National Environmental Research Institute
University of Aarhus · Denmark

NERI Technical Report No. 675, 2008

Annual Danish Emission Inventory Report to UNECE

Inventories from the base year of the protocols to year 2006

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Data sheet

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Abstract: This report is a documentation report on the emission inventories for Denmark as reported to the UNECE Secretariat under the Convention on Long Range Transboundary Air Pollution due by 15 February 2008. The report contains information on Denmark's emission inventories regarding emissions of (1) SO_X for the years 1980-2006, (2) NO_X, CO, NMVOC and NH_3 for the years 1985-2006; (3) Particulate matter: TSP, PM_{10}, $PM_{2.5}$ for the years 2000-2006, (4) Heavy Metals: Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn for the years 1990-2006, and (5) Polyaromatic hydrocarbons (PAH): Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene for the years 1990-2006. Further, the report contains information on background data for emissions inventory.

Keywords:	Emission Inventory; Emissions; Projections; UNECE; EMEP; NO_X; CO; NMVOC; SO_X; NH_3; TSP; PM_{10}; $PM_{2.5}$; Pb; Cd; Hg; As; Cr; Cu; Ni; Se; Zn; Polyaromatic hydrocarbons; Benzo(a)pyrene, Benzo(b)fluoranthene.
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Summary

I Background information on emission inventories

Annual report

This report is Denmark's Annual Emissions Inventory Report due May 2008 to the UNECE-Convention on Long-Range Transboundary Air Pollution (LRTAP). The report contains information on Denmark's inventories for all years from the base years of the protocols to 2006.

The gases reported under the LRTAP Convention are SO_2, NO_X, NMVOC, CO, NH_3, As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, dioxins/furans, PAHs, TSP, PM_{10} and $PM_{2.5}$.

The annual emission inventory for Denmark is reported in the Nomenclature for Reporting (NFR) format as requested in the reporting guidelines.

The issues addressed in this report are: trends in emissions, description of each NFR category, uncertainty estimates, recalculations, planned improvements and procedures for quality assurance and control. The structure of the report is, as far as possible, the same as the National Inventory Report to UNFCCC.

This report and NFR tables are available to the public on NERI's homepage: http://www.dmu.dk/Luft/Emissioner/Home+of+Inventory/ and on the Eionet central data repository: http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_EMEP_UNECE

Responsible institute

The National Environmental Research Institute (NERI), Aarhus University, is responsible for the annual preparation and submission to the UNECE-LRTAP Convention of the Annual Danish Emissions Report and the inventories in the NFR format in accordance with the guidelines. NERI participates in meetings under the UNECE Task Force on Emission Inventories and Projections and the related expert panels, where parties to the convention prepare the guidelines and methodologies on inventories.

II Trends in emissions

Acidifying gases

Figure S.1 shows the emission of Danish acidifying gases in terms of acid equivalents. In 1990, the relative contribution in acid equivalents was almost equal for the three gases. In 2006, the most important acidification factor in Denmark was ammonia nitrogen and the relative contributions

for SO_2, NO_X and NH_3 were 8 %, 40 % and 52 %, respectively. However, regarding long-range transport of air pollution, SO_2 and NO_X are still the most important pollutants.

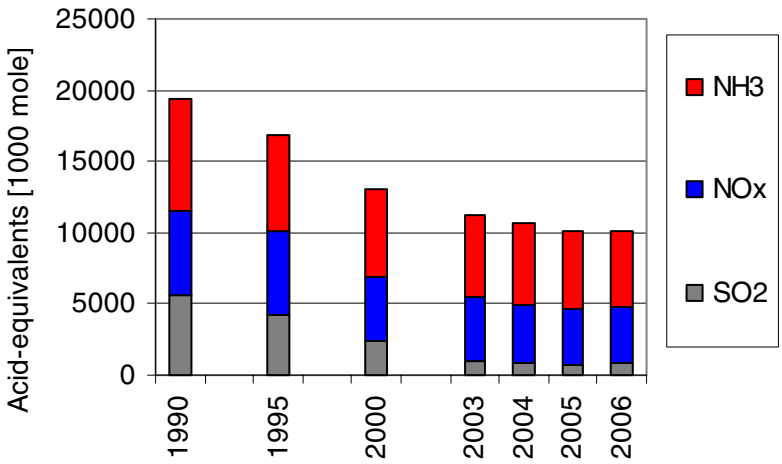


Figure S.1 Emissions of NH_3, NO_X and SO_2 in acid equivalents.

SO_2

The main part of the SO_2 emission originates from combustion of fossil fuels, i.e. mainly coal and oil, in public power and district heating plants. From 1980 to 2006, the total emission decreased by 94 %. The large reduction is largely due to installation of desulphurisation plant and use of fuels with lower content of sulphur in public power and district heating plants. Despite the large reduction of the SO_2 emissions, these plants make up 41 % of the total emission. Also emissions from industrial combustion plants, non-industrial combustion plants and other mobile sources are important. National sea traffic (navigation and fishing) contributes with about 7 % of the total SO_2 emission. This is due to the use of residual oil with high sulphur content.

NO_X

The largest sources of emissions of NO_X are Transport followed by other mobile sources and combustion in energy industries (mainly public power and district heating plants). The transport sector is the sector contributing the most to the emission of NO_X and, in 2006, 42 % of the Danish emissions of NO_X stems from road transport, national navigation, railways and civil aviation. Also emissions from national fishing and off-road vehicles contribute significantly to the NO_X emission. For non-industrial combustion plants, the main sources are combustion of gas oil, natural gas and wood in residential plants. The emissions from public power plants and district heating plants have decreased by 57 % from 1985 to 2006. In the same period, the total emission decreased by 37 %. The reduction is due to the increasing use of catalyst cars and installation of low-NO_X burners and denitrifying units in power and district heating plants.

