series fluctuations for electricity trade, fuel consumption and NO_x emission (DEA 2004b).

5 Greenhouse gas emission

The total Danish greenhouse gas (GHG) emission in the year 2003 was 74.008 Gg CO_2 equivalent not including land-use change and forestry or 72.804 Gg CO_2 equivalent including land-use change and forestry. The greenhouse gas pollutants HFCs, PFCs and SF_6 are not emitted from combustion plants and, as such, only the pollutants CO_2, CH_4 and N_2O are considered below.

The global warming potentials of CH_4 and N_2O applied in greenhouse gas inventories refer to the second IPCC assessment report (IPCC 1995):

- 1 g CH_4 equals 21 g CO_2
- 1 g N_2O equals 310 g CO_2

The GHG emissions from stationary combustion are listed in Table 16. The emission from stationary combustion accounts for 57% of the total Danish GHG emission.

The CO_2 emission from stationary combustion plants accounts for 70% of the total Danish CO_2 emission (not including land-use change and forestry). CH_4 accounts for 9% of the total Danish CH_4 emission and N_2O for only 5% of the total Danish N_2O emission.

Table 16 Greenhouse gas emission for the year 2003 [1].

	CO_2	CH_4	N_2O
	Gg CO_2 equivalent		
1A1 Fuel consumption, Energy industries	31402	330	328
1A2 Fuel consumption, Manufacturing Industries and Construction[1]	4662	31	46
1A4 Fuel consumption, Other sectors [1]	5465	160	67
Total emission from stationary combustion plants	**41529**	**521**	**440**
Total Danish emission (gross)	59329	5873	8060
		%	
Emission share for stationary combustion	70	9	5

1) Only stationary combustion sources of the sector is included

CO_2 is the most important GHG pollutant and accounts for 97,7% of the GHG emission (CO_2 eq.). This is a much higher share than for the total Danish GHG emissions where CO_2 only accounts for 81% of the GHG emission (CO_2 eq.).

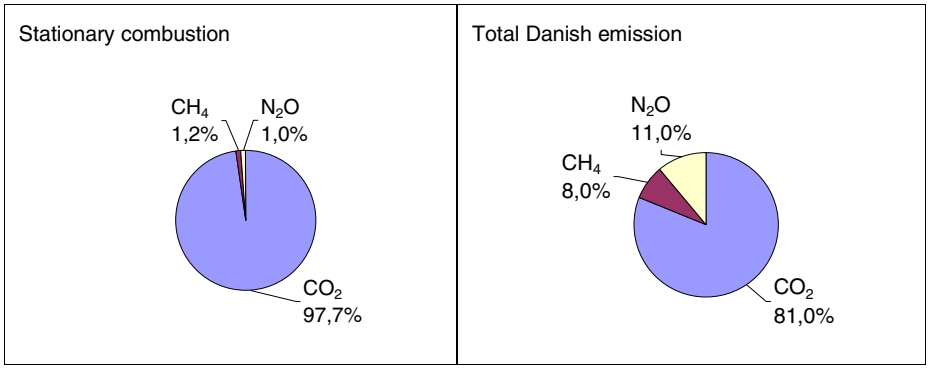


Figure 5 GHG emission (CO_2 equivalent), contribution from each pollutant.

Figure 6 depicts the time-series of GHG emission (CO_2 eqv.) from stationary combustion and it can be seen that the GHG emission development follows the CO_2 emission development very closely. Both the CO_2 and the total GHG emission is higher in 2003 than in 1990, CO_2 by 10% and GHG by 11%. However, fluctuations in the GHG emission level are large.

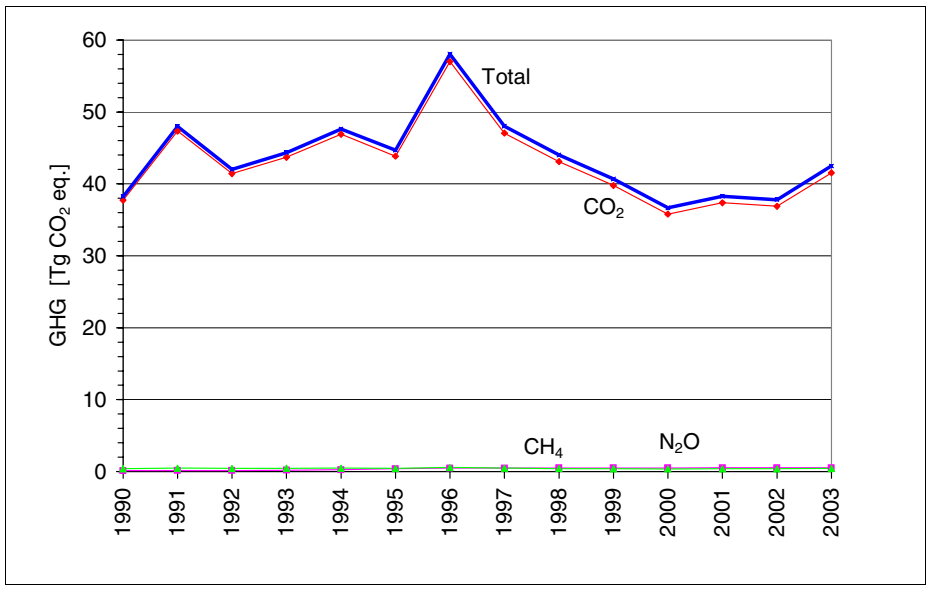


Figure 6 GHG emission time-series for stationary combustion.

The fluctuations in the time-series are mainly a result of electricity import/export activity, but also of outdoor temperature variations from year to year. The fluctuations follow the fluctuations in fuel consumption discussed in Chapter 4.

Figure 7 shows the corresponding time-series for degree days, electricity trade and CO_2 emission. As mentioned in Chapter 4, the Danish Energy Authority estimates a correction of the actual emissions without random variations in electricity imports/exports and in ambient temperature. This emission trend, which is smoothly decreasing, is also illustrated in Figure 7. The corrections are included here to explain the fluctuations in the emission time-series. The GHG emission corrected for electricity import/export and ambient temperature has decreased by 20% since 1990, and the CO_2 emission by 21%.

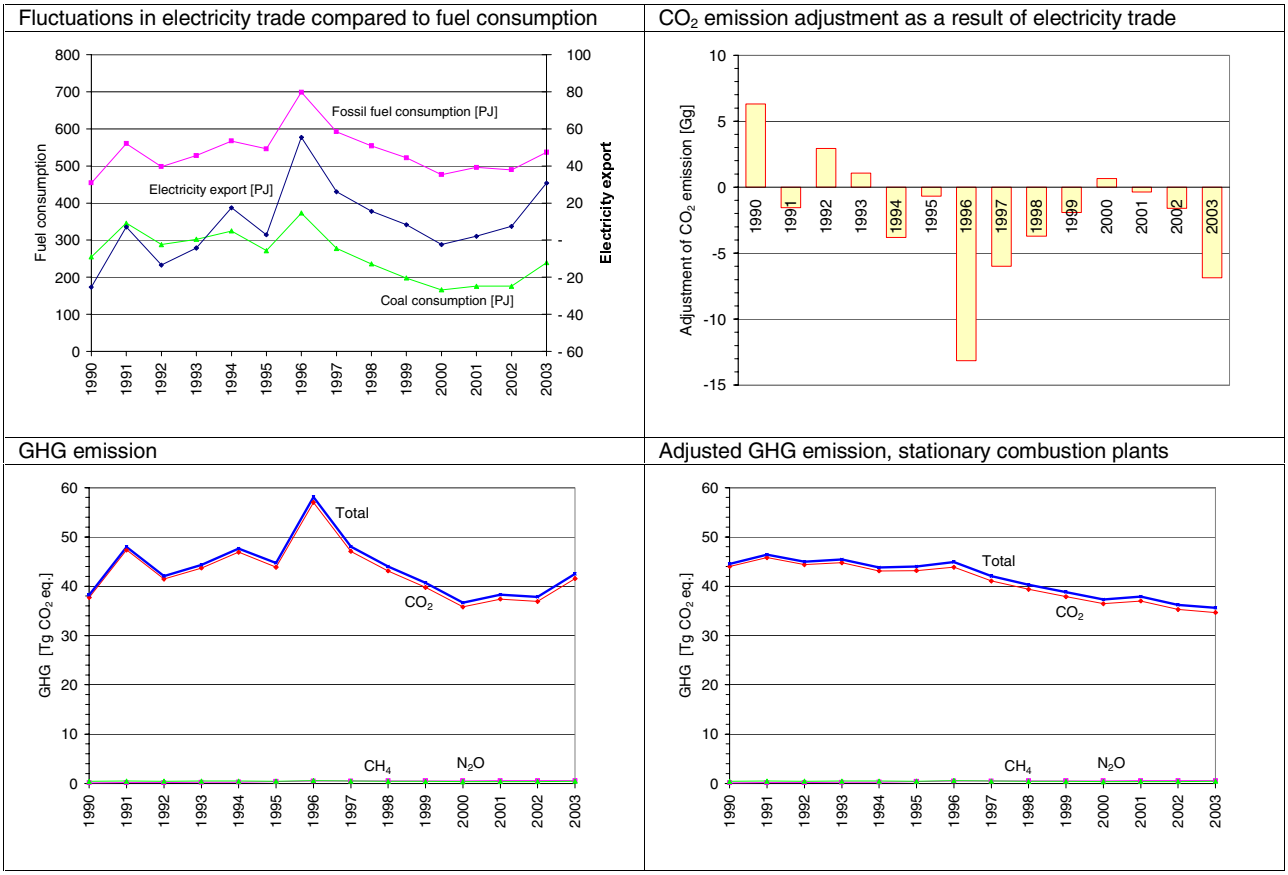


Figure 7 GHG emission time-series for stationary combustion, adjusted for electricity import/export (DEA 2004b).

5.1 CO_2

The CO_2 emission from stationary combustion plants is one of the most important GHG emission sources. Thus the CO_2 emission from stationary combustion plants accounts for 70% of the total Danish CO_2 emission. Table 17 lists the CO_2 emission inventory for stationary combustion plants for 2003. Figure 8 reveals that *Electricity and heat production* accounts for 70% of the CO_2 emission from stationary combustion. This share is somewhat higher than the fossil fuel consumption share for this sector, which is 64% (Figure 1). Other large CO_2 emission sources are industrial plants and residential plants. These are the sectors, which also account for a considerable share of fuel consumption.

Table 17 CO_2 emission from stationary combustion plants 2003 [1)]

CO_2	**2003**	
1A1a Public electricity and heat production	28869	Gg
1A1b Petroleum refining	1013	Gg
1A1c Other energy industries	1520	Gg
1A2 Industry	4662	Gg
1A4a Commercial / Institutional	854	Gg
1A4b Residential	3890	Gg
1A4c Agriculture / Forestry / Fisheries	721	Gg
Total	**41529**	**Gg**

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

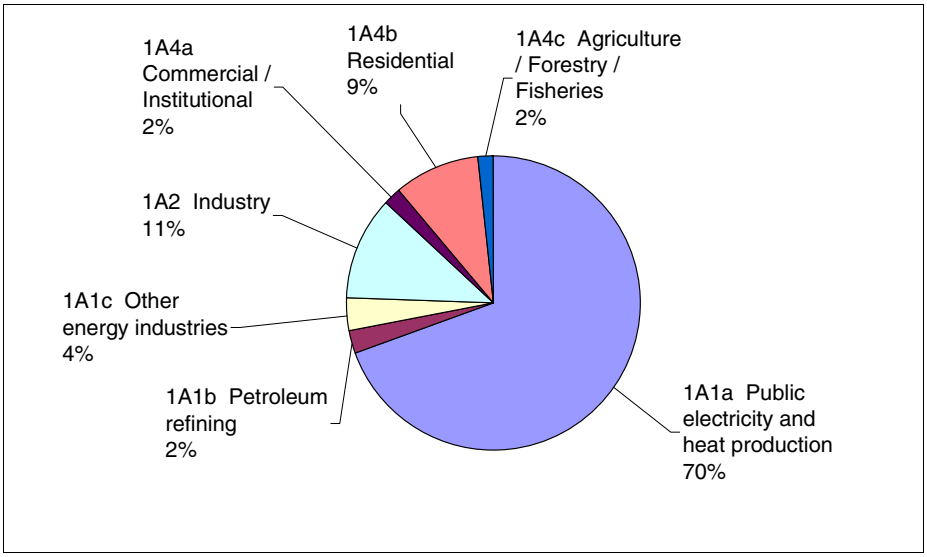


Figure 8 CO_2 emission sources, stationary combustion plants, 2003.

The sector *Electricity and heat production* consists of the SNAP source sectors: *Public power* and *District heating*. The CO_2 emissions from each of these subsectors are listed in Table 18. The most important subsector is power plant boilers >50MW.

Table 18 CO_2 emission from subsectors to *1A1a Electricity and heat production*.

SNAP source	SNAP name	2003	
0101	Public power	0	Gg
010101	Combustion plants ≥ 300MW (boilers)	23365	Gg
010102	Combustion plants ≥ 50MW and < 300 MW (boilers)	939	Gg
010103	Combustion plants <50 MW (boilers)	177	Gg
010104	Gas turbines	2515	Gg
010105	Stationary engines	1561	Gg
0102	District heating plants	-	Gg
010201	Combustion plants ≥ 300MW (boilers)	-	Gg
010202	Combustion plants ≥ 50MW and < 300 MW (boilers)	41	Gg
010203	Combustion plants <50 MW (boilers)	260	Gg
010204	Gas turbines	-	Gg
010205	Stationary engines	10	Gg

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 Climate Convention reporting. In 2003 the CO_2 emission from biomass combustion was 9108 Gg.

In Figure 9 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 45% of the fossil fuel consumption and for 55% of the CO_2 emission. Natural gas accounts for 36% of the fossil fuel consumption but only 27% of the CO_2 emission.

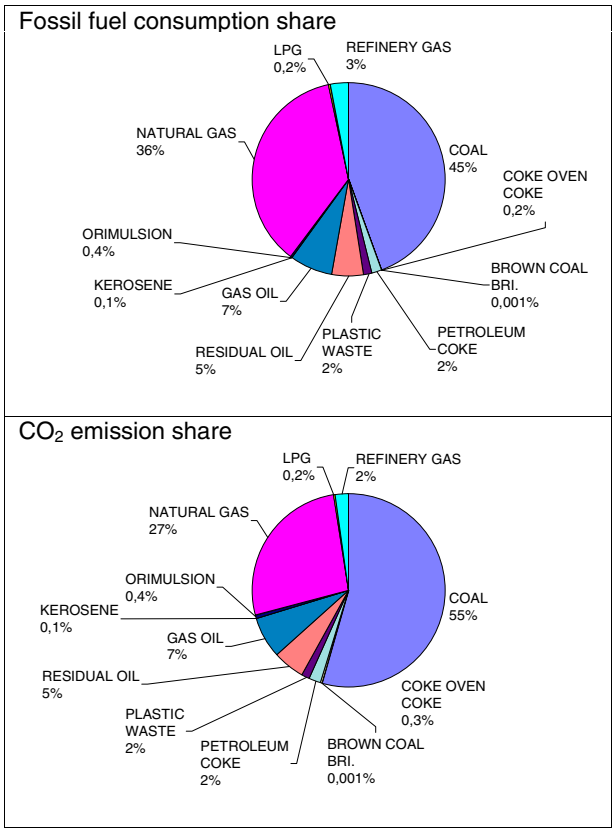


Figure 9 CO_2 emission, fuel origin.

Time-series for CO_2 emission are provided in Figure 10. Despite an increase in fuel consumption of 25% since 1990, CO_2 emission from stationary combustion has increased by only 10% due to of the change in fuel type used.

The fluctuations in total CO_2 emission follow the fluctuations in CO_2 emission from *Electricity and heat production* (Figure 10) and in coal consumption (Figure 11). The fluctuations are a result of electricity import/export activity as discussed in Chapter 5.

Figure 11 compares time-series for fossil fuel consumption and the CO_2 emission. As mentioned above, the consumption of coal has decreased whereas the consumption of natural gas, with a lower CO_2 emission factor, has increased. Total fossil fuel use increased by 18% between 1990 and 2003.

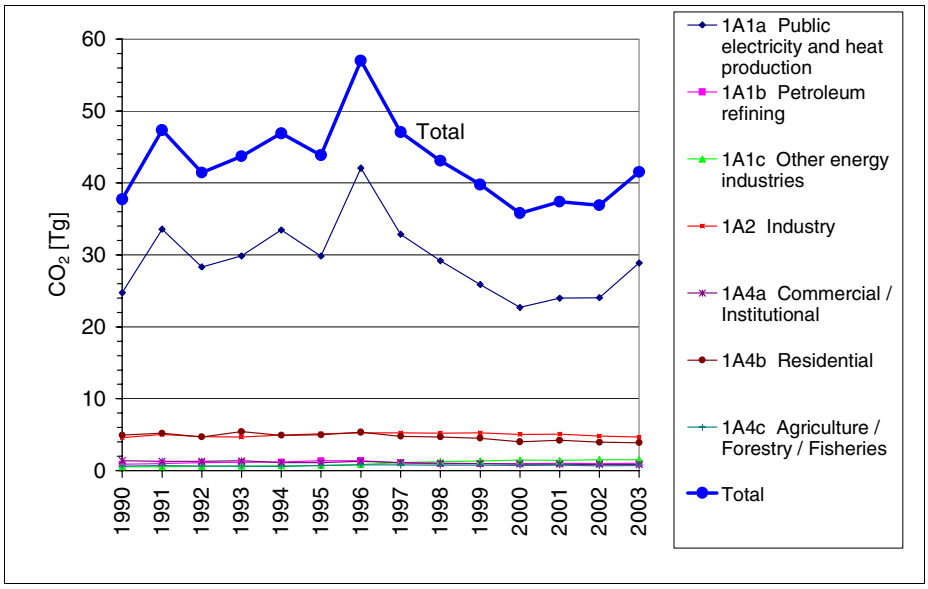


Figure 10 CO_2 emission time-series for stationary combustion plants.

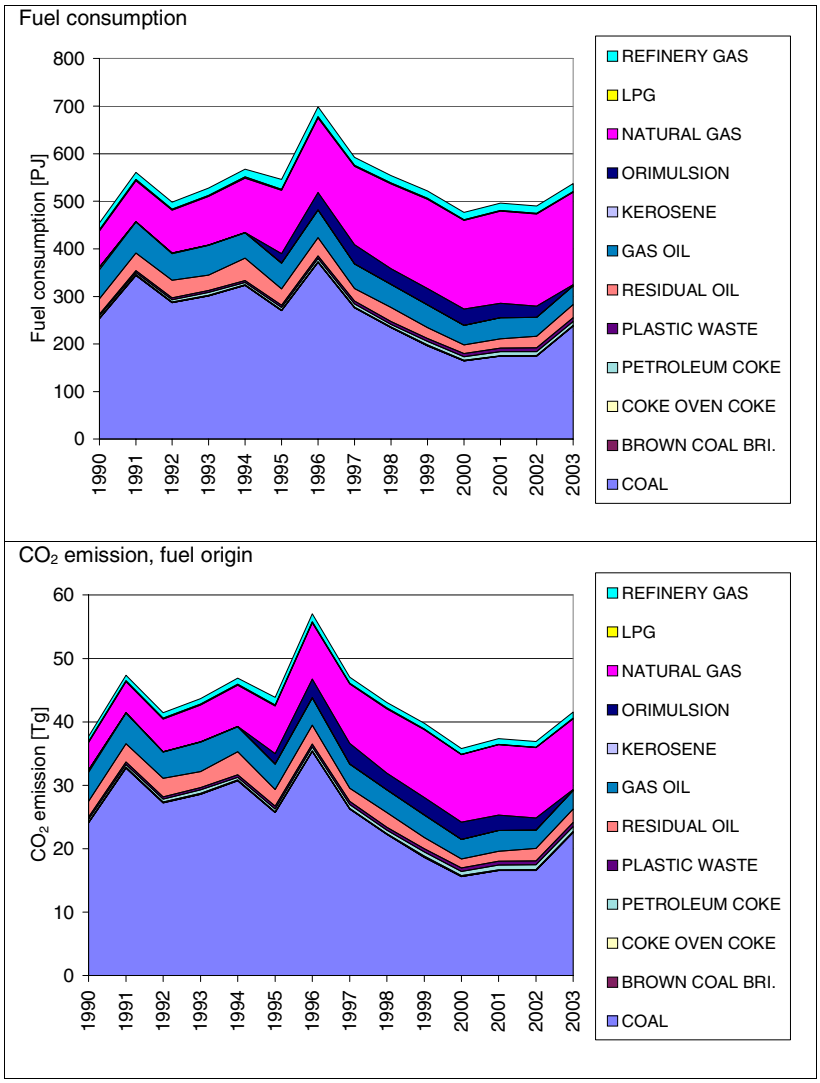


Figure 11 Fossil fuel consumption and CO_2 emission time-series for stationary combustion.

5.2 CH_4

CH_4 emission from stationary combustion plants accounts for 9% of the total Danish CH_4 emission. Table 19 lists the CH_4 emission inventory for stationary combustion plants in 2003. Figure 12 reveals that *Electricity and heat production* accounts for 64% of the CH_4 emission from stationary combustion, this being closely aligned with fuel consumption share.

Table 19 CH_4 emission from stationary combustion plants 2003 [1)].

CH_4	2003	
1A1a Public electricity and heat production	15647	Mg
1A1b Petroleum refining	2	Mg
1A1c Other energy industries	58	Mg
1A2 Industry	1485	Mg
1A4a Commercial / Institutional	961	Mg
1A4b Residential	4562	Mg
1A4c Agriculture / Forestry / Fisheries	2094	Mg
Total	24809	Mg

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

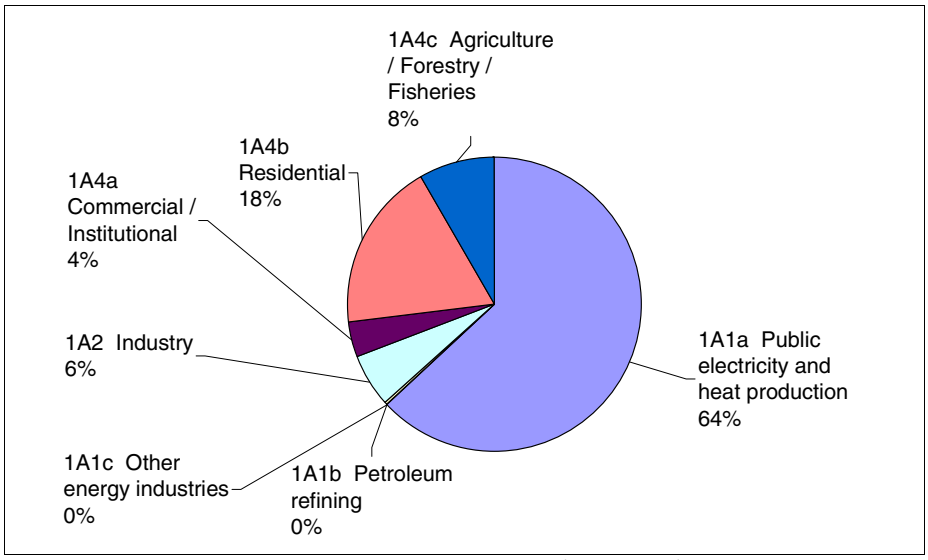


Figure 12 CH_4 emission sources, stationary combustion plants, 2003.

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 as discussed in Chapter 4.5.2. A considerable number of lean-burn gas engines are in operation in Denmark and these plants account for 75% of the CH_4 emission from stationary combustion plants (Figure 13). The engines are installed in CHP plants and the fuel used is either natural gas or biogas.

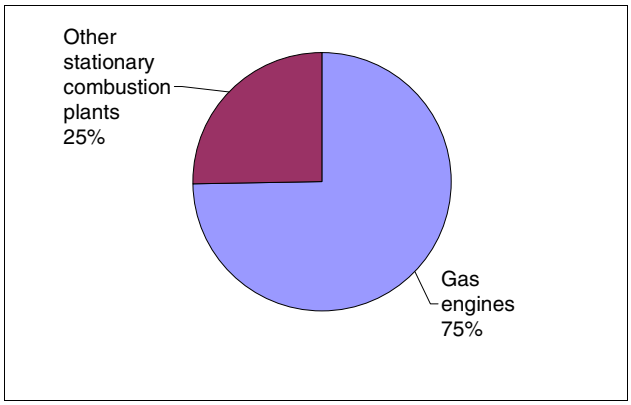


Figure 13 Gas engine CH_4 emission share, 2003.

The CH_4 emission from stationary combustion increased by a factor of 4,3 since 1990 (Figure 14). This results from the considerable number of lean-burn gas engines installed in CHP plants in Denmark in this period. Figure 15 provides time-series for the fuel consumption rate in gas engines and the corresponding increase of CH_4 emission.

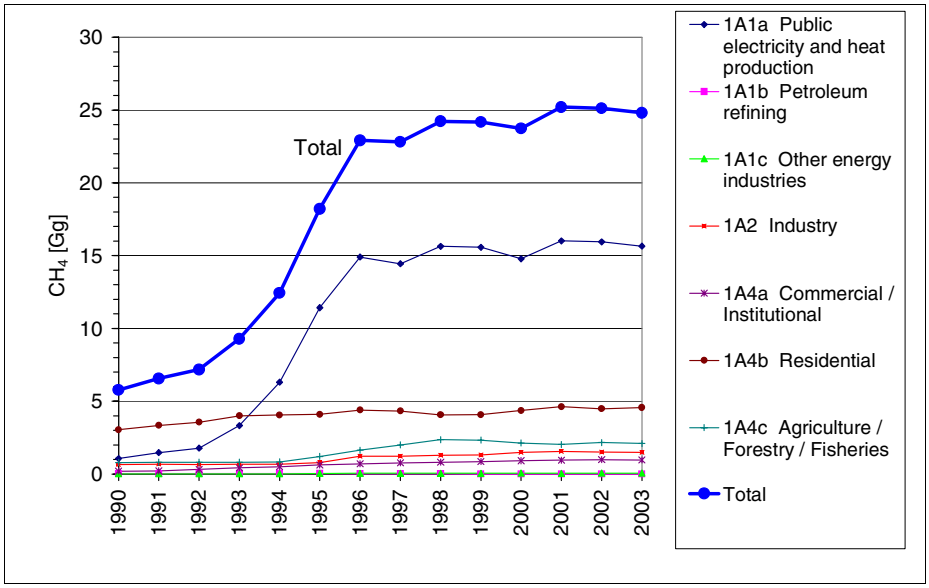


Figure 14 CH_4 emission time-series for stationary combustion plants.

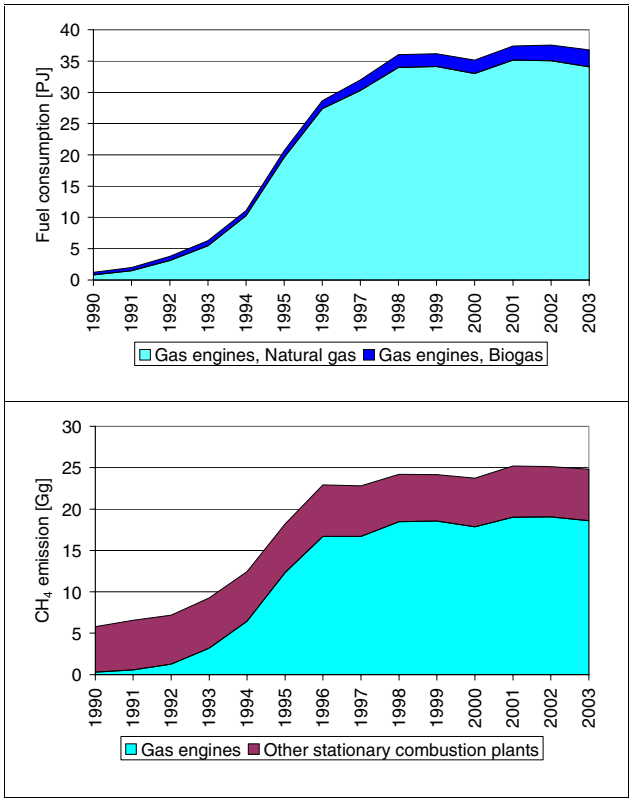


Figure 15 Fuel consumption and CH_4 emission from gas engines, time-series.

5.3 N_2O

The N_2O emission from stationary combustion plants accounts for 5% of the total Danish N_2O emission. Table 20 lists the N_2O emission inventory for stationary combustion plants in the year 2003. Figure 16 reveals that *Electricity and heat production* accounts for 68% of the N_2O emission from stationary combustion. This is only a little higher than the fuel consumption share.

Table 20 N_2O emission from stationary combustion plants 2003 [1)].

N_2O	2003	
1A1a Public electricity and heat production	963	Mg
1A1b Petroleum refining	36	Mg
1A1c Other energy industries	58	Mg
1A2 Industry	149	Mg
1A4a Commercial / Institutional	27	Mg
1A4b Residential	161	Mg
1A4c Agriculture / Forestry / Fisheries	27	Mg
Total	**1420**	Mg

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

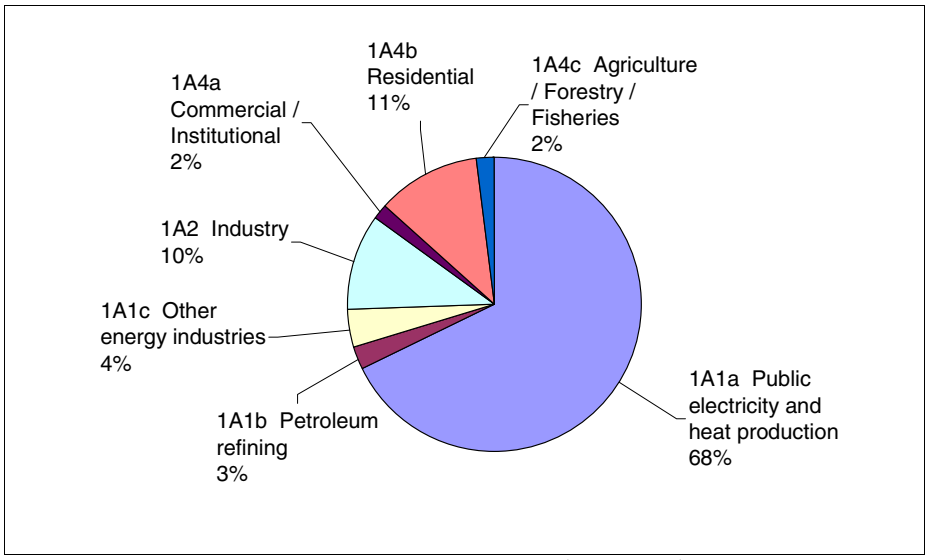


Figure 16 N_2O emission sources, stationary combustion plants, 2003.

Figure 17 shows time-series for N_2O emission. The N_2O emission from stationary combustion increased by 11% from 1990 to 2003, but again fluctuations in emission level due to electricity import/export are considerable.

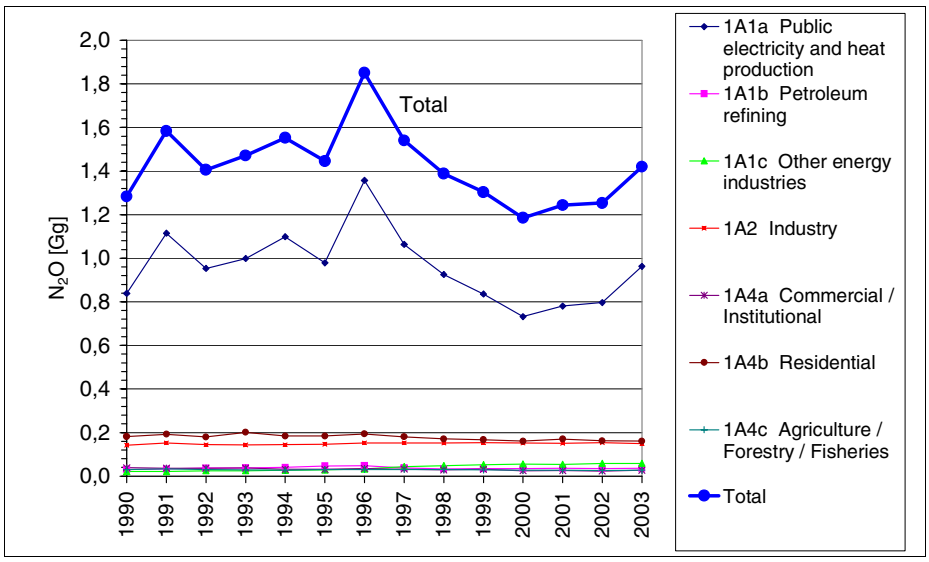


Figure 17 N_2O emission time-series for stationary combustion plants.

6 SO_2, NO_X, NMVOC and CO

The emissions of SO_2, NO_X, NMVOC and CO from Danish stationary combustion plants 2003 are presented in Table 21. The emission of these pollutants is reported to the LRTAP Convention and the pollutants are also included in the report to the Climate Convention.

SO_2 from stationary combustion plants accounts for 87% of the total Danish emission. NO_X, CO and NMVOC account for 41%, 31% and 12% of total Danish emissions, respectively.

Table 21 SO_2, NO_X, NMVOC and CO emission from stationary combustion 2003 [1)].

Pollutant	NO_X Gg	CO Gg	NMVOC Gg	SO_2 Gg
1A1 Fuel consumption, Energy industries	64,5	12,6	4,3	17,5
1A2 Fuel consumption, Manufacturing Industries and Construction (Stationary combustion)	13,4	12,3	0,7	5,9
1A4 Fuel consumption, Other sectors (Stationary combustion)	7,7	158,8	13,5	3,6
Total emission from stationary combustion plants	**85,6**	**183,7**	**18,5**	**26,9**
Total Danish emission	209,1	592,5	158,5	31,0
		%		
Emission share for stationary combustion	41	31	12	87

1) Only emissions from stationary combustion plants in the sectors are included

6.1 SO_2

Stationary combustion is the most important emission source for SO_2 accounting for 87% of the total Danish emission. Table 22 and Figure 18 present the SO_2 emission inventory for the stationary combustion subsectors.

Electricity and heat production is the largest emission source accounting for 63% of the emission, however, the SO_2 emission share is almost the same as the fuel consumption share for this sector, which is 64%. This is possibly due to effective flue gas desulphurisation equipment installed in power plants combusting coal. Figure 19 shows the SO_2 emission from *Electricity and heat production* on a disaggregated level. Power plants >300MW_{th} represent the main emission source, accounting for 83% of the emission.

The fuel origin of the SO_2 emission is shown in Figure 20. Disaggregation of total emissions from point sources using several fuels is based on emission factors. As expected the emission from natural gas is negligible and the emission from coal combustion is considerable (61%). Most remarkably is the emission share from residual oil combustion, which is 20%. This emission is very high compared to the fuel consumption share of 4%. The emission factor for residual oil combusted in the industrial sector is uncertain because knowledge of the applied flue gas cleaning technology in this sector is insufficient.

The SO_2 emission from *Industry* is 22%, a remarkably high emission share compared with fuel consumption. The main emission sources in the industrial sector are combustion of coal and residual oil, but emissions from the cement industry is also a considerable emission source. Some years ago, SO_2 emission from the industrial sector only accounted for a small portion of the total emission, but as a result of reduced emissions from power plants the share has now increased.

Time-series for SO_2 emission from stationary combustion are shown in Figure 21. The SO_2 emission from stationary combustion plants has decreased by 94% from 1980 and 78% from 1995. The large emission decrease is mainly a result of the reduced emission from *Electricity and heat production*, made possible due to installation of desulphurisation plants 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 63% of the total emission from stationary combustion, as mentioned above. The emission from other sectors also decreased considerably since 1980.

Table 22 SO_2 emission from stationary combustion plants 2003 [1)].

SO_2	2003	
1A1a Public electricity and heat production	16958	Mg
1A1b Petroleum refining	495	Mg
1A1c Other energy industries	9	Mg
1A2 Industry	5851	Mg
1A4a Commercial / Institutional	364	Mg
1A4b Residential	1738	Mg
1A4c Agriculture / Forestry / Fisheries	1511	Mg
Total	26924	Mg

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

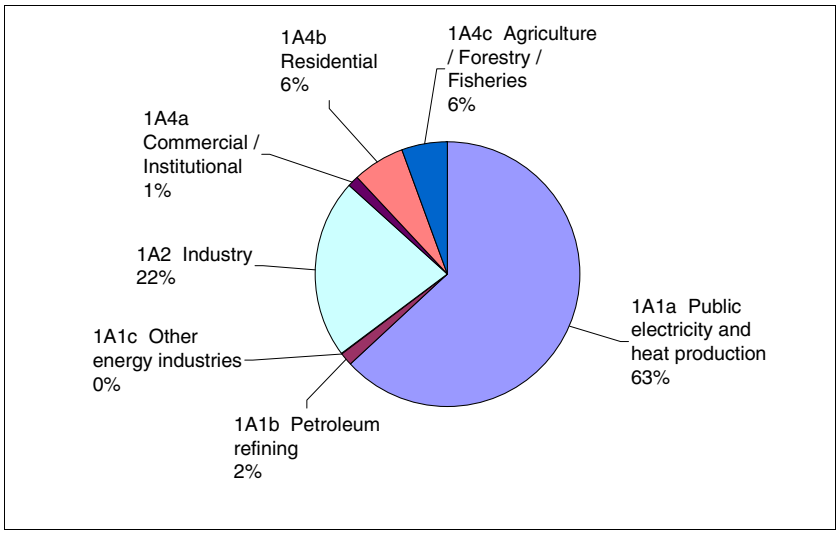


Figure 18 SO_2 emission sources, stationary combustion plants, 2003.

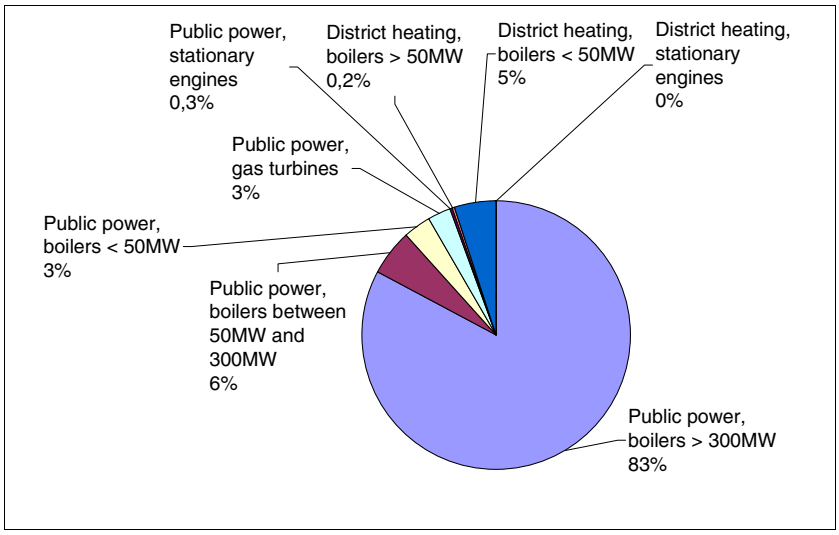


Figure 19 Disaggregated SO_2 emissions from *Energy and heat production.*

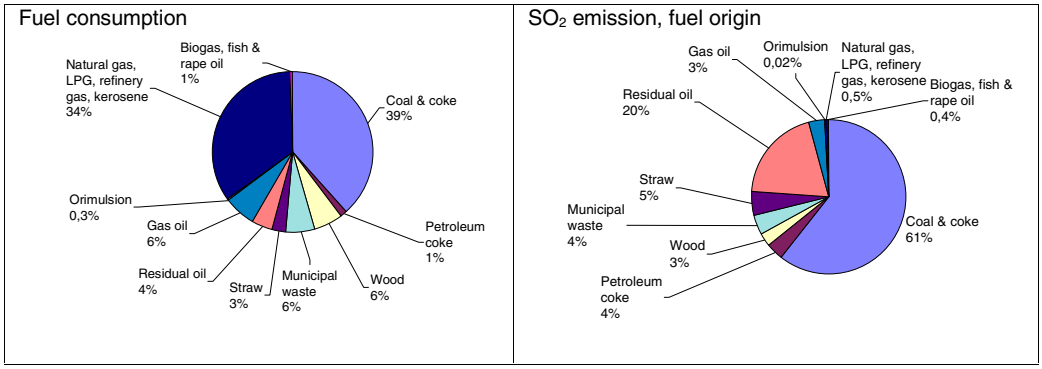


Figure 20 Fuel origin of the SO_2 emission from stationary combustion plants.

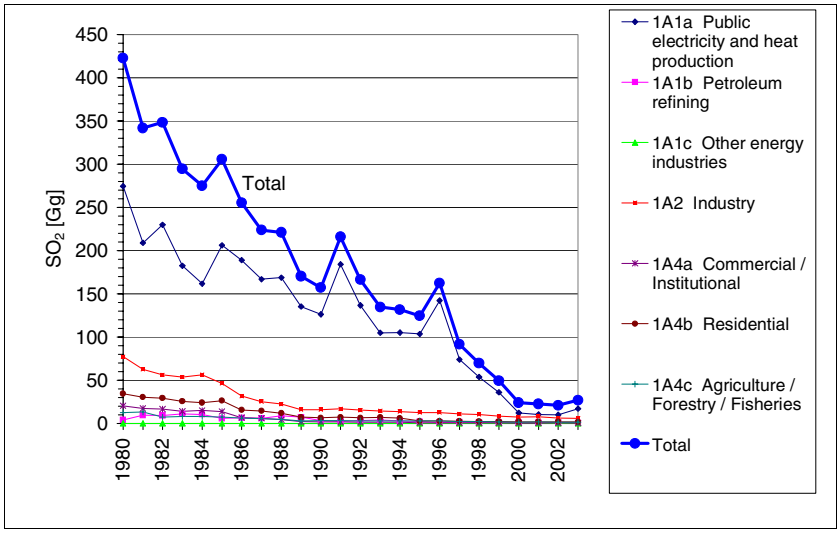


Figure 21 SO_2 emission time-series for stationary combustion.

6.2 NO_x

Stationary combustion accounts for 41% of the total Danish NO_x emission. Table 23 and Figure 22 show the NO_x emission inventory for stationary combustion subsectors.

Electricity and heat production is the largest emission source accounting for 65% of the emission from stationary combustion plants. Power plants >50MW_{th} are the main emission source in this sector accounting for 78% of the emission.

Figure 23 shows fuel origin of the NO_x emission from sector 1A1a Electricity and heat production. The fuel origin of the NO_x emission is almost the same as the fuel consumption in this plant category. The emission from coal combustion is, however, somewhat higher than the fuel consumption share.

Industrial combustion plants are also an important emission source accounting for 16% of the emission. The main industrial emission source is cement production, accounting for 63% of the emission.

Residential plants accounts for 6% of the NO_x emission. The fuel origin of this emission is mainly wood, gas oil and natural gas accounting for 37%, 29% and 23% of the residential plant emission, respectively.

Time-series for NO_x emission from stationary combustion are shown in Figure 24. NO_x emission from stationary combustion plants has decreased by 43% from 1985 and 23% from 1995. The reduced emission is mainly a result of the reduced emission from *Electricity and heat production* due to installation of low NO_x burners and selective catalytic reduction (SCR) units. The fluctuations in the time-series follow the fluctuations in *Electricity and heat production*, which, in turn, result from electricity trade fluctuations.

Table 23 NO_x emission from stationary combustion plants 2003 [1)].

	2003	
1A1a Public electricity and heat production	56247	Mg
1A1b Petroleum refining	1645	Mg
1A1c Other energy industries	6615	Mg
1A2 Industry	13419	Mg
1A4a Commercial / Institutional	1245	Mg
1A4b Residential	4865	Mg
1A4c Agriculture / Forestry / Fisheries	1544	Mg
Total	**85581**	Mg

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

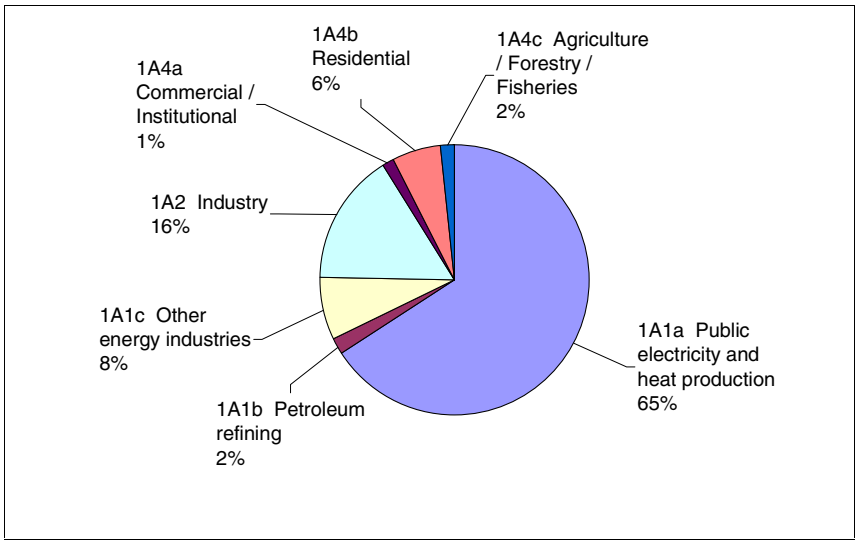


Figure 22 NO_x emission sources, stationary combustion plants, 2003.

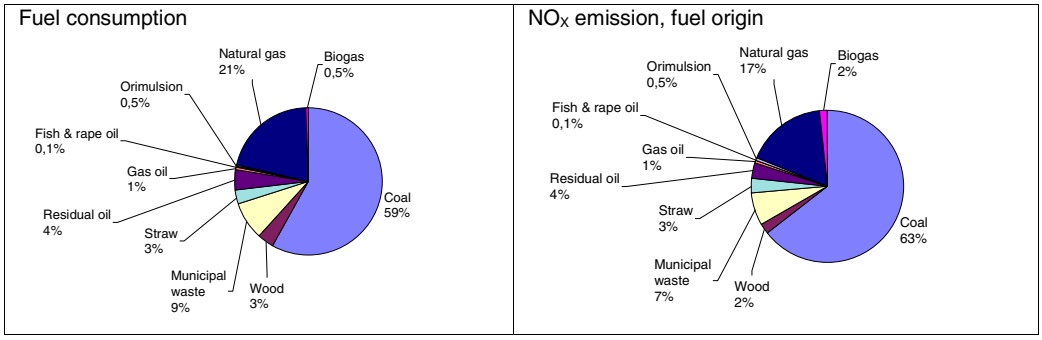


Figure 23 NO_x emissions from 1A1a Electricity and heat production, fuel origin.

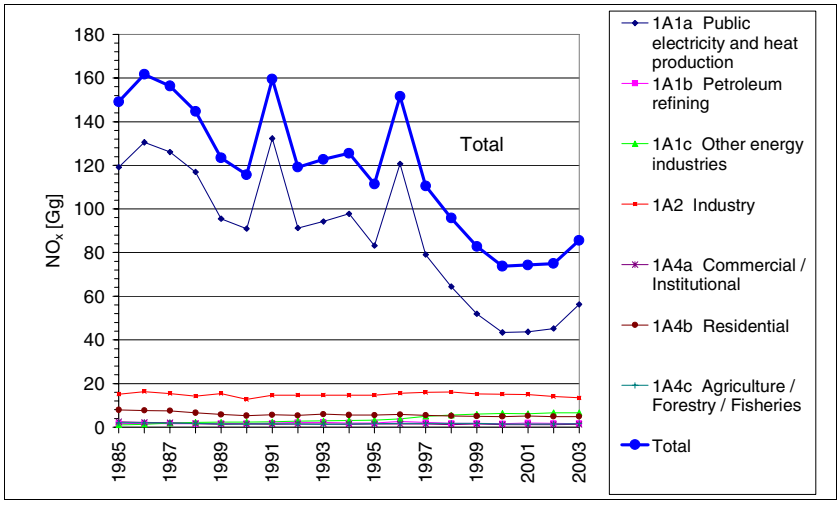


Figure 24 NO_x emission time-series for stationary combustion.

6.3 NMVOC

Stationary combustion plants account for 12% of the total Danish NMVOC emission. Table 24 and Figure 25 present the NMVOC emission inventory for the stationary combustion subsectors.

Residential plants are the largest emission source accounting for 60% of the total emission from stationary combustion plants. For residential plants NMVOC is mainly emitted from wood and straw combustion, see Figure 26.

Electricity and heat production is also a considerable emission source, accounting for 23% of the total emission. Lean-burn gas engines have a relatively high NMVOC emission factor and are the most important emission source in this subsector (see Figure 26). The gas engines are either natural gas or biogas fuelled.

Time-series for NMVOC emission from stationary combustion are shown in Figure 27. The emission has increased by 43% from 1985 and 15% from 1995. The increased emission is mainly a result of the increased use of lean-burn gas engines in CHP plants as discussed in Chapter 7.2.

The emission from residential plants is 23% higher in 2003 than in 1990, but the NMVOC emission from wood combustion almost doubled since 1990 due to increased wood consumption. However the emission from straw combustion in farmhouse boilers has decreased over this period.

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

Table 24 NMVOC emission from stationary combustion plants 2003 [1)].

	2003	
1A1a Public electricity and heat production	4222	Mg
1A1b Petroleum refining	2	Mg
1A1c Other energy industries	39	Mg
1A2 Industry	721	Mg
1A4a Commercial / Institutional	751	Mg
1A4b Residential	11115	Mg
1A4c Agriculture / Forestry / Fisheries	1629	Mg
Total	18478	Mg

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

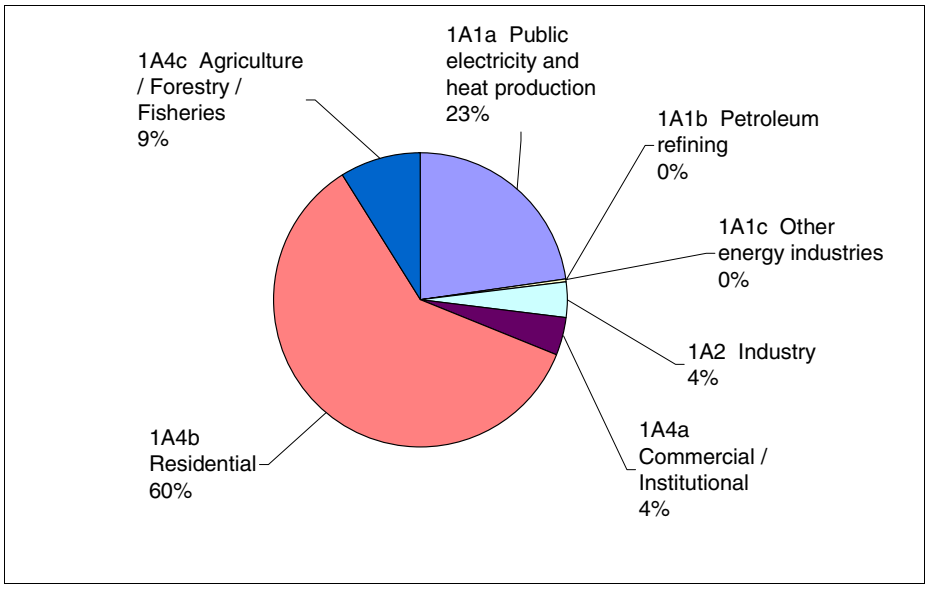


Figure 25 NMVOC emission sources, stationary combustion plants, 2003.

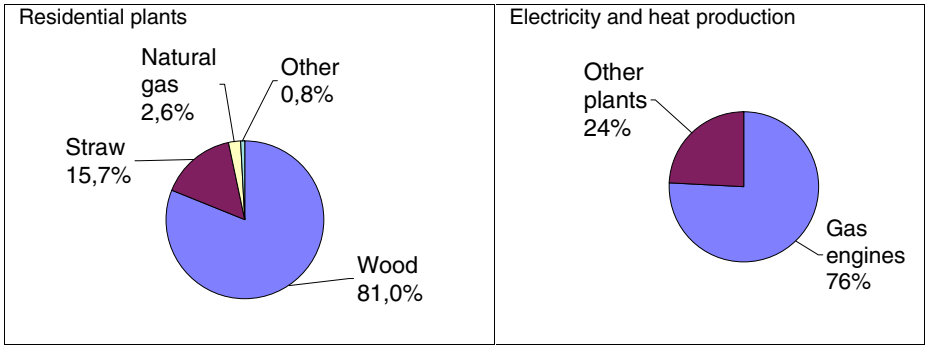


Figure 26 NMVOC emission from residential plants and from electricity and heat production, 2003.

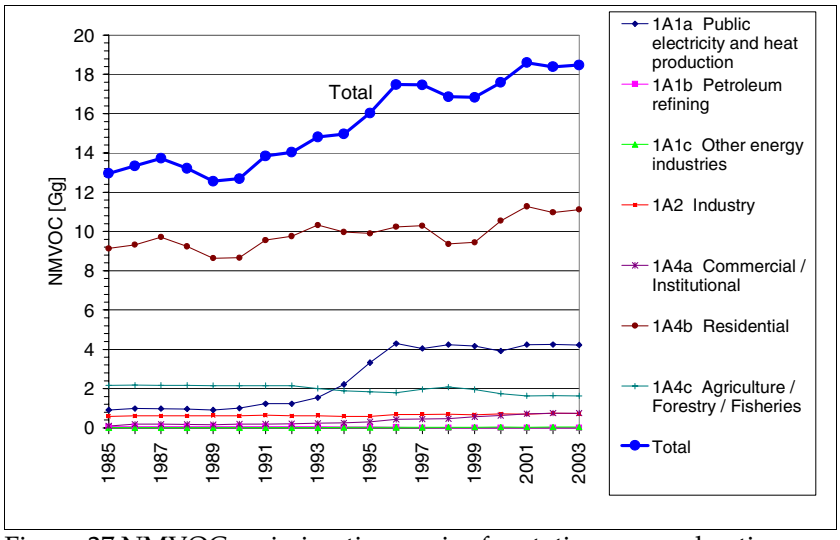


Figure 27 NMVOC emission time-series for stationary combustion.

6.4 CO

Stationary combustion accounts for 31% of the total Danish CO emission. Table 25 and Figure 28 presents the CO emission inventory for stationary combustion subsectors.

Residential plants are the largest emission source, accounting for 80% of the emission. Wood combustion accounts for 90% of the emission from residential plants, see Figure 29. This is in spite of the fact that the fuel consumption share is only 19%. 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 30. The emission has increased by 2% from 1985 and decreased 3% from 1995. The time-series for CO from stationary combustion plants follows the time-series for CO emission from residential plants.

The consumption of wood in residential plants has increased by 68% since 1990 leading to an increase in the CO emission. The increase in CO emission from residential plants is lower than the increase in wood consumption, because CO emission from straw-fired farmhouse boilers has decreased considerably. Both the annual straw consumption in residential plants and the CO emission factor for farmhouse boilers have decreased.

Table 25 CO emission from stationary combustion plants 2003 [1)].

	2003	
1A1a Public electricity and heat production	12205	Mg
1A1b Petroleum refining	242	Mg
1A1c Other energy industries	183	Mg
1A2 Industry	12308	Mg
1A4a Commercial / Institutional	937	Mg
1A4b Residential	149242	Mg
1A4c Agriculture / Forestry / Fisheries	8599	Mg
Total	**183715**	Mg

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

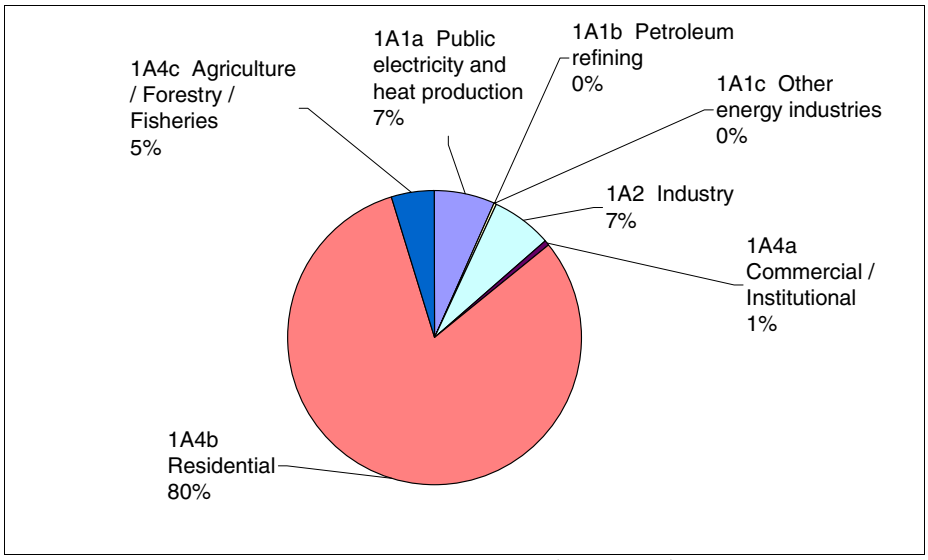


Figure 28 CO emission sources, stationary combustion plants, 2003.

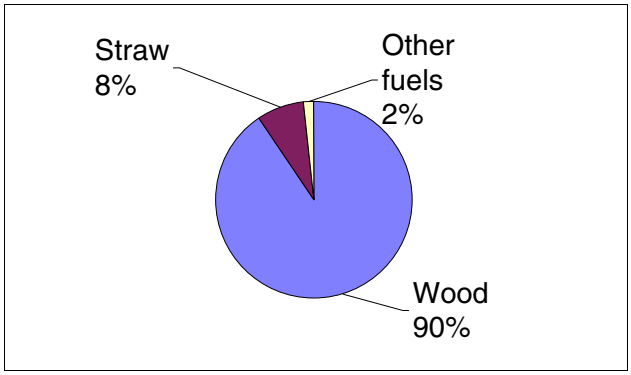


Figure 29 CO emission sources, residential plants, 2003.

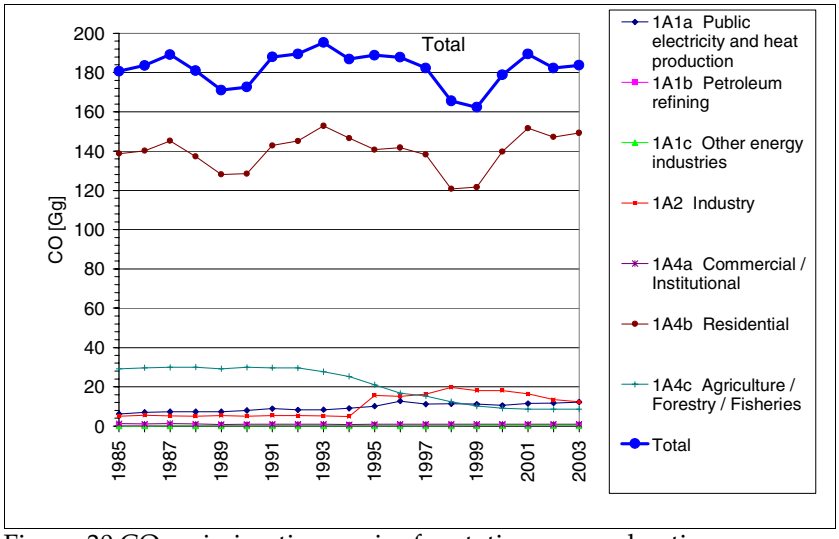


Figure 30 CO emission time-series for stationary combustion.

7 Particulate matter (PM)

The emission of total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ from Danish stationary combustion plants 2003 is presented in Table 26. The PM emission is reported to the LRTAP Convention.

To date, only PM emissions from stationary combustion, transport, agriculture and part of the industrial sector have been included in the Danish inventory. TSP from stationary combustion accounts for 35% of the total Danish emission. The emission shares for PM_{10} and $PM_{2.5}$ are 44% and 56%, respectively.

Table 26 Danish PM emissions 2003.

Pollutant	TSP Mg	PM_{10} Mg	$PM_{2.5}$ Mg
1A1 Fuel combustion, Energy industries	1432	1141	953
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion) 1)	1023	683	407
1A4 Fuel combustion, Other sectors (Stationary combustion) 1)	12323	11683	11048
Total emission from stationary combustion plants	**14779**	**13507**	**12409**
Total Danish emission (gross)	42685	30497	22243
		%	
Emission share for stationary combustion	35	44	56

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

Table 27 and Figure 31 show the PM emission inventory for the stationary combustion subsectors. Residential plants are the largest emission source accounting for 84% of the $PM_{2.5}$ emission from stationary combustion plants.

The primary sources of PM emissions are:

- Residential boilers, stoves and fireplaces combusting wood
- Farmhouse boilers combusting straw
- Power plants primarily combusting coal
- Coal and residual oil combusted in industrial boilers and processes

Furthermore, there are considerable emissions from:

- Residential boilers using gas oil
- Refineries

The PM emission from wood combusted in residential plants is the predominant source. Thus 78% of the $PM_{2.5}$ emission from stationary combustion is emitted from residential wood combustion. This corresponds to 43% of the overall Danish emission. A literature review (Nielsen et al. 2003) and a Nordic Project (Sternhufvud et al. 2004) has demonstrated that the emission factor uncertainty for residential combustion of wood in stoves and boilers is extremely high.

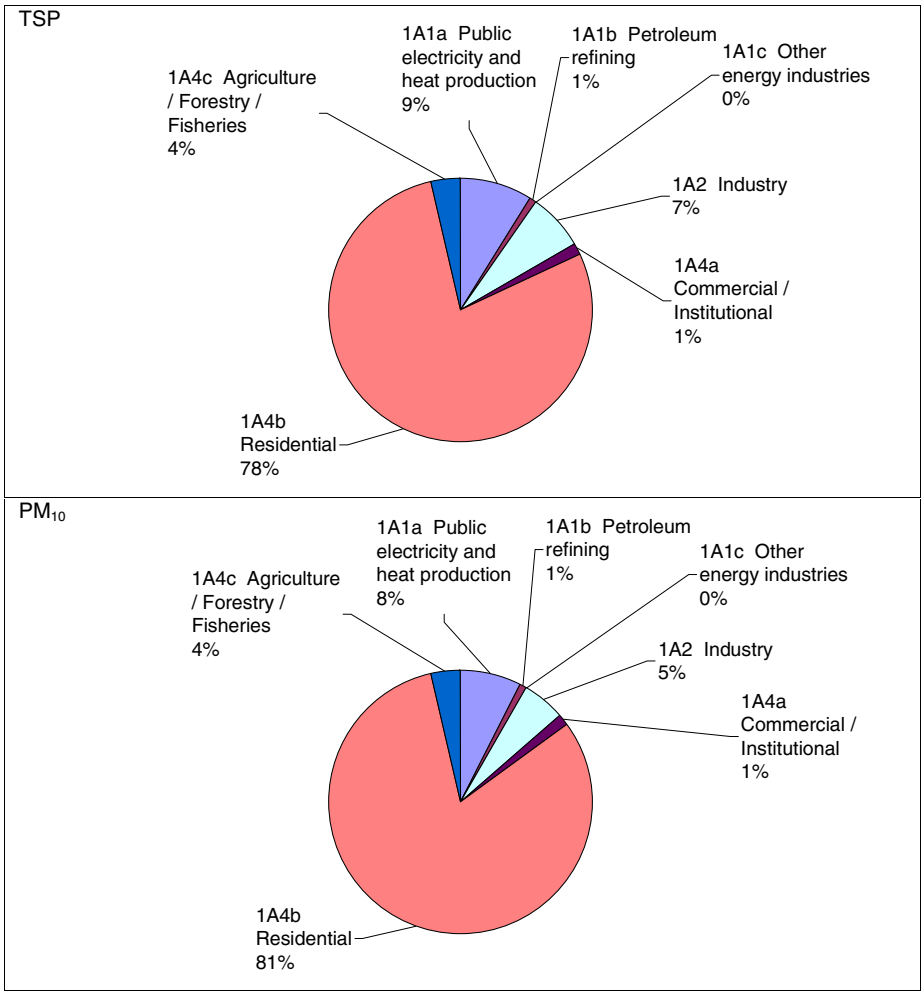
In Figure 32 the fuel consumption and the $PM_{2.5}$ emission of residential plants is shown. Wood combustion accounts for 92% of the $PM_{2.5}$ emission from residential plants in spite of the limited wood consumption share.

Emission inventories for PM have only been reported for the years 2000-2003 and the short time-series for TSP, PM_{10} and $PM_{2.5}$ emission is shown in Figure 33.

Table 27 PM emission from stationary combustion plants, 2003 [1)].

	TSP	PM_{10}	$PM_{2.5}$	
1A1a Public electricity and heat production	1301	1020	837	Mg
1A1b Petroleum refining	128	119	115	Mg
1A1c Other energy industries	3	2	1	Mg
1A2 Industry	1023	683	407	Mg
1A4a Commercial / Institutional	192	185	172	Mg
1A4b Residential	11601	11005	10417	Mg
1A4c Agriculture / Forestry / Fisheries	529	493	459	Mg
Total	**14779**	**13507**	**12409**	Mg

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



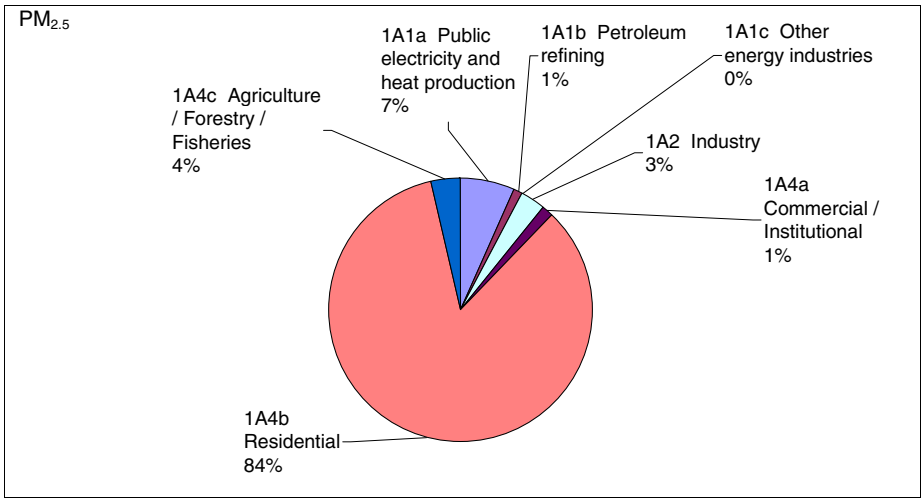


Figure 31 PM emission sources, stationary combustion plants, 2003.

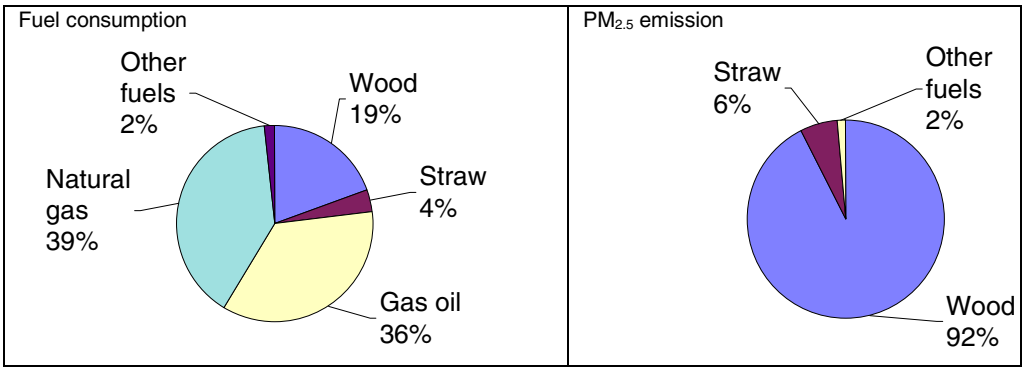


Figure 32 Fuel consumption and $PM_{2.5}$ emission from residential plants.

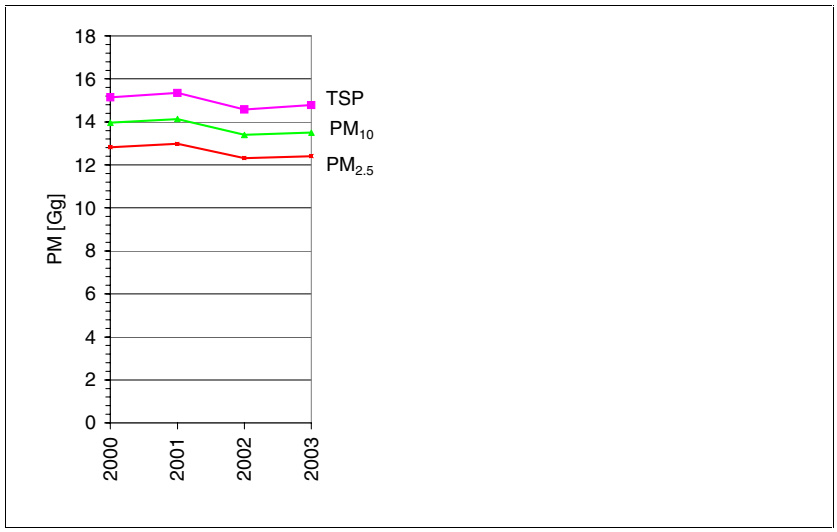


Figure 33 PM emission time-series for stationary combustion.

8 Heavy metals

Emission inventories for 9 heavy metals are reported to the LRTAP Convention. Three of the metals are considered priority metals: Pb, Cd and Hg. The 2003 emissions are presented in Table 28.

Stationary combustion plants are the most important emission sources for heavy metals. For Cu the emission share from stationary combustion plants is 11%, but for all other heavy metals the emission share is more than 70%, see Table 28.

Table 28 The emission of heavy metals in 2003, reported to the LRTAP Convention in 2004.

Pollutant	Pb Mg	Cd Mg	Hg Mg	As Mg	Cr Mg	Cu Mg	Ni Mg	Se Mg	Zn Mg
1A1 Fuel combustion, Energy industries	1,91	0,21	0,72	0,46	0,50	0,62	3,33	1,03	13,34
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion)	1,15	0,17	0,24	0,19	0,37	0,18	4,68	0,79	1,54
1A4 Fuel combustion, Other sectors (Stationary combustion)	0,33	0,15	0,27	0,07	0,11	0,22	0,82	0,17	3,03
Total emission from stationary combustion plants	**3,39**	**0,53**	**1,22**	**0,72**	**0,98**	**1,01**	**8,83**	**1,99**	**17,91**
Total Danish emission	4,66	0,58	1,24	0,76	1,23	8,80	10,57	2,11	23,27
Emission share for stationary combustion	73%	91%	99%	95%	80%	11%	84%	94%	77%

Table 29 and Figure 34 present the heavy metal emission inventory for the stationary combustion subsectors. The sectors *Electricity and heat production* and *Industry* have the highest emission shares. *Electricity and heat production* accounts for 55%, 38% and 58% of the emission of the priority metals Pb, Cd and Hg, respectively.

Table 30 presents the emission share for the two most important emission source categories: Power plants >25MW$_e$ and municipal waste incineration plants.

Table 29 Heavy metal emission from stationary combustion plants, 2003 [1)].

	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	
1A1a Public electricity and heat production	446	203	473	603	712	2743	1885	1016	13336	kg
1A1b Petroleum refining	13	12	30	12	4	582	21	11	3	kg
1A1c Other energy industries	0	0	0	0	0	0	0	0	0	kg
1A2 Industry	193	168	368	177	237	4684	1154	791	1542	kg
1A4a Commercial / Institutional	15	20	44	57	94	169	154	19	554	kg
1A4b Residential	35	111	30	140	155	52	129	130	2392	kg
1A4c Agriculture / Forestry / Fisheries	21	15	38	23	24	600	43	24	85	kg
Total	**722**	**529**	**984**	**1012**	**1225**	**8831**	**3387**	**1992**	**17912**	**kg**

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

Table 30 Heavy metal emission share for large power plants and municipal waste incineration plants, 2003.

Pollutant	Emission share of plant category	
	Municipal waste incineration, CHP and district heating	Power plants >25MW$_e$
As	30%	17%
Cd	21%	2%
Cr	14%	24%
Cu	33%	13%
Hg	27%	15%
Ni	3%	8%
Pb	38%	7%
Se	0%	49%
Zn	58%	1%

Figure 34 Heavy metal emission sources, stationary combustion plants, 2003.

Time-series for heavy metal emissions are provided in Figure 35. Heavy metal emissions have decreased considerably since 1990, see Table 31. Emissions have decreased despite increased incineration of municipal waste. This has been made possible due to installation and improved performance of gas cleaning devices in waste incineration plants and also in large power plants, the latter a further important emission source.

The estimated As emission level decreased remarkably from 1994 to 1995. Plant-specific emission data for power plants are available for all power plants from 1995 onwards and the general point source emission factor for power plants has potentially been overestimated.

Table 31 Decrease in heavy metal emission 1990-2003.

Pollutant	Decrease since 1990
As	50%
Cd	50%
Cr	84%
Cu	72%
Hg	60%
Ni	59%
Pb	78%
Se	54%
Zn	7%

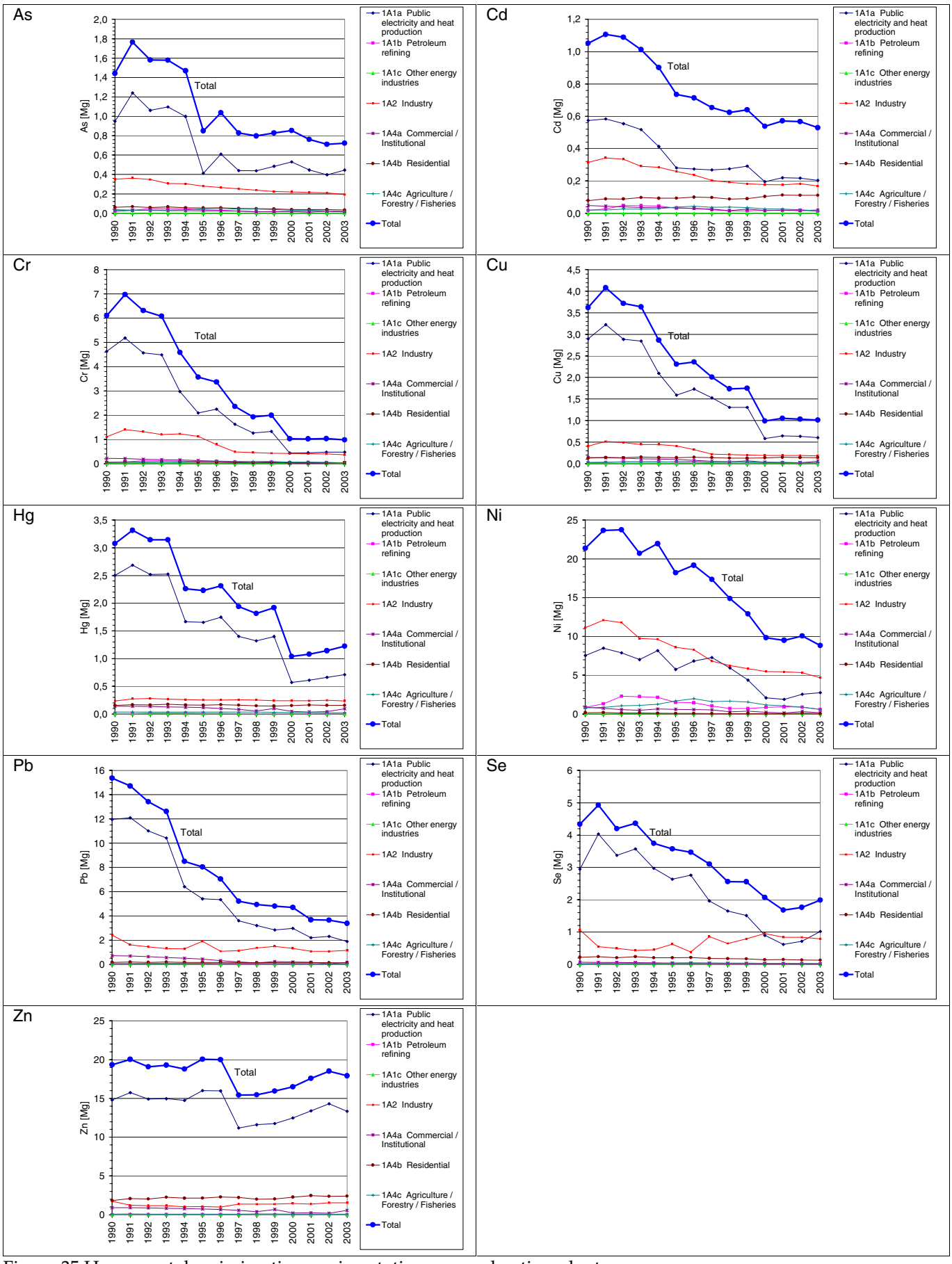


Figure 35 Heavy metal emission time-series, stationary combustion plants.

9 PAH and dioxin

Emission inventories for four PAHs and for dioxin are reported to the LRTAP Convention. Dioxin emission inventories are estimated by COWI for the Danish Environmental Protection Agency (Hansen & Hansen 2003). The emission inventories for PAH are presented in Table 32. Stationary combustion plants account for more than 90% of the PAH emissions.

Table 32 The emission for the year 2003 reported to the LRTAP Convention in 2004.

Pollutant	Benzo(a)-pyrene Mg	Benzo(b)flu o-ranthene Mg	Benzo(k)flu o-ranthene Mg	Indeno(1,2,3-c,d)pyrene Mg
1A1 Fuel combustion, Energy industries	0,01	0,03	0,01	0,01
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion)	0,03	0,09	0,02	0,01
1A4 Fuel combustion, Other sectors (Stationary combustion)	2,88	3,74	1,22	2,14
Total emission from stationary combustion plants	**2,91**	**3,87**	**1,25**	**2,15**
Total Danish emission (gross)	2,97	3,95	1,34	2,22
Emission share for stationary combustion	98%	98%	94%	97%

Table 33 and Figure 37 present the PAH emission inventory for the stationary combustion subsectors. Residential combustion is the largest emission source. Combustion of wood is the predominant source, accounting for more than 98% of the emission in residential plants, see Figure 36.

Time-series for PAH emission are presented in Figure 38. The increasing emission trend is a result of the increased combustion of wood in residential plants. The time-series for wood combustion in residential plants is also provided in Figure 38.

Table 33 PAH emission from stationary combustion plants, 2003.

	Benzo(a)-pyrene Mg	Benzo(b)-fluoranthene Mg	Benzo(k)-fluoranthene Mg	Indeno(1,2,3-c,d)pyrene Mg
1A1a Public electricity and heat production	8	32	15	8
1A1b Petroleum refining	0	0	0	0
1A1c Other energy industries	0	0	0	0
1A2 Industry	26	92	16	7
1A4a Commercial / Institutional	165	217	72	117
1A4b Residential	2574	3372	1124	1816
1A4c Agriculture / Forestry / Fisheries	140	153	27	205
Total	**2913**	**3867**	**1254**	**2154**

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

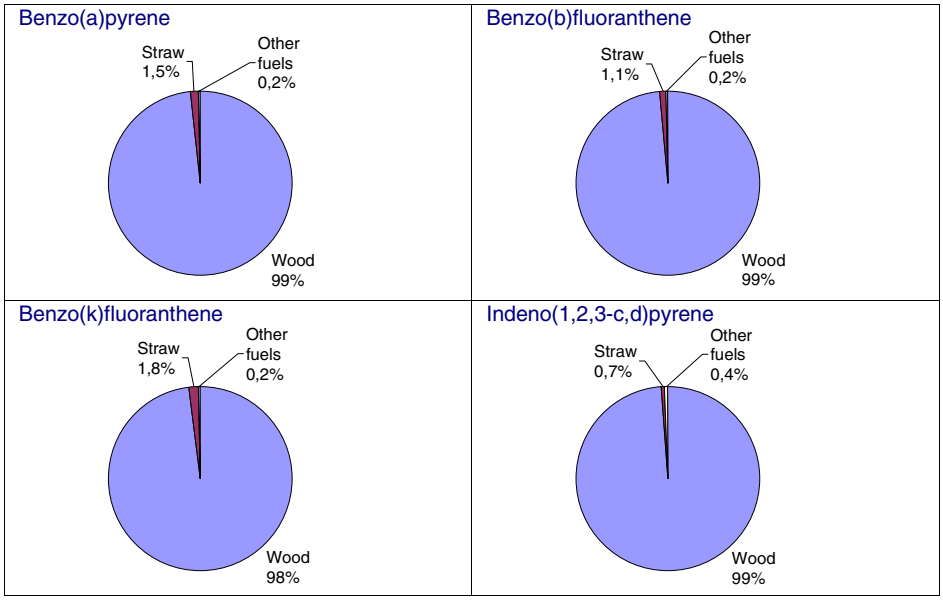


Figure 36 PAH emission from residential combustion plants (stationary), fuel origin.

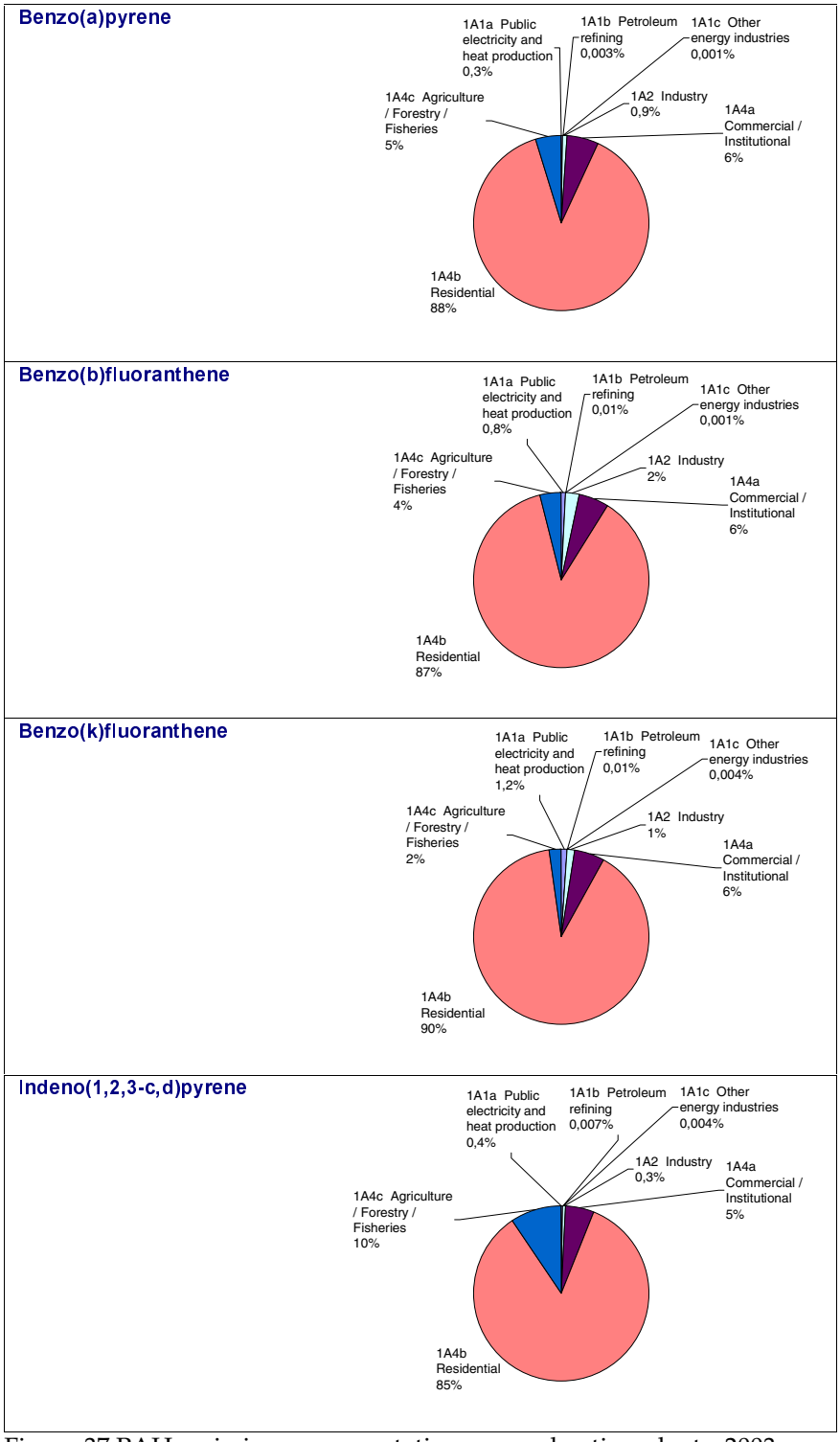


Figure 37 PAH emission sources, stationary combustion plants, 2003.