NH_3

Almost all atmospheric emissions of NH_3 result from agricultural activities. Only a minor part originates from road transport. This part is, however, increasing due to increasing use of catalyst cars. The major part of the emission from agriculture stems from livestock manure (78 %) and the largest losses of ammonia occur during the handling of the manure

in stables and in field application. Other contributions come from crops (16 %), use of mineral fertilisers (6 %) and sewage sludge used as fertiliser (less than 1 %). The total ammonia emission decreased by 36 % from 1985 to 2006. This is due to the active national environmental policy efforts of the past twenty years.

Other air pollutants

NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation vehicles are still the main contributor, even though the emissions have declined since the introduction of catalyst cars in 1990. The evaporative emissions mainly originate from the use of solvents. The emissions from the energy industries have increased during the nineties due to the increasing use of stationary gas engines, which have much higher emissions of NMVOC than conventional boilers. The total anthropogenic emissions have decreased by 37 % from 1985 to 2006, largely due to the increased use of catalyst cars and reduced emissions from use of solvents.

CO

Transport is responsible for the dominant share of the total CO emission. Also other mobile sources and non-industrial combustion plants contribute significantly to the total emission of this pollutant. The drop in the emissions from 1989 to 1990 was a consequence of a law forbidding the burning of agricultural waste on fields. The emission decreased further by 22 % from 1990 to 2006, largely because of decreasing emissions from road transportation.

PAHs

The present emission inventory for PAH (poly aromatic hydrocarbons) includes the four PAHs reported to UNECE: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno-(1,2,3-cd) pyrene. The most important sources of the PAH emission are combustion of wood in the residential sector and road transportation. The increasing emission trend is due to increasing combustion of wood in the residential sector.

Particulate Matter

The particulate matter (PM) emission inventory has been reported for the years 2000-2006. The inventory includes the total emission of particles TSP (Total Suspended Particles), emission of particles smaller than 10 µm (PM_{10}) and emission of particles smaller than 2.5 µm ($PM_{2.5}$).

The largest $PM_{2.5}$ emission sources are the residential sector (64 %), road traffic (15 %) and other mobile sources (9 %). For the latter, the most important source is off-road vehicles and machinery in the industrial sector and the agricultural-/forestry sector (38 and 36 % respectively). For the road transport sector, exhaust emissions account for the major part (77 %) of the emissions.

The largest TSP emission sources are the residential sector and the agricultural sector. The TSP emissions from transport are also important and include both exhaust emissions and the non-exhaust emissions from brake and tyre wear and road abrasion. The non-exhaust emissions account for 46 % of the TSP emission from road transport.

Heavy metals

In general, the most important sources of heavy metal emissions are combustion of fossil fuels and waste. The heavy metal emissions have decreased substantially in recent years. The reductions span from 7 % to 95 % for Cu and Pb, respectively. The reason for the reduced emissions is mainly increased use of gas cleaning devices at power and district heating plants (including waste incineration plants). The large reduction in the Pb emission is due to a gradual shift towards unleaded gasoline.

III Recalculations and Improvements

In general, considerable work is being carried out to improve the inventories. New investigations and research carried out in Denmark and abroad are, as far as possible, included as the basis for the emission estimates and included as data in the inventory databases. Furthermore, the updates of the EMEP/CORINAIR guidebook and the work in the Task Force on Emission Inventories and Projections and its expert panels are followed closely in order to be able to incorporate the best scientific information as the basis for the inventories. Further important references in this regard are the IPCC guidelines and IPCC good practice guidance.

Implementation of new results in inventories is made in a way so that improvements better reflect Danish conditions and circumstances. In improving the inventories, care is taken to consider implementation of improvements for the whole time-series of inventories, to promote consistency. Such efforts lead to recalculation of previously submitted inventories.

The most important recalculations for the various sectors are mentioned below.

Energy

Stationary Combustion

The national energy statistics has been updated for the years 1980-2005. Generally there are only minor changes compared to previous submissions.

For natural gas fired gas engines NO_x, NMVOC and CO emission factors have been updated for the entire time-series based on new research.

Anew estimate for national sea transport has resulted in corrections for heavy fuel oil in the industrial sector 1A2, for further information see paragraph on mobile sources.

Mobile sources

Road transport

An error in the distribution of the total mileage between passenger cars and vans has been corrected from 1985 to 2005, and this change in input data has given slight emission changes. The mileage for passenger cars has been reduced in the new situation, and due to the fuel balance in the calculation model for diesel more fuel has been allocated to vans and heavy duty vehicles which in general have higher fuel related emission factors.

Also changes have been made to the gasoline fuel consumption input data for the NERI model, throughout the 1985-2005 periods. The gasoline fuel consumption generally increases, due to a reduced gasoline consumption calculated for non road working machinery in the same years. This latter fuel amount is being subtracted from the road transport sales of gasoline reported by the DEA, prior to NERI road transport model input.

The emission factors for NMVOC have been updated in the model. NMVOC is derived as the difference between VOC and CH_4, and the latter emission factors have been revised due to updates in the COPERT IV background data, both for cold start and operationally hot engines.

For NH_3, the hot start emission factors for passenger cars and vans have been updated in the NERI model, and in addition a new cold start calculation module has been implemented. The NERI model changes are based on the updated COPERT IV methodology and emission data.

National sea transport

Based on new research findings, the fuel consumption of heavy oil and gas oil for national sea transport is now calculated directly by NERI. Fuel adjustments are made in the fishery sector (gas oil) and stationary industry sources (heavy fuel oil) in order to maintain the grand national energy balance. The fuel consumption changes for national sea transport cause the emissions to change from 1985 to 2005.

Fishery

Fuel adjustments are made for gas oil, which affects the emissions for this sector. The emission changes for fisheries are followed by the opposite emission changes in national sea transport of approximately the same absolute values.

Military

Emission factors derived from the new road transport simulations have caused minor emission changes from 1985-2005.

Residential

The emissions somewhat decrease due to a smaller amount of fuel used by gasoline fuelled working machinery.

Agriculture

Updated stock information for ATV's (All Terrain Vehicles) 2002-2005, has given a small fuel use and emissions increase for these years.

Railways

No changes have been made.

Aviation

No changes have been made.

Industrial processes

The time series has been completed for heavy metals from metal production.

Solvent

The previous method was based on results from an agreement between the Danish Industry and the Danish Environmental Protection Agency (DEPA). The emissions from various industries were reported to the Danish EPA. The reporting was not annual and linear interpolation was used between the reporting years. It is important to notice that not all use of solvents was included in this agreement and no activity data were available. It is not possible to perform direct comparison of methodologies or to make corrections to the previous method, due to the fundamental differences in structure. But an increase in total emissions was expected due to the more comprehensive list of chemicals.

Improvements and additions are continuously being implemented in the new approach, due to the comprehensiveness and complexity of the use and application of solvents in industries and households. The main improvements in the 2006 reporting include revisions of the following

- Propane and butane is used as aerosol in spraying cans primarily in households. The mean volume of a can is set to 200 ml according to information from e.g. trade associations. This reduces the propane and butane emissions compared to previous inventories.
- Propylalcohol used as windscreen washing agent is reallocated from autopaint and repair to household use.
- Emission factor for propylalcohol used as windscreen washing agent, corresponding to approximately 80% of the annually used amount, is changed to 1.0 for use. Approximately 20% of the annual propylalcohol use is used in closed industrial processes. This amount is assigned a low emission factor of 0.01.

Agriculture

Compared with the previous NH_3 and PM emissions inventory (submission 2007), some updates have been made. These changes only reflect small changes for the total emission - less than 1%.

There have been no changes in the methodology. The data received from Statistics Denmark, concerning the livestock production and the cultivated area for 2005, are updated and these updated data are implemented in the inventory. Previous inventory had some small errors on grassing days for dairy cattle from 1990 to 1995, which is now corrected.

Sammenfatning

I Baggrund for emissionsopgørelser

Årlig rapport

Denne rapport er Danmarks årlige rapport om emissionsopgørelser sendt til UNECE-konventionen om langtransporteret grænseoverskridende luftforurening (LRTAP) i maj 2008. Rapporten indeholder oplysninger om Danmarks opgørelser for alle år fra basisårene for protokollerne til 2006.

Gasserne der rapporteres til LRTAP-konventionen er SO_2, NO_X, NMVOC, CO, NH_3, As, Cd, Cr, Cu, HG, Ni, Pb, Se, Zn, dioxiner/furaner, PAH, TSP, PM_{10} og $PM_{2,5}$.

Den årlige emissionsopgørelse for Danmark rapporteres i det format (NFR) som angivet i retningslinierne for rapportering.

Emnerne behandlet i rapporten er: Udvikling i emissioner, beskrivelse af hver NFR-kategori, usikkerheder, rekalkulationer, planlagte forbedringer og procedure for kvalitetssikring og -kontrol. Strukturen i rapporten er, så vidt muligt, den samme som den nationale emissionsopgørelsesrapport sendt til FN's konvention om klimaændringer (UNFCCC).

Denne rapport og NFR-tabellerne er tilgængelige for offentligheden på DMU's hjemmeside:
http://www.dmu.dk/Luft/Emissioner/Home+of+Inventory/ samt på Eionets hjemmeside:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_EMEP_UNECE

Ansvarlig institution

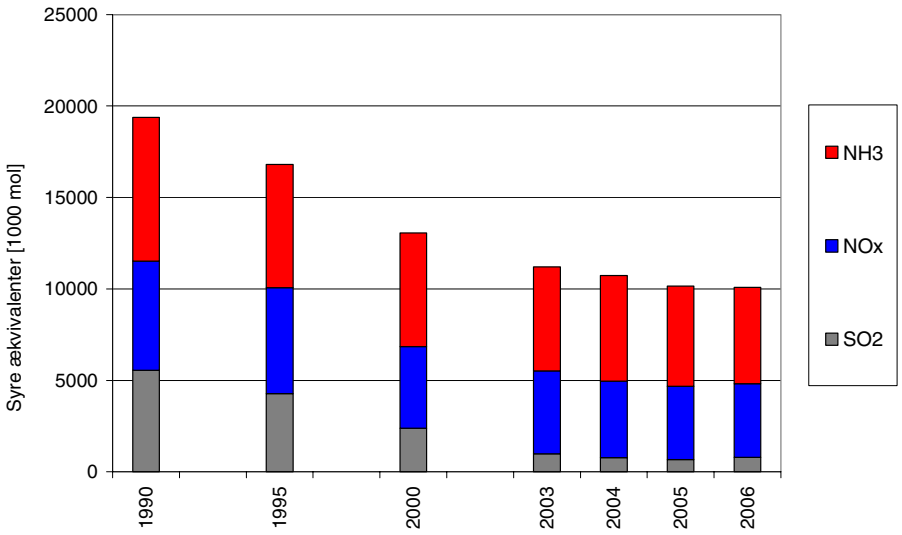
Danmarks Miljøundersøgelser (DMU), Aarhus Universitet er ansvarlig for udarbejdelse af den årlige danske emissionsrapport og opgørelserne i NFR-format i overensstemmelse med retningslinierne samt rapportering til UNECE-LRTAP-konventionen. DMU deltager i møder under UNECEs arbejdsgruppe for emissionsopgørelser og –fremskrivninger samt ekspertpaneler, hvor parter i konventionen udarbejder retningslinier og metoder for emissionsopgørelserne.