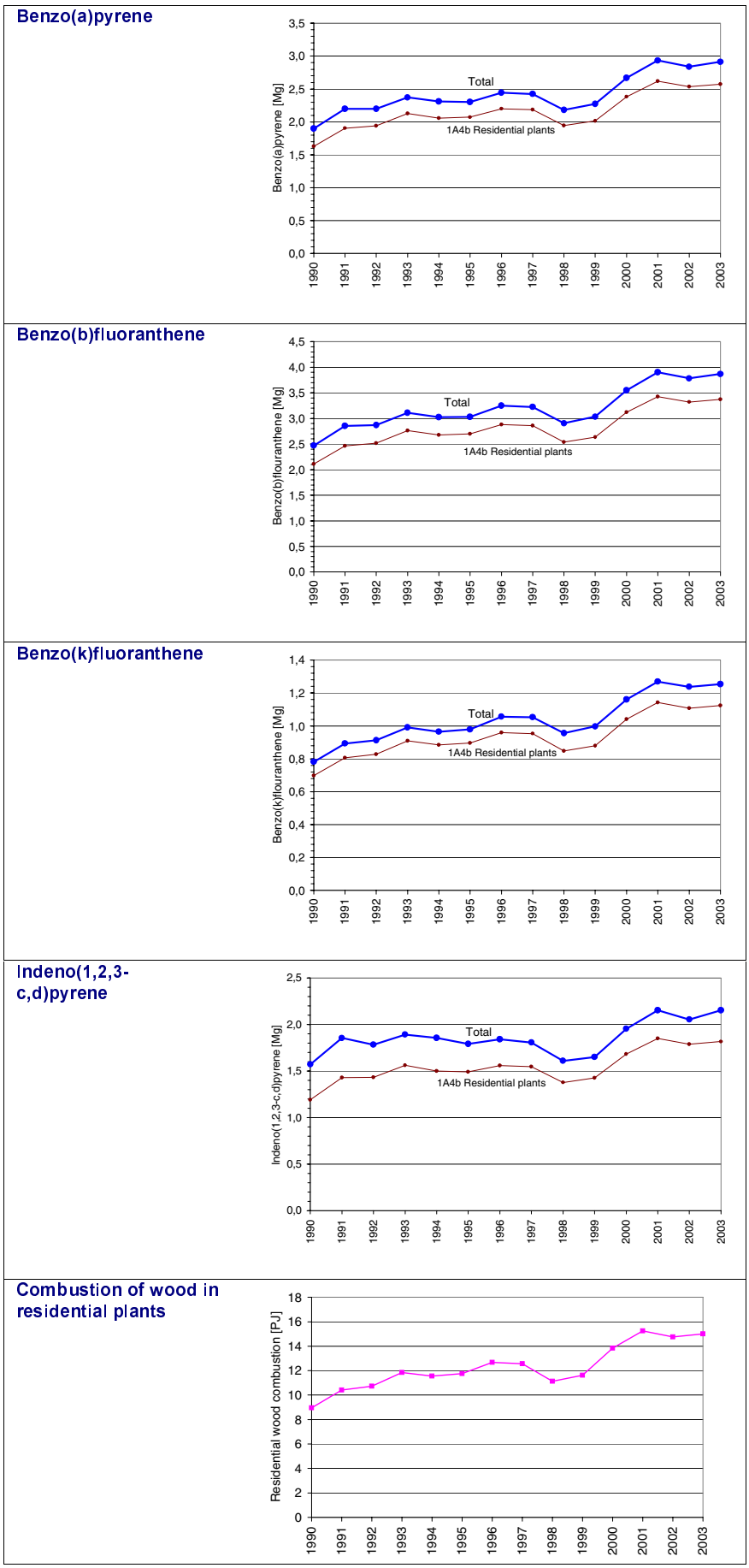


Figure 38 PAH emission time-series, stationary combustion plants. Comparison with wood consumption in residential plants.

10 QA/QC and validation

The elaboration of a formal QA/QC plan started in 2004. A first draft QA/QC plan (in Danish) for stationary combustion has been developed and this draft version is now applied as one of two sector specific QA/QC cases. Adaptation to the general QA/QC plan will be performed in 2005.

The draft QA/QC plan for stationary combustion includes:

- Documentation concerning external data sources, including contacts, contracts with data supplier, archiving and suggested QC.
- Compilation of the data for the emission database, including current QC and suggested QC
- Data input to the emission database, including information on whether the data transfer is manual or not, current QC during and after data input, suggested QC.
- Emission inventory, including current and suggested QC of the emission inventory (consistency and completeness)
- Data transfer from the emission database to the reporting formats, including current and planned QC and archiving.
- A suggestion for the future archiving structure
- A time schedule for the QC plan
- QA
- Verification

The QC is not implemented yet. This year the QC procedures applied are the same as those applied last year. The QC includes:

- 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 IPCC and LRTAP 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 IPCC reference approach validates the fuel consumption rates and CO_2 emissions of fuel combustion. Fuel consumption rates and CO_2 emissions differ by less than 1,5% (1990-2003). The reference approach is further discussed below.
- 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 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
- Most emission factor references are now incorporated in the emission database, itself.
- 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 work from companies that have implemented some QA/QC work. The two major power plant owners / operators in Denmark: E2 and Elsam both obtained the ISO 14001 certification for an environmental management system. Danish Gas Technology Centre and dk-Teknik[2] both run accredited laboratories for emission measurements.

10.1 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 1996). 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 Authority and published on their home page (DEA 2004b). 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 1996). 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 national 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. Further consumption for non-energy purposes is subtracted in the reference approach, because non-energy use of fuels is not, as yet, included in the Danish national approach.

Three fuels are used for non-energy purposes: lube oil, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 10,8 PJ in 2003.

In 2003 the fuel consumption rates in the two approaches differ by 0,28% and the CO_2 emission differs by 0,04%. In the period 1990-2003 fuel consumption differs by less than 1,5%, and the CO_2 emission by less than 1,4%. The differences are below 1% for all years except 1998. According to IPCC Good Practice Guidance (IPCC 2000) the difference should be within 2%. The reference approach for 2003 and the comparison with the Danish national approach are provided in Appendix 12. The appendix also includes a correspondence list for the fuel categories (Danish Energy Authority/IPCC reference approach).

[2] Now FORCE

A comparison of the national approach and the reference approach is illustrated in Figure 39.

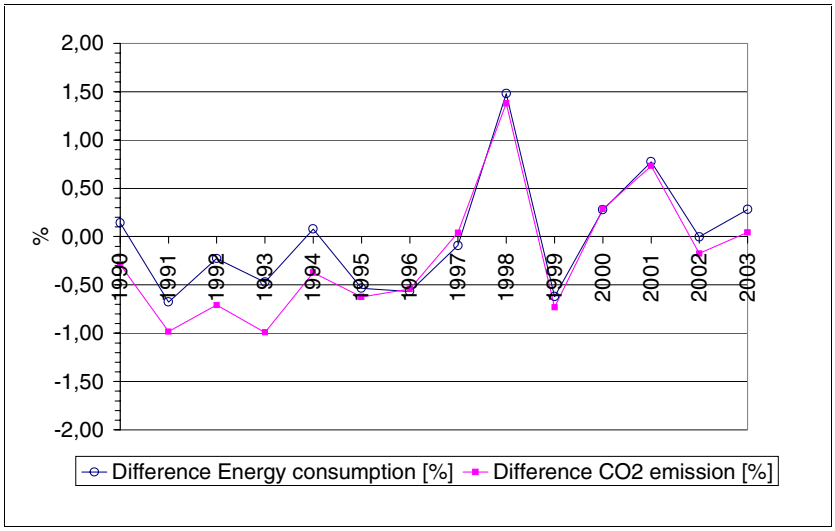


Figure 39 Comparison of the reference approach and the national approach.

10.2 External review

The first national external review of this annually updated report was performed in 2004 by Jan Erik Johnsson, Technology University of Denmark. The review was performed after the reporting in 2004 and thus the improvements of emission factors suggested by Jan Erik Johnsson have been included the inventory presented in this report.

This year the report has been reviewed by Mr. Bo Sander. Again the review was performed after the reporting of data to the Climate Convention and the LRTAP Convention and thus suggested data improvements will be included in the inventory reported in 2006.

10.3 Key source analysis

As part of the reportings for the Climate Convention a key source analysis for the Danish emission inventory has been performed. A key source has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level of emission, the trend in emissions, or both.

Stationary combustion key sources for greenhouse gases are shown in Table 33b. The CO_2 emissions from eight different fuels are key sources in the Danish inventory. Further CH_4 emission is a trend key source due to the increased electricity production based on gas engines.

The key source analysis will be considered in the future QC for stationary combustion.

Table 33b Key sources, stationary combustion

Source		Pollutant	Key source	Level or trend
CO_2 Emission from stationary Combustion	Coal	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Petroleum coke	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Plastic waste	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Residual oil	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Gas oil	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Kerosene	CO_2	Yes	Trend
CO_2 Emission from stationary Combustion	Natural gas	CO_2	Yes	Level, Trend
CO_2 Emission from stationary Combustion	Refinery gas	CO_2	Yes	Level
Non-CO_2 Emission from stationary Combustion		CH_4	Yes	Trend

11 Uncertainty

According to the IPCC Good Practice Guidance (IPCC 2000) uncertainty estimates should be included in the annual National Inventory Report. Likewise, uncertainty estimates for the LRTAP Convention inventories are included in the report for these inventories.

Uncertainty estimates include uncertainty with regard to the total emission inventory as well as uncertainty with regard to trends. The GHG emission from stationary combustion plants has been estimated with an uncertainty interval of ±11% and the increase in the GHG emission since 1990 has been estimated to be 11,1% ± 1,7 %-age-points.

11.1 Methodology

The Danish uncertainty estimates for GHGs are based on a methodology included in IPCC Good Practice Guidance (IPCC 2000). The estimates are based on uncertainties for emission factors and fuel consumption rates, respectively. The input data required for the uncertainty calculations are:

- Emission data for the base year and the last year
- Uncertainty for activity rates
- Uncertainty for emission factors

11.1.1 Greenhouse gases

The Danish uncertainty estimates for GHGs are based on the tier 1 approach in IPCC Good Practice Guidance (IPCC 2000). The uncertainty levels have been estimated for the following emission source subcategories within stationary combustion:

- CO_2 emission from each of the applied fuel categories
- CH_4 emission from gas engines
- CH_4 emission from all other stationary combustion plants
- N_2O emission from all stationary combustion plants

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.

Most of the applied uncertainty estimates for activity rates and emission factors are default values from the IPCC Reference Manual. A few of the uncertainty estimates are, however, based on national estimates.

Table 34 Uncertainty rates for activity rates and emission factors.

IPCC Source category	Gas	Activity data uncertainty %	Emission factor uncertainty %
Stationary Combustion, Coal	CO_2	1 [1)]	5 [3)]
Stationary Combustion, BKB	CO_2	3 [1)]	5 [1)]
Stationary Combustion, Coke oven coke	CO_2	3 [1)]	5 [1)]
Stationary Combustion, Petroleum coke	CO_2	3 [1)]	5 [1)]
Stationary Combustion, Plastic waste	CO_2	5 [4)]	5 [4)]
Stationary Combustion, Residual oil	CO_2	2 [1)]	2 [3)]
Stationary Combustion, Gas oil	CO_2	4 [1)]	5 [1)]
Stationary Combustion, Kerosene	CO_2	4 [1)]	5 [1)]
Stationary Combustion, Orimulsion	CO_2	1 [1)]	2 [3)]
Stationary Combustion, Natural gas	CO_2	3 [1)]	1 [3)]
Stationary Combustion, LPG	CO_2	4 [1)]	5 [1)]
Stationary Combustion, Refinery gas	CO_2	3 [1)]	5 [1)]
Stationary combustion plants, gas engines	CH_4	2,2 [1)]	40 [2)]
Stationary combustion plants, other	CH_4	2,2 [1)]	100 [1)]
Stationary combustion plants	N_2O	2,2 [1)]	1000 [1)]

1) IPCC Good Practice Guidance (default value)
2) Kristensen (2003)
3) Jensen & Lindroth (2003)
4) NERI assumption

11.1.2 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 2003 as well as on uncertainties for fuel consumption and emission factors for each of the main SNAP sectors. For particulate matter 2000 is considered to be the base year, but for all other pollutants the base year is 1990. The applied uncertainties for activity rates and emission factors are default values referring to Pulles & Aardenne 2003. The uncertainty for PM is, however, estimated by NERI. 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 35. The uncertainty for fuel consumption in stationary combustion plants was assumed to be 2%.

Table 35 Uncertainty rates for emission factors [%].

SNAP sector	SO_2	NO_X	NMVOC	CO	PM	HM	PAH
01	10	20	50	20	50	100	100
02	20	50	50	50	500	1000	1000
03	10	20	50	20	50	100	100

11.2 Results

The uncertainty estimates for stationary combustion emission inventories are shown in Table 36. Detailed calculation sheets are provided in Appendix 9.

The uncertainty interval for GHG is estimated to be ±11% and the uncertainty for the trend in GHG emission is ±1,7%-age points. The main sources of uncertainty for GHG emission are N_2O emission (all plants) and CO_2 emission from coal combustion. The main source of uncertainty in the trend in GHG emission is CO_2 emission from the combustion of coal and natural gas.

The total emission uncertainty is 7% for SO_2, 16% for NO_X, 38% for NMVOC and 43% for CO. For PM, heavy metals and PAH the uncertainty estimate is greater than 100%.

Table 36 Danish uncertainty estimates, 2003.

Pollutant	Uncertainty Total emission	Trend 1990-2003	Uncertainty Trend
	[%]	[%]	[%-age points]
GHG	10,8	+11,1	± 1,7
CO_2	2,9	+10,1	± 1,7
CH_4	39	+330	± 320
N_2O	1000	+10,7	± 3,4
SO_2	7	-82,9	±0,5
NO_X	16	-26	±2
NMVOC	38	46	±15
CO	43	6,4	±4,1
TSP [1)]	417	-2,4	±7,3
PM_{10} [1)]	432	-3,3	±4,4
$PM_{2.5}$ [1)]	445	-3,2	±4,6
As	120	-50	±5
Cd	281	-50	±70
Cr	131	-84	±11
Cu	226	-72	±38
Hg	231	-60	±47
Ni	114	-59	±3
Pb	117	-78	±10
Se	109	-54	±13
Zn	185	-7	±22
Benzo(b)fluoranthene	968	57	±4
Benzo(k)fluoranthene	976	60	±29
Benzo(a)pyrene	988	53	±5
Indeno(1,2,3-c,d)	993	37	±9

1. The base year for PM is year 2000

12 Geographical distribution of the emissions

Geographical distribution of emissions has been reported to the LRTAP Convention for the years 1990, 1995 and 2000 (Illerup et al. 2003). The emissions are disaggregated to a grid of 50x50 km^2. Gridded data are reported for SO_2, NO_X, NMVOC, CO, PM, heavy metals and PAH. The assumptions and methodology will not be discussed here, but gridded emission data for SO_2 from stationary combustion plants are illustrated in Figure 40. The gridded emission data are available on the EU EIONET (European Environment Information and Observation Network) homepage, which can be linked from the NERI home page, www.dmu.dk.

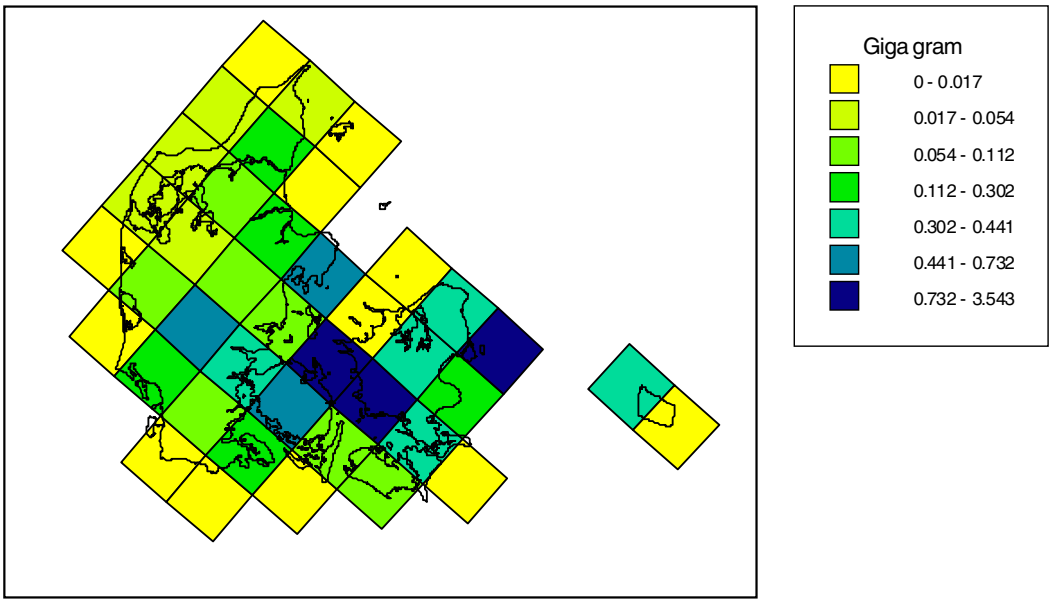


Figure 40 Gridded SO_2 emission from stationary combustion, 2000 (Hansen & Illerup 2003).

13 Improvements/recalculations since reporting in 2004

Improvements and recalculations since the 2004 emission inventory include:

- Update of fuel rates according to the latest energy statistics. The update included the years 1980-2002.

- Disaggregation of fuel consumption and emissions to industrial subsectors. In addition to fuel consumption the following pollutants have been disaggregated: CO_2, CH_4, N_2O, SO_2, NO_X, NMVOC and CO. The disaggregation itself does not change the reported totals. Disaggregation of the remaining pollutants is planned next year.

- A contract between NERI and the Danish Energy Authority specifying the content of the data supply for the emission inventory and deadlines has been signed. This contract also specifies that NERI will get access to the plant specific CO_2 data that will be collected by DEA from 2006.

- Brown coal and coke oven coke are not included in fuel category coal as in the former inventories.

- Improved emission factors for fish & rape oil have been estimated.

- As a result of the first national external review a few emission factors have been improved. These changes do not change the estimated total emissions considerably.

- The PM emission factors for residential plants have been changed as a result of a Nordic project focussing on these factors.

Furthermore, a few minor errors for large point sources have been corrected. These corrections do not affect greenhouse gases.

14 Future improvements

Some planned improvements of the emission inventories are discussed below.

1) Improved documentation for CO_2 emission factors

The CO_2 emission factors applied for the Danish inventories are considered accurate, but documentation will be improved in future inventories. The documentation will be improved when the large plants start reporting CO_2 emission based on plant specific CO_2 emission factors (2006).

2) Improved documentation for other emission factors

Reporting of and references for the applied emission factors have been improved in the current year and will be further developed in future inventories.

3) QA/QC and validation

The QA/QC and validation of the inventories for stationary combustion will be implemented as part of the work that has been initiated for the Danish inventory as a whole. Implementation will start in 2005.

4) Uncertainty estimates

Uncertainty estimates are based mainly on default uncertainty levels for activity rates and emission factors. More country-specific uncertainty estimates will be incorporated in future inventories.

The uncertainty of the N_2O emission factor from stationary combustion plants is a default value from the IPCC GPG. This uncertainty is a major uncertainty in the total Danish GHG inventory. Several of the applied N_2O emission factors are, however, based on emission measurements on a considerable number of Danish plants, and thus the uncertainty is considered overestimated. A country specific uncertainty estimate for N_2O will be estimated next year.

5) Other improvements

- The criteria for including a plant as a point source should be defined and the list of plants updated annually.
- HM emission factors should be compared to new Danish legislation and updated if relevant.
- White spirit will be dislocated to the fuel category Other oil in the IPCC reference approach.

15 Conclusion

The annual Danish emission inventories are prepared and reported by NERI. The inventories are based on the Danish energy statistics and on a set of emission factors for various sectors, technologies and fuels. Plant-specific emissions for large combustion sources are incorporated in the inventories.

Since 1990 fuel consumption has increased by 25% - fossil fuel consumption, however, by only 18%. The use of coal has decreased whereas the use of natural gas and renewable fuels has increased. The Danish fuel consumption fluctuates due to variation in the import/export of electricity from year to year.

Stationary combustion plants account for more than 50% of the total Danish emission for the following pollutants: SO_2, CO_2, heavy metals (except Cu), $PM_{2.5}$ and PAH. Furthermore, the emission from stationary combustion plants accounts for more than 10% of the total Danish emission for the following pollutants: NO_X, CO, NMVOC, TSP, PM_{10} and Cu. Stationary combustion plants account for less than 10% of the total Danish CH_4 and N_2O emission.

Public power plants are the most important stationary combustion emission source for SO_2, CO_2, NO_X and heavy metals.

Lean-burn gas engines installed in decentralised CHP plants are the largest stationary combustion emission source for CH_4. Furthermore, these plants are also a considerable emission source for NMVOC.

Residential plants represent the most important stationary combustion source for CO, NMVOC, particulate matter and PAH. Wood combustion in residential plants is the predominant emission source.

The greenhouse gas emission (GHG) development follows the CO_2 emission development closely. Both the CO_2 and the total GHG emission were higher in 2003 than in 1990: CO_2 by 10% and GHG by 11%. However fluctuations in the GHG emission level are great. The fluctuations in the time-series are a result of electricity import/export and of outdoor temperature variations from year to year.

The CH_4 emission from stationary combustion has increased by a factor of 4,3 since 1990. This is a result of the considerable number of lean-burn gas engines installed in CHP plants in Denmark during this period.

SO_2 emission from stationary combustion plants has decreased by 94% from 1980 and by 78% from 1995. The considerable emission decrease is mainly a result of the reduced emission from electricity and heat production due to installation of desulphurisation technology and the use of fuels with lower sulphur content.

The NO_X emission from stationary combustion plants has decreased by 43% since 1985 and 23% since 1995. The reduced emission is mainly a result of the reduced emission from electricity and heat pro-

duction. The fluctuations in the emission time-series follow fluctuations in electricity import/export.

Wood consumption in residential plants has increased by 68% from 1990 to 2003 leading to an increased CO emission. The increase in CO emission from residential plants is less than the increase in wood consumption, because CO emission from straw-fired farmhouse boilers has decreased considerably.

The NMVOC emission from stationary combustion plants has increased by 43% from 1985 and 15% from 1995. The increased NMVOC emission is mainly a result of the increased use of lean-burn gas engines. The emission from residential plants is relatively constant, but the emission from wood combustion increased considerably and the emission from straw combustion decreased.

All the heavy metal emissions decreased considerably since 1990 – between 7% and 84%. This is a result of the installation and improved performance of gas cleaning devices in municipal waste incineration plants and large power plants.

The PAH emission has increased since 1990 due to the increased consumption of wood in residential plants.

The uncertainty level of the Danish greenhouse gas emission from stationary combustion is estimated to be within a range of ±11% and the trend uncertainty within a range of ±1,7%-age points. The sources contributing the most to the uncertainty estimates are the N_2O emission (all plants) and the CO_2 emission from coal combustion.

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Appendix

Appendix 1: The Danish emission inventory for the year 2003 reported to the Climate Convention in 2004

Appendix 2: Emission inventory for the year 2003 reported to the LRTAP Convention in 2004

Appendix 3: IPCC/SNAP source correspondence list

Appendix 4: Emission factors, references

Appendix 5: Fuel rate

Appendix 6: Emission factors

Appendix 7: Implied emission factors for power plants and municipal waste incineration plants

Appendix 8: Large point sources

Appendix 9: Uncertainty estimates

Appendix 10: Lower Calorific Value (LCV) of fuels

Appendix 11: Adjustment of CO_2 emission

Appendix 12: Reference approach

Appendix 13: Emission inventory 2003 based on SNAP sectors

Appendix 1 The Danish emission inventory for the year 2003 reported to the Climate Convention

Table 37 The Danish emission inventory for the year 2003 reported to the Climate Convention in 2005 (Illerup et al. 2005a).

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**58.124,39**	**5.873,26**	**8.059,69**	**695,48**	**19,34**	**31,37**	**72.803,53**
1. Energy	**57.634,90**	**770,94**	**911,89**				**59.317,73**
A. Fuel Combustion (Sectoral Approach)	57.085,08	594,27	908,91				58.588,26
1. Energy Industries	31.401,90	329,84	327,56				32.059,30
2. Manufacturing Industries and Construction	5.404,21	34,02	55,80				5.494,03
3. Transport	12.785,27	65,09	428,94				13.279,30
4. Other Sectors	7.401,72	165,23	95,16				7.662,12
5. Other	91,98	0,09	1,45				93,52
B. Fugitive Emissions from Fuels	549,82	176,67	2,98				729,46
1. Solid Fuels	0,00	93,10	0,00				93,10
2. Oil and Natural Gas	549,82	83,57	2,98				636,36
2. Industrial Processes	**1.488,18**	**0,00**	**894,66**	**695,48**	**19,34**	**31,37**	**3.129,04**
A. Mineral Products	1.485,51	0,00	0,00				1.485,51
B. Chemical Industry	2,67	0,00	894,66	0,00	0,00	0,00	897,33
C. Metal Production	0,00	0,00	0,00		0,00	0,00	0,00
D. Other Production	NE						0,00
E. Production of Halocarbons and SF_6				0,00	0,00	0,00	0,00
F. Consumption of Halocarbons and SF_6				695,48	19,34	31,37	746,19
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**205,59**		**0,00**				**205,59**
4. Agriculture	**0,00**	**3.705,53**	**6.192,47**				**9.898,00**
A. Enteric Fermentation		2.733,61					2.733,61
B. Manure Management		971,93	560,31				1.532,24
C. Rice Cultivation		0,00					0,00
D. Agricultural Soils [2]		0,00	5.632,16				5.632,16
E. Prescribed Burning of Savannas		0,00	0,00				0,00
F. Field Burning of Agricultural Residues		0,00	0,00				0,00
G. Other		0,00	0,00				0,00
5. Land-Use Change and Forestry [1]	**-1.204,28**	**0,00**	**0,00**				**-1.204,28**
6. Waste	**0,00**	**1.396,79**	**60,67**				1.457,46
A. Solid Waste Disposal on Land	0,00	1.152,81					1.152,81
B. Wastewater Handling		243,97	60,67				304,65
C. Waste Incineration	0,00	0,00	0,00				0,00
D. Other	0,00	0,00	0,00				0,00
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
							0,00
Memo Items:							
International Bunkers	**5.317,55**	**2,38**	**84,92**				**5.404,85**
Aviation	2.187,52	0,89	23,63				2.212,04
Marine	3.130,03	1,49	61,28				3.192,81
Multilateral Operations	**0,00**	**0,00**	**0,00**				**0,00**
CO_2 Emissions from Biomass	**9.107,71**						**9.107,71**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0,00	-3.533,00	-3.533,00			-3.533,00
B. Forest and Grassland Conversion	0,00		0,00	0,00	0,00	0,00
C. Abandonment of Managed Lands	0,00	0,00	0,00			0,00
D. CO_2 Emissions and Removals from Soil	2.477,81	-149,09	2.328,72			2.328,72
E. Other	0,00	0,00	0,00	0,00	0,00	0,00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	2.477,81	-3.682,09	-1.204,28	0,00	0,00	-1.204,28

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	74.007,81
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	72.803,53

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

Appendix 2 Emission inventory for the year 2003 reported to the LRTAP Convention in 2004

Table 38 Emission inventory for the year 2003 reported to the LRTAP in 2005 (a) (Illerup et al. 2005b).

	NOx	CO	NMVOC	SOx	TSP	PM10	PM2.5
	Gg NO2	Gg	Gg	Gg SO2	Mg	Mg	Mg
1 A 1 a Public Electricity and Heat Production	56,25	12,20	4,22	16,96	1301,37	1020,33	837,02
1 A 1 b Petroleum refining	1,65	0,24	0,00	0,49	128,14	119,07	114,54
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	6,61	0,18	0,04	0,01	2,75	1,65	1,38
1 A 2 Manufacturing Industries and Construction	15,18	13,84	3,64	4,71	1313,35	1109,23	990,08
1 A 2 a Iron and Steel	IE	IE	IE	IE	174,60	52,38	7,86
1 A 2 b Non-ferrous Metals	IE	IE	IE	IE	25,82	23,25	10,71
1 A 2 c Chemicals	IE	IE	IE	IE	IE	IE	IE
1 A 2 d Pulp, Paper and Print	IE	IE	IE	IE	IE	IE	IE
1 A 2 e Food Processing, Beverages and Tobacco	IE	IE	IE	IE	IE	IE	IE
1 A 2 f Other (Please specify in a covering note)	8,89	9,25	0,09	1,35	435,46	379,00	236,75
1 A 3 a ii Civil Aviation (Domestic, LTO)	0,18	0,60	0,10	0,00	1,24	1,24	1,24
1 A 3 a ii Civil Aviation (Domestic, Cruise)	0,40	0,12	0,02	0,00	1,65	1,65	1,65
1 A 3 b Road Transportation	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 b i R.T., Passenger cars	29,91	238,54	18,26	0,21	709,98	709,98	709,98
1 A 3 b ii R.T., Light duty vehicles	10,45	15,63	1,88	0,07	1551,32	1551,32	1551,32
1 A 3 b iii R.T., Heavy duty vehicles	24,42	6,29	2,80	0,10	1157,03	1157,03	1157,03
1 A 3 b iv R.T., Mopeds & Motorcycles	0,12	14,01	2,75	0,00	45,45	45,45	45,45
1 A 3 b v R.T., Gasoline evaporation	NA	NA	6,16	NA	NA	NA	NA
1 A 3 b vi R.T., Automobile tyre and brake wear	NA	NA	NA	NA	1310,43	981,85	534,94
1 A 3 b vii R.T., Automobile road abrasion	NA	NA	NA	NA	925,16	462,58	249,79
1 A 3 c Railways	3,54	0,61	0,22	0,01	118,60	118,60	118,60
1 A 3 d ii National Navigation	8,84	20,04	11,38	1,86	587,59	559,38	532,57
1 A 3 e Other (Please specify in a covering note)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 A 3 e i Pipeline compressors	IE	IE	IE	IE	IE	IE	IE
1 A 3 e ii Other mobile sources and machinery	NO	NO	NO	NO	NO	NO	NO
1 A 4 a Commercial / Institutional	1,24	0,94	0,75	0,36	192,18	185,23	172,16
1 A 4 b Residential	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 b i Residential plants	4,86	149,24	11,11	1,74	11601,15	11004,63	10416,91
1 A 4 b ii Household and gardening (mobile)	0,24	47,60	4,16	0,00	25,97	25,97	25,97
1 A 4 c Agriculture / Forestry / Fishing	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 A 4 c i Stationary	1,54	8,60	1,63	1,51	529,47	492,81	459,36
1 A 4 c ii Off-road Vehicles and Other Machinery	19,63	20,77	4,46	0,38	2012,45	1912,46	1818,47
1A 4 c iii National Fishing	11,39	1,48	0,47	0,86	367,28	348,93	331,50
1 A 5 a Other, Stationary (including Military)	NO	NO	NO	NO	NO	NO	NO
1 A 5 b Other, Mobile (Including military)	0,45	0,31	0,06	0,00	24,87	24,87	24,87
1B1 Fugitive Emissions from Solid Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 B 1 a Coal Mining and Handling	NA	31,78	NA	NA	1404,12	561,65	56,16
1 B 1 b Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO
1 B 1 c Other (Please specify in a covering note)	NO	NO	NO	NO	NO	NO	NO
1 B 2 Oil and natural gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 B 2 a Oil	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 B 2 a i Exploration Production, Transport	NA	NA	10,06	IE	NA	NA	NA
1 B 2 a iv Refining / Storage	NA	NA	3,71	0,25	NA	NA	NA
1 B 2 a v Distribution of oil products	NA	NA	1,04	NA	NA	NA	NA
1 B 2 a vi Other	NO	NO	NO	NO	NO	NO	NO
1 B 2 b Natural gas	NA	NA	0,06	NA	NA	NA	NA
1 B 2 c Venting and flaring	2,83	0,24	0,03	0,10	2,18	2,18	2,18
2 A MINERAL PRODUCTS (b)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2 A 1 Cement Production	IE	IE	IE	IE	IE	IE	IE
2 A 2 Lime Production	IE	IE	IE	IE	IE	IE	IE
2 A 3 Limestone and Dolomite Use	IE	IE	IE	IE	IE	IE	IE
2 A 4 Soda Ash Production and use	IE	IE	IE	IE	IE	IE	IE
2 A 5 Asphalt Roofing	NE	NE	NE	NE	NE	NE	NE
2 A 6 Road Paving with Asphalt	NE	NE	NE	NE	NE	NE	NE
2 A 7 Other including Non Fuel Mining & Construction (Please specify in a covering note)	NE	NE	0,02	NE	0,00	0,00	0,00
2 B CHEMICAL INDUSTRY	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2 B 1 Ammonia Production	NO	NO	NO	NO	NO	NO	NO
2 B 2 Nitric Acid Production	0,46	NE	NE	NE	323,00	258,00	194,00
2 B 3 Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO
2 B 4 Carbide Production	NO	NO	NO	NO	NO	NO	NO
2 B 5 Other (Please specify in a covering note)	0,02	NE	0,03	NE	NE	NE	NE
2 C METAL PRODUCTION	NA	NE	NE	NA	NE	NE	NE
2 D OTHER PRODUCTION (b)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2 D 1 Pulp and Paper	NE	NE	NE	NE	NE	NE	NE
2 D 2 Food and Drink	NE	NE	0,52	NE	NE	NE	NE
2 G OTHER (Please specify in a covering note)	NO	NO	NO	NO	NO	NO	NO
3 A PAINT APPLICATION	NA	NA	41,36	NA	NA	NA	NA
3 B DEGREASING AND DRY CLEANING	NA	NA	8,50	NA	NA	NA	NA
3 C CHEMICAL PRODUCTS, MANUFACTURE AND PROCESSING	NA	NA	1,21	NA	NA	NA	NA
3 D OTHER including products containing HMs and POPs (Please specify in a covering note)	NA	NA	16,10	NA	NA	NA	NA

4 B MANURE MANAGEMENT (c)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4 B 1 Cattle	IE	IE	IE	IE	IE	IE	IE
4 B 1 a Dairy	NA	NA	NA	NA	574,34	258,44	57,46
4 B 1 b Non-Dairy	NA	NA	NA	NA	1087,30	489,26	108,78
4 B 2 Buffalo	NO	NO	NO	NO	NO	NO	NO
4 B 3 Sheep	NA	NA	NA	NA	NE	NE	NE
4 B 4 Goats	NA	NA	NA	NA	NE	NE	NE
4 B 5 Camels and Llamas	NO	NO	NO	NO	NO	NO	NO
4 B 6 Horses	NA	NA	NA	NA	NE	NE	NE
4 B 7 Mules and Asses	NO	NO	NO	NO	NO	NO	NO
4 B 8 Swine	NA	NA	NA	NA	12591,55	5666,46	1258,64
4 B 9 Poultry	NA	NA	NA	NA	2159,02	971,84	215,72
4 B 13 Other	NA	NA	NA	NA	NE	NE	NE
4 C RICE CULTIVATION	NO	NO	NO	NO	NO	NO	NO
4 D AGRICULTURAL SOILS	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4 D 1 Direct Soil Emission	NA	NA	1,64	NA	NE	NE	NE
4 F FIELD BURNING OF AGRICULTURAL WASTES	NA	NA	NA	NA	NA	NA	NA
4 G OTHER (d)	NO	NO	NO	NO	NO	NO	NO
5 B FOREST AND GRASSLAND CONVERSION	NO	NO	NO	NO	NO	NO	NO
6 A SOLID WASTE DISPOSAL ON LAND	NA	NA	NE	NA	NA	NA	NA
6 B WASTE-WATER HANDLING	NA	NA	NE	NA	NA	NA	NA
6 C WASTE INCINERATION (e)	NO	NO	NO	NO	NO	NO	NO
6 D OTHER WASTE (f)	0,00	0,00	0,00	0,00	0,05	0,05	0,05
7 OTHER	NO	NO	NO	NO	NO	NO	NO
National Total	**209**	**593**	**158**	**31**	**42685**	**30497**	**22243**
Memo Items							
International Aviation (LTO)	0,93	0,63	0,11	0,01	3,34	3,34	3,34
International Aviation (Cruise)	8,35	1,06	0,30	0,06	31,96	31,96	31,96
International Navigation	85,76	7,29	2,29	44,11	4976,36	4727,55	4491,17
5 E Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00
X (11 08 Volcanoes)	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 38 Emission inventory for the year 2003 reported to the LRTAP in 2005 (b) (Illerup et al. 2005b).

	Pb Mg	Cd Mg	Hg Mg	As Mg	Cr Mg	Cu Mg	Ni Mg	Se Mg	Zn Mg
1 A 1 a Public Electricity and Heat Production	1,89	0,20	0,71	0,45	0,47	0,60	2,74	1,02	13,34
1 A 1 b Petroleum refining	0,02	0,01	0,00	0,01	0,03	0,01	0,58	0,01	0,00
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 A 2 Manufacturing Industries and Construction	0,22	0,14	0,08	0,11	0,26	0,50	4,53	0,10	1,15
1 A 2 a Iron and Steel	0,63	0,01	NE	0,03	0,10	NE	0,11	0,44	0,44
1 A 2 b Non-ferrous Metals	0,01	0,00	NE	NE	NE	0,00	NE	NE	-
1 A 2 c Chemicals	IE	IE	IE	IE	IE	IE	IE	IE	IE
1 A 2 d Pulp, Paper and Print	IE	IE	IE	IE	IE	IE	IE	IE	IE
1 A 2 e Food Processing, Beverages and Tobacco	IE	IE	IE	IE	IE	IE	IE	IE	IE
1 A 2 f Other (Please specify in a covering note)	0,30	0,02	0,15	0,05	0,03	0,03	0,05	0,25	0,16
1 A 3 a ii Civil Aviation (Domestic, LTO)	1,03	0,00	NE	NE	0,00	0,02	0,00	0,00	0,01
1 A 3 a ii Civil Aviation (Domestic, Cruise)	-	0,00	-	-	0,00	0,06	0,00	0,00	0,03
1 A 3 b Road Transportation	-	-	-	-	-	-	-	-	-
1 A 3 b i R.T., Passenger cars	0,05	0,02	NE	NE	0,10	3,55	0,15	0,02	2,09
1 A 3 b ii R.T., Light duty vehicles	0,00	0,01	NE	NE	0,03	1,13	0,05	0,01	0,66
1 A 3 b iii R.T., Heavy duty vehicles	0,00	0,01	NE	NE	0,05	1,63	0,07	0,01	0,96
1 A 3 b iv R.T., Mopeds & Motorcycles	0,00	0,00	NE	NE	0,00	0,04	0,00	0,00	0,02
1 A 3 b v R.T., Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 A 3 b vi R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 A 3 b vii R.T., Automobile road abrasion	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 A 3 c Railways	-	0,00	-	-	0,00	0,12	0,00	0,00	0,07
1 A 3 d ii National Navigation	0,02	0,00	0,01	0,03	0,01	0,10	1,35	0,04	0,13
1 A 3 e Other (Please specify in a covering note)	-	-	-	-	-	-	-	-	-
1 A 3 e i Pipeline compressors	IE	IE	IE	IE	IE	IE	IE	IE	IE
1 A 3 e ii Other mobile sources and machinery	NO	NO	NO	NO	NO	NO	NO	NO	NO
1 A 4 a Commercial / Institutional	0,15	0,02	0,09	0,02	0,04	0,06	0,17	0,02	0,55
1 A 4 b Residential	-	-	-	-	-	-	-	-	-
1 A 4 b i Residential plants	0,13	0,11	0,16	0,03	0,03	0,14	0,05	0,13	2,39
1 A 4 b ii Household and gardening (mobile)	0,00	0,00	NE	NE	0,00	0,04	0,00	0,00	0,03
1 A 4 c Agriculture / Forestry / Fishing	-	-	-	-	-	-	-	-	-
1 A 4 c i Stationary	0,04	0,02	0,02	0,02	0,04	0,02	0,60	0,02	0,09
1 A 4 c ii Off-road Vehicles and Other Machinery	0,00	0,00	NE	-	0,02	0,66	0,03	0,00	0,39
1A 4 c iii National Fishing	0,02	0,00	0,01	0,01	0,01	0,01	0,08	0,04	0,10
1 A 5 a Other, Stationary (including Military)	NO	NO	NO	NO	NO	NO	NO	NO	NO
1 A 5 b Other, Mobile (Including military)	0,08	0,00	-	-	0,00	0,05	0,00	0,00	0,03
1B1 Fugitive Emissions from Solid Fuels	-	-	-	-	-	-	-	-	-
1 B 1 a Coal Mining and Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 B 1 b Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO	NO	NO
1 B 1 c Other (Please specify in a covering note)	NO	NO	NO	NO	NO	NO	NO	NO	NO
1 B 2 Oil and natural gas	-	-	-	-	-	-	-	-	-
1 B 2 a Oil	-	-	-	-	-	-	-	-	-
1 B 2 a i Exploration Production, Transport	NA	NA	NA	NA	NA	NA	NA	NA	NO
1 B 2 a iv Refining / Storage	NA	NA	NA	NA	NA	NA	NA	NA	NO
1 B 2 a v Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NO
1 B 2 a vi Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1 B 2 b Natural gas	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 B 2 c Venting and flaring	-	-	-	-	-	-	-	-	-
2 A MINERAL PRODUCTS (b)	-	-	-	-	-	-	-	-	-
2 A 1 Cement Production	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 A 2 Lime Production	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 A 3 Limestone and Dolomite Use	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 A 4 Soda Ash Production and use	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 A 5 Asphalt Roofing	NE	NE	NE	NE	NE	NE	NE	NE	NE
2 A 6 Road Paving with Asphalt	NE	NE	NE	NE	NE	NE	NE	NE	NE
2 A 7 Other including Non Fuel Mining & Construction (Please specify in a covering note)	NE	NE	NE	NE	NE	NE	NE	NE	NE
2 B CHEMICAL INDUSTRY	-	-	-	-	-	-	-	-	-
2 B 1 Ammonia Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2 B 2 Nitric Acid Production	NE	NE	NE	NE	NE	NE	NE	NE	NE
2 B 3 Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2 B 4 Carbide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2 B 5 Other (Please specify in a covering note)	NE	NE	NE	NE	NE	NE	NE	NE	NE
2 C METAL PRODUCTION	0,07	0,00	-	NE	-	0,05	-	NE	0,63
2 D OTHER PRODUCTION (b)	-	-	-	-	-	-	-	-	-
2 D 1 Pulp and Paper	NA	NA	NA	NA	NA	NA	NA	NA	NA
2 D 2 Food and Drink	NA	NA	NA	NA	NA	NA	NA	NA	NA
2 G OTHER (Please specify in a covering note)	NO	NO	NO	NO	NO	NO	NO	NO	NO
3 A PAINT APPLICATION	NA	NA	NA	NA	NA	NA	NA	NA	NA
3 B DEGREASING AND DRY CLEANING	NA	NA	NA	NA	NA	NA	NA	NA	NA
3 C CHEMICAL PRODUCTS, MANUFACTURE AND PROCESSING	NA	NA	NA	NA	NA	NA	NA	NA	NA
3 D OTHER including products containing HMs and POPs (Please specify in a covering note)	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B MANURE MANAGEMENT (c)	-	-	-	-	-	-	-	-	-
4 B 1 Cattle	IE	IE	IE	IE	IE	IE	IE	IE	IE
4 B 1 a Dairy	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 1 b Non-Dairy	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 2 Buffalo	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 B 3 Sheep	NA	NA	NA	NA	NA	NA	NA	NA	NA

4 B 4 Goats	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 5 Camels and Llamas	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 B 6 Horses	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 7 Mules and Asses	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 B 8 Swine	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 9 Poultry	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 B 13 Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 C RICE CULTIVATION	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 D AGRICULTURAL SOILS	-	-	-	-	-	-	-	-	-
4 D 1 Direct Soil Emission	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 F FIELD BURNING OF AGRICULTURAL WASTES	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 G OTHER (d)	NO	NO	NO	NO	NO	NO	NO	NO	NO
5 B FOREST AND GRASSLAND CONVERSION	NO	NO	NO	NO	NO	NO	NO	NO	NO
6 A SOLID WASTE DISPOSAL ON LAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
6 B WASTE-WATER HANDLING	NA	NA	NA	NA	NA	NA	NA	NA	NA
6 C WASTE INCINERATION (e)	NO	NO	NO	NO	NO	NO	NO	NO	NO
6 D OTHER WASTE (f)	NE	NE	NE	NE	NE	NE	NE	NE	NE
7 OTHER	NO	NO	NO	NO	NO	NO	NO	NO	NO
National Total	**4,66**	**0,58**	**1,24**	**0,76**	**1,23**	**8,80**	**10,6**	**2,11**	**23,3**
Memo Items									
International Aviation (LTO)	0,09	0,00	-	-	0,00	0,11	0,00	0,00	0,06
International Aviation (Cruise)	-	0,01	-	-	0,03	1,07	0,04	0,01	0,63
International Navigation	0,15	0,02	0,03	0,27	0,12	0,27	15,04	0,30	0,69
5 E Other	-	-	-	-	-	-	-	-	-
X (11 08 Volcanoes)	-	-	-	-	-	-	-	-	-

Table 38 Emission inventory for the year 2003 reported to the LRTAP in 2005 (c) (Illerup et al. 2005b).