II Udviklingen i emissioner

Forsurende gasser

Figur S.1 viser emissionen af danske forsurende gasser opgjort i syreækvivalenter. I 1990 var det relative bidrag af syreækvivalenter næsten ens for de tre gasarter. I 2006 var ammoniak den vigtigste forsurende faktor i Danmark og de relative bidrag for SO_2, NO_X og NH_3 var på hen-

holdsvis 8 %, 40 % og 52 %. Med hensyn til langtransporteret luftforurening er det dog stadig SO_2 og NO_X, der er de største kilder.



Figur S.1 Emissioner af NH_3, NO_X og SO_2 i syreækvivalenter.

SO_2

Hovedparten af SO_2-emissionerne stammer fra forbrænding af fossile brændsler, dvs. primært kul og olie, på kraftværker, kraftvarmeværker og fjernvarmeværker. Fra 1980 til 2006 er det totale udslip reduceret med 94 %. Den store reduktion er primært opnået gennem installation af afsvovlingsanlæg og brug af brændsler med lavt svovlindhold på kraftværker og fjernvarmeværker. Trods den store reduktion er disse værker kilde til 41 % af det samlede udslip. Også emissioner fra industrielle forbrændingsanlæg, ikke-industrielle forbrændingsanlæg og andre mobile kilder er væsentlige bidragsydere til emissionen. National søfart (sejlads og fiskeri) bidrager med omkring 7 % af den totale SO2-emission. Dette skyldes brug af fuelolie med et højt svovlindhold.

NO_X

Den største kilder til emissioner af NO_X er transport sektoren efterfulgt af andre mobile kilder og forbrænding i energisektoren (hovedsageligt kraftværker og fjernvarmeværker). Transportsektoren er den sektor, der bidrager mest til udledningen af NO_X og i 2006 stammede 42 % af de danske NO_X-emissioner fra vejtransport, national søfart, jernbaner og civil luftfart. Også emissioner fra nationalt fiskeri og off-road køretøjer (entreprenør-, landbrugsmaskiner, m.m.) bidrager betydeligt til NO_X-emissionen. For ikke-industrielle forbrændingsanlæg er de primære kilder forbrænding af gasolie, naturgas og træ i husholdninger. Emissionerne fra kraftværker og fjernvarmeværker er faldet med 57 % fra 1985 til 2006. I samme periode er den totale emission faldet med 37 %. Reduktionen skyldes øget brug af katalysatorer i biler og installation af lav-NO_X-brændere og de-NO_X-anlæg på kraftværker og fjernvarmeværker.

NH_3

Stort set alle atmosfæriske emissioner af NH_3 stammer fra aktiviteter i landbruget. Kun en mindre del skyldes vejtransport. Denne del er dog stigende pga. den øgede brug af biler med katalysator. Hovedparten af emissionen fra landbruget stammer fra husdyrgødning (78 %) og de største tab af ammoniak optræder under håndtering af gødningen i stal-

den og under spredning på marken. Andre bidrag kommer fra afgrøder (16 %), brug af kunstgødning (6 %) og slam fra rensningsanlæg brugt som gødning (mindre end 1 %). Den totale ammoniakemission er faldet 37 % fra 1985-2006. Dette er et resultat af den nationale miljøpolitik, der er ført gennem de seneste 20 år.

Anden luftforurening

NMVOC

Emissionen af NMVOC stammer fra mange forskellige kilder og kan opdeles i to hovedgrupper: Ufuldstændig forbrænding og fordampning. Hovedkilderne til NMVOC-emissioner fra ufuldstændig forbrændingsprocesser er vejtrafik og andre mobile kilder, som national sejlads og ikke vejgående maskiner. Køretøjer til vejtransport er fortsat den største bidragsyder, selvom emissionerne er faldet siden introduktionen af biler med katalysator i 1990. Emissionerne fra fordampning stammer hovedsageligt fra brugen af opløsningsmidler. Emissionerne fra energisektoren er steget igennem 90'erne pga. øget brug af stationære gasmotorer, som har meget højere emissioner af NMVOC end konventionelle kedler. De totale menneskeskabte emissioner er faldet med 37 % fra 1985 til 2006, primært som følge af øget brug af biler med katalysator og reducerede emissioner fra brug af opløsningsmidler.

CO

Selvom biler med katalysator blev introduceret i 1990, er vejtransport stadig årsag til den største del af den totale CO-emission. Også andre mobile kilder og ikke-industrielle forbrændingsanlæg bidrager betydeligt til den totale emission af denne gas. Faldet i emissioner i 1990 var en konsekvens af loven, der forbyder markafbrænding. Emissionen faldt med 22% fra 1990 til 2005 hovedsageligt pga. faldende emissioner fra vejtransport.

PAH'er

Den nuværende emissionsopgørelse for PAH (polycycliske aromatiske hydrocarboner) inkluderer de fire PAH'er der rapporteres til LRTAP-konventionen: Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene og indeno(1,2,3-cd)pyrene. De vigtigste kilder til emission af PAH er forbrænding af træ i husholdningerne samt vejtransport. De stigende emissioner skyldes øget forbrænding af træ i husholdningerne.

Partikler

Emissionsopgørelsen for partikler (Particulate Matter, forkortet PM) er blevet rapporteret for årene 2000-2006. Opgørelsen inkluderer den totale emission af partikler TSP (Total Suspended Particles), emissionen af partikler mindre end 10 µm (PM_{10}) og emissionen af partikler mindre end 2,5 µm ($PM_{2,5}$).

De største kilder til $PM_{2,5}$-emission er husholdninger (64 %), vejtrafik (15 %) og andre mobile kilder (9 %). For den sidstes vedkommende er offroad køretøjer i industrien samt landbrugs- og skovbrugsmaskiner de vigtigste kilder (henholdsvis 38 og 36%). I transportsektoren tegner udstødningsemissioner sig for størstedelen (77 %).

De største kilder til TSP-emission er landbrugssektoren og husholdningerne. TSP-emissionen fra transport er også vigtig og inkluderer både

udstødningsemissioner og ikke-udstødningsrelaterede emissioner fra slid af bremser, dæk og vej. De ikke-udstødningsrelaterede emissioner udgør 46 % af TSP-emissionen fra transport.

Tungmetaller

Generelt er de vigtigste kilder til emissioner af tungmetaller forbrænding af fossile brændsler og affald. Emissionerne af tungmetaller er faldet betydeligt de seneste år. Reduktionerne spænder fra 7 % til 95 % for henholdsvis Cu og Pb. Årsagen til de reducerede emissioner er hovedsageligt den øgede brug af røggasrensning på kraftværker og fjernvarmeværker (inklusive affaldsforbrændingsanlæg). Den store reduktion i emissionen af Pb skyldes et løbende skift til fordel for blyfri benzin, som er nødvendigt for biler med katalysator.

III Rekalkulationer og forbedringer

Generelt pågår der et betydeligt arbejde med at forbedre emissionsopgørelserne. Nye undersøgelser og forskning fra Danmark og udlandet inkluderes så vidt muligt som basis for emissionsestimaterne. Desuden følges arbejdet med opdateringer af EMEP/CORINAIR-retningslinjerne for emissionsopgørelser nøje med henblik på at indarbejde de bedste videnskabelige informationer som basis for opgørelserne. Andre vigtige kilder er IPCCs retningslinier (IPCC Guidelines og IPCC Good Practice Guidance).

Opgørelserne opdateres løbende med ny viden, således opgørelserne bedst mulig afspejler danske forhold. Ved forbedringer lægges vægt på, at opdateringer omfatter hele tidsserier for at sikre konsistente data. Disse tiltag medfører rekalkulation af tidligere indberettede opgørelser. De vigtigste rekalkulationer for de forskellige sektorer er nævnt i nedenstående.

Stationære forbrændingsanlæg

Den seneste officielle energistatistik er implementeret i opgørelsen. Der er tale om mindre ændringer.

Emissionsfaktorerne for NO_x, NMVOC og CO fra naturgasfyrede gasmotorer er opdateret i forbindelse med et nationalt forskningsprojekt.

Et nyt estimat for national søfart har medført korrektioner i forbruget af tung olie i industrien, sektor 1A2. For yderligere oplysninger henvises der til afsnittet om transport.

Transport

Vejtransport

En fejl i fordelingen af antal kørte kilometre mellem person- og varebiler er blevet korrigeret for 1985 til 2005, denne ændring har medført små ændringer i emissionerne. Antal kørte kilometre for personbiler er reduceret og pga. brændselbalancen i beregningsmodellen for diesel er der blevet allokeret mere brændsel til varebiler og tunge køretøjer, som generelt har en højere brændselsrelateret emissionsfaktor.

Der er også foretaget ændringer i benzin mængden i beregningsmodellen for 1985 til 2005. Benzinforbruget til vejtransport er øget på grund af et mindre beregnet forbrug til non-road maskiner. Mængden af benzin estimeret til non-road kilder trækkes fra den mængde benzin Energistyrelsen rapporterer, som solgt til vejtrafik inden det indarbejdes i DMU's vejtrafik model.

Emissionsfaktorerne for NMVOC er blevet opdateret i modellen. NMVOC bliver beregnet som forskellen mellem VOC og CH_4, CH_4 emissionsfaktorerne er blevet opdateret på grund af opdateringer i COPERT IV modellens baggrundsdata både for koldstarter og ved almindelig drifttemperatur.

For NH_3 er varmstarts emissionsfaktorerne for personbiler og varebiler opdateret i DMU's model. Derudover er der implementeret et nyt beregningsmodul for koldstarter. Ændringerne i DMU's model er baseret på den opdaterede COPERT IV models metodik og emissionsdata.

National søfart

Baseret på ny forskning bliver brændselsforbruget for tung og let olie for national søfart beregnet direkte af DMU. Der er foretaget korrektioner for forbruget af let olie i fiskerisektoren, mens forbruget af tung olie bliver korrigeret indenfor den stationære industrisektor. Korrektionerne udføres for at der sikres overensstemmelse med energistatistikken. Ændringerne i brændselsforbrug for de nævnte sektorer berører årene 1985 til 2005.

Fiskeri

Ændringerne nævnt under national søfart påvirker emissionerne for fiskerisektoren.

Militær

Emissionsfaktorer fra de nye simulationer af vejtrafikken har medført mindre ændringer fra 1985 til 2005.

Husholdninger

Emissionerne falder på grund af et reduceret benzin forbrug til haveredskaber.

Landbrug

Opdaterede data for antallet af ATV'er for årene 2002 til 2005 har medført en lille stigning i brændselsforbrug og emissioner for de pågældende år.

Jernbane

Der er ikke foretaget genberegninger i denne sektor.