	Dioxin g I-tec	Benzo(a)-pyrene Mg	Benzo(b)-fluoranthene Mg	Benzo(k)-fluoranthene Mg	Indeno(1,3,3-c,d)pyrene Mg
1 A 1 a Public Electricity and Heat Production	4,700	0,008	0,032	0,015	0,008
1 A 1 b Petroleum refining	NA	0,000	0,000	0,000	0,000
1 A 1 c Manufacture of Solid fuels and Other ENRrgy Industries	NA	0,000	0,000	0,000	0,000
1 A 2 Manufacturing Industries and Construction	NA	0,004	0,018	0,016	0,006
1 A 2 a Iron and Steel	1,460	NA	NA	NA	NA
1 A 2 b NAn-ferrous Metals	0,400	NA	NA	NA	NA
1 A 2 c Chemicals	0,004	NA	NA	NA	NA
1 A 2 d Pulp, Paper and Print	NA	NA	NA	NA	NA
1 A 2 e Food Processing, Beverages & Tobacco	NA	NA	NA	NA	NA
1 A 2 f Other (Please specify in a covering NAte)	0,070	0,025	0,078	0,004	0,003
1 A 3 a ii Civil Aviation (Domestic, LTO)	NA	0,000	0,000	0,000	0,000
1 A 3 a ii Civil Aviation (Domestic, Cruise)	NA	-	-	-	-
1 A 3 b Road Transportation	0,200	-	-	-	-
1 A 3 b i R.T., Passenger cars	IE	0,028	0,028	0,028	0,032
1 A 3 b ii R.T., Light duty vehicles	IE	0,015	0,014	0,013	0,014
1 A 3 b iii R.T., Heavy duty vehicles	IE	0,004	0,020	0,030	0,005
1 A 3 b iv R.T., Mopeds & Motorcycles	IE	0,001	0,001	0,001	0,001
1 A 3 b v R.T., GasoliNR evaporation	IE	NA	NA	NA	NA
1 A 3 b vi R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA
1 A 3 b vii R.T., Automobile road abrasion	NA	NA	NA	NA	NA
1 A 3 c Railways	0,007	0,000	0,001	0,001	0,000
1 A 3 d ii National Navigation	1,300	0,001	0,004	0,002	0,005
1 A 3 e Other (Please specify in a covering NAte)	-	-	-	-	-
1 A 3 e i PipeliNR compressors	NA	NA	NA	NA	NA
1 A 3 e ii Other mobile sources and machiNRry	-	NO	NO	NO	NO
1 A 4 a Commercial / Institutional	NA	0,165	0,217	0,072	0,117
1 A 4 b Residential	NA	NA	NA	NA	NA
1 A 4 b i Residential plants	18,850	2,574	3,372	1,124	1,816
1 A 4 b ii Household and gardening (mobile)	3,300	0,000	0,000	0,000	0,000
1 A 4 c Agriculture / Forestry / Fishing	NA	NA	NA	NA	NA
1 A 4 c i Stationary	NA	0,140	0,153	0,027	0,205
1 A 4 c ii Off-road Vehicles and Other MachiNRry	NA	0,004	0,008	0,008	0,004
1A 4 c iii National Fishing	NA	NA	NA	NA	NA
1 A 5 a Other, Stationary (including Military)	-	NO	NO	NO	NO
1 A 5 b Other, Mobile (Including military)	NA	0,000	0,000	0,000	0,000
1B1 Fugitive Emissions from Solid Fuels	-	-	-	-	-
1 B 1 a Coal Mining and Handling	NA	NA	NA	NA	NA
1 B 1 b Solid fuel transformation	NO	NO	NO	NO	NO
1 B 1 c Other (Please specify in a covering NAte)	NO	NO	NO	NO	NO
1 B 2 Oil and natural gas	-	-	-	-	-
1 B 2 a Oil	-	-	-	-	-
1 B 2 a i Exploration Production, Transport	NA	NA	NA	NA	NA
1 B 2 a iv Refining / Storage	NA	NA	NA	NA	NA
1 B 2 a v Distribution of oil products	NA	NA	NA	NA	NA
1 B 2 a vi Other	NA	NA	NA	NA	NA
1 B 2 b Natural gas	NA	NA	NA	NA	NA
1 B 2 c Venting and flaring	NA	-	-	-	-
2 A MINRRAL PRODUCTS (a)	-	-	-	-	-
2 A 1 Cement Production	0,800	NA	NA	NA	NA
2 A 2 Lime Production	NA	NA	NA	NA	NA
2 A 3 LimestoNR and Dolomite Use	NA	NA	NA	NA	NA
2 A 4 Soda Ash Production and use	NA	NA	NA	NA	NA
2 A 5 Asphalt Roofing	NA	NA	NA	NA	NA
2 A 6 Road Paving with Asphalt	0,041	NA	NA	NA	NA
2 A 7 Other including NAn Fuel Mining & Construction (Please specify in a covering NAte)	0,160	NA	NA	NA	NA
2 B CHEMICAL INDUSTRY	-	-	-	-	-
2 B 1 Ammonia Production	NO	NO	NO	NO	NO
2 B 2 Nitric Acid Production	NA	NA	NA	NA	NA
2 B 3 Adipic Acid Production	NO	NO	NO	NO	NO
2 B 4 Carbide Production	NO	NO	NO	NO	NO
2 B 5 Other (Please specify in a covering NAte)	NA	NA	NA	NA	NA
2 C METAL PRODUCTION	NA	NA	NA	NA	NA
2 D OTHER PRODUCTION (a)	NA	NA	NA	NA	NA
2 D 1 Pulp and Paper	NA	NA	NA	NA	NA
2 D 2 Food and Drink	NA	NA	NA	NA	NA
2 G OTHER (Please specify in a covering NAte)	-	NO	NO	NO	NO
3 A PAINT APPLICATION	NA	NA	NA	NA	NA
3 B DEGREASING AND DRY CLEANING	NA	NA	NA	NA	NA
3 C CHEMICAL PRODUCTS, MANUFACTURE AND PROCESSING	NA	NA	NA	NA	NA
3 D OTHER including products containing HMs and POPs (Please specify in a covering NAte)	13,250	NA	NA	NA	NA
4 B MANURE MANAGEMENT (b)	-	-	-	-	-

4 B 1 Cattle	NA	NA	NA	NA	NA
4 B 1 a Dairy	NA	NA	NA	NA	NA
4 B 1 b NAn-Dairy	NA	NA	NA	NA	NA
4 B 2 Buffalo	-	NO	NO	NO	NO
4 B 3 Sheep	NA	NA	NA	NA	NA
4 B 4 Goats	NA	NA	NA	NA	NA
4 B 5 Camels and Llamas	NO	NO	NO	NO	NO
4 B 6 Horses	NA	NA	NA	NA	NA
4 B 7 Mules and Asses	-	NO	NO	NO	NO
4 B 8 SwiNR	NA	NA	NA	NA	NA
4 B 9 Poultry	NA	NA	NA	NA	NA
4 B 13 Other	NA	NA	NA	NA	NA
4 C RICE CULTIVATION	NO	NO	NO	NO	NO
4 D AGRICULTURAL SOILS	-	-	-	-	-
4 D 1 Direct Soil Emission	NA	NA	NA	NA	NA
4 F FIELD BURNING OF AGRICULTURAL WASTES	NO	NO	NO	NO	NO
4 G OTHER (c)	NO	NO	NO	NO	NO
5 B FOREST AND GRASSLAND CONVERSION	NO	NO	NO	NO	NO
6 A SOLID WASTE DISPOSAL ON LAND	5,150	NA	NA	NA	NA
6 B WASTEWATER HANDLING	0,002	NA	NA	NA	NA
6 C WASTE INCINRRATION (d)	17,700	NO	NO	NO	NO
6 D OTHER WASTE (e)	NA	NA	NA	NA	NA
7 OTHER	10,250	NO	NO	NO	NO
National Total	**78,000**	**2,968**	**3,948**	**1,340**	**2,218**
International Aviation (LTO)	NA	0,000	0,000	0,000	0,000
International Aviation (Cruise)	NA	-	-	-	-
International MariNR (b)	NA	0,005	0,017	0,008	0,029
5 E Other	NO	NO	NO	NO	NO
X (11 08 VolcaNAes)	NO	NO	NO	NO	NO

Appendix 3 IPCC/SNAP source correspondence list

Table 39 Correspondence list for IPCC source categories 1A1, 1A2 and 1A4 and SNAP (EMEP/Corinair 2004).

SNAP_id	SNAP_name	IPCC source
01	Combustion in energy and transformation industries	
0101	Public power	1A1a
010101	Combustion plants >= 300 MW (boilers)	1A1a
010102	Combustion plants >= 50 and < 300 MW (boilers)	1A1a
010103	Combustion plants < 50 MW (boilers)	1A1a
010104	Gas turbines	1A1a
010105	Stationary engines	1A1a
0102	District heating plants	1A1a
010201	Combustion plants >= 300 MW (boilers)	1A1a
010202	Combustion plants >= 50 and < 300 MW (boilers)	1A1a
010203	Combustion plants < 50 MW (boilers)	1A1a
010204	Gas turbines	1A1a
010205	Stationary engines	1A1a
0103	Petroleum refining plants	1A1b
010301	Combustion plants >= 300 MW (boilers)	1A1b
010302	Combustion plants >= 50 and < 300 MW (boilers)	1A1b
010303	Combustion plants < 50 MW (boilers)	1A1b
010304	Gas turbines	1A1b
010305	Stationary engines	1A1b
010306	Process furnaces	1A1b
0104	Solid fuel transformation plants	1A1c
010401	Combustion plants >= 300 MW (boilers)	1A1c
010402	Combustion plants >= 50 and < 300 MW (boilers)	1A1c
010403	Combustion plants < 50 MW (boilers)	1A1c
010404	Gas turbines	1A1c
010405	Stationary engines	1A1c
010406	Coke oven furnaces	1A1c
010407	Other (coal gasification, liquefaction, ...)	1A1c
0105	Coal mining, oil/gas extraction, pipeline compressors	
010501	Combustion plants >= 300 MW (boilers)	1A1c
010502	Combustion plants >= 50 and < 300 MW (boilers)	1A1c
010503	Combustion plants < 50 MW (boilers)	1A1c
010504	Gas turbines	1A1c
010505	Stationary engines	1A1c
02	Non-industrial combustion plants	
0201	Commercial and institutional plants (t)	1A4a
020101	Combustion plants >= 300 MW (boilers)	1A4a
020102	Combustion plants >= 50 and < 300 MW (boilers)	1A4a
020103	Combustion plants < 50 MW (boilers)	1A4a
020104	Stationary gas turbines	1A4a
020105	Stationary engines	1A4a
020106	Other stationary equipments (n)	1A4a
0202	Residential plants	1A4b
020201	Combustion plants >= 50 MW (boilers)	1A4b
020202	Combustion plants < 50 MW (boilers)	1A4b
020203	Gas turbines	1A4b
020204	Stationary engines	1A4b
020205 [2)]	Other equipments (stoves, fireplaces, cooking,...) [2)]	1A4b
0203	Plants in agriculture, forestry and aquaculture	1A4c
020301	Combustion plants >= 50 MW (boilers)	1A4c
020302	Combustion plants < 50 MW (boilers)	1A4c
020303	Stationary gas turbines	1A4c
020304	Stationary engines	1A4c
020305	Other stationary equipments (n)	1A4c
03	Combustion in manufacturing industry	
0301	Comb. in boilers, gas turbines and stationary	1A2f
030101	Combustion plants >= 300 MW (boilers)	1A2f
030102	Combustion plants >= 50 and < 300 MW (boilers)	1A2f
030103	Combustion plants < 50 MW (boilers)	1A2f
030104	Gas turbines	1A2f
030105	Stationary engines	1A2f
030106	Other stationary equipments (n)	1A2f
0302	Process furnaces without contact	
030203	Blast furnace cowpers	1A2a

030204	Plaster furnaces	1A2f
030205	Other furnaces	1A2f
0303	Processes with contact	
030301	Sinter and pelletizing plants	1A2a
030302	Reheating furnaces steel and iron	1A2a
030303	Gray iron foundries	1A2a
030304	Primary lead production	1A2b
030305	Primary zinc production	1A2b
030306	Primary copper production	1A2b
030307	Secondary lead production	1A2b
030308	Secondary zinc production	1A2b
030309	Secondary copper production	1A2b
030310	Secondary aluminium production	1A2b
030311	Cement (f)	1A2f
030312	Lime (includ. iron and steel and paper pulp industr.)(f)	1A2f
030313	Asphalt concrete plants	1A2f
030314	Flat glass (f)	1A2f
030315	Container glass (f)	1A2f
030316	Glass wool (except binding) (f)	1A2f
030317	Other glass (f)	1A2f
030318	Mineral wool (except binding)	1A2f
030319	Bricks and tiles	1A2f
030320	Fine ceramic materials	1A2f
030321	Paper-mill industry (drying processes)	1A2d
030322	Alumina production	1A2b
030323	Magnesium production (dolomite treatment)	1A2b
030324	Nickel production (thermal process)	1A2b
030325	Enamel production	1A2f
030326	Other	1A2f
08 1)	Other mobile sources and machinery	
0804 1)	Maritime activities	
080403 1)	National fishing	1A4c
0806 1)	Agriculture	1A4c
0807 1)	Forestry	1A4c
0808 1)	Industry	1A2f
0809 1)	Household and gardening	1A4b

1) Not stationary combustion. Included in a IPCC sector that also includes stationary combustion plants
2) Stoves, fireplaces and cooking is included in the sector 0202 or 020202 in the Danish inventory. It is not possible based on the Danish energy statistics to split the residential fuel consumption between stoves/fireplaces/cooking and residential boilers.

Appendix 4 Emission factors, references

Contents

1 SO_2

1.1 Coal, large power plants

Sector 1A1a (SNAP 0101, 010101, 010102, 010103, 010104, 010105)

The SO_2 emission and the fuel consumption for Danish power plants >25MW_e are available for all plants for the years 1990 and onwards. In general the plant specific data have been included in the emission inventories. For some years a small part of the coal consumption has, however, been included as an area source. The SO_2 emission factor for coal has been estimated as an average value based on the annual reporting from the electricity transmission companies in Denmark, Eltra and Elkraft System[1]. The total SO_2 emission from power plants >25MW_e has been assumed to origin from coal or residual oil. This has lead to a conservative estimate of the emission factor because SO_2 is also emitted from other fuels, and furthermore the emission from residual oil is higher than for coal (Danish plants > 25MW_e). The calculated time-series for the SO_2 emission factor are shown below. In 2003 the fuel consumption data were stated in TJ.

The emission factors for 1980-1982 refer to Fenhann & Kilde (1994). These emission factors were also estimated based on the plant specific data for plants > 25MW_e. In the inventories for 1980-1989 the power plants are not included as point sources, but the plant specific data are considered in the SO_2 emission factor.

Table 1 SO_2 emission factor for coal combusted in centralised power plants

Year	Total SO_2 emission	Total fuel consumption	Coal Consumption	H_u of coal	Oil consumption	H_u of Residual oil	Fuel consumption coal and residual oil	SO_2 emission factor
	[1000 ton] 1)	[PJ] 1)	[Kton] 1)	[GJ/ton] 2)	[Kton] 1)	[GJ/ton] 2)	[TJ]	[g/GJ]
1990	119	243	9153	25,3	84	40,4	234965	**506**
1991	175	323	11975	25,4	62	40,4	306670	**571**
1992	130	279	11083	25,8	9	40,4	286305	**454**
1993	100	298	9820	25,2	295	40,4	259382	**386**
1994	103	337	11303	24,5	585	40,4	300558	**343**
1995	97	301	12293	24,5	232	40,4	310551	**312**
1996	138	432	12524	24,7	470	40,7	328472	**420**
1997	71	345	12886	24,96	226	40,65	330821	**215**
1998	51	305	7375	25	227	40,65	193603	**263**
1999	34	277	6709	25	215	40,65	176465	**193**
2000	9,4	252	5745	24,8	103	40,65	146663	**64**
2001	7,8	240	6397	24,9	163	40,65	165918	**47**
2002	7,9	246	6481	24,9	287	40,65	173048	**45**
2003	14,9	301	226	24,9	17	40,65	243222	**61**

1) Eltra and Elkraft System, annual reporting of total SO_2 and NO_x emissions from Danish power plants > 25MW_e

2) Danish Energy Authority, 2003

[1] Now part of the energy transmission company Energinet.dk

Table 2 SO_2 emission factor for coal combusted in centralised power plants, 1980-1989

	SO_2 emission factor 1) [g/GJ]
1980	714
1981	714
1982	714
1983	587
1984	508
1985	559
1986	549
1987	507
1988	560
1989	590

1980-1982 Fenhann & Kilde 1994, 1983-1989

1.2 Coal, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP 0102(xx), 03(xxxx), 02(xxxx))

1990-2003

According to Danish legislation the maximum sulphur content of coal used in plants that are not large power plants is 0,9% (Bek. 532, 2001). This value has been in force since 1989 (Bek. 901, 1994, Bek. 562, 1988). The average sulphur content from 1990 to 2003 has been assumed to be a little below the maximum – 0,8%. The lower heating value of coal used in other plants than power plants (Other hard coal) was 26,5 GJ/ton during the period 1991-2003 (DEA, 2004b). In spite of the fact that the lower calorific value was 26,1 GJ/ton in 1990 (DEA, 2004b) the same emission factor has been applied for 1990 as for 1991 and onwards. The sulphur retention in ash has been assumed to be 0,05 referring to EMEP/CorinAir Guidebook (EMEP/CorinAir, 2005, page B111-22, Table 8). Based on these data the emission factor 574 g/GJ has been calculated (see below).

$$EMF_{SO2} = 10^6 \cdot ((2 \cdot C_s \cdot (1-\bullet_s)) / H_u)$$

$$EMF_{SO2} = 10^6 \cdot ((2 \cdot 0{,}8 \cdot 0{,}01 \cdot (1-0{,}05)) / 26{,}5) = 574 \text{ g/GJ}$$

1980-1989

For the years 1980-1988 the sulphur content of coal has been assumed to be 0,9% and the average lower calorific value is 26,1 GJ/ton (DEA, 2004b). Based on the assumption that the sulphur retention in ash is 0,05 the estimated emission factor for 1980-1989 is 655 g/GJ. The emission factors that have been applied differ a little from this value. The difference is very small but the applied emission factor for 1980-1989 could be updated to ensure that the emission factors are referenced correctly.

Table 3 Emission factors for coal not applied in large power plants

Year	Sulphur content [%]	Sulphur retention in ash [kg/kg]	Lower heating value [GJ/ton]	Estimated emission factor [g/GJ]	Applied emission factor [g/GJ]
1980-1988	0,9	0,05	26,1 1)	655	649
1989	0,9	0,05	26,1 1)	655	584
1990-2003	0,8	0,05	26,5 2)	574	574

1. Average value for 1980-1989
2. The lower heating value for 1990 hasve been assumed to be 26,5 GJ/tonnes.

1.3 Brown coal briquettes and Coke oven coke

Sector 1A2f, 1A4a, 1A4b, 1A4c (SNAP 0301, 0201, 0202, 0203)

The emission factors for brown coal briquettes (BKB) and Coke oven coke have been assumed to be the same as for coal applied for other plants than power plants. This is a NERI assumption. The consumption of BKB and Coke oven coke has been very low in the considered time-series.

1.4 Petroleum coke

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP: All)

The emission factor for petroleum coke has been based on maximum sulphur content according to Danish legislation and on the lower heating values that is part of the Danish energy statistics.

The lower heating value for petroleum coke has been 31,4 GJ/ton all years since 1980 (DEA, 2004b).

According to Danish legislation the sulphur content of petroleum coke should be below 1% in 2001 and onwards (Bek. 532, 2001). In the years 1988 – 2000 the maximum sulphur content according to Danish legislation was 1,3% (Bek. 901, 1994; Bek 562, 1988). The same sulphur content has been assumed for 1980-1987.

The sulphur retention in ash has been assumed to be 0,05 referring to EMEP/CorinAir Guidebook value for coal (EMEP/CorinAir 2005, page B111-22, Table 8). It has been assumed that sulphur flue gas cleaning is not applied in plants combusting petroleum coke.

$EMF_{SO2} = 10^6 \cdot ((2 \cdot C_s \cdot (1-\bullet_s)) / H_u)$

1980-2000: $EMF_{SO2} = 10^6 \cdot ((2 \cdot 1,3 \cdot 0,01 \cdot (1-0,05)) / 31,4) = 787$ g/GJ

2001-2003: $EMF_{SO2} = 10^6 \cdot ((2 \cdot 1,0 \cdot 0,01 \cdot (1-0,05)) / 31,4) = 605$ g/GJ

1.5 Wood, CHP plants

Sector 1A1a (SNAP 0101, 010101, 010102, 010103, 010104)

The SO_2 emission factor for wood combusted in CHP plants refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on two wood combusting plants. Despite the limited number of plants on which emission measurements were performed the fuel consumption of the plants represented 44% of the wood consumption in CHP plants in 2000. The emission factor 1,74 g/GJ has been applied for the inventories for 1992 and onwards. Before 1992 wood was not combusted in CHP plants.

1.6 Wood, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP 010105, 0102(xx), 0301(xx), 0201(xx), 0202, 0203(xx))

The emission factor refers to two reports, both in Danish: Serup et al. (1999) and Christiansen et al. (1997).

According to Serup et al. (1999) the emission factor is in the interval 5-30 g/GJ and a typical value is 15 g/GJ. According to Christiansen et al. (1997) the emission factor is in the interval 15-30 g/GJ.

Until now the emission factor 25 g/GJ has been applied all years. However, 15-20 g/GJ might be a better estimate.

1.7 Municipal waste, CHP plants

Sector 1A1a (SNAP 0101(xx))

The emission factor for the years 2000-2003 refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on 16 CHP plants (19 combustion units) combusting municipal waste representing more than 70% of the consumption in CHP plants in 2000.

The flue gas cleaning systems in municipal waste CHP plants have been developed considerably during the last decade. Thus the emission factor applied for 2000 and onwards is not valid for the previous years. Power production based on municipal waste began in 1988 in Denmark.

The emission factors applied for the years 1990 and 1995 also refers to Nielsen & Illerup (2003). The estimates for 1990 and 1995, included in this report, have been based on knowledge of flue gas cleaning systems of the plants in 1990 and 1995 (Illerup et al., (1999). For plants with no flue gas cleaning the sulphur content was assumed to be 0,24% (Risø, 2005) and the sulphur retention in ash was assumed to be 63% (Blinksbjerg, 1994) and thus the estimated emission factor was 169 g/GJ. Further emission factors for plants with different flue gas cleaning systems were applied (Nielsen & Illerup, 2003).

The estimated emission factors were 138 g/GJ in 1990 and 30 g/GJ in 1995. The emission factor time-series between 1990 and 1995 and between 1995 and 2000 have been assumed linear (NERI assumption). In 1988 and 1989 the emission factor has been assumed to be the same as in 1990.

The emission factor time-series are shown below. Unfortunately a wrong emission factor has been applied in 1988-1990. This will be corrected in the inventories reported in 2006.

Table 4 Emission factors for CHP plants combusting municipal waste

Year	Applied emission factor [g/GJ]	Correct emission factor [1] [g/GJ]
1988	116	138
1989	116	138
1990	116	138
1991	116	
1992	95	
1993	73	
1994	52	
1995	30	
1996	29	
1997	28	
1998	26	
1999	25	
2000	24	
2001	24	
2002	24	
2003	24	

In the inventories reported in 2005 the emission factor applied for 1988-1990 is not correct. The error will be corrected next year.

1.8 Municipal waste, district heating and other plants

Sector 1A1a, 1A2f, 1A4a (SNAP 0102(xx), 0301(xx), 0102(xx))

The emission factor for the year 2000 was based on plant specific fuel consumption data in year 2000 (DEA, 2001) and on SO_2 emission data (annual environmental reports 2001) for each of the 5 non-power producing plants. Based on these data the emission factor 67 g/GJ has been estimated. The same emission factor has been applied for the following years.

The flue gas cleaning system applied in 1990 on plants that are not power producing refers to Illerup et al. (1999). The amount of municipal waste combusted in each flue gas cleaning category also refers to Illerup et al. (1999). For plants with no flue gas cleaning the sulphur content was assumed to be 0,24% and the sulphur retention in ash was assumed to be 63% (169 g/GJ). These assumptions refer to Risø (2005) and Blinksbjerg (1994) and the same assumptions have been applied for CHP plants with no sulphur flue gas cleaning. For plants with sulphur flue gas cleaning the emission factors refer to the emission factors estimated for CHP plants year 2000 (Nielsen & Illerup, 2003) with the same flue gas cleaning system. The estimated emission factor for 1990 is 138 g/GJ [2]. The emission factor time-series between 1990 and 2000 have been assumed linear (NERI assumption).

In 1980-1989 the emission factor has been assumed to be the same as in 1990 (NERI assumption).

Time-series and emission factor estimates for 1990 and 2000 are shown below.

[2] The emission factor is equal to the factor for CHP plants. This is, however, a accidental occurrence.

Table 5 Emission factors for non-power producing plants combusting municipal waste, 1990

Flue gas cleaning 1)	Municipal waste combustion 1990[2] [ton]	SO_2 emission factor[3] [g/GJ]	Consumption x emission factor 1990 [ton · g/GJ]
No sulphur cleaning	1327760	169	224391440
ESP WET	30700	50,5	1550350
SD (CYK) FB	148430	10,3	1528829
Other WET	12000	26,6	319200
Other DRY	156900	20,6	3232140
Total	1675790		231021959
			Emission factor 1990 [g/GJ]
			138

1. WET: wet flue gas cleaning, SD: semidry flue gas cleaning, DRY: dry flue gas cleaning, ESP: electrostatic precipitator, FB: fabric filter, CYK: cyclone
2. Illerup et al. 1999
3. Nielsen & Illerup 2003

Table 6 Emission factors for non- power producing plants combusting municipal waste, 2000

Fuel consumption [GJ]	SO_2 emission [ton]	SO_2 emission factor [g/GJ]
1440233	96,42	67

Table 7 Emission factors time-series for non- power producing plants combusting municipal waste

Year	Emission factor [g/GJ]
1980-1989	138
1990	138
1991	131
1992	124
1993	117
1994	110
1995	103
1996	95
1997	88
1998	81
1999	74
2000	67
2001	67
2002	67
2003	67

1.9 Straw, CHP plants and power plants

Sector 1A1a (SNAP 0101(xx))

The SO_2 emission factor for straw combusted in CHP plants < 25MW_e refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on five straw combusting plants. Despite the limited number of plants on which emission measurements were performed, the fuel consumption of the plants represented 58% of the straw consumption in decentralised CHP plants in 2000. The emission factor 47,1 g/GJ has also been applied for combustion of straw in large power plants. However, plant specific SO_2 emission data are usually available for large power plants. The emission factor has been applied for all years.

1.10 Straw, other plants

Sector 1A1a, 1A2f, 1A4b, 1A4c (SNAP 0102(xx), 0301(xx), 0202, 0203(xx))

The SO_2 emission factor (130 g/GJ) for straw combusted in plants that are not power producing refers to Nikolaisen et al. (1998). The reference states the typical value 130 g/GJ for district heating plants and an interval of 100-170 g/GJ. The emission factor for small farmhouse boilers and other plants has been assumed to be the same (NERI assumption).

1.11 Residual oil, large power plants

Sector 1A1a (SNAP 0101(xx))

The SO_2 emission and the fuel consumption for Danish power plants >25MW_e are available for all plants for the years 1990 and onwards (Eltra & Elkraft System). In general the plant specific data have been included in the emission inventories. For some years a small part of the residual oil consumption has, however, been included as an area source. For 1990-2001 NERI hasve estimated the SO_2 emission factor for residual oil based on the sulphur content of the residual oil applied in power plants >25MW_e. This information was part of the reporting from the power plant owners (Eltra & Elkraft System) to the Danish Energy Authority at that time. The lower heating value for residual oil refers to DEA (2004b). There is no sulphur retention in ash and it has been assumed that there was no sulphur flue gas cleaning. The estimated emission factors are shown below.

The emission factors applied for 2002 and 2003 have been estimated based on the few large power plant blocks combusting primarily residual oil. This calculation, which is carried out by NERI, also refers to Eltra & Elkraft System. The emission factor for 2003 was not updated in the emission inventories reported in 2005. This will be corrected before the next reportings.

Table 8 Emission factors time-series for residual oil applied in power plants

Year	Average sulphur content [%][1)]	Sulphur retention in ash [kg/kg]	Lower heating value [GJ/ton][2)]	Emission factor [g/GJ]
1990	0,9	0	40,4	446
1991	0,95	0	40,4	470
1992	0,99	0	40,4	490
1993	0,96	0	40,4	475
1994	3,16	0	40,4	1564
1995	0,71	0	40,4	351
1996	0,83	0	40,7	408
1997	0,7	0	40,65	344
1998	0,75	0	40,65	369
1999	0,75	0	40,65	369
2000	0,82	0	40,65	403
2001	0,641	0	40,65	315
2002				290 [3)]
2003				334 [3)]

1. Eltra & Elkraft System annual reportings
2. DEA 2005
3. Estimated based on plant specific data from Eltra & Elkraft System annual reportings

The emission factors for 1980-1989 refer to Fenhann & Kilde (1994). These emission factors were also estimated based on the plant specific data for plants > 25MW_e. In the inventories for 1980-1989 the power plants are not included as point sources, but the plant specific data are considered in the SO_2 emission factor.

1.12 Residual oil, refineries

Sector 1A1b (SNAP 010306)

For the years 1980-1993 the total SO_2 emission data from refinery furnaces (SNAP 030106) have been reported by Fenhann (1996). The data from Fenhann are not fuel specific and the SO_2 emission factors for residual oil have been estimated based on the assumption that the emission factors for gas oil (94 g/GJ), LPG (0,13 g/GJ) and refinery gas (190 g/GJ) applied in refinery furnaces are constant in the years 1980-1993. Thus the emission factor for residual oil combusted in refinery furnaces is used as a tool for making the estimated total SO_2 emission correct and to much should not be read into the emission factor time-series 1980-1993. Still the data from Fenhann (1996) are considered the best available data and preferred despite the methodology problems. As mentioned in Chapter 1.20 the emission factor for refinery gas (190 g/GJ) will be changed before the 2006 inventories and thus the emission factors for residual oil combusted in refinery furnaces will also be changed. The total emission from refinery furnaces will, however, be the same.

The refineries have been included in the Danish inventory as point sources from 1994 and onwards and as plant specific SO_2 emission data included in the inventories. Thus the emission factor has only been applied in the years in which a small amount of residual oil has been included as an area source.

The emission factor for 2003 has been estimated based on plant specific data from the two refineries in operation in Denmark (537 g/GJ). It has been assumed that all SO_2 originate from residual oil.

The main part of the fuel consumption has been included as part of point sources with plant specific SO_2 emission data. The emission factor estimated for 2003 will be applied for 1994-2002 in future inventories. This will not cause considerable changes of the estimated SO_2 emission from refinery furnaces.

1.13 Residual oil, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP 0102xx, 0301xx, 0201xx, 0202, 0203xx)

The emission factor for applied for 1997-2003 refers to Risø (2005) and to a note from the parlamential committee for environment (Miljø- og planlægningsudvalget, 1998).

According to Risø (2005) the average sulphur content of residual oil sold in Denmark has been 0,7% since 1997. Risø refers to the Danish Oil Forum. This is supported by Miljø- og planlægningsudvalget (1998). According to this reference the tax policy for fuel oil sold in Denmark has caused a sulphur content considerably under the legislative limit of 1% (Bek. 532, 2001; Bek. 580, 2000; Bek. 901, 1994; Bek. 562, 1988) that has been in force since 1988. The sulphur content of 0,7% has been confirmed by oil fact sheets from Shell (2005). The lower heating values refer to the Danish energy statistics (DEA, 2004b).

For the years 1988-1996 the legislative maximum sulphur content of 1% (Bek. 901, 1994; Bek. 562, 1988) has been assumed by NERI. The lower heating values refer to the Danish energy statistics (DEA, 2004b).

For the years 1980-1987 the emission factors refer to Risø (2005). These emission factors werebased on a sulphur content of 2,35% in 1980-1985 and 1,45% in 1986-1987.

1.14 Gas oil

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP <04)

For the years 1980-1988 the emission factors 234 g/GJ and 141 g/GJ were based on a sulphur content of 0,5% (1980-1985) and 0,3% (1986-1988) respectively. These legislative values refer to Cir. 122 (1986). The emission factors are confirmed by Risø (2005).

For the years 1989-1994 the emission factor 94 g/GJ refers to Danish legislation (Bek. 901, 1994; Bek 562, 1988) concerning sulphur content (0,2%) and the lower heating values refer to the Danish energy statistics (DEA 2004b).

For the years 1995-2003 the emission factor 23 g/GJ was based on a sulphur content of 0,05%, which is below the Danish legislation – 0,2% (Bek. 901, 1994; Bek. 580, 2000; Bek. 532, 2001). The sulphur content has been lower than the 0,2% due to Danish tax laws (Bek. 688, 1998). According to the tax laws the base sulphur content (no tax) for gas oil has been 0,05% since 1995. The low average sulphur content for gas oil applied in Denmark refers to a note from the parlamential committee for environment (Miljø- og planlægningsudvalget, 1998). According to this reference the oil sold in Denmark in 1998 had a sulphur content of 0,05% regardless of the legislative limit of 0,2% sulphur. The lower heating value for gas oil refers to DEA (2004b). The sulphur content of 0,05% has been confirmed by product data sheets from Q8, Shell and Statoil.

1.15 Kerosene

Sector 1A2f, 1A4a, 1A4b, 1A4c (SNAP <04)

The emission factor 5 g/GJ has been based on a sulphur content of 0,01%.

According to a product sheet from Shell (2005) the maximum sulphur content of kerosene is 0,05%. However, this maximum sulphur content has been stated in the product sheets as it is the maximum sulphur content allowed to avoid sulphur taxes (Bek. 688, 1998).

The actual sulphur content is somewhat lower (Tønder, 2004). According to Tønder (2004) the sulphur content was approximately 95-107 mg S/litre. According to the product sheet from Shell (2005) the density of kerosene is 775-840 g/litre and thus the actual sulphur content is approximately 0,012% sulphur.

The NERI estimate is based on a sulphur content of 0,01% sulphur (Tønder, 2004) and the lower heating value 43,1 GJ/ton that refers to the product data sheet from Shell (2005).

1.16 Fish & rape oil

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP <04)

The sulphur content of rape oil is below 0,001% and typically 0,0005% (Folkecenter for Vedvarende Energi, 2000). The lower heating value is 37,2 GJ/ton (DEA, 2004b). Based on these data the estimated emission factor is 0,2-0,6 g/GJ. However, NERI applies an emission factor that is somewhat higher – 1 g/GJ.

1.17 Orimulsion

Sector 1A1a (SNAP 010101)

Orimulsion has only been applied in a single large power plant boiler in Denmark. This power plant boiler has been included in the inventories as a point source with plant specific SO_2 emission data included all years. Thus the emission factors that are stated in the area source emission factor time-series are only included for information. The emission factors have been estimated based on the plant specific data from the power plant boiler combusting orimulsion. The plant specific SO_2 emission data refers to Eltra & Elkraft System (annual reporting) and the fuel consumption data refers to DEA (2004a) and the similar DEA data reported in former years.

1.18 Natural gas

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP <04)

This sulphur content refers to the Danish gas transmission company Gastra[3] (2005). The sulphur content originates from the H_2S content of natural gas and from the added odorant (THT, C_4H_8S). Natural gas data and estimates of the emission factor are shown below.

Table 9 SO_2 emission factor for natural gas

Data	Value	Reference
Hydrogen Sulphide	3,16 mg H_2S /m_n^3 natural gas	http://www.gastra.dk/dk/index.asp (23-05-2005)
THT	15 mg THT/m_n^3.	http://www.gastra.dk/dk/energi-service/gaskvalitet/datablad/datablad.htm (23-05-2005)
H_2S sulphur content	94% w/w (32/34)	Calculation
THT sulphur content	36% w/w (32/88)	Kristensen 2003
Sulphur content in 1 m_n^3	8,4 mg S/m_n^3	Calculation
Lower heating value	39,77 MJ/m_n^3	http://www.gastra.dk/dk/index.asp (23-05-2005)
SO_2 emission factor	0,42 g/GJ	Calculation

S content = 3,16·0,94+15·0,36= 8,4 mg S /m_n^3 mg/m_n^3
Emission factor = 2·(8,4/39,77) = 0,42 g/GJ

The estimated emission factor 0,42 g/GJ has been based on average 2004 gas. The emission factor that has actually been applied in the Danish inventories is 0,3 g/GJ. This emission factor has been applied for all years. The emission factor 0,3 g/GJ refers to the latest environmental report from Danish Gas Technology Centre (Schmidt, 2004) and will be applied unchanged in future inventories.

The SO_2 emission from gas engines is somewhat higher due to the consumption of lube oil. This has not been taken into account in the Danish inventories.

[3] Now part of the Danish energy transmission company Energinet.dk. Gastra is a former part of DONG.

1.19 LPG

Sector 1A1a, 1A1b, 1A2f, 1A4a, 1A4b, 1A4c (SNAP <04)

The main part of the sulphur content in LPG originates from odorant that is added (Krebs, 2003). The maximum sulphur content of LPG is 50 mg S / kg (Krebs, 2003). The odourant applied is Ethylmercaptan (Augustesen, 2003). According to the Danish legislation concerning fuel gas a minimum of 8,8 mg odorant/m^3 should be added if ethylmercaptan (C_2H_6S) is used (Gasreglementet 2001). According to specifications from Statoil a minimum of 12 mg odourant/m^3 is added (Augustesen, 2003). The S content in the odourant is 51,61% and thus it corresponds to a sulphur content of 12·0,5161=6,19 mg S/m^3. The weight of 1 m^3 propane is 1,96 kg/m^3, whereas the weight of butane is 2,59 kg/m^3. A 40% propane / 60% butane weights 2,34 kg/m^3. Thus the sulphur content is at least 6,19/2,34=2,65 mg S/kg corresponding to 0,000265%.

The sulphur content of LPG is in the interval 0,000265% to 0,005%. NERI has assumed that the sulphur content is slightly above the specified minimum: 0,0003% S.

The lower heating value 46 GJ/ton refers to DEA (2004b) and the estimated emission factor is 0,13 g/GJ.