Luftfart

Der er ikke foretaget genberegninger i denne sektor.

Industri

Tidsserien for emission af tungmetaller fra metalproduktion er blevet opdateret så den nu er komplet.

Opløsningsmidler

Den tidligere benyttede metode var baseret på resultater fra en aftale mellem Miljøstyrelsen og virksomheder i industrien. Emissionerne fra forskellige industrier blev indrapporteret til Miljøstyrelsen. Rapporteringen var ikke årlig og det var derfor nødvendigt at interpolere. Det er vigtigt at bemærke, at det ikke var hele forbruget af opløsningsmidler, der var inkluderet i denne aftale. Det er ikke muligt direkte at sammenligne med den tidligere metode, pga. fundamentale ændringer i metoden. En stigning i emissioner var forventet pga. den mere detaljerede liste over kemikalier.

Forbedringer og udbygning af opgørelsen sker løbende, pga. kompleksiteten af forbruget og anvendelsen af opløsningsmidler i både industrien og husholdninger. De væsentligste forbedringer i denne rapportering omfatter:

- Propan og butan bruges som drivmiddel i spraydåser, primært i husholdninger. Gennemsnitsvolumnet af en dåse sættes til 200 mL på baggrund af oplysninger fra brancheorganisationer. Dette reducerer propan og butan emission sammenlignet med tidligere opgørelser.

- Propylalkohol brugt som sprinklervæske er blevet relokeret fra sektoren "Autopaint and Repair" til husholdninger.

- Emissionsfaktoren for propylalkohol brugt i sprinklervæske, hvilket svarer til ca. 80 % af den totale mængde er ændret til 1,0 for anvendelse. Ca. 20 % af det årlige forbrug af propylalkohol bliver anvendt i lukkede industrielle processer, derfor bruges der for disse 20 % en lavere emissionsfaktor på 0,01.

Landbrug

Sammenlignet med 2007 afleveringen er der foretaget få opdateringer. Disse ændringer udgør kun små forskelle. For både NH_3 og PM er der tale om ændringer på under 1 %.

Der har ikke været ændringer i metodikken. Data modtaget fra Danmarks Statistik omkring husdyrproduktion og det dyrkede areal er blevet opdateret, og disse opdaterede data er blevet implementeret i emissionsopgørelserne. Der er rettet en mindre fejl angående græsningsdage for malkekvæg mellem 1990 og 1995.

1 Introduction

1.1 Background information on emission inventories

1.1.1 Annual report

According to the Guidelines for Estimating and Reporting Emission Data/2002/7 prepared by the Task Force on Emission Inventories and Projections, countries party to the UNECE-Convention on Long-Range Transboundary Air Pollution are required annually to submit an informative report to the Secretariat.

This report is Denmark's Annual Emissions Inventory Report due May 2008. The report contains information on Denmark's inventories for all years from the base years of the protocols to 2006.

The annual emission inventory for Denmark is reported in the Nomenclature for Reporting (NFR) format as requested in the reporting guidelines.

The issues addressed in this report are: trends in emissions, description of each NFR category, uncertainty estimates, recalculations, planned improvements and procedures for quality assurance and control. The structure of the report is, as far as possible, the same as the National Inventory Report to UNFCCC.

This report and NFR tables are available to the public on NERI's homepage:
http://www.dmu.dk/Luft/Emissioner/Home+of+Inventory/ and on the Eionet central data repository:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_EMEP_UNECE

1.2 A description of the institutional arrangement for inventory preparation

The National Environmental Research Institute (NERI), Aarhus University, is responsible for the annual preparation and submission to the UNECE-LRTAP Convention of the Annual Danish Emissions Report, and the inventories in the NFR Format in accordance with the guidelines. NERI participates in meetings under the UNECE Task Force on Emission Inventories and Projections and the related expert panels where parties to the convention prepare the guidelines and methodologies on inventories.

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

Danish Energy Authority, The Ministry Climate and Energy: Annual energy statistics in a format suitable for the emission inventory work and fuel-use data for the large combustion plants.

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

Statistics Denmark, The Ministry of Economic and Business Affairs. Statistical yearbook, sales statistics for manufacturing industries and agricultural statistics.

The Faculty of Agricultural Sciences, Aarhus University. Data on use of mineral fertiliser, feeding stuff consumption and nitrogen turnover in animals.

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

Danish Centre for Forest and Landscape, University of Copenhagen. Background data for Forestry and CO_2 uptake by forest.

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

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

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

Formerly, the provision of data was on a voluntary basis, but more formal agreements are now prepared.

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

The background data (activity data and emission factors) for estimation of the Danish emission inventories is collected and stored in central databases located at NERI. The databases are in Access format and handled with software developed by the European Environmental Agency and NERI. As input to the databases, various sub-models are used to estimate and aggregate the background data in order to fit the format and level in the central databases. The methodologies and data sources used for the different sectors are described in Chapter 1.4 and Chapters 3 to 6. As part of the QA/QC plan (Chapter 1.5), the data structure for data processing support the pathway from collection of raw data to data compilation, modelling and final reporting.

For each submission, databases and additional tools and submodels are frozen together with the resulting NFR-reporting format. This material is placed on central institutional servers, which are subject to routine back-

up services. Material which has been backed up is archived safely. A further documentation and archiving system is the official journal for NERI, for which obligations apply to NERI, as a governmental institute. In this journal system, correspondence, both in-going and out-going, is registered, which in this case involves the registration of submissions and communication on inventories with the UNECE-LRTAP Secretariat, the European Commission, review teams, etc.

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

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

QA/QC Level	Name	Application type	Path	Type	Input sources
4 store	CFR Submissions (UNFCCC and EU)	External report	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_4a_Storage\	MS Excel, xml	CRF Reporter
3 process	CRF Reporter	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	(exe + mdb)	manual input and Importer2CRF
3 process	Importer2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	MS Access	CRF Reporter, CollectEr2CRFand excel files
3 process	CollectER2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_3b_Processes	MS Access	NERIRep
2 process 3 store	NERIRep	Help tool	Working path: I:\ROSPROJ\LUFT_EMI\DMURep	MS Access	CollectER databases; dk1972.mdb..dkxxxx.mdb
2 process	CollectER	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_2b_Processes	(exe +mdb)	manual input
2 store	dk1972.mdb.dkxxxx.mdb	Datastore	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_AllSectors\Level_2a_Storage	MS Access	CollectER

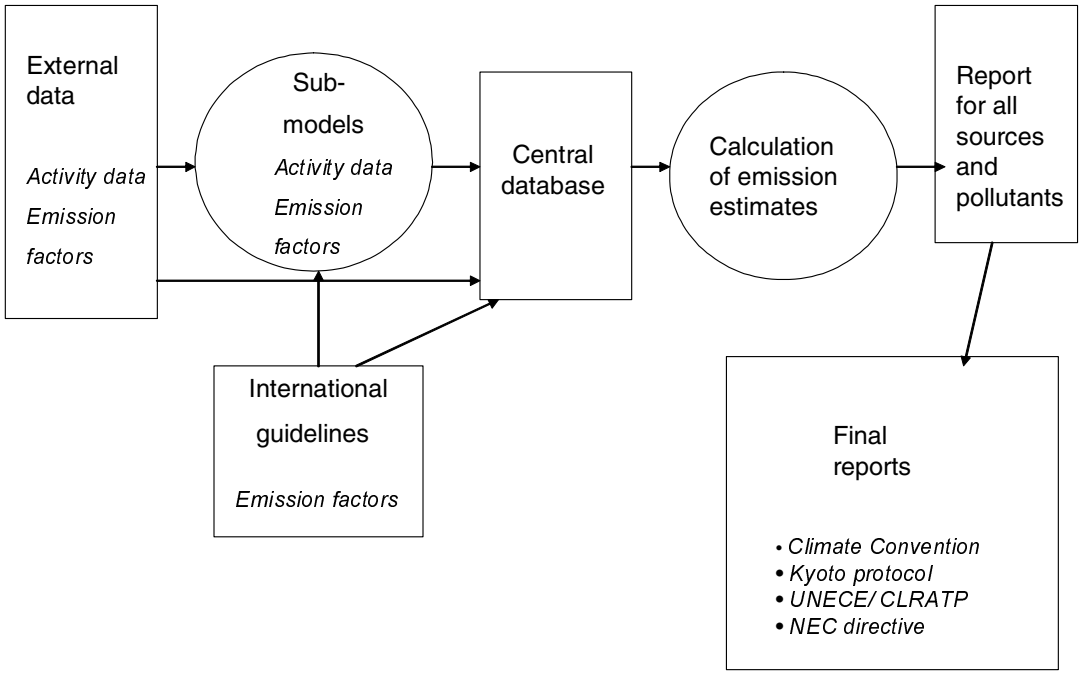


Figure 1.1 Schematic diagram of the process of inventory preparation.

1.4 Brief description of methodologies and data sources used

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

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

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

1.4.1 The specific methodologies regarding Stationary Combustion Plants

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

The Danish emission inventory for stationary combustion plants is based on the CORINAIR system described in the Emission Inventory Guidebook (EMEP/CORINAIR, 2007). The inventory is based on activity rates from the Danish energy statistics and on emission factors for different fuels, plants and sectors.

The Danish Energy Authority aggregates fuel consumption rates in the official Danish energy statistics to SNAP categories.

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

A number of large plants, e.g. power plants and municipal waste incineration plants are registered individually as large point sources and emission data from the actual plants are used. This enables use of plant-specific emission factors that refer to emission measurements stated in annual environmental reports. Emission factors of SO_2, NO_X, HM and PM are often plant specific.

Please refer to Chapter 3 and Annex 2A for further information on emission inventories for stationary combustion plants.

1.4.2 Fugitive emissions from oil (CRF Table 1.B.2. a)

Offshore activities

Emissions from offshore activities are estimated according to the methodology described in the Emission Inventory Guidebook (EMEP/CORINAIR, 2007). The sources include extraction of oil and gas, onshore oil tanks, and onshore and offshore loading of ships. The emission factors are based on the figures given in the guidebook except for in the case of onshore oil tanks where national values are used.

Oil Refineries – Petroleum products processing

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

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

Natural gas transmission and distribution

Inventories of NMVOC emission from gas transmission and distribution are based on annual environmental reports from the Danish gas transmission company, DONG, and on a Danish inventory for the years 1999-

2006 reported by the Danish gas sector (transmission and distribution companies).

Please refer to Chapter 3 for further information on fugitive emissions from fuels.

1.4.4 Specific methodologies regarding transport

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

An internal NERI model with a structure similar to the European COPERT III emission model (Ntziachristos, 2000) is used to calculate the Danish annual emissions for road traffic. The new emission factors from COPERT IV have been implemented in the Danish model. The emissions are calculated for operationally hot engines, during cold start and fuel evaporation. The model also includes the emission effect of catalyst wear. Input data for vehicle stock and mileage is obtained from the Danish Road Directorate, and is grouped according to average fuel consumption and emission behaviour. For each group, the emissions are estimated by combining vehicle type and annual mileage figures with hot emission factors, cold:hot ratios and evaporation factors (Tier 2 approach).