1.20 Refinery gas, refinery furnaces

Sector 1A1b (SNAP 030106)

The SO_2 emission from combustion of refinery gas in refinery furnaces has been included as a point source with plant specific SO_2 emission data in 1994 and onwards.

In 1980-1993 the consumption of refinery gas in refinery furnaces has been included as area sources and thus an emission factor applied. The emission factor 190 g/GJ has been based on plant specific emission data from the three refineries in operation in Denmark in 1994. The emission factor has been estimated based on the assumption that all SO_2 from refinery furnaces originate from refinery gas, and thus the emission share from residual oil has been assumed to be zero. This assumption is, however, considered inappropriate and the time-series will be changed before the 2006 reporting. Due to the way the emission factor for residual oil has been estimated the total SO_2 from refinery furnaces will, however, not change.

1.21 Refinery gas, gas turbines and other plants

The emission factor for gas turbines (1 g/GJ) has been based on plant specific emission data from a gas turbine only combusting refinery gas. The turbine is installed in a Danish refinery plant. Plant specific emission data for 1995-2002 have been included in the estimate. In the Danish energy statistics refinery gas also occurs in a few other non-furnace plants. For these plants the emission factor has been assumed to be the same as for the gas turbine (NERI assumption).

1.22 Biogas, gas engines

Sector 1A1a, 1A1c, 1A2f, 1A4a, 1A4c (SNAP 010105, 010205, 010505, 030105, 020105, 020304)

The SO_2 emission factor for biogas fuelled engines refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on 5 biogas engines. Despite the limited number of emission measurements the fuel consumption of the plants represented 11% of the biogas consumption in gas engines in year 2000.

1.23 Biogas, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4c (SNAP 0101, 010101, 010102, 010103, 010104, 0102, 010203, 0301, 030102, 030104, 0201, 020103, 020104, 0203)

The emission factor 25 g/GJ has been estimated based on a H_2S content of 200 ppm. The sulphur content refers to Christiansen (2003) and to Hjort-Gregersen (1999). The biogas has been assumed to be a typical manure gas consisting of approximately 35% CO_2 and 65% CH_4. The sulphur content is 0,025% (w/w).

Table 10 SO_2 emission factor for biogas

Dato	Value
H_2S content	200 ppm
Density H_2S	1,521 kg/m^3
Lower heating value	23,48 MJ/m_n^3
SO_2 emission factor	24,4 g/GJ
200·1,521/23,48 = 12,96 mg H_2S/MJ	
12,96·32/34 = 12,19 mg S/MJ	
2·12,19=24,4 mg SO_2/MJ	

2 NO_x

2.1 Coal, large power plants

Sector 1A1a (SNAP 010101, 010102, 010103, 010104, 010105)

It has been assumed that the small fuel consumption of coal registered in plant category 010105 (engines) is actually combusted in another public power plant (SNAP 0101xx).

The NO_x emission and the fuel consumption for Danish power plants >25MW_e are available for all plants for the years 1990 and onwards. In general the plant specific data have been included in the emission inventories.

For some years a small part of the coal consumption has, however, been included as an area source. The NO_x emission factors for coal have been estimated as an average value based on the annual reporting from the electricity transmission companies in Denmark, Eltra and Elkraft System[4]. The implied emission factors have been estimated based on the assumption that all fuels contribute equally to the NO_x emission (total NO_x emission/total fuel consumption). The estimated emission factors have, however, only been applied for coal and residual oil.

The calculated time- series for the NO_x emission factor are shown below.

Table 11 NO_x emission factors for coal and residual oil, power plants

Year	NO_x emission [ton]	Total fuel consumption [TJ]	Estimated NO_x emission factor [g/GJ]
1990	83	243	342
1991	124	323	384
1992	82	279	294
1993	86	298	289
1994	90	337	267
1995	72	301	239
1996	108	432	250
1997	69	345	200
1998	54	305	177
1999	42	277	152
2000	32,5	252	129
2001	29	240	122
2002	32	246	130
2003	43	301	144

The emission factors for 1980-1982 refer to Fenhann & Kilde (1994). The emission factor for 1983-1989 has been estimated by NERI based on emission data from Fenhann & Kilde (1994) and fuel consumption data from the Danish energy statistics (DEA, 2004a).

2.2 Coal, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP 0102(xx), 0301(xx), 02(xx))

[4] Both are now part of the energy transmission company Energinet.dk

The 2000-2003 emission factor for other plants refers to Danish legislation (Luftvejledningen, 2001). According to this legislation the NO_x emission from 5-50 MW boilers should be below 200 mg/m_n^3 (ref. 10% O_2). This equals the emission factor 95 g/GJ[5]. The NO_x emission limit applies for new plants (2001 and onwards), but NERI has also applied the emission factor for year 2000.

For 1980-1992 the applied emission factor 200 g/GJ refers to Fenhann and Kilde (1994). NERI has assumed the same emission factor for 1993-1999.

For comparison legislation concerning plants larger than 50MW (Bek. 689, 1990) has ensured that the emission limit, which was 650 g/m_n^3 (ref. 6% O_2) for plants installed before 1992 has been changed to 200 g/m_n^3 (ref. 6% O_2) for plants installed after 1992. These emission limits corresponds to 225 g/GJ and 69 g/GJ. However, in the inventories for 1990 and onwards plants larger than 50 MW have in general been included in the inventory as point sources with plant specific NO_x emission data.

2.3 Brown coal briquettes and Coke oven coke

Sector 1A2f, 1A4a, 1A4b & 1A4c (SNAP 0301(xx), 02(xx))

Emission factors for brown coal briquettes and coke oven coke have been assumed to be the same as for coal (NERI assumption). The consumption of these two fuels has been very low all years.

2.4 Petroleum coke, power plants, district heating and industry

Sector 1A1a & 1A2f (SNAP 0101(xx), 0102(xx), 0301(xx))

NERI have assumed that the emission factor for petroleum coke combusted in power plants, district heating plants and industrial plants is the same as for coal combustion in district heating/industrial plants. This has been assumed for all years.

2.5 Petroleum coke, residential and other plants

Sector 1A4a, 1A4b, 1A4c (SNAP 0201(xx), 0202(xx), 0203(xx))

The emission factor for petroleum coke combusted in residential plants or other plants refers to the EMEP/Corinair Guidebook (EMEP/CorinAir, 2004). The guidebook (page B112-15) suggests the NO_x emission factor 50 g/GJ for petroleum coke combusted in non-residential plants.

2.6 Wood, CHP plants and large power plants

Sector 1A1a (SNAP 010101, 010102, 010103, 010104)

The NO_x emission factor for wood combusted in CHP plants refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on two wood combusting plants. Despite the limited number of plants on which emission measurements were performed the fuel consumption of the plants represented 44% of the wood consumption in CHP plants in year 2000. The emission factor 69 g/GJ

[5] The equation in the legislation is not correct. The constant 212 should have been 130.

has been applied for the inventories for 1992 and onwards. Wood was not combustion in CHP plants before 1992.

2.7 Wood, residential plants

Sector 1A4b (SNAP 0202)

The emission factor for wood combustion in residential plants 120 g/GJ refers to the IPCC Reference Manual (IPCC, 1996). The emission factor for conventional stoves has been applied (page 1.56). The default emission factor for residential wood combustion is 100 g/GJ (page 1.38).

2.8 Wood, other plants

Sector 1A1a, 1A2f, 1A4a, 1A4c (SNAP 010105, 0102(xx), 0301(xx), 0201(xx), 0203(xx))

The applied emission factor for wood combustion in district heating plants, industrial plants and other non-power producing and non-residential plants is 130 g/GJ. Several references have been considered:

- According to Danish legislation (Luftvejledningen, 2001) the allowed NO_x emission for wood combustion is 300 mg/m_n^3 (ref. 10% O_2) that equals 143 g/GJ. This applies for 1-50 MW boilers and thus most district heating plants and industrial plants are included.
- According to a Danish report from 1999 (Serup et al. 1999) the emission factor for district heating plants combusting wood is in the interval 40-140 g/GJ and a typical value is 90 g/GJ.
- According to another Danish report from 1997 (Christensen, 1997) the emission factor is 55-230 g/GJ.
- According to the IPCC Reference Manual (IPCC, 1996) the default emission factor for district heating and industry is 100 g/GJ (page 1.38). On the detailed level the following emission factors have been stated:
  - Industrial stoker boilers 65 g/GJ (page 1.54)
  - Commercial boilers 130 g/GJ (page 1.57)

The applied emission factor 130 g/GJ is in the right level, but might be somewhat too high. In future inventories the emission factor 90 g/GJ will be applied at least for resent years.

2.9 Municipal waste, CHP plants

Sector 1A1a (SNAP 0101(xx))

The NO_x emission factor for municipal waste combusted in CHP plants refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on five municipal waste CHP plants. Including the existing emission measurements that were collected during the project, data was available from 15 plants (17 combustion lines). These plants represented 70% of the consumption of municipal waste in CHP plants in year 2000. The emission factor 124 g/GJ has been applied for the inventories from 1988, which was the first year that included municipal waste combustion in CHP plants.

The current legislation for municipal waste incineration plants (Bek. 162, 2003) states two emission limits: 400 mg/m_n^3 (ref. 11% O_2) corresponding to 210 g/GJ for existing plants with a capacity of less than 6 tonnes/hour and 200 mg/m_n^3 (ref. 11% O_2) corresponding to 105 g/GJ for other plants. These emission factors will, however, not be fully implemented for existing plants until 2010. The former legislation concerning waste incineration (Bek. 41, 1997 and Vejledning 60273, 1993) did not include legislation concerning NO_x emission.

2.10 Municipal waste, other plants

Sector 1A1a, 1A2f, 1A4a (SNAP 0102(xx),0301(xx), 0201(xx))

The NO_x emission factor 164 g/GJ applied for non-power producing plants (mainly district heating plants) has been estimated by NERI based on plant specific emission data from non-power producing plants in 2000. The same emission factor has been applied in 1985-2003. In recent years the main part of municipal waste has been applied in power producing plants.

The current legislation will not be fully implemented until 2010 (see Chapter 2.9).

2.11 Straw, CHP plants and large power plants

Sector 1A1a (SNAP 0101(xx))

The NO_x emission factor for wood combusted in CHP plants < 25MW_e refers to a Danish study (Nielsen & Illerup, 2003) that included emission measurements on five straw combusting plants. Despite the limited number of plants on which emission measurements were performed, the fuel consumption of the plants represented 58% of the straw consumption in decentralised CHP plants in 2000. The emission factor 131 g/GJ has also been applied for combustion of straw in large power plants. However, plant specific NO_x emission data are usually available for large power plants. The emission factor has been applied for all years.

2.12 Straw, other plants

Sector 1A1a, 1A2f, 1A4b, 1A4c (SNAP 0102(xx), 0301(xx), 0202, 0203(xx))

The NO_x emission factor (153 g/GJ) for straw combusted in non-power producing plants refers to Danish legislation.

- According to Luftvejledningen (2001) the NO_x emission from 1-50 MW boilers should be below 300 mg/m_n^3 (ref. 10% O_2) corresponding to 156 g/GJ. A considerable part of the boilers are below five MW and thus the legislation is only relevant for part of the straw consumption. For plants producing district heating more than half the consumption is covered by the legislation. However, small farmhouse boilers are not regulated by the legislation.
- According to Bek. 689 (1990) the NO_x emission for large boilers (> 50MW) should be below 400 mg/m_n^3 (ref. 6% O_2) corresponding to 153 g/GJ. This is the present reference for the emission factor. However, the plant size is not typical for non-power producing boilers combusting straw. The reference should be altered in future inventories.

Due to lack of data from farmhouse boilers and other non district heating plants the emission factor has been assumed to be the same as for district heating plants (NERI assumption).

According to the EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) the emission factor for agricultural waste is 80-100 g/GJ. The reference has not been considered in the determination of the emission factor and it suggests that the present emission factor might be overestimated.

According to Nikolaisen et al. (1998) the typical emission factor for Danish district heating plants combusting straw is 90 g/GJ with a typical interval of 40-150 g/GJ. This reference has not been considered in the determination of the emission factor. However, the reference is considered relevant and it is suggested that the emission factor 90 g/GJ is applied for district heating plants in future inventories. The new emission factor meets the legislative emission limits in Luftvejledningen (2001). Due to lack of data from other non-power producing plants the emission factor 90 g/GJ will be applied for these as well.

2.13 Residual oil, power plants

Sector 1A1a (SNAP 0101(xx))

The NO_x emission and the fuel consumption for Danish power plants >25MW_e are available for all plants for the years 1990 and onwards. In general the plant specific data have been included in the emission inventories.

For some years a small part of the residual oil consumption has, however, been included as an area source. The NO_x emission factor for residual oil has been estimated as an average value based on the annual reporting from the electricity transmission companies in Denmark, Eltra and Elkraft System[6]. The implied emission factors have been estimated based on the assumption that all fuels contribute equally to the NO_x emission (total NO_x emission/total fuel consumption). The estimated emission factors have, however, only been applied for coal and residual oil. The calculated time-series for the NO_x emission factor are shown in Chapter 2.1.

For the years 1980-1989 the applied emission factor is 240 g/GJ. This emission factor refers to Fenhann & Kilde (1994).

2.14 Residual oil, industrial plants

Sector 1A2f (SNAP 0301(xx))

The NO_x emission factor for residual oil combusted in industrial plants refers to Danish legislation.

- According to Luftvejledningen (2001) the NO_x emission from 2-50 MW boilers should be below 300 mg/m_n^3 (ref. 10% O_2) corresponding to 142 g/GJ. Residual oil should not be applied in boilers < 2 MW in Denmark.
- According to Bek 689 (1990) the NO_x emission from boilers > 50 MW should be below 450 mg/m_n^3 (ref. 3% O_2) corresponding to 130 g/GJ. The emission from plants installed after 1992 should be below 225 mg/m_n^3 (ref. 3% O_2) corresponding

[6] Both are now part of the energy transmission company Energinet.dk

to 65 g/GJ. A later update of the legislation (Bek. 518, 1995) confirms the same emission limits for residual oil.

The industrial plants combusting residual oil have been analysed based on the energy statistics (DEA, 2004a; DEA, 2004c). Considering the year 2003 the industrial consumption on plants that produce power and/or district heating added up to 10% of the overall residual oil consumption in the industrial sector. The remaining 90% has been assumed to be boilers < 50 MW. The plants producing power or district heating are almost all > 50MW. The data are insufficient to decide which share has been installed before 1992, but it is a very limited number of plants and they are rather old. Thus approximately 90% of the consumption should have an emission factor below 142 g/GJ and approximately 10% should have an emission factor below 130 g/GJ.

Based on these reflections NERI has assumed that the emission factor is 130 g/GJ. The same emission factor has been assumed for all years. The emission factor has been assumed to be the same independent of plant type (engine, gas turbine or boiler) and independent of boiler capacity (NERI assumption).

For comparison the EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) suggests the emission factor 165 g/GJ for industrial plants (unknown plant type, page B112-15). IPCC suggests the emission factor 170 g/GJ for industrial boilers combusting residual oil (IPCC, 1996). Both references suggest emission factors above Danish legislation.

2.15 Residual oil, other plants

Sector 1A1a, 1A1b, 1A4a, 1A4b, 1A4c (SNAP 0102(xx), 010306, 0201(xx), 0202, 0203(xx))

Residual oil combusted in plants that are not either power plants or industrial plants has been assumed to be boilers < 50MW. Thus the plants have to meet Danish legislation of 142 g/GJ (Luftvejledningen, 2001).

The EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) does not include a default emission factor for residual oil combusted in non-industrial plants. The IPCC Reference Manual (IPCC, 1996) suggests 130-200 g/GJ for utility boilers and 170 g/GJ for commercial boilers. Thus the legislative emission limit seems to be a reasonable choice.

The emission factor for refinery furnaces has been assumed to be the same (NERI assumption).

2.16 Gas oil, power plants

Sector 1A1a (SNAP 0101, 010101, 010102)

The emission factor applied for 2003 (249 g/GJ) has been estimated by NERI based on plant specific emission data 2003 (Eltra & Elkraft System, 2004) from two power plant boilers that only apply gas oil. Gas oil consumption ads up to less than 1% of the fuel consumption in power plants.

According to former sector reports for stationary combustion the emission factor applied for 1985-2002 (220 g/GJ) has been based on plant specific emission data for year 2000. However, the assumptions and the estimate itself have not been properly

archived and therefore the 2003 emission factor (249 g/GJ) will be applied for 1985-2002 in future inventories.

2.17 Gas oil, gas turbines

Sector 1A1a, 1A2f (SNAP 010104, 030104)

The emission factor for gas turbines combusting gas oil (350 g/GJ) hasve been estimated by NERI based on plant specific emission data from power plant turbines for the year 2000 (Eltra & Elkraft System, 2001). The emission factor has been applied for all years. Almost all gas oil fuelled gas turbines in operation in Denmark in 2003 were installed in centralised power plants.

The IPCC Reference Manual (IPCC, 1996) recommends 300 g/GJ for gas oil combustion in gas turbines. The EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) states the interval 100-531 g/GJ (page B112-15).

Legislation for plants > 50 MW (Bek. 689, 1990 and Bek. 518, 1995) states the emission limits 225 mg/m_n^3 (ref. 3% O_2) for "new plants" corresponding to 65 g/GJ or 450 mg/m_n^3 (ref. 3% O_2) for old plants corresponding to 130 g/GJ. However, the legislation excepts reciprocating engines and gas turbines. The new legislation for plants > 50 MW (Bek. 808, 2003) excludes gas turbine plants installed before 2003. Gas oil fuelled gas turbines have not been installed in Denmark since the 2003 legislation came into force.

2.18 Gas oil, stationary engines

Sector 1A1a, 1A1c, 1A2f, 1A4a, 1A4c (SNAP 010105, 010205, 010505, 030105, 020105, 020304)

The emission factor for gas oil combusted in stationary engines (700 g/GJ) refers to the EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) that states an interval of 80-1493 g/GJ. The emission is not regulated in Danish legislation.

2.19 Gas oil, small power plant boilers, district heating plants and industrial boilers

Sector 1A1a, 1A1b, 1A2f (SNAP 010103, 0201, 020101, 020102, 020103, 010306,0301, 030102, 030103, 030106)

According to the Danish energy statistics (DEA, 2004c) 81% of the district heating boilers in operation in Denmark in 2003 were applied in boilers < 50MW. Industrial boilers were all > 50MW. Small power plant boilers (SNAP 010103) are all < 50MW. However, both power plant boilers and district heating boilers are usually installed in plants that are > 50 MW and thus the plants should meet the emission limit for plants > 50MW.

The applied emission factor 65 g/GJ (1997-2003) has been based on Danish legislation for large boilers (Bek. 689, 1990). The emission factor corresponds to the emission limit 225 mg/m_n^3 (ref. 3% O_2) that applies for boilers > 50 MW installed after 1987. Plants installed before 1987 have to meet a somewhat higher emission limit (130 g/GJ). The emission limit for 1987 and onwards has been confirmed in the 1995 legislation for large boilers (Bek. 518, 1995). In the 2003 legislation (Bek. 808, 2003) for

large boilers the emission limit is 450 mg/m_n^3 (ref. 3% O_2) for plants installed before 2003. This corresponds to 130 g/GJ. For plants installed after 2003 the emission limit is 400 mg/m_n^3 (ref. 3% O2) corresponding to 116 g/GJ.

The EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) states the emission factor 70 g/GJ and the IPCC guidelines (IPCC, 1996) recommend the emission factor 65 g/GJ for industrial boilers. Thus these two references confirm the emission factor level.

For the years 1985-1990 the emission factor 100 g/GJ has been applied. This emission factor refers to Fenhann & Kilde (1994). The emission factors applied for 1991-1996 have been assumed to follow a constant decrease rate (NERI assumption). For small power plant boilers (SNAP 010103) the applied emission factors for 1994-1995 are not correct. The error will be corrected in the next inventory.

2.20 Gas oil, residential plants, commercial and institutional plants and plants in agriculture, forestry and aquaculture

Sector 1A4a, 1A4b, 1A4c (SNAP 0201, 020102, 020103, 0202, 0203, 020302)

Residential plants, commercial and institutional plants and plants in agriculture, forestry and aquaculture are all small plants. 120 kW - 50 MW boilers have to meet the Danish legislation in Luftvejledningen (2001). The emission limit is 110 mg/m_n^3 (ref. 10% O_2) for plants installed before 2001 and 250 mg/m_n^3 (ref. 10% O_2) for plants installed after 2001 corresponding to 52 g/GJ and 118 g/GJ. NERI is not acquainted with the year of installation for small boilers.

The EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) states the emission factor 47 g/GJ for residential gas oil combustion. IPCC Guidelines (IPCC, 1996) recommends the emission factor 65 g/GJ for residential combustion of gas oil.

NERI has assumed the same emission factor for residential plants, commercial and institutional plants and plants in agriculture, forestry and aquaculture. The applied emission factor 52 g/GJ refers to Luftvejledningen (2001).

2.21 Kerosene

Sector 1A2f, 1A4a, 1A4b, 1A4c (SNAP 0301, 0201, 0202, 0203)

The emission factor for kerosene 50 g/GJ refers to the EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004).

2.22 Fish & rape oil

Sector 1A1a, 1A2f, 1A4c (SNAP 010103, 0102(xx), 030105, 020304)

The emission factors for fish & rape oil have been assumed to be the same as for gas oil.

2.23 Orimulsion

Sector 1A1a (SNAP 010101)

Orimulsion has only been applied in a single large power plant boiler in Denmark. This power plant boiler has been included in the inventories as a point source with plant specific NO_x emission data included all years. Thus the emission factors that are stated in the area source emission factor time-series are only included for information. The emission factors have been estimated based on the plant specific data from the power plant boiler combusting orimulsion. The plant specific NO_x emission data refer to Eltra & Elkraft System (annual reporting) and the fuel consumption data refer to DEA (2004a) and the similar DEA data reported in former years.

2.24 Natural gas, power plants

Sector 1A1a (SNAP 0101, 010101, 010102)

Natural gas fuelled power plants have been included in the inventory as point sources with plant specific emission data (1990 and onwards). However, an area source emission factor has been estimated but only applied if small inconsistencies occur between plant specific fuel consumption data and total fuel consumption data.

The emission factor applied for 1985-1989 (240 g/GJ) refers to Fenhann & Kilde (1994).

The emission factor applied for 1990 and onwards 115 g/GJ has been based on plant specific emission data from power plants > 25 MW_e year 2000. Gas turbine plants were not included in the estimate.

In the new Danish legislation (Bek. 808, 2003) for existing large power plants combusting gas the emission limit is 350 mg/m_n^3 (ref. 3% O_2) corresponding to 97 g/GJ. This emission factor will be applied from 2004 and onwards.

2.25 Natural gas, gas turbines (and combined cycle plants)

Sector 1A1a, 1A2f, 1A4a, 1A4c (SNAP 010104, 030104, 020104, 020303)

Gas turbines > 25MW_e have been included in the inventory as point sources with plant specific NO_x emission data.

The NO_x emission factor for gas turbines applied for the years 2000 and onwards (124 g/GJ) refers to a Danish study (Nielsen & Illerup, 2003). This study included emission measurements on 17 gas turbine plants < 25MW_e. The emission measurements included in the estimate represented 67% of the natural gas consumption in gas turbines < 25MW_e in 2000. Time-series have been estimated based on the 1990 and 1995 emission factors (161 g/GJ and 141 g/GJ) also estimated in Nielsen & Illerup (2003). The decline rates in 1990-1995 and in 1995-2000 have been assumed constant.

The Danish legislation (Bek. 720, 1998) for gas turbines sets the emission limit to 200 mg/m_n^3 (ref. 5% O_2) corresponding to 62 g/GJ. Gas turbines installed before 1998 have to meet this emission limit in 2006. In 2003 it is still too soon to apply the lower emission factor.

2.26 Natural gas, gas engines

Sector 1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c (SNAP 010105, 010205, 010505, 030105, 020105, 020204, 020304)

The NO_x emission factor for gas engines applied for the years 2000 and onwards (168 g/GJ) refers to a Danish study (Nielsen & Illerup, 2003). This study included emission measurements on 157 gas engines. The emission measurements included in the estimate represented 54% of the natural gas consumption in gas engines in 2000. Time-series have been estimated based on the 1990 and 1995 emission factors (276 g/GJ and 194 g/GJ) also estimated in Nielsen & Illerup (2003). The decline rates in 1990-1995 and in 1995-2000 have been assumed constant.

The Danish legislation (Bek. 720, 1998) for gas engines sets the emission limit to 550 mg/m_n^3 (ref. 5% O_2) corresponding to 172 g/GJ. Gas engines installed before 1998 have to meet this emission limit in 2006. In 2003 it is still too soon to apply the lower emission factor.

2.27 Natural gas, small boilers

Sector 1A4a, 1A4b, 1A4c (SNAP 0201, 020103, 0202, 020202, 0203)

NERI has assumed that small natural gas fuelled boilers are the boilers applied in residential plants, commercial & institutional plants and plants in agriculture, forestry and aquaculture.

The applied emission factor for 1985-1989 (50 g/GJ) refers to Fenhann & Kilde (1994).

The emission factor applied for 1990 and onwards is 30 g/GJ. Several references have been taken into account. The first two are the primary references for the applied emission factor.

- According to the environmental report from Danish Gas Technology Centre (Gruijthuijsen & Jensen, 2000) the emission factor for residential plants is 20 g/GJ for condensing boilers and 50 g/GJ for conventional boilers.
- According to Danish legislation (Luftvejledningen, 2001) for 120 kW – 50 MW boilers new boilers have to meet the emission limit at 65 mg/m_n^3 (ref. 10% O_2) and for boilers installed before 2001 the emission limit is 125 mg/m_n^3 (ref. 10% O_2) corresponding to 29 g/GJ and 57 g/GJ, respectively.
- The IPCC Guidelines (IPCC, 1996) states the emission factor to 47 g/GJ for residential boilers and to 45 g/GJ for commercial boilers
- The EMEP/CorinAir Guidebook (EMEP/CorinAir, 2004) states the emission factors to 38 g/GJ for small consumers and to 30-46 g/GJ for residential boilers.

2.28 Natural gas, district heating boilers and industrial boilers

Sector 1A1a (SNAP 010103, 010202, 010203, 0301, 030102, 030103, 030106)

Boilers in district heating plants, industry and smaller boilers installed at power producing plants are considered large boilers – however, not larger than 50 MW.

The emission factor applied for 1985-1989 is 100 g/GJ. This emission factor has been applied for industrial boilers in Fenhann & Kilde (1994). However, Fenhann & Kilde

(1994) states other emission factors for district heating plants and boilers installed in public power plants[7].

The emission factor for 1990 and onwards – 42 g/GJ – refers to a report from Danish Gas Technology Centre (Wit & Andersen, 2003). The emission factor is the average of the stated NO_x emission interval 30-55 g/GJ for ordinary gas-blower burners.

Regarding Danish legislation (Luftvejledningen, 2001) for 120 kW – 50 MW boilers new boilers have to meet the emission limit at 65 mg/m_n^3 (ref. 10% O_2) and for boilers installed before 2001 the emission limit is 125 mg/m_n^3 (ref. 10% O_2) corresponding to 29 g/GJ and 57 g/GJ respectively. Almost all boilers in operation are installed before 2001 (Kristensen, 2005 and Wit, 2005).

2.29 LPG

Sector 1A1a, 1A2f, 1A4a, 1A4b, 1A4c (SNAP: All)

The emission factors applied for LPG refer to the IPCC Guidelines (IPCC, 1996). The emission-applied factors are:

- 96 g/GJ for combustion in energy and transformation industry or in industrial plants (SNAP 01 and 03)
- 71 g/GJ for combustion in commercial and institutional plants and in agriculture, forestry and aquaculture (SNAP 0201 and 0203)
- 47 g/GJ for residential plants (SNAP 0202)

The same emission factors have been applied for all years.

2.30 Refinery gas, gas turbine

Sector 1A1b (SNAP 010304)

The applied emission factor for refinery gas combusted in gas turbines refers to plant specific emission data in 2000. The only refinery- fuelled gas turbine in operation in Denmark has, however, been included as a point source with plant specific emission data since 1994.

2.31 Refinery gas, other

Sector 1A1b (SNAP 0103, 010306)

The refineries have been included as point sources with plant specific emission factors in the Danish inventory since 1994. The emission factor 100 g/GJ for refinery gas not applied in gas turbines refers to Fenhann & Kilde (1994).

[7] All boiler capacities

2.32 Biogas, gas engines

Sector 1A1a, 1A1c, 1A2f, 1A4a, 1A4c (SNAP 010105, 010205, 010505, 030105, 020105, 020304)

The NO_x emission factor for gas engines applied for the years 2000 and onwards (540 g/GJ) refers to a Danish study (Nielsen & Illerup, 2003). This study included emission measurements on 15 gas engines. The emission measurements included in the estimate represented 21% of the biogas consumption in gas engines in 2000. Time-series have been estimated based on the 1990 and 1995 emission factors (711 g/GJ and 635 g/GJ) also estimated in Nielsen & Illerup (2003). The decline rates in 1990-1995 and in 1995-2000 have been assumed constant.

2.33 Biogas, industrial boilers > 50 MW

Sector 1A2f (SNAP 030102)

For industrial boilers > 50 MW the applied emission factor refers to Danish legislation for large boilers (Bek. 689, 1990 and Bek. 518, 1995). According to the legislation the emission limit for gas fuelled boilers > 50MW installed after 1987 is 225 mg/m_n^3 (ref. 5% O_2) corresponding to 59 g/GJ. The actual emission factor applied is 54 g/GJ, which is based on a somewhat different biogas quality than the biogas quality that has been assumed in resent years. In the next inventory the emission factor 59 g/GJ will be applied to achieve full agreement with the reference.

In the new legislation for boilers > 50 MW (Bek. 808, 2003) the emission limit is somewhat higher, but this has not been taken into consideration.

2.34 Biogas, other boilers

Sector 1A1a, 1A2f, 1A4a, 1A4c (SNAP 0101, 010101, 010102, 010103, 010104, 0102, 010203, 0301, 0201, 020103, 0203)

All boilers not registered as industrial boilers > 50 MW have been assumed < 50 MW. For boilers < 50 MW the emission factor 28 g/GJ refers to Danish legislation (Luftvejledningen, 2001).

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Appendix 5 Fuel rate

Table 40 Fuel consumption rate of stationary combustion plants [GJ].

fuel	fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
102	COAL	253443653	344304910	286838436	300798816	323397473	270346016	371908021	276277339	234284905	196471582	164707939	174308631	174654028	237988396
106	BROWN COAL BRI.	115932	166823	95324	128246	91500	74609	56053	54331	47745	37607	25748	32903	18922	3056
107	COKE OVEN COKE	1275912	1449734	1181054	1154538	1226146	1272910	1226000	1253015	1346306	1422574	1187177	1109591	1068454	995409
110	PETROLEUM COKE	4459523	4403568	4814028	6179382	4308896	4849824	6381422	6523131	5797915	7283513	7291583	8313464	8281655	8465315
111	WOOD AND SIMIL.	18246814	20042438	21030661	22220199	21939961	21844810	23389205	23459226	22937838	24402570	26744717	28699132	31173732	35915081
114	MUNICIP. WASTES	15499033	16744033	17797251	19409907	20312344	22906324	24952440	26770061	26590826	29138335	30351595	32233660	35056955	36174969
117	STRAW	12481150	13306150	13880150	13366000	12662374	13053146	13545635	13911770	13903702	13668183	12219993	13698193	15651212	16718510
118	SEWAGE SLUDGE											40162	0	64508	55369
203	RESIDUAL OIL	32115776	37019676	37331786	32498181	46701347	34069407	38484607	26693239	29479704	22987286	18041774	20248414	24751387	27181710
204	GAS OIL	61673851	65356000	55971755	62121901	53387561	53919044	57780170	51428302	48289913	47661150	41310063	43981473	39146911	39429204
206	KEROSENE	5086021	943393	783765	771272	649577	580777	539748	436636	417009	255606	169963	286786	256128	338430
210	NAPHTA														
215	RAPE & FISH OIL	744000	744000	744000	800000	245419	250912	60409	13751	13620	27148	49046	191475	126772	258882
225	ORIMULSION						19913113	36766527	40488416	32580001	34190632	34148181	30243677	23846404	1921399
301	NATURAL GAS	76092457	86106669	90466659	102475053	114585627	132698633	156276599	164489313	178706886	187876815	186121969	193826826	193718209	195004805
303	LPG	2529846	2444287	2165623	2168768	2152828	2361756	2558236	2012873	2049212	1779679	1456930	1184179	1062049	1133994
308	REFINERY GAS	14169000	14537000	14865000	15405000	16359999	20837864	21476000	16945381	15225340	15723812	15556268	15755428	15197000	16554512
309	BIOGAS	752001	910000	898999	1077001	1279488	1753646	1985110	2390005	2635029	2612573	2870670	3020152	3331898	3542571
Total		**498684968**	**608478681**	**548864491**	**580574264**	**619300540**	**600732790**	**757386181**	**653146789**	**614305951**	**585539065**	**542293778**	**567133984**	**567406224**	**621681612**

Table 41 Detailed fuel consumption data for stationary combustion plants [GJ]

ipcc_id	fuel	fuel_gr_abbr	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1A1a	102	COAL	0101	8523090	12892052	10175750	8221270										
1A1a	102	COAL	010101	219780959	303105248	252745120	269458670	295430108	244510483	347251766	252648133	211429498	176640613	146911420	158990462	161608390	225396935
1A1a	102	COAL	010102	2118951	2653700	2250130	2269060	8604699	8380814	9032905	8671429	9022776	8238010	6224846	4970502	4684578	4578267
1A1a	102	COAL	010103					837469	526213	149470	38928	24301	33747	35480	24354	15476	33831
1A1a	102	COAL	010104					272428	269521	301136	74422						
1A1a	102	COAL	010105					20360									
1A1a	102	COAL	0102	6017000	6635000	5173000	3581000	0	0	0	0						
1A1a	102	COAL	010201					153003	20286								
1A1a	102	COAL	010202					1112251	789684	199724	64713	17914	371	371	1494	363	371
1A1a	102	COAL	010203					377837	316754	228340	48919	48071	6562	3551	439	0	0
1A1a	110	PETROLEUM COKE	0101				1239000										
1A1a	110	PETROLEUM COKE	0102														
1A1a	111	WOOD AND SIMIL.	0101			172000	515000										
1A1a	111	WOOD AND SIMIL.	010101					42966				263719	0		920	65930	304980
1A1a	111	WOOD AND SIMIL.	010102			0	0	1053223	865377	861821	1001257	1371873	2377322	2274825	2186568	3175531	5854505
1A1a	111	WOOD AND SIMIL.	010103					623575	671570	578451	644712	575350	732058	669817	747047	780123	446474
1A1a	111	WOOD AND SIMIL.	010104					78890	4410							120031	1656898
1A1a	111	WOOD AND SIMIL.	010105										1674	53468	60394	61748	369
1A1a	111	WOOD AND SIMIL.	0102	3217000	3648000	4096000	3751000	0	0	0	0						
1A1a	111	WOOD AND SIMIL.	010201					8537									
1A1a	111	WOOD AND SIMIL.	010202					44	43575	164768	190941	207278	193907	179937	249689	164347	196112
1A1a	111	WOOD AND SIMIL.	010203					3337730	3490933	3857403	3795439	3971995	3928219	3882223	4297719	4650874	5066279
1A1a	114	MUNICIP. WASTES	0101	990000	3563000	5578000	8433000										
1A1a	114	MUNICIP. WASTES	010101									1288015	1278184	1230861	2809020	3502130	143440
1A1a	114	MUNICIP. WASTES	010102		0	0	0	5110126	6527009	7152947	10831534	11715082	16937780	18305718	17902293	19002825	22524122
1A1a	114	MUNICIP. WASTES	010103					2909656	3755268	5002562	3074395	1957053	4039009	8361289	8343163	8321439	7848203
1A1a	114	MUNICIP. WASTES	010104					1665338	2027577	3191968	3025187	2806452	2452693	416975	0	0	625367
1A1a	114	MUNICIP. WASTES	010105											0	0	0	0
1A1a	114	MUNICIP. WASTES	0102	13567000	12142000	11111000	9839000	0	0	0	0						
1A1a	114	MUNICIP. WASTES	010201					6980									
1A1a	114	MUNICIP. WASTES	010202					3472288	3703267	4646064	4649086	4617704					
1A1a	114	MUNICIP. WASTES	010203					5908716	5559213	3698956	3978326	3458148	2915393	1395589	2195038	2430354	2570284
1A1a	117	STRAW	0101	479000	985000	1487000	1643000										
1A1a	117	STRAW	010101					100254	82215	610291	740153	1013770	1339800	1119600	1587710	2643060	3191917
1A1a	117	STRAW	010102	0	0	0	0	621557	1286956	1704388	1845052	1751935	1819429	1826796	1746166	1640945	1712033
1A1a	117	STRAW	010103					1126908	1297258	1361686	1174181	1180826	1058038	640340	1905033	1754340	1927521
1A1a	117	STRAW	010104												101730	1215692	1706623
1A1a	117	STRAW	0102	3524000	3843000	3915000	3806000	0	0	0	0						
1A1a	117	STRAW	010201					22040									
1A1a	117	STRAW	010202					57304	179931	114376	95990	136489	141564	150510	97600	0	0
1A1a	117	STRAW	010203					3378461	3409001	3699694	3564019	3525786	3565456	3290636	3418313	3555625	3338866
1A1a	203	RESIDUAL OIL	0101	774830	364138	1742448	741228							0	0	0	0
1A1a	203	RESIDUAL OIL	010101	7171573	10052580	8691120	8420050	22142392	11174241	16072213	7736420	11557361	7213503	4045724	5950549	5018057	7329328
1A1a	203	RESIDUAL OIL	010102	42265	16950	27100	24390	180490	253891	443479	420683	510374	762923	513002	253635	278953	334256
1A1a	203	RESIDUAL OIL	010103					252297	173028	201180	159318	115535	101551	108599	117384	120150	106040
1A1a	203	RESIDUAL OIL	010104					320163	347198	237194	302167	355440	118177	117319	1767903	6694775	9358988
1A1a	203	RESIDUAL OIL	010105	9332	9332	9332	9332	11554	4323	4888	2415	5984	4137	17206	533	656	5900
1A1a	203	RESIDUAL OIL	0102	2006000	2236000	1141000	879000	0	0	0	0						
1A1a	203	RESIDUAL OIL	010202					134116	172981	171395	140565	102376	135957	58729	86854	122795	83920
1A1a	203	RESIDUAL OIL	010203					858909	938696	1201058	874538	779146	961623	617493	611104	547566	323210
1A1a	204	GAS OIL	0101	239170	416396	641323	245263							0	0	0	0
1A1a	204	GAS OIL	010101					12386	51300	41614	194854	108730	258004	135602	122718	92395	956997
1A1a	204	GAS OIL	010102	0	0	0	0	42898	30019	153012	113506	82184	158532	278595	366847	279069	114717
1A1a	204	GAS OIL	010103					59149	40405	78104	41727	44468	61232	0	34258	36567	16629
1A1a	204	GAS OIL	010104	43987	43987	43987	43987	43987	75632	81094	54042	146795	60385	103191	40026	75242	79241
1A1a	204	GAS OIL	010105	16843	32617	34690	34750	116493	136913	99083	100449	133710	108002	68733	84634	66390	63501
1A1a	204	GAS OIL	0102	1941000	813000	744000	947000	0	0	0	0						
1A1a	204	GAS OIL	010201					27268	7000								

1A1a	204	GAS OIL	010202					174046	360676	799818	514978	418139	257831	694229	830045	166763	256178
1A1a	204	GAS OIL	010203					843648	444369	554844	509625	652349	296296	233116	354842	306816	1125856
1A1a	204	GAS OIL	010205					717					1055	0	0	0	0
1A1a	210	NAPHTA	0101														
1A1a	215	RAPE & FISH OIL	010103					33707	24000	21799	188	5213	6974				2168
1A1a	215	RAPE & FISH OIL	0102	744000	744000	744000	800000										
1A1a	215	RAPE & FISH OIL	010202														18807
1A1a	215	RAPE & FISH OIL	010203					211712	226912	38610	13563	8407	20174	48900	190810	126336	237665
1A1a	225	ORIMULSION	010101						19913113	36766527	40488416	32580001	34190632	34148181	30243677	23846404	1921399
1A1a	301	NATURAL GAS	0101								5511	21264	16787	14558	11364	2	1188
1A1a	301	NATURAL GAS	010101	4005028	4394781	3279455	4422200	8437973	10453816	12217008	14600070	20808855	21307826	23541558	20514966	19246614	20165293
1A1a	301	NATURAL GAS	010102	0	0	0	0	295111	299964	1346036	5620044	5987198	2416146	1589836	4250088	2893468	1877463
1A1a	301	NATURAL GAS	010103					2487008	1775265	1558418	1138214	958646	716525	683789	733694	657392	1057907
1A1a	301	NATURAL GAS	010104	1859206	2396900	4806049	7327221	7776734	8547713	14500109	12220262	13002948	21614378	22973678	25003005	30030786	29928352
1A1a	301	NATURAL GAS	010105	677767	1291319	2199496	4168579	8358415	16419956	22162423	24109208	26700713	26833951	25639911	27865345	27701651	27012113
1A1a	301	NATURAL GAS	0102	11033000	13655000	12350000	11420000	0	0	0	0	0					
1A1a	301	NATURAL GAS	010202					1072469	1017168	844253	660506	539227	282207	217700	286968	291201	278471
1A1a	301	NATURAL GAS	010203					6160497	5525191	3803076	2420020	1988837	1873511	1427019	1768484	1482319	1849960
1A1a	301	NATURAL GAS	010205					131795	338556	377124	230400	235829	226189	203414	228049	207211	171691
1A1a	303	LPG	0101		1000	1000	3000										
1A1a	303	LPG	010103						736	0							
1A1a	303	LPG	0102	9000	13000	10000	0	0	0		0						
1A1a	303	LPG	010203					2732					9	246	0	0	0
1A1a	308	REFINERY GAS	010101							35204	40077						
1A1a	309	BIOGAS	0101	141178	218984	29049	41826										
1A1a	309	BIOGAS	010101					16910	419	24075	19550						
1A1a	309	BIOGAS	010102	0	0	0	0	9835	0	94326	40561	50269	29597	25771	23338	20466	21787
1A1a	309	BIOGAS	010103					54324	118012	79237	111449	86924	103711	134968	123991	90125	97272
1A1a	309	BIOGAS	010104			78865	89233	199961	169040	6536							
1A1a	309	BIOGAS	010105	94822	175016	251085	405941	415191	599387	826301	1229745	1548936	1500477	1548734	1589322	1686300	1704661
1A1a	309	BIOGAS	0102	30000	30000	53000	53000	0	0	0	0						
1A1a	309	BIOGAS	010203					45538	43775	54145	33623	31287	25003	21733	11129	12650	17130
1A1a	309	BIOGAS	010205					40607									
1A1b	203	RESIDUAL OIL	010306	1309202	2038140	3568653	3490237	3336717	2333787	2244019	1622382	1106086	1089501	1322995	1442929	1362640	907082
1A1b	204	GAS OIL	010306		40029	44476	29125	49319	33321	21879	87482						3085
1A1b	303	LPG	010306		0	4600		8004	15042	20654	18492						
1A1b	308	REFINERY GAS	0103	458000	926000	1526000	15917										
1A1b	308	REFINERY GAS	010304				2067083	2355000	2289700	5069590	4081532	2996106	4172606	3907567	3978922	3855200	3804097
1A1b	308	REFINERY GAS	010306	13520108	13485940	13236820	13213580	14004999	18548164	16336522	12771044	12202506	11551206	11648701	11776506	11341800	12750415
1A1c	204	GAS OIL	010505													151	116
1A1c	301	NATURAL GAS	010502	0	0	0	0	0	399247	390587	417415	413342	409043	340514	352650	379362	322831
1A1c	301	NATURAL GAS	010504	9482284	9703068	11118697	11235480	12267791	12506433	14849859	19454575	21636547	23561526	25015663	24413386	26179968	26247274
1A1c	301	NATURAL GAS	010505	1760	3520	3520	3520	2570	4494	7551	4939	15340	13883	13889	11887	11473	12396
1A1c	309	BIOGAS	010505	6803	6803	6803	6803	5946	51779	60257	57462	31144	29028	32507	28627	31216	31791
1A2f	102	COAL	0301	8850301	8982254	6751419	7698631	5866929	4832666	4460978	4494493	4676030	3714902	3667193	3358610	2126818	1536650
1A2f	102	COAL	030102					614624	1051344	1449890	1466575	1405667	1411682	1063375	997381	998229	1569871
1A2f	102	COAL	030103					190179	182609	192925	192444	0					
1A2f	102	COAL	030311	5018873	6048697	6577274	6602369	6913652	7224934	7067609	7209034	6627624	5638061	5708047	4718458	4348589	3368675
1A2f	106	BROWN COAL BRI.	0301	4374	6680	3806	17714	2745	2031	1464	1025						
1A2f	107	COKE OVEN COKE	0301	1169318	1351052	1077654	1073318	1163151	286685	303658	295421	319382	380768	238247	223280	279401	276382
1A2f	107	COKE OVEN COKE	030318						937440	885600	930960	1006560	1030320	943920	883440	786240	693360
1A2f	110	PETROLEUM COKE	0301	300247	0	56107	122868	0	98156	110026	33598	25842	38999	285426	127924	223785	229902
1A2f	110	PETROLEUM COKE	030311	2499252	2991306	3234048	3230652	3469025	3707398	4966161	5229890	4774684	6398880	6474743	7656733	7543476	7714392
1A2f	111	WOOD AND SIMIL.	0301	5783743	5690367	5750550	5821715	4464819	4254327	4097885	4166034	4273637	4250138	4450170	4410404	5854411	5970723
1A2f	111	WOOD AND SIMIL.	030102									1776	1496	955	950	0	0
1A2f	111	WOOD AND SIMIL.	030103					481414	412555	623748	523545	412235	413749	439542	430608	410827	294774
1A2f	114	MUNICIP. WASTES	0301	28033	28033	37251	38907	26336	28516	27942	23857	28854	35287				
1A2f	114	MUNICIP. WASTES	030102									0				0	4602
1A2f	114	MUNICIP. WASTES	030311											505233	795492	1787613	1406393
1A2f	117	STRAW	0301									446	446				
1A2f	117	STRAW	030103						3085								
1A2f	117	STRAW	030105											386	91	0	0
1A2f	118	SEWAGE SLUDGE	030311											40162	0	64508	55369

1A2f	203	RESIDUAL OIL	0301	16528584	17769972	17383144	14202407	13060233	11277994	11328646	9336208	8615100	7973673	7362935	7287922	7207646	5361504
1A2f	203	RESIDUAL OIL	030102					741775	911133	788578	789663	663124	695536	714099	791893	808652	1644621
1A2f	203	RESIDUAL OIL	030103					200248	207326	165590	122783	121633	135661	140375	89987	0	0
1A2f	203	RESIDUAL OIL	030104								54439		0	0	0	0	0
1A2f	203	RESIDUAL OIL	030105												22	10	787
1A2f	203	RESIDUAL OIL	030311	1762853	2152997	2366678	2397243	2618777	2840311	1771379	1863965	2538540	885967	858853	784	591804	587464
1A2f	204	GAS OIL	0301	665894	1575562	0	0	522742	1582383	2123771	2078532	1729346	2532751	2209631	3180458	2615282	3015931
1A2f	204	GAS OIL	030102						3438			440	1327	3138	5071	199	3574
1A2f	204	GAS OIL	030103					1678	1453	11390	1015	1623	64	82107	19	0	0
1A2f	204	GAS OIL	030104								244	377	6787	51	0	897	0
1A2f	204	GAS OIL	030105			1447	1578	1578						103	511	0	0
1A2f	204	GAS OIL	030106	6098	6636	8644	2762	9433	7030	6743	8178	15603	70265	8070	9828	7066	6887
1A2f	204	GAS OIL	030315								1040	603	4950	1650	2009	681	933
1A2f	206	KEROSENE	0301	69635	45692	38315	35461	30485	24464	30937	27840	16078	8909	7552	25543	65146	48233
1A2f	215	RAPE & FISH OIL	030105													334	242
1A2f	301	NATURAL GAS	0301	22280195	23780869	23887554	25535326	29248293	30317634	29252137	29423362	29114015	31167462	28607520	30073159	29817088	29031473
1A2f	301	NATURAL GAS	030102					862925	2661779	2464665	2971625	2961903	3100115	2690206	2869052	1190136	2273628
1A2f	301	NATURAL GAS	030103					300216	64308	146812	169825	131608	126872	116411	117965	14707	118562
1A2f	301	NATURAL GAS	030104	506337	608907	664092	729919	761202	909952	2562511	3366152	5106083	6501018	6756339	6138931	6724143	6526151
1A2f	301	NATURAL GAS	030105	187	187	187	187	11210	172920	873431	960232	1157405	1160055	1556394	1641970	1545466	1543942
1A2f	301	NATURAL GAS	030106	136059	24239	37695	70154	53489	24415	15283	5288	31735	38608	50809	53712	25558	17229
1A2f	301	NATURAL GAS	030315								924066	903336	1005440	1101274	1089048	1016242	945777
1A2f	301	NATURAL GAS	030318						624960	590400	620640	671040	686880	629280	588960	524160	552240
1A2f	303	LPG	0301	1522719	1603834	1466190	1273678	1337017	1486636	1636596	1277738	1299081	991730	632947	387254	308697	353256
1A2f	308	REFINERY GAS	0301	190892	125060	102180	108420	0	0	34684	52728	26728					
1A2f	309	BIOGAS	0301	0	0	0	0	13014	126131	96199	117439	73558	32726	32593	27929	37953	33614
1A2f	309	BIOGAS	030102					6534	16370	16478	19080	16361	16116	15755	59220	71672	95546
1A2f	309	BIOGAS	030104						1053	1265	1137						
1A2f	309	BIOGAS	030105									381	269	1487	23805	18459	14205
1A4a	102	COAL	0201	87539	9010	95877	75870	90286	66065	41261	43063	2306					
1A4a	106	BROWN COAL BRI.	0201	1025	1720		8217	769	622	421	309						
1A4a	110	PETROLEUM COKE	0201	62023	104190	90150	96354	0	70415	90528	97770	70544	50434	12070	12086	5355	9003
1A4a	111	WOOD AND SIMIL.	0201	204488	204488	204488	204488	216160	273035	449435	471415	492803	642041	775926	918817	972914	973866
1A4a	111	WOOD AND SIMIL.	020105									2096	2057		97	796	0
1A4a	114	MUNICIP. WASTES	0201	914000	1011000	1071000	1099000	1182354	1274551	1222406	1179697	709930	1472645	122160	175985	0	977733
1A4a	114	MUNICIP. WASTES	020103					30550	30923	9595	7979	9588	7344	13770	12669	12594	74825
1A4a	203	RESIDUAL OIL	0201	1070494	865011	600545	517393	718786	677072	717757	729305	383913	450237	343022	173185	478286	170881
1A4a	203	RESIDUAL OIL	020103					87533	78081								
1A4a	204	GAS OIL	0201	11794783	10622868	10421008	10011485	7156617	6556065	6619841	6093376	5442142	5781168	4957566	4685349	4031236	3625867
1A4a	204	GAS OIL	020102					190782		215		75					
1A4a	204	GAS OIL	020103					72		57796	58202	53618	39101	71306	44010	43890	29646
1A4a	204	GAS OIL	020105			1361	1485	733	20330	1754	294	21	66	1277	673	743	727
1A4a	206	KEROSENE	0201	569083	209843	206978	188910	154647	124344	103314	96459	127964	117233	63008	79642	69668	74131
1A4a	301	NATURAL GAS	0201	6376293	6934201	7382035	8908566	7343015	8436587	11247402	9106736	8661696	7525335	7233923	7908341	7264139	8020520
1A4a	301	NATURAL GAS	020103					2177			2434	49460	10801	43211	67208	165296	11053
1A4a	301	NATURAL GAS	020104		0			11946	25798	31397	25514	22995	30739	23335	31001	42862	33669
1A4a	301	NATURAL GAS	020105	45985	88875	278287	350372	473892	609395	681480	866185	959184	985839	1033132	1044813	1079590	1023163
1A4a	303	LPG	0201	82757	77097	76519	122201	125183	131001	137989	128417	116413	109573	121621	119345	136552	169985
1A4a	303	LPG	020103									9					
1A4a	303	LPG	020105									803	771				
1A4a	309	BIOGAS	0201	199072	179112	83895	64492	112893	169712	173026	271951	225094	292653	310904	354917	358989	290434
1A4a	309	BIOGAS	020103							14474	39396	71226	74379	86680	84512	74286	85295
1A4a	309	BIOGAS	020104						27092								
1A4a	309	BIOGAS	020105	270479	290438	386655	406059	349088	410626	389678	404594	439292	436918	506512	504222	528119	531465
1A4b	102	COAL	0202	589051	1125243	866285	785646	618696	376645	85595	86470	127147	79262	14443	12906	15370	318
1A4b	106	BROWN COAL BRI.	0202	50600	66685	39107	80209	75963	62403	47324	48550	43847	37607	25748	32903	18922	3056
1A4b	107	COKE OVEN COKE	0202	106594	98682	103400	81220	62995	48785	36742	26634	20364	11486	5010	2871	2813	25667
1A4b	110	PETROLEUM COKE	0202	760877	697484	961122	990337	839871	734273	928841	839269	725791	705961	513190	513393	509008	511264
1A4b	111	WOOD AND SIMIL.	0202	8954433	10412433	10720473	11859633	11564240	11760665	12668890	12569083	11134265	11615183	13847545	15248320	14769200	15003101
1A4b	117	STRAW	0202	5086890	5086890	5086890	4750200	4413510	4076820	3633120	3891945	3773190	3442590	3111555	2901450	2901450	2901450
1A4b	203	RESIDUAL OIL	0202	216927	218605	167748	129878	95249	62794	66254	45933	43266	50365	35611	26881	148870	47430
1A4b	204	GAS OIL	0202	46463224	50638393	42913606	49967084	43678618	43287857	45295557	39595464	37849748	35675468	30275667	31506271	28997757	27510588
1A4b	206	KEROSENE	0202	4404777	659635	512024	520836	437788	410845	382564	287211	251843	118954	91190	159051	110143	205243

1A4b	301	NATURAL GAS	0202	17362132	20432645	21439693	24903983	24736624	26947401	30412122	28361811	29137977	28981613	27568914	29562248	28081591	29027446
1A4b	301	NATURAL GAS	020202							25676	24503	18059	31289	55319	69007	30105	63281
1A4b	301	NATURAL GAS	020204	0	7932	499046	776351	1022812	1094868	1448246	1488432	1575546	1554382	1439173	1450266	1392257	1451228
1A4b	303	LPG	0202	669665	521639	442269	672725	588599	628367	653211	510109	545681	624403	650995	648947	607682	596053
1A4c	102	COAL	0203	2457889	2853706	2203581	2106300	2294953	1797999	1446423	1238716	903571	708372	1079213	1234026	856215	1503478
1A4c	106	BROWN COAL BRI.	0203	59933	91738	52411	22106	12023	9553	6844	4447	3898					
1A4c	110	PETROLEUM COKE	0203	837124	610588	472601	500171	0	239582	285866	322604	201054	89239	6154	3328	31	754
1A4c	111	WOOD AND SIMIL.	0203	87150	87150	87150	68363	68363	68363	86804	96800	230244	230875	170093	147164	147000	147000
1A4c	111	WOOD AND SIMIL.	020304									567	13851	216	435		
1A4c	117	STRAW	0203	3391260	3391260	3391260	3166800	2942340	2717880	2422080	2594630	2515460	2295060	2074370	1934300	1934300	1934300
1A4c	117	STRAW	020302								5800	5800	5800	5800	5800	5800	5800
1A4c	203	RESIDUAL OIL	0203	1223716	1295951	1634018	1687023	1942109	2616552	3070977	2492455	2563430	2396266	1778526	1640210	1365228	910801
1A4c	203	RESIDUAL OIL	020302									9051	1105	3269	2069	1964	6081
1A4c	203	RESIDUAL OIL	020304									9345	11104	4017	4570	3335	3417
1A4c	204	GAS OIL	0203	502852	1166512	1117213	837382	455397	1280853	1829800	1972963	1609942	2347866	2181257	2711181	2420922	2612416
1A4c	204	GAS OIL	020302								7						
1A4c	204	GAS OIL	020304							3855	2324			4774	2723	4846	6315
1A4c	206	KEROSENE	0203	42526	28223	26448	26065	26657	21124	22933	25126	21124	10510	8213	22550	11171	10823
1A4c	215	RAPE & FISH OIL	020304											146	665	102	0
1A4c	301	NATURAL GAS	0203	2222000	2680002	2385006	2462538	2485322	2559680	2666407	2644836	2476128	2241939	2383877	2687167	2543009	2531111
1A4c	301	NATURAL GAS	020303						0	5959	26127	65805	77171	61906	59503	64374	53821
1A4c	301	NATURAL GAS	020304	104224	104224	135847	160657	282141	961133	1796227	2620381	3354165	3379285	3109418	2934589	3116038	2855572
1A4c	303	LPG	0203	245705	227717	165045	97164	91293	99974	109786	78117	87225	53193	51121	28633	9118	14700
1A4c	309	BIOGAS	0203					2750	4455	132108	26121	34614	30392	76487	80321	162277	163605
1A4c	309	BIOGAS	020304	9647	9647	9647	9647	6897	15795	17005	17897	25943	41304	76539	108819	239386	455766
Total				498684968	608478681	548864491	580574264	619300540	600732790	757386181	653146789	614305951	585539065	542293778	567133984	567406224	621681612

Appendix 6 Emission factors

Table 42 CO_2 emission factors.

Fuel	Emission factor		Unit	Reference type	IPCC fuel
	Biomass	Fossil fuel			Category
Coal		95	kg/GJ	Country specific	Solid
Brown coal briquettes		94,6	kg/GJ	IPCC reference manual	Solid
Coke oven coke		108	kg/GJ	IPCC reference manual	Solid
Petroleum coke		92	kg/GJ	Country specific	Liquid
Wood	102		kg/GJ	Corinair	Biomass
Municipal waste	94,5	17,6	kg/GJ	Country specific	Biomass / Other fuels
Straw	102		kg/GJ	Country specific	Biomass
Residual oil		78	kg/GJ	Corinair	Liquid
Gas oil		74	kg/GJ	Corinair	Liquid
Kerosene		72	kg/GJ	Corinair	Liquid
Fish & rape oil	74		kg/GJ	Country specific	Biomass
Orimulsion		80	kg/GJ	Country specific	Liquid
Natural gas		57,19	kg/GJ	Country specific	Gas
LPG		65	kg/GJ	Corinair	Liquid
Refinery gas		56,9	kg/GJ	Country specific	Liquid
Biogas	83,6		kg/GJ	Country specific	Biomass

Time-series for natural gas and municipal waste are shown below. All other emission factors are the same for 1990-2003.

Table 43 CO_2 emission factors, time-series.

Year	Natural gas [kg/GJ]	Municipal waste, plastic [kg/GJ]	Municipal waste biomass [kg/GJ]
1990	56,9	22,5	+89,6
1991	56,9	22,5	+89,6
1992	56,9	20,5	+91,6
1993	56,9	19,6	+92,5
1994	56,9	19,6	+92,5
1995	56,9	18,5	+93,6
1996	56,9	17,6	+94,5
1997	56,9	17,6	+94,5
1998	56,9	17,6	+94,5
1999	56,9	17,6	+94,5
2000	57,1	17,6	+94,5
2001	57,25	17,6	+94,5
2002	57,28	17,6	+94,5
2003	57,19	17,6	+94,5

Table 44 CH_4 emission factors and references 2003.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	1A1a	010101, 010102, 010103	1,5	EMEP/Corinair 2004
COAL	1A1a, 1A2f, 1A4b, 1A4c	010202, 010203, 0301, 0202, 0203	15	EMEP/Corinair 2004
BROWN COAL BRI.	all	all	15	EMEP/Corinair 2004, assuming same emission factor as for coal
COKE OVEN COKE	all	all	15	EMEP/Corinair 2004, assuming same emission factor as for coal
PETROLEUM COKE	all	all	15	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	2	Nielsen & Illerup 2003
WOOD AND SIMIL.	1A4a, 1A4b, 1A4c	0201, 0202, 0203	200	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a, 1A2f	010105, 010202, 010203, 0301, 030102, 030103	32	EMEP/Corinair 2004
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	0,59	Nielsen & Illerup 2003
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	all other	6	EMEP/Corinair 2004
STRAW	1A1a	010102, 010103	0,5	Nielsen & Illerup 2003
STRAW	1A1a, 1A2f, 1A4c	010202, 010203, 020302, 030105	32	EMEP/Corinair 2004
STRAW	1A4b, 1A4c	0202, 0203	200	EMEP/Corinair 2004
RESIDUAL OIL	all	all	3	EMEP/Corinair 2004
GAS OIL	all	all	1,5	EMEP/Corinair 2004
KEROSENE	all	all	7	EMEP/Corinair 2004
FISH & RAPE OIL	all	all	1,5	EMEP/Corinair 2004, assuming same emission factor as gas oil
ORIMULSION	1A1a	010101	3	EMEP/Corinair 2004, assuming same emission factor as residual oil
NATURAL GAS	1A1a	0101, 010101, 010102, 010202	6	DGC 2001
NATURAL GAS	1A1a	010103, 010203	15	Gruijthuijsen & Jensen 2000
NATURAL GAS	1A1a, 1Ac, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	1,5	Nielsen & Illerup 2003
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	1) 520	Nielsen & Illerup 2003
NATURAL GAS	1A1c, 1A2f, 1A4a, 1A4b, 1A4c	010502, 0301, 0201, 0202, 0203	6	DGC 2001
NATURAL GAS	1A2f, 1A4a, 1A4b	030103, 030106, 020103, 020202	15	Gruijthuijsen & Jensen 2000
LPG	all	all	1	EMEP/Corinair 2004
REFINERY GAS	1A1b	010304	1,5	EMEP/Corinair 2004
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	1) 323	Nielsen & Illerup 2003
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	all other	4	EMEP/Corinair 2004

1) 2003 emission factor. Time-series is shown below

Time-series for CH_4 emission factors for gas engines are shown below. All other CH_4 emission factors are the same for 1990-2003.

Table 45 CH_4 emission factors, time-series.

Year	Natural gas fuelled engines Emission factor [g/GJ]	Biogas fuelled engines Emission factor [g/GJ]
1990	257	239
1991	299	251
1992	347	264
1993	545	276
1994	604	289
1995	612	301
1996	596	305
1997	534	310
1998	525	314
1999	524	318
2000	520	323
2001	520	323
2002	520	323
2003	520	323

Table 46 N_2O emission factors and references 2003.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	all	all	3	EMEP/Corinair 2004
BROWN COAL BRI.	all	all	3	EMEP/Corinair 2004
COKE OVEN COKE	all	all	3	EMEP/Corinair 2004
PETROLEUM COKE	all	all	3	EMEP/Corinair 2004
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	0,8	Nielsen & Illerup 2003
WOOD AND SIMIL.	1A1a	010105, 010202, 010203	4	EMEP/Corinair 2004
WOOD AND SIMIL.	1A2f, 1A4a, 1A4b, 1A4c	all	4	EMEP/Corinair 2004
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	1,2	Nielsen & Illerup 2003
MUNICIP. WASTES	1A1a	010203	4	EMEP/Corinair 2004
MUNICIP. WASTES	1A2f, 1A4a	030102, 0201, 020103	4	EMEP/Corinair 2004
STRAW	1A1a	010102, 010103	1,4	Nielsen & Illerup 2003
STRAW	1A1a	010202, 010203	4	EMEP/Corinair 2004
STRAW	1A2f, 1A4b, 1A4c	all	4	EMEP/Corinair 2004
RESIDUAL OIL	all	all	2	EMEP/Corinair 2004
GAS OIL	all	all	2	EMEP/Corinair 2004
KEROSENE	all	all	2	EMEP/Corinair 2004
FISH & RAPE OIL	all	all	2	EMEP/Corinair 2004, assuming same emission factor as gas oil
ORIMULSION	1A1a	010101	2	EMEP/Corinair 2004, assuming same emission factor as residual oil
NATURAL GAS	1A1a	0101, 010101, 010102, 010103, 010202, 010203	1	EMEP/Corinair 2004
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	2,2	Nielsen & Illerup 2003
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	1,3	Nielsen & Illerup 2003
NATURAL GAS	1A1c, 1A2f, 1A4a, 1A4b, 1A4c	010502, 0301, 030103, 030106, 0201, 020103, 0202, 020202, 0203	1	EMEP/Corinair 2004
LPG	all	all	2	EMEP/Corinair 2004
REFINERY GAS	all	all	2,2	EMEP/Corinair 2004
BIOGAS	1A1a	010102, 010103, 010203	2	EMEP/Corinair 2004
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	0,5	Nielsen & Illerup 2003
BIOGAS	1A2f, 1A4a, 1A4c	0301, 030102, 0201, 020103, 0203	2	EMEP/Corinair 2004

The same N_2O emission factors are applied for 1990-2003

Table 47 SO_2, NO_X, NMVOC and CO emission factors and references 2003.

Fuel	IPCC sector	SNAP	SO_2 [g/GJ]	Ref.	NO_X [g/GJ]	Ref.	NMVOC [g/GJ]	Ref.	CO [g/GJ]	Ref.
COAL	1A1a	010101, 010102, 010103	**61**	18	**144**	18	**1,5**	1	**10**	3
COAL	1A1a, 1A2f, 1A4c	010202, 010203, 0301, 0203	**574**	19	**95**	4	**15**	1	**10**	1
COAL	1A4b	0202	**574**	19	**95**	4	**15**	1	**2000**	32
BROWN COAL BRI.	1A4b	0202	**574**	29	**95**	29	**15**	29	**2000**	29
COKE OVEN COKE	1A2f	0301	**574**	29	**95**	29	**15**	29	**10**	29
COKE OVEN COKE	1A4b	0202	**574**	29	**95**	29	**15**	29	**2000**	29
PETROLEUM COKE	1A2f	0301	**605**	20	**95**	29	**1,5**	1	**61**	4
PETROLEUM COKE	1A4a, 1A4b, 1A4c	0201, 0202, 0203	**605**	20	**50**	1	**1,5**	1	**1000**	1
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	**1,74**	31	**69**	31	**3,3**	31	**79**	31
WOOD AND SIMIL.	1A1a	010105	**25**	22, 21	**130**	22, 21, 4	**48**	1	**50**	3
WOOD AND SIMIL.	1A1a, 1A2f	010202, 010203, 0301, 030102, 030103	**25**	22, 21	**130**	22, 21, 4	**48**	1	**240**	4
WOOD AND SIMIL.	1A4a, 1A4c	0201, 020105, 0203	**25**	22, 21	**130**	22, 21, 4	**600**	1	**240**	4
WOOD AND SIMIL.	1A4b	0202	**25**	22, 21	**120**	22	**600**	1, 32	**9000**	12, 13
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	**23,9**	31	**124**	31	**0,98**	31	**7,4**	31
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	010203, 030102, 0201, 020103	**67**	9	**164**	9	**9**	1	**10**	9
STRAW	1A1a	010102, 010103	**47,1**	31	**131**	31	**0,8**	31	**63**	31
STRAW	1A1a, 1A2f, 1A4c	010202, 010203, 030105, 020302	**130**	5	**153**	4, 28	**50**	1	**325**	4, 5
STRAW	1A4b, 1A4c	0201, 0203	**130**	5	**153**	4, 28	**600**	1	**4000**	1,6,7
RESIDUAL OIL	1A1a	0101, 010101, 010102, 010103, 010104, 010105	**290**	9	**144**	18	**3**	1	**15**	3
RESIDUAL OIL	1A1a, 1A4a, 1A4b, 1A4c	010202, 010203, 0201, 0202, 0203, 020302	**344**	25, 10, 24	**142**	4	**3**	1	**30**	1
RESIDUAL OIL	1A1b	010306	**537**	33	**142**	4	**3**	1	**30**	1
RESIDUAL OIL	1A2f	0301, 030102, 030103	**344**	25, 10, 24	**130**	28	**3**	1	**30**	1
RESIDUAL OIL	1A2f	030104	**344**	25, 10, 24	**130**	28	**3**	1	**15**	1
RESIDUAL OIL	1A2f	030105	**344**	25, 10, 24	**130**	28	**3**	1	**100**	1
RESIDUAL OIL	1A4c	020304	**344**	25, 10, 24	**142**	4	**3**	1	**100**	1
GAS OIL	1A1a	0101, 010101, 010102	**23**	27	**249**	18	**1,5**	1	**15**	3
GAS OIL	1A1a, 1A2f	Gas turbines: 010104, 030104	**23**	27	**350**	9	**2**	1	**15**	3
GAS OIL	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Engines: 010105, 010205, 010505, 030105, 020105, 020304	**23**	27	**700**	1	**100**	1	**100**	1
GAS OIL	1A1a	010103	**23**	27	**65**	28	**1,5**	1	**15**	3
GAS OIL	1A1a, 1A1b, 1A2f	010202, 010203, 010306, 0301, 030102, 030103, 030106	**23**	27	**65**	28	**1,5**	1	**30**	1
GAS OIL	1A4a, 1A4c	0201, 020103, 0203	**23**	27	**52**	4	**3**	1	**30**	1
GAS OIL	1A4b	0202	**23**	27	**52**	4	**3**	1	**43**	1
KEROSENE	all	all	**5**	30	**50**	1	**3**	1	**20**	1
FISH & RAPE OIL	1A1a	010103	**1**	37	**220**	38	**1,5**	15	**15**	15
FISH & RAPE OIL	1A1a	010202, 010203	**1**	37	**65**	15	**1,5**	15	**15**	15
FISH & RAPE OIL	1A2f, 1A4c	030105, 020304	**1**	37	**700**	15	**100**	15	**100**	15
ORIMULSION	1A1a	010101	**12**	34	**86**	34	**3**	16	**15**	16
NATURAL GAS	1A1a	0101, 010101, 010102	**0,3**	17	**115**	9	**2**	14	**15**	3
NATURAL GAS	1A1a, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 030104, 020104, 020303	**0,3**	17	**124**	31	**1,4**	31	**6,2**	31
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	**0,3**	17	**168**	31	**117**	31	**175**	31
NATURAL GAS	1A1a, 1A2f	010103, 010202, 010203, 0301, 030103, 030106	**0,3**	17	**42**	36	**2**	14	**28**	4
NATURAL GAS	1A1c	010504	**0,3**	17	**250**	1, 8, 32	**1,4**	31	**6,2**	31
NATURAL GAS	1A4a, 1A4c	0201, 020103, 0203	**0,3**	17	**30**	1, 4, 11	**2**	14	**28**	4
NATURAL GAS	1A4b	0202, 020202	**0,3**	17	**30**	1, 4, 11	**4**	11	**20**	11
LPG	1A1a, 1A2f	010203, 0301	**0,13**	23	**96**	32	**2**	1	**25**	1
LPG	1A4a, 1A4c	0201, 0203	**0,13**	23	**71**	32	**2**	1	**25**	1
LPG	1A4b	0202	**0,13**	23	**47**	32	**2**	1	**25**	1
REFINERY GAS	1A1b	010304	**1**	2	**170**	9	**1,4**	35	**6,2**	35
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	010102, 010103, 010203, 0301, 0201, 020103, 0203	**25**	26	**28**	4	**4**	1	**36**	4
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	**19,2**	31	**540**	31	**14**	31	**273**	31
BIOGAS	1A2f	030102	**25**	26	**54**	4	**4**	1	**36**	4

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Time-series for emission factors for SO_2, NO_X, NMVOC and CO that are not the same in 1990-2003 are shown below. All other factors are constant in 1990-2003.

Table 48 SO_2, NO_X, NMVOC and CO emission factors time-series [g/GJ].

pol.	fuel	snap_id	ipcc_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
SO2	COAL	0101	1A1a	506	571	454	386										
SO2	COAL	010101	1A1a	506	571	454	386	343	312	420	215	263	193	64	47	45	61
SO2	COAL	010102	1A1a	506	571	454	386	343	312	420	215	263	193	64	47	45	61
SO2	COAL	010103	1A1a					343	312	420	215	263	193	64	47	45	61
SO2	COAL	010104	1A1a					343	312	420	215						
SO2	COAL	0102	1A1a	574	574	574	574	574	574	574	574						
SO2	COAL	0201	1A4a	574	574	574	574	574	574	574	574	574					
SO2	COAL	0202	1A4b	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	COAL	0203	1A4c	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	COAL	0301	1A2f	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	BROWN COAL BRI.	0201	1A4a	574	574		574	574	574	574	574						
SO2	BROWN COAL BRI.	0202	1A4b	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	BROWN COAL BRI.	0203	1A4c	574	574	574	574	574	574	574	574	574					
SO2	BROWN COAL BRI.	0301	1A2f	574	574	574	574	574	574	574	574						
SO2	COKE OVEN COKE	0202	1A4b	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	COKE OVEN COKE	0301	1A2f	574	574	574	574	574	574	574	574	574	574	574	574	574	574
SO2	PETROLEUM COKE	0201	1A4a	787	787	787	787	787	787	787	787	787	787	787	605	605	605
SO2	PETROLEUM COKE	0202	1A4b	787	787	787	787	787	787	787	787	787	787	787	605	605	605
SO2	PETROLEUM COKE	0203	1A4c	787	787	787	787	787	787	787	787	787	787	787	605	605	605
SO2	PETROLEUM COKE	0301	1A2f	787	787	787	787	787	787	787	787	787	787	787	605	605	605
SO2	MUNICIP. WASTES	0101	1A1a	116	116	95	73										
SO2	MUNICIP. WASTES	010102	1A1a		116	95	73	52	30			26	25	23,9	23,9	23,9	23,9
SO2	MUNICIP. WASTES	010103	1A1a					52	30	29	28	26	25	23,9	23,9	23,9	23,9
SO2	MUNICIP. WASTES	010104	1A1a					52	30	29	28	26	25	23,9	23,9	23,9	23,9
SO2	MUNICIP. WASTES	0102	1A1a	138	131	124	117	110	103	95	88						
SO2	MUNICIP. WASTES	010202	1A1a					110	103								

SO2	MUNICIP. WASTES	010203	1A1a					110	103	95	88	81	74	67	67	67	67
SO2	MUNICIP. WASTES	0201	1A4a	138	131	124	117	110	103	95	88	81	74	67	67	67	67
SO2	MUNICIP. WASTES	020103	1A4a					110	103	95	88	81	74	67	67	67	67
SO2	MUNICIP. WASTES	0301	1A2f	138	131	124	117	110	103	95	88	81	74				
SO2	MUNICIP. WASTES	030102	1A2f									81				67	67
SO2	RESIDUAL OIL	0101	1A1a	446	470	490	475							403	315	290	290
SO2	RESIDUAL OIL	010101	1A1a						351	408	344	369	369	403	315	290	290
SO2	RESIDUAL OIL	010102	1A1a	446	470	490	475	1564	351	408	344	369	369	403	315	290	290
SO2	RESIDUAL OIL	010103	1A1a					1564	351	408	344	369	369	403	315	290	290
SO2	RESIDUAL OIL	010104	1A1a					1564	351	408	344	369	369	403	315	290	290
SO2	RESIDUAL OIL	010105	1A1a	446	470	490	475	1564	351	408	344	369	369	403	315	290	290
SO2	RESIDUAL OIL	0102	1A1a	495	495	495	495	495	495	495	344						
SO2	RESIDUAL OIL	010202	1A1a					495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	010203	1A1a					495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	010306	1A1b	643	38	222	389				649	649	649	649	649	649	537
SO2	RESIDUAL OIL	0201	1A4a	495	495	495	495	495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	0202	1A4b	495	495	495	495	495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	0203	1A4c	495	495	495	495	495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	0301	1A2f	495	495	495	495	495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	030102	1A2f					495	495	495	344	344	344	344	344	344	344
SO2	RESIDUAL OIL	030103	1A2f					495	495	495	344	344	344	344	344	344	344
SO2	GAS OIL	0101	1A1a	94	94	94	94							23	23	23	23
SO2	GAS OIL	010101	1A1a					94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010102	1A1a	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010103	1A1a					94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010104	1A1a	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010105	1A1a	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	0102	1A1a	94	94	94	94	94	23	23	23						
SO2	GAS OIL	010201	1A1a					94	23								
SO2	GAS OIL	010202	1A1a					94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010203	1A1a					94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	010205	1A1a					94					23	23	23	23	23
SO2	GAS OIL	010306	1A1b		94	94	94	94	23	23	23						23
SO2	GAS OIL	0201	1A4a	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	020102	1A4a					94		23		23					
SO2	GAS OIL	020103	1A4a					94		23	23	23	23	23	23	23	23
SO2	GAS OIL	020105	1A4a			94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	0202	1A4b	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	0203	1A4c	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	0301	1A2f	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	030103	1A2f					94	23	23	23	23	23	23	23	23	23
SO2	GAS OIL	030105	1A2f			94	94	94						23	23	23	23
SO2	GAS OIL	030106	1A2f	94	94	94	94	94	23	23	23	23	23	23	23	23	23
SO2	ORIMULSION	010101	1A1a							147	149				10	12	12
NOX	COAL	0101	1A1a	342	384	294	289										
NOX	COAL	010101	1A1a	342	384	294	289	267	239	250	200	177	152	129	122	130	144
NOX	COAL	010102	1A1a	342	384	294	289	267	239	250	200	177	152	129	122	130	144
NOX	COAL	010103	1A1a					267	239	250	200	177	152	129	122	130	144
NOX	COAL	010104	1A1a					267	239	250	200						
NOX	COAL	010202	1A1a					200	200	200	200	200	200	95	95	95	95
NOX	COAL	010203	1A1a					200	200	200	200	200	200	95	95	95	95
NOX	COAL	0202	1A4b	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	COAL	0203	1A4c	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	COAL	0301	1A2f	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	BROWN COAL BRI.	0202	1A4b	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	COKE OVEN COKE	0202	1A4b	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	COKE OVEN COKE	0301	1A2f	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	PETROLEUM COKE	0301	1A2f	200	200	200	200	200	200	200	200	200	200	95	95	95	95
NOX	RESIDUAL OIL	0101	1A1a	342	384	294	289							129	122	130	144
NOX	RESIDUAL OIL	010101	1A1a						239	250	200	177	152	129	122	130	144
NOX	RESIDUAL OIL	010102	1A1a	342	384	294	289	267	239	250	200	177	152	129	122	130	144
NOX	RESIDUAL OIL	010103	1A1a					267	239	250	200	177	152	129	122	130	144
NOX	RESIDUAL OIL	010104	1A1a					267	239	250	200	177	152	129	122	130	144
NOX	RESIDUAL OIL	010105	1A1a	342	384	294	289	267	239	250	200	177	152	129	122	130	144
NOX	GAS OIL	0101	1A1a	220	220	220	220							220	220	220	249
NOX	GAS OIL	010101	1A1a					220	220	220	220	220	220	220	220	220	249
NOX	GAS OIL	010102	1A1a	220	220	220	220	220	220	220	220	220	220	220	220	220	249
NOX	GAS OIL	0102	1A1a	100	95	90	85	80	75	70	65						
NOX	GAS OIL	010201	1A1a					80	75								
NOX	GAS OIL	010202	1A1a					80	75	70	65	65	65	65	65	65	65
NOX	GAS OIL	010203	1A1a					80	75	70	65	65	65	65	65	65	65
NOX	GAS OIL	010306	1A1b		95	90	85	80	75	70	65						65
NOX	GAS OIL	0301	1A2f	100	95	90	85	80	75	70	65	65	65	65	65	65	65
NOX	GAS OIL	030102	1A2f						75			65	65	65	65	65	65
NOX	GAS OIL	030103	1A2f					80	75	70	65	65	65	65	65	65	65
NOX	GAS OIL	030106	1A2f	100	95	90	85	80	75	70	65	65	65	65	65	65	65
NOX	FISH & RAPE OIL	0102	1A1a	100	95	90	85										
NOX	FISH & RAPE OIL	010203	1A1a					80	75	70	65	65	65	65	65	65	65
NOX	ORIMULSION	010101	1A1a							139	138				88	86	86
NOX	NATURAL GAS	0101	1A1a								115	115	115	115	115	115	115
NOX	NATURAL GAS	010104	1A1a	161	157	153	149	145	141	138	134	131	127	124	124	124	124
NOX	NATURAL GAS	010105	1A1a	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	0102	1A1a	42	42	42	42	42	42	42	42	42					

NOX	NATURAL GAS	010205	1A1a					199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	010505	1A1c	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	0201	1A4a	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NOX	NATURAL GAS	020104	1A4a		157			145	141	138	134	131	127	124	124	124	124
NOX	NATURAL GAS	020105	1A4a	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	0202	1A4b	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NOX	NATURAL GAS	020204	1A4b	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	0203	1A4c	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NOX	NATURAL GAS	020303	1A4c						141	138	134	131	127	124	124	124	124
NOX	NATURAL GAS	020304	1A4c	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	0301	1A2f	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NOX	NATURAL GAS	030104	1A2f	161				145	141	138	134	131	127	124	124	124	124
NOX	NATURAL GAS	030105	1A2f	276	241	235	214	199	194	193	170	167	167	168	168	168	168
NOX	NATURAL GAS	030106	1A2f	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NOX	BIOGAS	010105	1A1a	711	696	681	665	650	635	616	597	578	559	540	540	540	540
NOX	BIOGAS	010505	1A1c	711	696	681	665	650	635	616	597	578	559	540	540	540	540
NOX	BIOGAS	020105	1A4a	711	696	681	665	650	635	616	597	578	559	540	540	540	540
NOX	BIOGAS	020304	1A4c	711	696	681	665	650	635	616	597	578	559	540	540	540	540
NOX	BIOGAS	030105	1A2f									578	559	540	540	540	540
NMVOC	NATURAL GAS	010105	1A1a	58	67	78	122	136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	010205	1A1a					136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	010505	1A1c	58	67	78	122	136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	020105	1A4a	58	67	78	122	136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	020204	1A4b	58	67	78	122	136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	020304	1A4c	58	67	78	122	136	137	134	120	118	118	117	117	117	117
NMVOC	NATURAL GAS	030105	1A2f	58	67	78	122	136	137	134	120	118	118	117	117	117	117
CO	WOOD AND SIMIL.	0102	1A1a	400	373	347	320	293	267	240	240						
CO	WOOD AND SIMIL.	010202	1A1a					293	267	240	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	010203	1A1a					293	267	240	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0201	1A4a	400	373	347	320	293	267	240	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0203	1A4c	400	373	347	320	293	267	240	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0301	1A2f	400	373	347	320	293	267	240	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	030103	1A2f					293	267	240	240	240	240	240	240	240	240
CO	MUNICIP. WASTES	0102	1A1a	100	85	70	55	40	25	10	10						
CO	MUNICIP. WASTES	010202	1A1a					40	25								
CO	MUNICIP. WASTES	010203	1A1a					40	25	10	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	0201	1A4a	100	85	70	55	40	25	10	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	020103	1A4a					40	25	10	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	0301	1A2f	100	85	70	55	40	25	10	10	10	10				
CO	STRAW	0102	1A1a	600	554	508	463	417	371	325	325						
CO	STRAW	010202	1A1a					417	371	325	325	325	325	325	325	325	325
CO	STRAW	010203	1A1a					417	371	325	325	325	325	325	325	325	325
CO	STRAW	0202	1A4b	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000	4000	4000	4000	4000
CO	STRAW	0203	1A4c	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000	4000	4000	4000	4000
CO	NATURAL GAS	010105	1A1a	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	010205	1A1a					216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	010505	1A1c	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	020105	1A4a	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	020204	1A4b	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	020304	1A4c	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	NATURAL GAS	030105	1A2f	181	202	203	217	216	212	211	174	174	174	175	175	175	175
CO	BIOGAS	010105	1A1a	230	234	239	243	248	252	256	260	265	269	273	273	273	273
CO	BIOGAS	010505	1A1c	230	234	239	243	248	252	256	260	265	269	273	273	273	273
CO	BIOGAS	020105	1A4a	230	234	239	243	248	252	256	260	265	269	273	273	273	273
CO	BIOGAS	020304	1A4c	230	234	239	243	248	252	256	260	265	269	273	273	273	273
CO	BIOGAS	030105	1A2f									265	269	273	273	273	273

Table 49 PM emission factors and references 2003.

Fuel	IPCC sector	SNAP	TSP [g/GJ]	Reference	PM_{10} [g/GJ]	Reference	$PM_{2.5}$ [g/GJ]	Reference
COAL	1A1a	010101, 010102, 010103	3	12	2,6	12	2,1	12
COAL	1A1a	010202, 010203	6	9	6	9	5	9
COAL	1A2f, 1A4b, 1A4c	0301, 0202, 0203	17	6	12	14	7	14
BROWN COAL BRI.	1A4b	0202	17	16	12	16	7	16
COKE OV.COKE	1A2f, 1A4b	0301, 0202	17	16	12	16	7	16
PETROLEUM COKE	1A2f	0301	10	9	7	9	3	9
PETROLEUM COKE	1A4a, 1A4b, 1A4c	0201, 0202, 0203	100	9	60	9	30	9
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	7,9	3	1,94	3	1,23	3
WOOD AND SIMIL.	1A1a, 1A2f	010105, 010202, 010203, 0301, 030102, 030103	19	1	13	2	10	2
WOOD AND SIMIL.	1A4a, 1A4c	0201, 020105, 0203	143	1	143	9	135	9
WOOD AND SIMIL.	1A4b	0202	715	17	679	17	643	17
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	2,02	3	1,126	3	1,084	3
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	010203, 030102, 0201, 020103	6	10	5	11	4	11
STRAW	1A1a	010102, 010103	3,97	3	0,133	3	0,102	3
STRAW	1A1a, 1A2f, 1A4c	010202, 010203, 030105, 020302	21	1	15	2	12	2
STRAW	1A4b, 1A4c	0202, 0203	234	4	222	5	211	5
RESIDUAL OIL	1A1a	0101, 010101, 010102, 010103, 010104, 010105, 010202, 010203	3	9	3	9	2,5	9
RESIDUAL OIL	1A1b	010306	50	9	40	9	35	9
RESIDUAL OIL	1A2f, 1A4a, 1A4b, 1A4c	0301, 030102, 030103, 030104, 030105, 0201, 0202, 0203, 020302	14	6	10,5	13	7	13
RESIDUAL OIL	1A4c	Engines: 020304	60	9	50	9	40	9
GAS OIL	all	all	5	9	5	9	5	9
KEROSENE	all	all	5	9	5	9	5	9
FISH & RAPE OIL	all	all	3	15	3	15	3	15
ORIMULSION	1A1a	010101	1,9	12	1,8	12	1,6	12
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	0101, 010101, 010102, 010103, 010202, 010203, 010502, 0301, 030103, 030106, 0201, 020103, 0202, 020202, 0203	0,1	9	0,1	9	0,1	9
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	0,1	3	0,061	3	0,051	3
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	0,76	3	0,189	3	0,161	3
LPG	all	all	0,2	9	0,2	9	0,2	9
REFINERY GAS	1A1b	010304	5	9	5	9	5	9
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	2,63	3	0,451	3	0,206	3
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	010102, 010103, 010203, 0301, 030102, 0201, 020103, 0203	1,5	6	1,5	7	1,5	7

1. Luftvejledningen 2001. Vejledning fra Miljøstyrelsen nr 2 2001. Luftvejledningen, Begrænsning af luftforurening fra virksomheder (Danish legislation)
2. Particulate size distribution for wood and straw combustion in power plants refers to the TNO CEPMEIP emission factor database 2001 (wood). Available on the internet at: http://www.air.sk/tno/cepmeip/
3. Nielsen, M. & Illerup, J.B: 2003. Emissionsfaktorer og emissionsopgørelse for decentral kraftvarme. Eltra PSO projekt 3141. Kortlægning af emissioner fra decentrale kraftvarmeværker. Delrapport 6. Danmarks Miljøundersøgelser. 116 s. –Faglig rapport fra DMU nr. 442.(In Danish, whith an english summary). Available on the Internet at :http://www.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/FR442.pdf
4. German, L., 2003. The Danish Technological Institute, Personal communication, rough estimate
5. Particulate size distribution for wood and straw combustion in residential plants refers to the TNO CEPMEIP emission factor database 2001 (wood). Available on the internet at: http://www.air.sk/tno/cepmeip/
6. Bek. 689 1990. Bekendtgørelse 689 af 15/10/1990. Bekendtgørelse om begrænsning af emissioner af svovldioxid, kvælstofoxider og støv fra store fyringsanlæg. Miljøstyrelsen 1990 (and Bekendtgørelse 518/1995) (Danish legislation)
7. All TSP emission is assumed to be <2,5µm (NERI assumption)
8. -
9. The TNO CEPMEIP emission factor database 2001. Available on the internet at: http://www.air.sk/tno/cepmeip/
10. Implied emission factor calculation based on annual environmental reports of a large number of municipal waste incineration plants, 2000
11. Particulate size distribution is unknown. The PM_{10} fraction is assumed to equal 85% of TSP and the $PM_{2.5}$ fraction is assumed to equal 70% of TSP (NERI assumption)
12. Livbjerg, H. Thellefsen, M. Sander, B. Simonsen, P., Lund, C., Poulsen, K.& Fogh, C.L., 2001. Feltstudier af Forbrændingsaerosoler, EFP -98 Projekt, Aerosollaboratoriet DTU, FLS Miljø, Forskningscenter Risø, Elsam, Energi E2 (in Danish)
13. Particulate size distribution for residual oil combustion refers to the TNO CEPMEIP emission factor database 2001. Available on the internet at: http://www.air.sk/tno/cepmeip/
14. Particulate size distribution for coal combustion refers to the TNO CEPMEIP emission factor database 2001. Available on the internet at: http://www.air.sk/tno/cepmeip/
15. Assuming same emission factors as for gas oil (NERI assumption).
16. Same emission factor as for coal is assumed (NERI assumption)
17. Illerup, J.B., Nielsen, M. 2004. Improved PM emission inventory for residential wood combustion. Available on the internet at: http://www.dmu.dk/NR/rdonlyres/11C23CE2-582B-48F0-8EBD-FF3BA608F2E2/3319/PMworkshopDKresidentialwoodburning_.pdf. The poster have been based on Sternhufvud et al. 2004: Sternhufvud, C., Karvosenoja, N., Illerup, J., Kindbom, K., Lükewille, A., Johansson, M. Jensen, D. 2003. Particulate matter emissions and abatement options in residential wood burning in the Nordic countries.

Time-series have been estimated for the PM emission factors for residential wood combustion. All other emission factors are constant in 2000-2003. The time-series for residential wood combustion are shown below.

Table 49b PM emission factors, time series

	2000	2001	2002	2003
TSP	807	743	720	715
PM_{10}	767	706	684	679
$PM_{2.5}$	726	669	648	643

Table 50 HM emission factors and references 2003.

Fuel	IPCC sec-tor	SNAP	As [mg/GJ]	Refer ence	Cd [mg/GJ]	Refer ence	Cr [mg/GJ]	Refer ence	Cu [mg/GJ]	Refer ence	Hg [mg/GJ]	Refer ence	Ni [mg/GJ]	Refer ence	Pb [mg/GJ]	Refer ence	Se [mg/GJ]	Refer ence	Zn [mg/GJ]	Refer ence
COAL	all	all	3,2	1	0,1	1	2,3	1	3,1	1	1,7	1	4,4	1	6	1	0,5	1	10,5	1
BROWN COAL BRI.	1A4b	0202	3,2	1	0,1	1	2,3	1	3,1	1	1,7	1	4,4	1	6	1	0,5	1	10,5	1
COKE OV.COKE	all	all	3,2	1	0,1	1	2,3	1	3,1	1	1,7	1	4,4	1	6	1	0,5	1	10,5	1
PETROLEUM COKE	all	all	3,2	1	0,1	1	2,3	1	3,1	1	1,7	1	4,4	1	6	1	0,5	1	10,5	1
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	2,34	2	0,9	2	2,34	2	2,6	2	0,72	2	2,34	2	3,62	2			136	1
WOOD AND SIMIL.	1A1a 1A2f 1A4a 1A4b 1A4c	010105 010202 010203 0301 030102 030103 0201 020105 0202 0203			6,8	1			6,8	1	6,8	1			3,4	1			136	1
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	6,74	2	4,73	2	2,43	2	10,03	2	7,39	2	4,71	2	123	2			359,5	1
MUNICIP. WASTES	1A1a 1A2f 1A4a	010203, 030102, 0201, 020103	3,53	1	9,21	1	32,97	1	31,8	1	58,7	1	55,4	1	137,57	1			359,5	1
STRAW	1A1a	010102, 010103	2	2	0,72	2	1,52	2	1,66	2	0,53	2	1,62	2	6,12	2			8,39	1
STRAW	1A1a, 1A2f, 1A4b, 1A4c	010202, 010203, 030105, 0202, 0203, 020302			0,62	1	0,62	1	1,06	1	6,8	1	0,53	1	3,22	1			8,39	1
RESIDUAL OIL	all	all	14,07	1	13,5	1	33,33	1	12,96	1	4,3	1	642	1	23,46	1	12,3	1	2,72	1
GAS OIL	all	all	1,17	1	0,23	1	0,94	1	1,17	1	1,17	1	0,64	1	2,34	1	4,68	1	11,7	1
FISH & RAPE OIL	all	all	1,17	3	0,23	3	0,94	3	1,17	3	1,17	3	0,64	3	2,34	3	4,68	3	11,7	3
ORIMULSION	1A1a	010101	14,07	4	13,5	4	33,33	4	12,96	4	4,3	4	642	4	23,46	4	12,3	4	2,72	4

1. Illerup, J.B., Geertinger, A., Hoffmann, L. & Christiansen, K., 1999. Emissionsfaktorer for tungmetaller 1990-1996. Danmarks Miljøundersøgelser. 66 s. – Faglig rapport fra DMU nr. 301. (In Danish) Available on the internet at: http://www.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/fr301.pdf
2. Nielsen, M. & Illerup, J.B. 2003. Emissionsfaktorer og emissionsopgørelse for decentral kraftvarme. Eltra PSO projekt 3141. Kortlægning af emissioner fra decentrale kraftvarmeværker. Delrapport 6. Danmarks Miljøundersøgelser. 116 s. –Faglig rapport fra DMU nr. 442.(In Danish, whith an english summary). Available on the Internet at :http://www.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/FR442.pdf
3. Assumed same emission factors as for gas oil (NERI assumption)
4. Assumed same emission factors as for residual oil (NERI assumption)

For large power plants combusting coal or residual oil other emission factors are applied for point sources than for area sources. The emission inventories are, however, mainly based on plants specific emission data from each plant. The large point source emission factors that differ from the area source emission factors are shown below.

Table 51 HM emission factors [mg/GJ] 2003 for large point sources. Only emission factors that differ from the area source emission factors are included.

Fuel	SNAP	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Coal	010102	3,3	0,1	8,02	4,41	2,2	6,81	6	13	10,5
Residual oil	010101, 010102	1,48	4,43	1,33	1,48	0,15	191	1,48	0,59	11,7

Time-series for emission factors for heavy metals is not constant for municipal waste. Time-series are shown in Table 52. All other factors are constant in 1990-2003.

Table 52 HM emission factors time-series for municipal waste [mg/GJ].

pollutant	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
As	0101	7,82	7,21	6,74	6,74										
As	010102		7,21	6,74	6,74	6,74	6,74			6,74	6,74	6,74	6,74	6,74	6,74
As	0102	7,82	7,21	6,59	5,98	5,37	4,76	4,14	3,53						
As	0201	7,82	7,21	6,59	5,98	5,37	4,76	4,14	3,53	3,53	3,53	3,53	3,53	3,53	3,53
As	0301	7,82	7,21	6,59	5,98	5,37	4,76	4,14	3,53	3,53	3,53				
Cd	0101	31,3	28,2	25	21,8										
Cd	010102		28,2	25	21,8	18,7	15,5			9,21	9,21	4,73	4,73	4,73	4,73
Cd	010103					18,7	15,5	12,4	9,21	9,21	9,21	4,73	4,73	4,73	4,73
Cd	0102	31,3	28,2	25	21,8	18,7	15,5	12,4	9,21						
Cd	0201	31,3	28,2	25	21,8	18,7	15,5	12,4	9,21	9,21	9,21	9,21	9,21	9,21	9,21
Cd	0301	31,3	28,2	25	21,8	18,7	15,5	12,4	9,21	9,21	9,21				
Cr	0101	186	164	142	120										
Cr	010102		164	142	120	98,6	76,7			33	33	2,43	2,43	2,43	2,43
Cr	010103					98,6	76,7	54,8	33	33	33	2,43	2,43	2,43	2,43
Cr	0102	186	164	142	120	98,6	76,7	54,8	33						
Cr	0201	186	164	142	120	98,6	76,7	54,8	33	33	33	33	33	33	33
Cr	0301	186	164	142	120	98,6	76,7	54,8	33	33	33				
Cu	0101	123	110	97,3	84,2										
Cu	010102		110	97,3	84,2	71,1	58			31,8	31,8	10	10	10	10
Cu	010103					71,1	58	44,9	31,8	31,8	31,8	10	10	10	10
Cu	0102	123	110	97,3	84,2	71,1	58	44,9	31,8						
Cu	0201	123	110	97,3	84,2	71,1	58	44,9	31,8	31,8	31,8	31,8	31,8	31,8	31,8
Cu	0301	123	110	97,3	84,2	71,1	58	44,9	31,8	31,8	31,8				
Hg	0101	132	122	111	101										
Hg	010102		122	111	101	90,3	79,8			58,7	58,7	7,39	7,39	7,39	7,39
Hg	010103					7,39	79,8	69,2	58,7	58,7	58,7	7,39	7,39	7,39	7,39
Hg	0102	132	122	111	101	90,3	79,8	69,2	58,7						
Hg	0201	132	122	111	101	90,3	79,8	69,2	58,7	58,7	58,7	58,7	58,7	58,7	58,7
Hg	0301	132	122	111	101	90,3	79,8	69,2	58,7	58,7	58,7				
Ni	0101	192	172	153	133										
Ni	010102		172	153	133	114	94,4			55,4	55,4	4,71	4,71	4,71	4,71
Ni	010103					114	94,4	74,9	55,4	55,4	55,4	4,71	4,71	4,71	4,71
Ni	0102	192	172	153	133	114	94,4	74,9	55,4						
Ni	0201	192	172	153	133	114	94,4	74,9	55,4	55,4	55,4	55,4	55,4	55,4	55,4
Ni	0301	192	172	153	133	114	94,4	74,9	55,4	55,4	55,4				
Pb	0101	639	639	555	472										
Pb	010102		639	555	472	388	305			138	138	123	123	123	123
Pb	010103					388	305	221	138	138	138	123	123	123	123
Pb	0102	723	639	555	472	388	305	221	138						
Pb	0201	723	639	555	472	388	305	221	138	138	138	138	138	138	138
Pb	0301	723	639	555	472	388	305	221	138	138	138				
Zn	0101	805	741	678	614										
Zn	010102		741	678	614	550	487			360	360	360	360	360	360
Zn	010103					550	487	423	360	360	360	360	360	360	360
Zn	010104					550	487	423	360	360	360	360	360	360	360
Zn	0102	805	741	678	614	550	487	423	360						
Zn	010202					550	487								
Zn	010203					550	487	423	360	360	360	360	360	360	360
Zn	0201	805	741	678	614	550	487	423	360	360	360	360	360	360	360
Zn	020103					550	487	423	360	360	360	360	360	360	360
Zn	0301	805	741	678	614	550	487	423	360	360	360				

Table 53 PAH emission factors 2003.

Fuel	IPCC id	SNAP	Benzo(a)-pyrene		Benzo(b)-fluoranthene		Benzo(k)-fluoranthene		Indeno(1,2,3-c,d)-pyrene	
			[µg/GJ]	Refer-ence	[µg/GJ]	Refer-ence	[µg/GJ]	Refer-ence	[µg/GJ]	Refer-ence
COAL	1A1a	010101, 010102, 010103, 010202, 010203	0,14	4	0,29	4	0,29	4	0,28	4
COAL	1A2f	0301	23	4	929	4	929	4	698	4
COAL	1A4b, 1A4c	0202, 0203	59524	4	63492	4	1984	4	119048	4
BROWN COAL BRI.	1A4b	0202	59524	4 (9)	63492	4 (9)	1984	4 (9)	119048	4 (9)
COKE OV.COKE	1A2f	0301	23	4 (9)	929	4 (9)	929	4 (9)	698	4 (9)
COKE OV.COKE	1A4b	0202	59524	4 (9)	63492	4 (9)	1984	4 (9)	119048	4 (9)
PETROLEUM COKE	all	all	3184	5	9554	5				
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	3	8	2	8	2	8	2	8
WOOD AND SIMIL.	1A1a, 1A2f	010105, 010202, 010203, 0301, 030102, 030103	6,46	4	1292,52	4	1292,52	4	11,56	4
WOOD AND SIMIL.	1A4a, 1A4b, 1A4c	0201, 020105, 0202, 0203	168707	4	221769	4	73469	4	119728	4
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	0,8	8	1,7	8	0,8	8	0,9	8
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	010203, 030102, 0201, 020103	67	5	571	5	1	5	1	5
STRAW	1A1a	010102	1,6	1	1,4	1	1	1	1,6	1
STRAW	1A1a	010103	21	8	157	8	90	8	23	8
STRAW	1A1a, 1A2f	010202, 010203, 030105	1529	2	3452	2	1400	2	1029	2
STRAW	1A4b, 1A4c	0202, 0203, 020302	12956	2	12828	2	6912	2	4222	2
RESIDUAL OIL	1A1a, 1A1b	0101, 010101, 010102, 010103, 010104, 010105, 010202, 010203, 010306	109,6	4	475,41	4	93,21	4	177,28	4
RESIDUAL OIL	1A2f 1A4a 1A4b 1A4c	0301, 030102, 030103, 030104, 030105, 0201, 0202, 0203, 020302, 020304	80	4	42	4	66	4	160	4
GAS OIL	1A1a, 1A1b 1A1c	0101, 010101, 010102, 010103, 010104, 010105, 010202, 010203, 010205, 010306, 010505	109,6	4	475,41	4	93,21	4	177,28	4
GAS OIL	1A2f 1A4a 1A4b 1A4c	0301, 030102, 030103, 030104, 030105, 030106, 0201, 020103, 020105, 0202, 0203, 020304	80	4	42	4	66	4	160	4
FISH & RAPE OIL	1A1a	010103, 010202, 010203	109,6	3	475,41	3	93,21	3	177,28	3
FISH & RAPE OIL	1A2f, 1A4c	030105, 020304	80	3	42	3	66	3	160	3
ORIMULSION	1A1a	010101	109,6	4 (7)	475,41	4 (7)	93,21	4 (7)	177,28	4 (7)
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 010504, 030104, 020104, 020303	1	8	1	8	2	8	3	8
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	3	8	42	8	24	8	6	8
NATURAL GAS	1A4b	020202	0,133	6	0,663	6	0,265	6	2,653	6
BIOGAS	all	all	1	8	1	8	0,4	8	1,1	8

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9. Same emission factor as for coal is assumed (NERI assumption)

The same PAH emission factors have been applied for 1990-2003.

Appendix 7 Implied emission factors for municipal waste incineration plants and power plants combustion coal

Table 54 Implied emission factors for municipal waste incineration plants 2003.

Pollutant	Implied Emission factor	Unit
SO_2	26	g/GJ
NO_X	112	g/GJ
TSP	2,8	g/GJ
PM_{10}	2,3	g/GJ
$PM_{2.5}$	1,9	g/GJ
As	8,4	mg/GJ
Cd	3,6	mg/GJ
Cr	4,5	mg/GJ
Cu	11	mg/GJ
Hg	12	mg/GJ
Ni	9,6	mg/GJ
Pb	42	mg/GJ
Zn	342	mg/GJ

Table 55 Implied emission factors for power plants combusting coal, 2003.

Pollutant	Implied Emission factor	Unit
SO_2	58	g/GJ
NO_X	152	g/GJ
TSP	2,9	g/GJ
PM_{10}	2,3	g/GJ
$PM_{2.5}$	1,9	g/GJ
As	0,56	mg/GJ
Cd	0,06	mg/GJ
Cr	1,1	mg/GJ
Cu	0,63	mg/GJ
Hg	1,0	mg/GJ
Ni	3,5	mg/GJ
Pb	1,2	mg/GJ
Se	4,6	mg/GJ
Zn	0,59	mg/GJ

Appendix 8 Large point sources

Table 56 Large point sources, fuel consumption in 2003 (1A1, 1A2 and 1A4).

lps_id	lps name	part_id	SNAP_id	fuel_id	fuel	fuel consumption [GJ]	IPCC source
001	Amagervaerket	01	010101	102	COAL	4372370	1A1a
001	Amagervaerket	01	010101	203	RESIDUAL OIL	187970	1A1a
001	Amagervaerket	02	010101	102	COAL	1847481	1A1a
001	Amagervaerket	02	010101	117	STRAW	36157	1A1a
001	Amagervaerket	02	010101	203	RESIDUAL OIL	803381	1A1a
001	Amagervaerket	03	010101	102	COAL	15278680	1A1a
001	Amagervaerket	03	010101	203	RESIDUAL OIL	101118	1A1a
002	Svanemoellevaerket	05	010101	203	RESIDUAL OIL	8511	1A1a
002	Svanemoellevaerket	05	010101	301	NATURAL GAS	1382528	1A1a
002	Svanemoellevaerket	07	010104	301	NATURAL GAS	4911978	1A1a
003	H.C.Oerstedsvaerket	03	010101	203	RESIDUAL OIL	475381	1A1a
003	H.C.Oerstedsvaerket	03	010101	301	NATURAL GAS	1888909	1A1a
003	H.C.Oerstedsvaerket	07	010101	203	RESIDUAL OIL	699400	1A1a
003	H.C.Oerstedsvaerket	07	010101	301	NATURAL GAS	2280826	1A1a
004	Kyndbyvaerket	21	010101	203	RESIDUAL OIL	708241	1A1a
004	Kyndbyvaerket	22	010101	203	RESIDUAL OIL	694267	1A1a
004	Kyndbyvaerket	26	010101	203	RESIDUAL OIL	157631	1A1a
004	Kyndbyvaerket	28	010101	203	RESIDUAL OIL	168012	1A1a
004	Kyndbyvaerket	41	010105	204	GAS OIL	2035	1A1a
004	Kyndbyvaerket	51	010104	204	GAS OIL	14539	1A1a
004	Kyndbyvaerket	52	010104	204	GAS OIL	10722	1A1a
005	Masnedoevaerket	12	010102	111	WOOD AND SIMIL.	129622	1A1a
005	Masnedoevaerket	12	010102	117	STRAW	466590	1A1a
005	Masnedoevaerket	31	010104	204	GAS OIL	18945	1A1a
007	Stigsnaesvaerket	01	010101	102	COAL	4973380	1A1a
007	Stigsnaesvaerket	01	010101	203	RESIDUAL OIL	233254	1A1a
007	Stigsnaesvaerket	02	010101	102	COAL	14494500	1A1a
007	Stigsnaesvaerket	02	010101	203	RESIDUAL OIL	137880	1A1a
008	Asnaesvaerket	01	010101	203	RESIDUAL OIL	53407	1A1a
008	Asnaesvaerket	02	010101	102	COAL	7395263	1A1a
008	Asnaesvaerket	02	010101	203	RESIDUAL OIL	84665	1A1a
008	Asnaesvaerket	04	010101	102	COAL	10578939	1A1a
008	Asnaesvaerket	04	010101	203	RESIDUAL OIL	74661	1A1a
008	Asnaesvaerket	05	010101	102	COAL	19696621	1A1a
008	Asnaesvaerket	05	010101	203	RESIDUAL OIL	1275842	1A1a
008	Asnaesvaerket	05	010101	225	ORIMULSION	1921399	1A1a
009	Statoil Raffinaderi	01	010306	203	RESIDUAL OIL	279129	1A1b
009	Statoil Raffinaderi	01	010306	308	REFINERY GAS	8030099	1A1b
010	Avedoerevaerket	01	010101	102	COAL	12743451	1A1a
010	Avedoerevaerket	01	010101	203	RESIDUAL OIL	133010	1A1a
010	Avedoerevaerket	01	010101	204	GAS OIL	593077	1A1a
010	Avedoerevaerket	02	010104	111	WOOD AND SIMIL.	1505813	1A1a
010	Avedoerevaerket	02	010104	117	STRAW	1706623	1A1a
010	Avedoerevaerket	02	010104	203	RESIDUAL OIL	9316307	1A1a
010	Avedoerevaerket	02	010104	301	NATURAL GAS	7609397	1A1a
011	Fynsvaerket	03	010101	102	COAL	1778840	1A1a
011	Fynsvaerket	03	010101	114	MUNICIP. WASTES	143440	1A1a
011	Fynsvaerket	03	010101	203	RESIDUAL OIL	105670	1A1a
011	Fynsvaerket	03	010101	301	NATURAL GAS	3481430	1A1a
011	Fynsvaerket	07	010101	102	COAL	15646110	1A1a
011	Fynsvaerket	07	010101	203	RESIDUAL OIL	231590	1A1a
011	Fynsvaerket	08	010102	114	MUNICIP. WASTES	2642140	1A1a
011	Fynsvaerket	08	010102	204	GAS OIL	17291	1A1a
012	Studstrupvaerket	03	010101	102	COAL	14661460	1A1a
012	Studstrupvaerket	03	010101	203	RESIDUAL OIL	238470	1A1a
012	Studstrupvaerket	04	010101	102	COAL	17260700	1A1a
012	Studstrupvaerket	04	010101	117	STRAW	1456510	1A1a
012	Studstrupvaerket	04	010101	203	RESIDUAL OIL	154990	1A1a
014	Vendsysselvaerket	02	010101	102	COAL	9036830	1A1a
014	Vendsysselvaerket	02	010101	203	RESIDUAL OIL	122030	1A1a
014	Vendsysselvaerket	03	010101	102	COAL	22488770	1A1a
014	Vendsysselvaerket	03	010101	203	RESIDUAL OIL	238700	1A1a
014	Vendsysselvaerket	03	010101	204	GAS OIL	5070	1A1a
016	Kemira Danmark	03	030104	301	NATURAL GAS	899788	1A2f
017	Shell Raffinaderi	01	010306	203	RESIDUAL OIL	627953	1A1b
017	Shell Raffinaderi	01	010306	308	REFINERY GAS	4720316	1A1b
017	Shell Raffinaderi	05	010304	308	REFINERY GAS	2670246	1A1b
018	Skaerbaekvaerket	03	010101	204	GAS OIL	340150	1A1a
018	Skaerbaekvaerket	03	010101	301	NATURAL GAS	11131600	1A1a
019	Enstedvaerket	03	010101	102	COAL	31756460	1A1a
019	Enstedvaerket	03	010101	203	RESIDUAL OIL	119150	1A1a
019	Enstedvaerket	04	010101	111	WOOD AND SIMIL.	304980	1A1a
019	Enstedvaerket	04	010101	117	STRAW	1699250	1A1a

019	Enstedvaerket	04	010101	204	GAS OIL	18700	1A1a
020	Esbjergvaerket	03	010101	102	COAL	21387080	1A1a
020	Esbjergvaerket	03	010101	203	RESIDUAL OIL	112140	1A1a
022	Oestkraft	05	010102	203	RESIDUAL OIL	17222	1A1a
022	Oestkraft	06	010102	102	COAL	725648	1A1a
022	Oestkraft	06	010102	111	WOOD AND SIMIL.	45403	1A1a
022	Oestkraft	06	010102	203	RESIDUAL OIL	28847	1A1a
023	Danisco Ingredients	01	030102	102	COAL	527257	1A2f
023	Danisco Ingredients	01	030102	301	NATURAL GAS	6433	1A2f
024	Dansk Naturgas Behandlingsanlaeg	01	010502	301	NATURAL GAS	322830,99	1A1c
025	Horsens Kraftvarmevaerk	01	010102	111	WOOD AND SIMIL.	77910	1A1a
025	Horsens Kraftvarmevaerk	01	010102	114	MUNICIP. WASTES	897730	1A1a
025	Horsens Kraftvarmevaerk	02	010104	301	NATURAL GAS	880180	1A1a
026	Herningvaerket	01	010102	111	WOOD AND SIMIL.	2239420	1A1a
026	Herningvaerket	01	010102	203	RESIDUAL OIL	36430	1A1a
026	Herningvaerket	01	010102	301	NATURAL GAS	1441710	1A1a
027	Vestforbraendingen	01	010102	114	MUNICIP. WASTES	2171692	1A1a
027	Vestforbraendingen	01	010102	204	GAS OIL	8680	1A1a
027	Vestforbraendingen	02	010102	114	MUNICIP. WASTES	3062799	1A1a
028	Amagerforbraendingen	01	010102	114	MUNICIP. WASTES	4312579	1A1a
029	Randersvaerket	01	010102	102	COAL	2829054	1A1a
029	Randersvaerket	01	010102	111	WOOD AND SIMIL.	339631	1A1a
029	Randersvaerket	01	010102	114	MUNICIP. WASTES	25700	1A1a
029	Randersvaerket	01	010102	309	BIOGAS	21787	1A1a
029	Randersvaerket	02	010102	204	GAS OIL	51483	1A1a
030	Grenaavaerket	01	010102	102	COAL	1023565	1A1a
030	Grenaavaerket	01	010102	111	WOOD AND SIMIL.	161708	1A1a
030	Grenaavaerket	01	010102	114	MUNICIP. WASTES	40500	1A1a
030	Grenaavaerket	01	010102	117	STRAW	818223	1A1a
030	Grenaavaerket	01	010102	203	RESIDUAL OIL	69771	1A1a
030	Grenaavaerket	01	010102	204	GAS OIL	8739	1A1a
031	Hilleroedvaerket	01	010104	301	NATURAL GAS	3057446	1A1a
032	Helsingoervaerket	01	010104	301	NATURAL GAS	1812439	1A1a
032	Helsingoervaerket	02	010105	301	NATURAL GAS	23496	1A1a
033	Staalvalsevaerket	01	030102	301	NATURAL GAS	1246687	1A2f
034	Stora Dalum	01	030102	301	NATURAL GAS	1020508	1A2f
035	Assens Sukkerfabrik	01	030102	102	COAL	400360	1A2f
035	Assens Sukkerfabrik	01	030102	203	RESIDUAL OIL	354876	1A2f
035	Assens Sukkerfabrik	01	030102	309	BIOGAS	24852	1A2f
036	Kolding Kraftvarmevaerk	01	010103	114	MUNICIP. WASTES	808370	1A1a
036	Kolding Kraftvarmevaerk	02	010103	114	MUNICIP. WASTES	282337	1A1a
037	Maabjergvaerket	02	010102	111	WOOD AND SIMIL.	409920	1A1a
037	Maabjergvaerket	02	010102	114	MUNICIP. WASTES	1759520	1A1a
037	Maabjergvaerket	02	010102	117	STRAW	427220	1A1a
037	Maabjergvaerket	02	010102	301	NATURAL GAS	205870	1A1a
038	Soenderborg Kraftvarmevaerk	01	010102	114	MUNICIP. WASTES	771028	1A1a
038	Soenderborg Kraftvarmevaerk	02	010104	301	NATURAL GAS	1207138	1A1a
039	Kara Affaldsforbraendingsanlaeg	01	010102	114	MUNICIP. WASTES	1713119	1A1a
039	Kara Affaldsforbraendingsanlaeg	01	010102	301	NATURAL GAS	9375	1A1a
040	Viborg Kraftvarmevaerk	01	010104	301	NATURAL GAS	2147962	1A1a
042	Nordforbraendingen	01	010102	114	MUNICIP. WASTES	1020319	1A1a
045	Aalborg Portland	01	030311	102	COAL	3368675	1A2f
045	Aalborg Portland	01	030311	110	PETROLEUM COKE	7714392	1A2f
045	Aalborg Portland	01	030311	114	MUNICIP. WASTES	1406393	1A2f
045	Aalborg Portland	01	030311	118	SEWAGE SLUDGE	55369	1A2f
045	Aalborg Portland	01	030311	203	RESIDUAL OIL	587464	1A2f
046	Aarhus Nord	01	010102	111	WOOD AND SIMIL.	18	1A1a
046	Aarhus Nord	01	010102	114	MUNICIP. WASTES	1748000	1A1a
047	Reno Nord	01	010103	114	MUNICIP. WASTES	1443472	1A1a
048	Silkeborg Kraftvarmevaerk	01	010104	301	NATURAL GAS	3285422	1A1a
049	Rensningsanlægget Lynetten	01	020103	114	MUNICIP. WASTES	74825	1A4a
049	Rensningsanlægget Lynetten	01	020103	204	GAS OIL	29646	1A4a
049	Rensningsanlægget Lynetten	01	020103	309	BIOGAS	85295	1A4a
050	I/S Fasan	01	010203	114	MUNICIP. WASTES	925586	1A1a
051	AVV Forbrændingsanlæg	01	010103	114	MUNICIP. WASTES	632342	1A1a
052	I/S REFA Kraftvarmeværk	01	010103	114	MUNICIP. WASTES	1072953	1A1a
053	Svendborg Kraftvarmeværk	01	010102	114	MUNICIP. WASTES	573143	1A1a
053	Svendborg Kraftvarmeværk	01	010102	301	NATURAL GAS	3270	1A1a
054	Kommunekemi	01	010102	114	MUNICIP. WASTES	685813	1A1a
054	Kommunekemi	01	010102	203	RESIDUAL OIL	50794	1A1a
054	Kommunekemi	01	010102	204	GAS OIL	14134	1A1a
054	Kommunekemi	02	010102	114	MUNICIP. WASTES	619308	1A1a
054	Kommunekemi	02	010102	203	RESIDUAL OIL	30525	1A1a
054	Kommunekemi	02	010102	204	GAS OIL	8668	1A1a
054	Kommunekemi	03	010102	114	MUNICIP. WASTES	480732	1A1a
054	Kommunekemi	03	010102	203	RESIDUAL OIL	20431	1A1a
054	Kommunekemi	03	010102	204	GAS OIL	5722	1A1a
054	Kommunekemi	04	010104	301	NATURAL GAS	15	1A1a
055	I/S Fælles Forbrænding	01	010203	114	MUNICIP. WASTES	263588	1A1a
056	Vestfyns Forbrænding	01	010203	114	MUNICIP. WASTES	230108	1A1a
058	I/S Reno Syd	01	010103	114	MUNICIP. WASTES	624003	1A1a
059	I/S Kraftvarmeværk Thisted	01	010103	111	WOOD AND SIMIL.	3878	1A1a
059	I/S Kraftvarmeværk Thisted	01	010103	114	MUNICIP. WASTES	538325	1A1a

059	I/S Kraftvarmeværk Thisted	01	010103	117	STRAW	4916	1A1a
060	Knudmoseværket	01	010103	114	MUNICIP. WASTES	391451	1A1a
060	Knudmoseværket	01	010103	301	NATURAL GAS	39698	1A1a
061	Kavo I/S Energien	01	010103	114	MUNICIP. WASTES	649194	1A1a
062	VEGA	01	010203	114	MUNICIP. WASTES	594392	1A1a
065	Haderslev Kraftvarmeværk	01	010103	114	MUNICIP. WASTES	665025	1A1a
065	Haderslev Kraftvarmeværk	01	010103	301	NATURAL GAS	166	1A1a
066	Frederiskhavn Affaldskraftvarmeværk	01	010103	114	MUNICIP. WASTES	374121	1A1a
066	Frederiskhavn Affaldskraftvarmeværk	01	010103	204	GAS OIL	1005	1A1a
067	Vejen Kraftvarmeværk	01	010103	114	MUNICIP. WASTES	366610	1A1a
068	Bofa I/S	01	010203	114	MUNICIP. WASTES	193475	1A1a
069	DTU	01	010104	301	NATURAL GAS	765102	1A1a
070	Næstved Kraftvarmeværk	01	010104	301	NATURAL GAS	347670	1A1a
071	Maricogen	01	030104	301	NATURAL GAS	2235321	1A2f
072	Hjørring KVV	01	010104	301	NATURAL GAS	1375744	1A1a
075	Rockwool A/S Hedehusene	01	030318	301	NATURAL GAS	90000	1A2f
076	Rockwool A/S Vamdrup	01	030318	107	COKE OVEN COKE	375840	1A2f
076	Rockwool A/S Vamdrup	01	030318	301	NATURAL GAS	250560	1A2f
077	Rockwool A/S Doense	01	030318	107	COKE OVEN COKE	317520	1A2f
077	Rockwool A/S Doense	01	030318	301	NATURAL GAS	211680	1A2f
078	Rexam Glass Holmegaard A/S	01	030315	204	GAS OIL	933	1A2f
078	Rexam Glass Holmegaard A/S	01	030315	301	NATURAL GAS	945777	1A2f
081	Haldor Topsøe	02	0301	301	NATURAL GAS	457200	1A2f
081	Haldor Topsøe	02	0301	303	LPG	300	1A2f
082	Danisco Sugar Nakskov	02	030102	102	COAL	642254	1A2f
082	Danisco Sugar Nakskov	02	030102	203	RESIDUAL OIL	562311	1A2f
082	Danisco Sugar Nakskov	02	030102	204	GAS OIL	2941	1A2f
082	Danisco Sugar Nakskov	02	030102	309	BIOGAS	12150	1A2f
083	Danisco Sugar Nykøbing	02	030102	203	RESIDUAL OIL	727434	1A2f
083	Danisco Sugar Nykøbing	02	030102	309	BIOGAS	58544	1A2f

Table 57 Large point sources, plant specific emissions (IPCC 1A1, 1A2 and 1A4)[1].

LPS_id	LPS name	LPS part	Sector (IPCC)	Sector (SNAP)	SO_2	NO_x	NMVOC	CO	TSP	PM_{10} 2)	$PM_{2.5}$ 2)	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
001	Amagervaerket	01	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
001	Amagervaerket	02	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
001	Amagervaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
002	Svanemoellevaerket	05	1A1a	010101	x	x														
002	Svanemoellevaerket	07	1A1a	010104		x														
003	H.C.Oerstedsvaerket	03	1A1a	010101	x	x						x	x	x	x	x	x	x	x	x
003	H.C.Oerstedsvaerket	07	1A1a	010101	x	x						x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	21	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	22	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	26	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	28	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	41	1A1a	010105					x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	51	1A1a	010104	x	x			x	x	x	x	x	x	x	x	x	x	x	x
004	Kyndbyvaerket	52	1A1a	010104	x	x			x	x	x	x	x	x	x	x	x	x	x	x
005	Masnedoevaerket	12	1A1a	010102	x															
005	Masnedoevaerket	31	1A1a	010104	x	x														
007	Stigsnaesvaerket	01	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
007	Stigsnaesvaerket	02	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
008	Asnaesvaerket	02	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
008	Asnaesvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
008	Asnaesvaerket	04	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
008	Asnaesvaerket	05	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
009	Statoil Raffinaderi	01	1A1b	010306	x															
010	Avedoerevaerket	01	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
010	Avedoerevaerket	02	1A1a	010104	x	x			x	x	x	x	x	x	x	x	x	x	x	x
011	Fynsvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
011	Fynsvaerket	07	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
011	Fynsvaerket	08	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x		
012	Studstrupvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
012	Studstrupvaerket	04	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
014	Vendsysselvaerket	02	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
014	Vendsysselvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
017	Shell Raffinaderi	01	1A1b	010306	x	x														
017	Shell Raffinaderi	05	1A1b	010304	x	x														
018	Skaerbaekvaerket	01	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	
018	Skaerbaekvaerket	03	1A1a	010101	x	x			x	x	x									
019	Enstedvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
019	Enstedvaerket	04	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
020	Esbjergvaerket	03	1A1a	010101	x	x			x	x	x	x	x	x	x	x	x	x	x	x
022	Oestkraft	05	1A1a	010102	x	x														
022	Oestkraft	06	1A1a	010102	x	x														
023	Danisco Ingredients	01	1A2f	030102	x															
024	Dansk Naturgas Behandlingsanlaeg	01	1A1c	010502		x														
025	Horsens Kraftvarmevaerk	01	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x		
025	Horsens Kraftvarmevaerk	02	1A1a	010104		x														
026	Herningvaerket	01	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
027	Vestforbraendingen	01	1A1a	010102	x	x			x	x	x					x				
027	Vestforbraendingen	02	1A1a	010102	x	x			x	x	x					x				
028	Amagerforbraendingen	01	1A1a	010102	x	x	x	x	x	x	x		x			x		x		
029	Randersvaerket	01	1A1a	010102	x	x			x	x	x									
030	Grenaavaerket	01	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x		
031	Hilleroedvaerket	01	1A1a	010104		x														
032	Helsingoervaerket	01	1A1a	010104		x														
032	Helsingoervaerket	02	1A1a	010105		x														
033	Staalvalsevaerket	01	1A2f	030102		x			x	x	x									
034	Stora Dalum	01	1A2f	030102		x														
035	Assens Sukkerfabrik	01	1A2f	030102	x				x	x	x									
036	Kolding Kraftvarmevaerk	01	1A1a	010103	x		x	x	x	x	x	x	x	x	x	x	x	x		
036	Kolding Kraftvarmevaerk	02	1A1a	010103	x		x	x	x	x	x	x	x	x	x	x	x	x		
037	Maabjergvaerket	02	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x		

038	Soenderborg Kraft-varmevaerk	01	1A1a	010102	x	x		x	x	x	x	x	x	x	x	x	x	x			x	
038	Soenderborg Kraft-varmevaerk	02	1A1a	010104		x																
039	Kara Affaldsforbraend-ingsanlaeg	01	1A1a	010102	x			x	x	x	x										x	
040	Viborg Kraftvarme-vaerk	01	1A1a	010104		x																
042	Nordforbraendingen	01	1A1a	010102	x			x	x	x	x										x	
046	Aarhus Nord	01	1A1a	010102	x				x	x	x										x	
047	Reno Nord	01	1A1a	010103	x			x	x	x	x	x	x	x	x	x	x	x			x	
048	Silkeborg Kraftvarme-vaerk	01	1A1a	010104		x																
049	Rensningsanlægget Lynetten	01	1A4a	020103	x				x	x	x	x	x	x	x	x	x	x			x	
050	I/S Fasan	01	1A1a	010203	x	x		x	x	x	x	x									x	
051	AVV Forbrænding-sanlæg	01	1A1a	010103	x			x	x	x	x										x	
052	I/S REFA Kraftvar-meværk	01	1A1a	010103					x	x	x										x	
053	Svendborg Kraftvar-meværk	01	1A1a	010102	x	x	x	x	x	x	x										x	
054	Kommunekemi	01	1A1a	010102	x			x	x	x	x							x				
054	Kommunekemi	02	1A1a	010102	x			x	x	x	x							x				
054	Kommunekemi	03	1A1a	010102	x			x	x	x	x							x				
056	Vestfyns Forbrænding	01	1A1a	010203	x	x		x	x	x	x											
058	I/S Reno Syd	01	1A1a	010103	x			x	x	x	x										x	
059	I/S Kraftvarmeværk Thisted	01	1A1a	010103	x			x	x	x	x		x				x				x	
060	Knudmoseværket	01	1A1a	010103	x			x	x	x	x						x				x	
061	Kavo I/S Energien	01	1A1a	010103	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
062	VEGA (Vestforbraend-ing Taastrup)	01	1A1a	010203	x	x		x	x	x	x										x	
065	Haderslev Kraftvar-meværk	01	1A1a	010103	x	x		x	x	x	x						x	x	x			
066	Frederiskhavn Af-faldskraftvarmeværk	01	1A1a	010103	x	x		x	x	x	x						x		x			
067	Vejen Kraftvarmeværk	01	1A1a	010103	x	x		x	x	x	x	x	x	x	x	x	x	x	x			
068	Bofa I/S	01	1A1a	010203	x			x	x	x	x								x			
069	DTU	01	1A1a	010104		x																
070	Næstved Kraftvar-meværk	01	1A1a	010104		x		x														
071	Maricogen	01	1A2f	030104		x																
072	Hjørring KVV	01	1A1a	010104		x																
075	Rockwool A/S Hede-husene	01	1A2f	030318	x		x	x	x	x	x											
076	Rockwool A/S Vam-drup	01	1A2f	030318	x		x	x	x	x	x											
077	Rockwool A/S Doense	01	1A2f	030318	x		x	x	x	x	x											
078	Rexam Glass Hol-megaard A/S	01	1A2f	030315		x		x	x	x	x										x	x	x
080	Saint-Gobain Isover A/S	01	1A2f	030316					x	x	x											
081	Haldor Topsøe	02	1A2f	0301					x	x	x											
082	Danisco Sugar Nak-skov	02	1A2f	030102					x	x	x											
083	Danisco Sugar Nykøbing	02	1A2f	030102					x	x	x											
045	Aalborg Portland	01/03	1A2f	030311	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Total				**18270**	**56439**	**20**	**9690**	**1605**	**1291**	**980**	**315**	**67**	**298**	**266**	**604**	**2059**	**1404**	**1203**	**227**		

1) Emission of the pollutants marked with "x" is plant specific. Emission of other pollutants is estimated based on emission factors. The total shown *in this table* only includes plant specific data.
2) Based on particle size distribution

Appendix 9 Uncertainty estimates

Table 58 Uncertainty estimation, GHG.

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 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	24077	22609	1	5	5,099	2,713	-0,108	0,591	-0,539	0,836	0,995
Stationary Combustion, BKB	CO_2	11	0	3	5	5,831	0,000	0,000	0,000	-0,002	0,000	0,002
Stationary Combustion, Coke	CO_2	138	108	3	5	5,831	0,015	-0,001	0,003	-0,006	0,012	0,013
Stationary Combustion, Petroleum coke	CO_2	410	779	3	5	5,831	0,107	0,008	0,020	0,042	0,086	0,096
Stationary Combustion, Plastic waste	CO_2	349	649	5	5	7,071	0,108	0,007	0,017	0,034	0,120	0,125
Stationary Combustion, Residual oil	CO_2	2505	2120	2	2	2,828	0,141	-0,017	0,055	-0,035	0,157	0,161
Stationary Combustion, Gas oil	CO_2	4564	2918	4	5	6,403	0,440	-0,056	0,076	-0,281	0,432	0,515
Stationary Combustion, Kerosene	CO_2	366	24	4	5	6,403	0,004	-0,010	0,001	-0,050	0,004	0,050
Stationary Combustion, Orimulsion	CO_2	0	154	1	2	2,236	0,008	0,004	0,004	0,008	0,006	0,010
Stationary Combustion, Natural gas	CO_2	4330	11152	3	1	3,162	0,830	0,166	0,292	0,166	1,237	1,248
Stationary Combustion, LPG	CO_2	164	74	4	5	6,403	0,011	-0,003	0,002	-0,014	0,011	0,018
Stationary Combustion, Refinery gas	CO_2	806	942	3	5	5,831	0,129	0,001	0,025	0,006	0,105	0,105
Stationary combustion plants, gas engines	CH_4	6	391	2,2	40	40,060	0,368	0,010	0,010	0,401	0,032	0,402
Stationary combustion plants, other	CH_4	115	130	2,2	100	100,024	0,307	0,000	0,003	0,007	0,011	0,013
Stationary combustion plants	N_2O	398	440	2,2	1000	1000,002	10,360	0,000	0,012	-0,045	0,036	0,058
Total		38239	42490				115,855					3,043

Total uncertainties	Overall uncertainty in the year (%):	10,764	Trend uncertainty (%):	1,744

Table 59 Uncertainty estimation, CO_2.

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	Gg CO_2	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	24077	22609	1	5	5,099	2,713	-0,108	0,591	-0,539	0,836	0,995
Stationary Combustion, BKB	CO_2	11	0	3	5	5,831	0,000	0,000	0,000	-0,002	0,000	0,002
Stationary Combustion, Coke	CO_2	138	108	3	5	5,831	0,015	-0,001	0,003	-0,006	0,012	0,013
Stationary Combustion, Petroleum coke	CO_2	410	779	3	5	5,831	0,107	0,008	0,020	0,042	0,086	0,096
Stationary Combustion, Plastic waste	CO_2	349	649	5	5	7,071	0,108	0,007	0,017	0,034	0,120	0,125
Stationary Combustion, Residual oil	CO_2	2505	2120	2	2	2,828	0,141	-0,017	0,055	-0,035	0,157	0,161
Stationary Combustion, Gas oil	CO_2	4564	2918	4	5	6,403	0,440	-0,056	0,076	-0,281	0,432	0,515
Stationary Combustion, Kerosene	CO_2	366	24	4	5	6,403	0,004	-0,010	0,001	-0,050	0,004	0,050
Stationary Combustion, Orimulsion	CO_2	0	154	1	2	2,236	0,008	0,004	0,004	0,008	0,006	0,010
Stationary Combustion, Natural gas	CO_2	4330	11152	3	1	3,162	0,830	0,166	0,292	0,166	1,237	1,248
Stationary Combustion, LPG	CO_2	164	74	4	5	6,403	0,011	-0,003	0,002	-0,014	0,011	0,018
Stationary Combustion, Refinery gas	CO_2	806	942	3	5	5,831	0,129	0,001	0,025	0,006	0,105	0,105
Total	CO_2	37720	41529				8,693					2,920

Total uncertainties	Overall uncertainty in the year (%):	2,948	Trend uncertainty (%):	1,709

Table 60 Uncertainty estimation, CH_4.

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							
		Mg CH_4	Mg CH_4	%	%	%	%	%	%	%	%	%
Stationary combustion plants, gas engines	CH_4	305	18601	2,2	40	40,060	30,036	2,993	3,221	119,728	10,023	120,147
Stationary combustion plants, other	CH_4	5470	6208	2,2	100	100,024	25,029	-2,967	1,075	-296,668	3,345	296,687
Total	CH_4	5774	24809				1528,6					102459
Total uncertainties				**Overall uncertainty in the year (%):**			**39,098**			**Trend uncertainty (%):**		**320,091**

Table 61 Uncertainty estimation, N_2O.

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 N_2O	Gg N_2O	%	%	%	%	%	%	%	%	%
Stationary combustion plants	N_2O	1,283	1,420	2,200	1000,000	1000,002	1000,002	0,000	1,107	0,000	3,444	3,444
Total	N_2O	1,283	1,420				1000005					11,858
Total uncertainties				**Overall uncertainty in the year (%):**			**1000,002**			**Trend uncertainty (%):**		**3,444**

Table 62 Uncertainty estimation, SO_2.

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in	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 uncer-	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	129579	17461	2	10	10,198	6,614	-0,030	0,111	-0,301	0,315	0,435
02	SO_2	11500	3612	2	20	20,100	2,697	0,010	0,023	0,209	0,065	0,219
03	SO_2	15921	5851	2	10	10,198	2,216	0,020	0,037	0,199	0,105	0,225
Total	SO_2	157000	26924				55,924					0,288

Total uncertainties	Overall uncertainty in the year (%):	**7,478**	Trend uncertainty (%):	**0,536**

Table 63 Uncertainty estimation, NO_X.

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 in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncer-	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg NO_x	Mg NO_x	%	%	%	%	%	%	%	%	%
01	NO_x	94953	64508	2	20	20,100	15,150	-0,049	0,5575	-0,980	1,577	1,856
02	NO_x	8056	7654	2	50	50,040	4,475	0,015	0,0661	0,732	0,187	0,756
03	NO_x	12709	13419	2	20	20,100	3,152	0,035	0,1160	0,694	0,328	0,768
Total	NO_x	115718	85581				259,498					4,607

Total uncertainties	Overall uncertainty in the year (%):	**16,109**	Trend uncertainty (%):	**2,146**

Table 64 Uncertainty estimation, NMVOC.

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 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 NMVOC	Mg NMVOC	%	%	%	%	%	%	%	%	%
01	NMVOC	1073	4263	2	50	50,040	11,545	0,213	0,3361	10,631	0,951	10,674
02	NMVOC	10996	13494	2	50	50,040	36,544	-0,197	1,0638	-9,866	3,009	10,314
03	NMVOC	615	721	2	50	50,040	1,951	-0,014	0,0568	-0,689	0,161	0,707
Total	NMVOC	12685	18478				1472,543					220,819

Total uncertainties	Overall uncertainty in the year (%):	**38,374**	Trend uncertainty (%):	**14,860**

Table 65 Uncertainty estimation, CO.

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 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 CO	Mg CO	%	%	%	%	%	%	%	%	%
01	CO	8256	12629	2	20	20,100	1,382	0,022	0,073	0,445	0,207	0,491
02	CO	159295	158778	2	50	50,040	43,248	-0,062	0,920	-3,083	2,601	4,034
03	CO	5082	12308	2	20	20,100	1,347	0,040	0,071	0,799	0,202	0,824
Total	CO	172633	183715				1874,073					17,193

Total uncertainties	Overall uncertainty in the year (%):	**43,291**	Trend uncertainty (%):	**4,146**

Table 66 Uncertainty estimation, TSP.

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 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							
		kg TSP	kg TSP	%	%	%	%	%	%	%	%	%
01	TSP	1158	1432	2	50	50,040	4,850	0,020	0,095	0,997	0,267	1,032
02	TSP	12843	12323	2	500	500,004	416,918	-0,014	0,814	-6,806	2,301	7,184
03	TSP	1146	1023	2	50	50,040	3,465	-0,006	0,068	-0,311	0,191	0,365
Total	TSP	15147	14779				173856,474					52,811

Total uncertainties	Overall uncertainty in the year (%):	**416,961**	Trend uncertainty (%):	**7,267**

Table 67 Uncertainty estimation, PM_{10}.

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 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							
		kg PM_{10}	kg PM_{10}	%	%	%	%	%	%	%	%	%
01	PM_{10}	941	1141	2	50	50,040	4,227	0,017	0,082	0,826	0,231	0,858
02	PM_{10}	12185	11683	2	500	500,004	432,470	-0,007	0,836	-3,529	2,366	4,249
03	PM_{10}	843	683	2	50	50,040	2,531	-0,009	0,049	-0,471	0,138	0,491
Total	PM_{10}	13969	13507				187054,310					19,030

Total uncertainties	Overall uncertainty in the year (%):	**432,498**	Trend uncertainty (%):	**4,362**

Table 68 Uncertainty estimation, $PM_{2.5}$.

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 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							
		kg $PM_{2.5}$	kg $PM_{2.5}$	%	%	%	%	%	%	%	%	%
01	$PM_{2.5}$	804	953	2	50	50,040	3,843	0,014	0,074	0,682	0,210	0,713
02	$PM_{2.5}$	11520	11048	2	500	500,004	445,192	-0,008	0,861	-3,797	2,437	4,511
03	$PM_{2.5}$	500	407	2	50	50,040	1,643	-0,006	0,032	-0,299	0,090	0,312
Total	$PM_{2.5}$	12825	12409				198213,438					20,958
Total uncertainties				Overall uncertainty in the year (%):			**445,212**				Trend uncertainty (%):	**4,578**

Table 69 Uncertainty estimation, As.

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 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							
		kg As	kg As	%	%	%	%	%	%	%	%	%
01	As	965	458	2	100	100,020	63,502	-0,017	0,318	-1,715	0,899	1,936
02	As	127	71	2	1000	1000,002	97,710	0,005	0,049	4,735	0,138	4,737
03	As	350	193	2	100	100,020	26,745	0,012	0,134	1,249	0,379	1,305
Total	As	1442	722				14295,159					27,894
Total uncertainties				Overall uncertainty in the year (%):			**119,562**				Trend uncertainty (%):	**5,281**

Table 70 Uncertainty estimation, Cd.

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 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							
		kg Cd	kg Cd	%	%	%	%	%	%	%	%	%
01	Cd	592	215	2	100	100,020	40,611	-0,079	0,204	-7,854	0,578	7,876
02	Cd	145	146	2	1000	1000,002	275,729	0,069	0,139	69,465	0,393	69,466
03	Cd	315	169	2	100	100,020	31,831	0,009	0,160	0,940	0,453	1,043
Total	Cd	1052	529				78688,984					4888,685
Total uncertainties				Overall uncertainty in the year (%):			**280,516**				Trend uncertainty (%):	**69,919**

Table 71 Uncertainty estimation, Cr.

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 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							
		kg Cr	kg Cr	%	%	%	%	%	%	%	%	%
01	Cr	4674	503	2	100	100,020	51,166	-0,041	0,082	-4,067	0,233	4,074
02	Cr	326	113	2	1000	1000,002	114,483	0,010	0,018	9,845	0,052	9,845
03	Cr	1104	368	2	100	100,020	37,404	0,031	0,060	3,108	0,171	3,113
Total	Cr	6103	984				17123,419					123,206

Total uncertainties	Overall uncertainty in the year (%):	130,856	Trend uncertainty (%):	11,100

Table 72 Uncertainty estimation, Cu.

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 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							
		kg Cu	kg Cu	%	%	%	%	%	%	%	%	%
01	Cu	2915	615	2	100	100,020	60,819	-0,055	0,170	-5,451	0,480	5,472
02	Cu	302	219	2	1000	1000,002	216,951	0,037	0,061	37,310	0,171	37,311
03	Cu	405	177	2	100	100,020	17,501	0,018	0,049	1,758	0,138	1,764
Total	Cu	3622	1012				51072,917					1425,145

Total uncertainties	Overall uncertainty in the year (%):	225,993	Trend uncertainty (%):	37,751

Table 73 Uncertainty estimation, Hg.

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 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							
		kg Hg	kg Hg	%	%	%	%	%	%	%	%	%
01	Hg	2509	716	2	100	100,020	58,420	-0,091	0,233	-9,142	0,658	9,165
02	Hg	330	273	2	1000	1000,002	222,729	0,046	0,089	45,974	0,251	45,974
03	Hg	238	237	2	100	100,020	19,322	0,046	0,077	4,610	0,218	4,615
Total	Hg	3076	1225				53394,404					2218,951

Total uncertainties	Overall uncertainty in the year (%):	231,072	Trend uncertainty (%):	47,106

Table 74 Uncertainty estimation, Ni.

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 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							
		kg Ni	kg Ni	%	%	%	%	%	%	%	%	%
01	Ni	8384	3326	2	100	100,020	37,668	-0,006	0,156	-0,642	0,440	0,778
02	Ni	1852	821	2	1000	1000,002	93,007	0,003	0,038	2,633	0,109	2,635
03	Ni	11140	4684	2	100	100,020	53,050	0,004	0,219	0,379	0,620	0,726
Total	Ni	21376	8831				12883,397					8,077

Total uncertainties	Overall uncertainty in the year (%):	**113,505**	Trend uncertainty (%):	**2,842**

Table 75 Uncertainty estimation, Pb.

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 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							
		kg Pb	kg Pb	%	%	%	%	%	%	%	%	%
01	Pb	11994	1906	2	100	100,020	56,291	-0,048	0,124	-4,770	0,351	4,782
02	Pb	946	327	2	1000	1000,002	96,518	0,008	0,021	7,703	0,060	7,704
03	Pb	2422	1154	2	100	100,020	34,075	0,040	0,075	4,030	0,212	4,035
Total	Pb	15361	3387				13645,559					98,501

Total uncertainties	Overall uncertainty in the year (%):	**116,814**	Trend uncertainty (%):	**9,925**

Table 76 Uncertainty estimation, Se.

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 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							
		kg Se	kg Se	%	%	%	%	%	%	%	%	%
01	Se	2961	1028	2	100	100,020	51,607	-0,076	0,237	-7,620	0,670	7,650
02	Se	308	173	2	1000	1000,002	86,943	0,007	0,040	7,255	0,113	7,256
03	Se	1066	791	2	100	100,020	39,717	0,069	0,182	6,929	0,516	6,948
Total	Se	4335	1992				11799,786					159,4417894

Total uncertainties	Overall uncertainty in the year (%):	**108,627**	Trend uncertainty (%):	**12,627**

Table 77 Uncertainty estimation, Zn.

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 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							
		kg Zn	kg Zn	%	%	%	%	%	%	%	%	%
01	Zn	14801	13338	2	100	100,020	74,479	-0,019	0,690	-1,890	1,950	2,716
02	Zn	2811	3032	2	1000	1000,002	169,261	0,022	0,157	22,120	0,443	22,125
03	Zn	1730	1542	2	100	100,020	8,612	-0,003	0,080	-0,311	0,226	0,384
Total	Zn	19342	17912				34270,633					497,030

Total uncertainties	Overall uncertainty in the year (%):	**185,123**	Trend uncertainty (%):	**22,294**

Table 78 Uncertainty estimation, Benzo(b)fluoranthene.

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 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							
		kg	kg	%	%	%	%	%	%	%	%	%
01		31	33	2	100	100,020	0,847	-0,006	0,013	-0,637	0,037	0,638
02		2391	3742	2	1000	1000,002	967,679	0,000	1,515	0,073	4,284	4,284
03		49	92	2	100	100,020	2,386	0,006	0,037	0,630	0,106	0,639
Total		2471	3867				936408,372					19,170

Total uncertainties	Overall uncertainty in the year (%):	**967,682**	Trend uncertainty (%):	**4,378**

Table 79 Uncertainty estimation, Benzo(k)fluoranthene.

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 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							
		kg	kg	%	%	%	%	%	%	%	%	%
01		11	15	2	100	100,020	1,181	-0,003	0,019	-0,270	0,054	0,275
02		749	1224	2	1000	1000,002	975,626	0,029	1,565	28,839	4,426	29,176
03		23	16	2	100	100,020	1,257	-0,026	0,020	-2,641	0,057	2,641
Total		782	1254				951849,639					858,313

Total uncertainties	Overall uncertainty in the year (%):	**975,628**	Trend uncertainty (%):	**29,297**

Table 80 Uncertainty estimation, Benzo(a)pyrene.

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 in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncer-	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		kg	kg	%	%	%	%	%	%	%	%	%
01		8	8	2	100	100,020	0,279	-0,002	0,004	-0,212	0,012	0,213
02		1880	2879	2	1000	1000,002	988,125	-0,003	1,516	-3,038	4,289	5,256
03		11	26	2	100	100,020	0,908	0,005	0,014	0,519	0,039	0,521
Total		1898	2913				976392,891					27,944

Total uncertainties	Overall uncertainty in the year (%):	**988,126**	Trend uncertainty (%):	**5,286**

Table 81 Uncertainty estimation, Indeno(1,2,3-c,d)pyrene.

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 in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncer-	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		kg	kg	%	%	%	%	%	%	%	%	%
01		6	8	2	100	100,020	0,376	0,000	0,005	-0,036	0,015	0,039
02		1552	2139	2	1000	1000,002	993,001	0,008	1,361	7,700	3,849	8,608
03		14	7	2	100	100,020	0,325	-0,007	0,004	-0,741	0,013	0,741
Total		1572	2154				986051,863					74,655

Total uncertainties	Overall uncertainty in the year (%):	**993,001**	Trend uncertainty (%):	**8,640**

Appendix 10 Lower Calorific Value (LCV) of fuels

Table 82 Time-series for calorific values of fuels (Danish Energy Authority, DEA 2004b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Crude Oil, Average	GJ / ton	42,40	42,40	42,40	42,70	42,70	42,70	42,70	43,00	43,00	43,00	43,00	43,00	43,00	43,00
Crude Oil, Golf	GJ / ton	41,80	41,80	41,80	41,80	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 / ton	42,70	42,70	42,70	42,70	42,70	42,70	42,70	43,00	43,00	43,00	43,00	43,00	43,00	43,00
Refinery Feedstocks	GJ / ton	41,60	41,60	41,60	41,60	41,60	41,60	41,60	42,70	42,70	42,70	42,70	42,70	42,70	42,70
Refinery Gas	GJ / ton	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00	52,00
LPG	GJ / ton	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00	46,00
Naphtha (LVN)	GJ / ton	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50	44,50
Motor Gasoline	GJ / ton	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80
Aviation Gasoline	GJ / ton	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80
JP4	GJ / ton	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80	43,80
		34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80	34,80
Other Kerosene	GJ / ton	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50
JP1	GJ / ton	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50
		35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87	35,87
Gas/Diesel Oil	GJ / ton	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70	42,70
Fuel Oil	GJ / ton	40,40	40,40	40,40	40,40	40,40	40,40	40,70	40,65	40,65	40,65	40,65	40,65	40,65	40,65
Orimulsion	GJ / ton	27,60	27,60	27,60	27,60	27,60	28,13	28,02	27,72	27,84	27,58	27,62	27,64	27,71	27,65
Petroleum Coke	GJ / ton	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40	31,40
Waste Oil	GJ / ton	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90
White Spirit	GJ / ton	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50	43,50
Bitumen	GJ / ton	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80	39,80
Lubricants	GJ / ton	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90	41,90
Natural Gas	GJ / 1000 Nm3	39,00	39,00	39,00	39,30	39,30	39,30	39,30	39,60	39,90	40,00	40,15	39,99	40,06	39,94
Town Gas	GJ / 1000 m3							17,00	17,00	17,00	17,00	17,01	16,88	17,39	16,88
Electricity Plant Coal	GJ / ton	25,30	25,40	25,80	25,20	24,50	24,50	24,70	24,96	25,00	25,00	24,80	24,90	25,15	24,73
Other Hard Coal	GJ / ton	26,10	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50	26,50
Gas Plant Coal	GJ / ton														
Coke	GJ / ton	31,80	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30	29,30
Brown Coal Briquettes	GJ / ton	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30	18,30
Straw	GJ / ton	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50	14,50
Wood Chips	GJ/Rummeter	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80	2,80
Firewood, Hardwood	GJ / m3	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40	10,40
Firewood, Conifer	GJ / m3	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60	7,60
Wood Pellets	GJ / ton	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50	17,50
Wood Waste	GJ / ton	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70	14,70
Wood Waste	GJ/Rummeter	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20	3,20
Biogas	GJ / 1000 m3								23,00	23,00	23,00	23,00	23,00	23,00	23,00
Waste Combustion	GJ / ton	8,20	8,20	9,00	9,40	9,40	10,00	10,50	10,50	10,50	10,50	10,50	10,50	10,50	10,50
Liquid Biofuels											37,60	37,60	37,60	37,60	37,60
Fish Oil	GJ / ton	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20	37,20

Table 83 Fuel category correspondence list, Danish Energy Authority, NERI and Climate convention reportings (IPCC).

Danish Energy Authority	NERI Emission database	IPCC fuel category
Other Hard Coal	Coal	Solid
Coke	Coke oven coke	Solid
Electricity Plant Coal	Coal	Solid
Brown Coal Briquettes	Brown coal briq.	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	Municip. wastes	Biomass 1)
Fish Oil	Fish & Rape oil	Biomass
Biogas	Biogas	Biomass
Biogas, other	Biogas	Biomass
Biogas, landfill	Biogas	Biomass
Biogas, sewage sludge	Biogas	Biomass

1) CO_2 from plastic part included in Other fuels

Appendix 11 Adjustment of CO_2 emission

Table 84 Adjustment of CO_2 emission (ref. Danish Energy Authority).

Degree Days		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Actual Degree Days	Degree days	2093	2515	3022	3434	3148	3297	3837	3236	3217	3056	2902	3279	3011	3111
Normal Degree Days	Degree days	2691	2691	3370	3370	3370	3370	3370	3370	3370	3370	3370	3370	3370	3370
Net electricity import	TJ	25 373	-7 099	13 486	4 266	-17 424	-2 858	-55 444	-26 107	-15 552	-8 327	2 394	-2 071	-7 453	-30 760
Actual CO_2 emission	1.000.000 tonnes	52,7	62,8	56,7	58,9	62,7	59,6	73,0	63,2	59,4	56,4	52,4	53,8	53,0	58,0
Adjusted CO_2 emission	1.000.000 tonnes	60,9	61,8	60,8	59,8	59,7	59,1	58,4	57,6	56,2	55,4	54,3	53,7	52,4	51,8

Appendix 12 Reference approach

TABLE 1.A(b) SECTORAL BACKGROUND DATA FOR ENERGY
CO_2 from Fuel Combustion Activities - Reference Approach (IPCC Worksheet 1-1)
(Sheet 1 of 1)

FUEL TYPES			Unit	Production	Imports	Exports	International bunkers	Stock change	Apparent consumption	Conversion factor [1] (TJ/Unit)	[1]	Apparent consumption (TJ)	Carbon emission factor (t C/TJ)	Carbon content (Gg C)	Carbon stored (Gg C)	Net carbon emissions (Gg C)	Fraction of carbon oxidized	Actual CO_2 emissions (Gg CO_2)
Liquid Fossil	Primary Fuels	Crude Oil	TJ	780.551,93	150.155,48	574.098,98		3.057,86	353.550,58	1,00	NCV	353.550,58	20,00	7.071,01		7.071,01	1,00	25.927,04
		Orimulsion	TJ	0,00	0,00	0,00		-1.921,40	1.921,40	1,00	NCV	1.921,40	22,00	42,27		42,27	1,00	154,99
		Natural Gas Liquids	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	17,20	0,00		0,00	1,00	0,00
	Secondary Fuels	Gasoline	TJ		38.197,16	44.363,08	18,16	-1.072,69	-5.111,39	1,00	NCV	-5.111,39	18,90	-96,61		-96,61	1,00	-354,22
		Jet Kerosene	TJ		22.975,27	21.494,43	29.710,44	-4.039,03	-24.190,57	1,00	NCV	-24.190,57	19,50	-471,72		-471,72	1,00	-1.729,63
		Other Kerosene	TJ		0,00	0,00	0,00	0,00	0,00	1,00	NCV	0,00	19,60	0,00		0,00	1,00	0,00
		Shale Oil	TJ		0,00	0,00		0,00	0,00	1,00	NCV	0,00	20,00	0,00		0,00	1,00	0,00
		Gas / Diesel Oil	TJ		82.301,53	48.524,02	20.729,77	1.467,11	11.580,63	1,00	NCV	11.580,63	20,20	233,93	0,00	233,93	1,00	857,74
		Residual Fuel Oil	TJ		37.489,83	47.253,02	20.461,87	1.912,75	-32.137,81	1,00	NCV	-32.137,81	21,10	-678,11		-678,11	1,00	-2.486,40
		LPG	TJ		103,13	4.769,19		-20,15	-4.645,91	1,00	NCV	-4.645,91	17,20	-79,91	0,00	-79,91	1,00	-293,00
		Ethane	TJ		0,00	0,00		0,00	0,00	1,00	NCV	0,00	16,80	0,00	0,00	0,00	1,00	0,00
		Naphtha	TJ		759,81	360,22		18,91	380,68	1,00	NCV	380,68	20,00	7,61	5,99	1,62	1,00	5,94
		Bitumen	TJ		8.061,33	125,81		-260,17	8.195,70	1,00	NCV	8.195,70	22,00	180,31	186,14	-5,83	1,00	-21,39
		Lubricants	TJ		2.054,61	217,04	103,95	-83,84	1.817,45	1,00	NCV	1.817,45	20,00	36,35	19,56	16,78	1,00	61,54
		Petroleum Coke	TJ		9.267,71	284,96		804,25	8.178,51	1,00	NCV	8.178,51	27,50	224,91		224,91	1,00	824,67
		Refinery Feedstocks	TJ		2.806,54	2.210,92		-964,12	1.559,75	1,00	NCV	1.559,75	20,00	31,19		31,19	1,00	114,38
		Other Oil	TJ		0,00	0,00		0,00	0,00	1,00	NCV	0,00	20,00	0,00		0,00	1,00	0,00
Liquid Fossil Totals												321.099,01		6.501,24	211,70	6.289,55		23.061,68
Solid Fossil	Primary Fuels	Anthracite [2]	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	26,80	0,00		0,00	1,00	0,00
		Coking Coal	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	25,80	0,00	0,00	0,00	1,00	0,00
		Other Bit. Coal	TJ	0,00	235.910,66	3.765,13	0,00	-4.194,81	236.340,34	1,00	NCV	236.340,34	25,80	6.097,58		6.097,58	1,00	22.357,80
		Sub-bit. Coal	TJ	0,00	0,00	0,00	0,00	0,00	0,00	1,00	NCV	0,00	26,20	0,00		0,00	1,00	0,00
		Lignite	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	27,60	0,00		0,00	1,00	0,00
		Oil Shale	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	29,10	0,00		0,00	1,00	0,00
		Peat	TJ	0,00	0,00	0,00		0,00	0,00	1,00	NCV	0,00	28,90	0,00		0,00	1,00	0,00
	Secondary Fuels	BKB & Patent Fuel	TJ		5,82	8,89		-3,07	0,00	1,00	NCV	0,00	25,80	0,00		0,00	1,00	0,00
		Coke Oven/Gas Coke	TJ		932,97	0,00		59,51	873,46	1,00	NCV	873,46	29,50	25,77		25,77	1,00	94,48
Solid Fuel Totals												237.213,80		6.123,35	0,00	6.123,35		22.452,28
Gaseous Fossil		Natural Gas (Dry)	TJ	301.555,94	0,00	108.622,54		-2.199,96	195.133,35	1,00	NCV	195.133,35	15,30	2.985,54	0,00	2.985,54	1,00	10.946,98
Total												**753.446,16**		**15.610,13**	**211,70**	**15.398,44**		**56.460,93**
Biomass total												92.700,68		2.746,35	0,00	2.746,35		10.069,93
		Solid Biomass	TJ	82.753,81	6.368,76	0,00		0,00	89.122,57	1,00	NCV	89.122,57	29,90	2.664,76		2.664,76	1,00	9.770,80
		Liquid Biomass	TJ	1.692,00	0,00	1.692,00		0,00	0,00	1,00	NCV	0,00	20,00	0,00		0,00	1,00	0,00
		Gas Biomass	TJ	3.578,11	0,00	0,00		0,00	3.578,11	1,00	NCV	3.578,11	22,80	81,58		81,58	1,00	299,13

TABLE 1.A(c) COMPARISON OF CO_2 EMISSIONS FROM FUEL COMBUSTION
(Sheet 1 of 1)

Denmark
2003
2005, Mar15

FUEL TYPES	Reference approach		National approach [1]		Difference [2]	
	Energy consumption (PJ)	CO_2 emissions (Gg)	Energy consumption (PJ)	CO_2 emissions (Gg)	Energy consumption (%)	CO_2 emissions (%)
Liquid Fuels (excluding international bunkers)	321,10	23.061,68	305,55	22.493,76	5,09	2,52
Solid Fuels (excluding international bunkers)	237,21	22.452,28	238,99	22.716,70	-0,74	-1,16
Gaseous Fuels	195,13	10.946,98	195,00	11.152,32	0,07	-1,84
Other [3]	-10,82	649,16	1,00	722,30	-1.179,48	-10,13
Total [3]	**742,63**	**57.110,09**	**740,54**	**57.085,08**	**0,28**	**0,04**

[1] "National approach" is used to indicate the approach (if different from the Reference approach) followed by the Party to estimate its CO_2 emissions from fuel combustion reported in the national GHG inventory.
[2] Difference of the Reference approach over the National approach (i.e. difference = 100% x ((RA-NA)/NA), where NA = National approach and RA = Reference approach).
[3] Emissions from biomass are not included.

Note: In addition to estimating CO_2 emissions from fuel combustion by sector, Parties should also estimate these emissions using the IPCC Reference approach, as found in the IPCC Guidelines, Worksheet 1-1(Volume 2. Workbook). The Reference approach is to assist in verifying the sectoral data. Parties should also complete the above tables to compare the alternative estimates, and if the emission estimates lie more than 2 percent apart, should explain the source of this difference in the documentation box provided.

Documentation Box:
Non-energy use of fuels is not included in the Danish National Approach. Fuel consumption for non-energy is subtracted in Reference Approach to make results comparable. CO2 emission from plastic part of municipal wastes is included in the Danish National Approach. CO2 emission from the plastic part of municipal wastes is added in Reference Approach to make results comparable. (Other fuels of sources 1A1, 1A2 and 1A4)

Table 85 Fuel category correspondence list for the reference approach.

Reference approach		Danish energy statistics
Biomass	Gas Biomass	Biogas, other
Biomass	Gas Biomass	Biogas, landfill
Biomass	Gas Biomass	Biogas, sewage sludge
Biomass	Liquid Biomass	Liquid biofuels
Biomass	Solid Biomass	Fish oil
Biomass	Solid Biomass	Waste combustion, plastic
Biomass	Solid Biomass	Waste combustion, other
Biomass	Solid Biomass	Firewood
Biomass	Solid Biomass	Straw
Biomass	Solid Biomass	Wood Chips
Biomass	Solid Biomass	Firewood
Biomass	Solid Biomass	Wood Pellets
Liquid fossil	Bitumen	Bitumen
Liquid fossil	Crude oil	Crude Oil
Liquid fossil	Crude oil	Waste Oil
Liquid fossil	Ethane	-
Liquid fossil	Gas/diesel oil	Gas/Diesel Oil
Liquid fossil	Gasoline	Aviation Gasoline
Liquid fossil	Gasoline	Motor Gasoline
Liquid fossil	Jet Kerosene	JP1
Liquid fossil	Jet Kerosene	JP4
Liquid fossil	LPG	LPG
Liquid fossil	Lubricants	Lubricants
Liquid fossil	Naphtha	White Spirit
Liquid fossil	Naphtha	Naphtha (LVN)
Gaseous fossil	Natural gas	Natural Gas
Liquid fossil	Natural gas liquids	-
Liquid fossil	Orimulsion	Orimulsion
Liquid fossil	Other kerosene	Other Kerosene
Liquid fossil	Petroleum coke	Petroleum Coke
Liquid fossil	Refinery feedstocks	Refinery Feedstocks
Liquid fossil	Residual fuel oil	Fuel Oil
Liquid fossil	Shale oil	-
Solid fossil	Anthracite	-
Solid fossil	BKB & Patent fuel	Brown Coal Briquettes
Solid fossil	Coke oven/gas coke	Coke
Solid fossil	Coking Coal	-
Solid fossil	Lignite	-
Solid fossil	Oil Shale	-
Solid fossil	Other Bit. Coal	Other Hard Coal
Solid fossil	Other Bit. Coal	Electricity Plant Coal
Solid fossil	Peat	-
Solid fossil	Sub-bit. coal	-

Appendix 13 Emission inventory 2003 based on SNAP sectors

Table 86 Emission inventory 2003 based on SNAP sectors.

SNAP 2)	SO2 [Mg]	NOX [Mg]	NMVOC [Mg]	CH4 [Mg]	CO [Mg]	CO_2 1) [Gg]	N2O [Mg]	TSP [Mg]	PM10 [Mg]	PM2,5 [Mg]	As [kg]	Cd [kg]	Cr [kg]	Cu [kg]	Hg [kg]	Ni [kg]	Pb [kg]	Se [kg]	Zn [kg]	Flouran-the [kg]	Benzo(b) [kg]	Benzo(k) [kg]	Benzo(a) [kg]	Benzo(g,,) [kg]	Indeno [kg]
Total 01	17461	64508	4263	15706	12629	37354	1057	1432	1141	953	458	215	503	615	716	3326	1906	1028	13338	242	33	15	8	19	8
101	-	0	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10101	14017	39525	411	491	2936	23735	722	746	601	495	128	18	240	142	214	1902	256	948	40	23	5	1	1	4	2
10102	969	4161	56	45	706	3841	51	134	89	72	162	79	98	218	156	232	903	48	8656	2	0	0	0	0	0
10103	568	1360	16	23	255	1169	14	56	39	32	134	34	29	107	124	148	438	1	2702	4	0	0	0	0	0
10104	482	3768	78	78	585	2917	89	154	151	126	6	4	4	8	5	51	79	5	249	19	5	1	1	2	2
10105	44	5500	3191	14597	5199	1704	36	25	6	5	0	0	0	0	0	4	0	0	1	4	1	1	0	0	0
102	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10202	40	67	11	9	65	63	2	5	4	4	2	3	3	3	2	54	3	2	30	1	0	0	0	0	0
10203	837	1837	440	315	2429	1379	49	181	130	103	14	65	99	126	211	353	205	10	1658	186	20	11	5	12	4
10204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10205	0	29	20	89	30	10	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-
103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10301	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10302	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10303	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10304	8	626	2	2	24	216	8	19	19	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10306	487	1020	-	-	219	796	27	109	100	96	13	12	30	12	4	582	21	11	3	2	0	0	0	0	0
104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10401	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10402	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10403	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10405	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10406	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10407	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10501	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10502	0	34	1	2	9	18	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10503	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10504	8	6562	37	39	163	1501	58	3	2	1	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
10505	1	19	2	17	11	3	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10506	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total 02	3612	7654	13494	7617	158778	7830	215	12323	11683	11048	71	146	113	219	273	821	327	173	3032	13724	3742	1224	2879	3877	2139
201	248	765	622	257	607	1005	25	168	166	157	10	19	41	44	69	166	150	19	527	792	217	72	165	223	117
20101	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20102	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20103	106	17	1	1	5	18	1	22	19	15	5	1	3	13	25	3	4	0	27	1	0	-	0	0	-
20104	0	4	0	0	0	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20105	11	459	127	704	324	103	2	2	0	0	-	-	-	-	-	-	-	-	0	0	0	0	-	0	0
20106	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
202	1737	4619	10945	3807	148987	5629	159	11600	11004	10417	35	111	30	140	155	52	129	130	2392	12355	3372	1124	2574	3485	1816
20201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20202	0	2	0	1	1	4	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20204	0	244	170	755	254	83	2	1	0	0	-	-	-	-	-	-	-	-	-	0	0	0	-	0	0
20205	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
203	1497	805	1288	461	7971	780	23	526	492	459	21	15	37	23	24	594	43	24	85	574	153	27	140	168	205
20301	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20302	3	2	0	0	2	1	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0

20303	0	7	0	0	0	3	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20304	11	731	341	1632	625	202	4	4	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
20305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total 03	5851	13419	721	1485	12308	5452	149	1023	683	407	193	169	368	177	237	4684	1154	791	1542	3468	92	16	26	8	7
301	3253	3120	394	417	2540	3148	77	251	185	136	86	114	186	120	71	3453	165	81	883	166	12	10	1	3	3
30101	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30102	1241	490	33	43	132	416	10	129	40	13	28	22	59	26	10	1063	49	21	23	27	2	2	0	1	1
30103	7	43	14	11	74	37	1	6	4	3	-	2	-	2	2	-	1	-	40	1	0	0	-	0	-
30104	2	610	9	10	40	373	14	1	0	0	-	-	-	-	-	-	-	-	-	0	-	0	-	0	0
30105	1	267	181	807	274	90	2	1	0	0	0	0	0	0	-	1	0	0	-	0	0	0	-	0	0
30106	0	1	0	0	1	1	0	0	0	0	0	-	0	0	0	-	0	0	0	0	-	-	-	-	-
302	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30205	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
303	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30301	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30302	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30303	-	-	-	-	-	-	-	175	52	8	26	12	96	-	-	113	629	437	437	-	-	-	-	-	-
30304	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30305	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30306	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30307	-	-	-	-	-	-	-	2	1	1	-	0	-	1	-	-	9	-	-	-	-	-	-	-	-
30308	-	-	-	-	-	-	-	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30309	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30310	-	-	-	-	-	-	-	24	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30311	882	8401	77	177	1103	1225	40	175	157	70	51	18	25	25	153	51	25	18	127	3264	78	3	25	2	2
30312	-	-	-	-	-	-	-	30	15	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30313	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30314	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30315	0	397	2	6	6	54	1	26	23	21	-	-	-	-	-	-	272	234	25	-	-	-	-	-	-
30316	-	-	-	-	-	-	-	102	92	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30317	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30318	464	89	10	14	8137	106	3	103	92	72	2	0	2	2	1	3	4	0	7	10	1	1	0	0	0
30319	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30320	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30321	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30322	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30323	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30324	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30325	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30326	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30327	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1) Including CO_2 emission from biomass
2) SNAP sector codes are shown in appendix 3

National Environmental Research Institute

The National Environmental Research Institute, NERI, is a research institute of the Ministry of the Environment. In Danish, NERI is called *Danmarks Miljøundersøgelser (DMU)*.
NERI's tasks are primarily to conduct research, collect data, and give advice on problems related to the environment and nature.

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Included in the annual report is a list of the publications from the current year.