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

Off-road working machines and equipment are grouped in the following sectors: inland waterways, agriculture, forestry, industry, and household and gardening. In general, the emissions are calculated by combining information on the number of different machine types and their respective load factors, engine sizes, annual working hours and emission factors (Tier 2 approach).

Please refer to Chapter 3 and Annex 2B for further information on emissions from transport.

1.4.5 Specific methodologies regarding industrial processes

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

Mineral products

The sub-sector includes production of cement, lime, container glass/glass wool, mineral wool, other production (consumption of limestone), and roofing and road paving with asphalt. The activity data as well as emission data are primarily based on information from environmental statements termed "Green National Accounts" (In Danish: "Grønne regnskaber") prepared by companies according to obligations under Danish law. The published information is supplemented with information obtained directly from companies or by use of standard emission factors. The distribution of TSP between PM_{10} and $PM_{2.5}$ is based on European average data.

Chemical industry

The sub-sector includes production of nitric acid, catalysts, fertilisers and pesticides. The activity data as well as emission data are based on information from the companies as accounted for and published in the "Green National Accounts" combined with information obtained by contact to the companies. The distribution of TSP between PM_{10} and $PM_{2.5}$ is based on European average data. Production of nitric acid ceased in the middle of 2004.

Metal production

The sub-sector includes production of steel sheets and bars, cast iron, aluminium, lead and lead products and various other metal products. The activity data as well as emission data for the steelworks are based on information from the companies as accounted for and published in the "Green National Accounts", combined with information obtained by contact with the companies. The activity data or the other processes are based on information from Statistics Denmark combined with Danish average emission factors and standard emission factors. The distribution of TSP between PM_{10} and $PM_{2.5}$ is based on European average data.

Other production

The sub-sector includes breweries. The activity data is obtained from Statistics Denmark and the emission factors are obtained from the IPCC guidelines.

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

1.4.6 Specific methodologies regarding solvents

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

Simple mass balances for calculating the use and emissions of chemicals are set up: 1) use = production + import – export, 2) emission = use * emission factor. Production, import and export figures are extracted from Statistics Denmark databases, from which a list of 427 single chemicals, a few groups and products are generated. For each of these a "use"

amount in tonnes per year (from 1995 to 2006) is calculated. It is found that 44 different NMVOCs comprise over 95 % of the total use, and it is these 44 chemicals that are investigated further. The "use" amounts are distributed in industrial activities according to the Nordic SPIN (Substances in Preparations in Nordic Countries) database, where information on industrial use categories and products is available in a NACE coding system. The chemicals are also related to specific products. Emission factors are obtained from regulators or the relevant industry.

Outputs from the inventory are: a list where the 44 most predominant NMVOCs are ranked according to emissions to air; specification of emissions from industrial sectors and from households; contribution from each chemical to emissions from industrial sectors and households; tidal (annual) trend in NMVOC emissions, expressed as total NMVOC and single chemicals, and specified in industrial sectors and households.

Please refer to Chapter 5 for further information on emission inventories for solvents.

1.4.7 Specific methodologies regarding agriculture

The emissions from the agricultural sector include emissions of ammonia and particulate matter. The emissions are registered in NFR tables 4B Manure Management and 4D Agricultural Soils. Table 4F Field Burning of Agricultural Wastes has only been completed until 1989, because burning of plant residue has been prohibited since 1990.

The calculations of the ammonia and PM emissions are based on the Emission Inventory Guidebook (EMEP/CORINAIR, 2007). In Denmark, a model-based system is applied for calculation of ammonia emissions, particulate matter and greenhouse gases. This model is called DIEMA (Danish Integrated Emission Model for Agriculture), and data on activity and emissions are collected, evaluated and discussed in close corporation with the Faculty of Agricultural Sciences, Aarhus University and the Danish Agricultural Advisory Centre.

Livestock numbers and data concerning the land use and crop yield are based on the Agricultural Statistics published by Statistics Denmark. The emission factors used to calculate the emissions are primarily based on information from the Faculty of Agricultural Sciences, Aarhus University and the Danish Agricultural Advisory Centre. Furthermore, activity data from the Danish Environmental Protection Agency and the Danish Plant Directorate are used.

Uncertainties for ammonia emissions from manure management and agricultural soils have been estimated. The estimated emissions for particulate matter are associated with very high uncertainties, which are estimated to be of several hundred percent. To ensure data quality, activity data and data for estimation of emission factors are collected and discussed in corporation with specialists and researchers at different institutes and research departments. This means that the emission inventories are continuously evaluated according to the latest knowledge and information. Furthermore, time-series of both emission factors and activity data are prepared, and considerable variations are checked and revised.

Please refer to Chapter 6 and Appendix 2C for further information on emission inventories for agriculture.

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

In the Danish National Inventory Report to UNFCCC (Nielsen et al., 2008), the plan for Quality Control (QC) and Quality Assurance (QA) for greenhouse gas emission inventories prepared by the Danish National Environmental Research Institute is outlined. The plan is in accordance with the guidelines provided by the UNFCCC (IPCC, 1997) and the "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" (IPCC, 2000). The ISO 9000 standards are also used as important input for the plan. The plan also, to some extent, includes the gases reported to the UNECE-LRTAP Convention.

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

The uncertainty estimates are based on the simple Tier 1 approach in the EMEP/CorinAir *Good Practice Guidance for LRTAP Emission Inventories* (Pulles & Aardenne 2001).

The uncertainty estimates are based on emission data for the base year and year 2006, and on uncertainties for activity rates and emission factors for each of the main SNAP sectors. For particulate matter, the year 2000 is considered as the base year, but for all other pollutants the base year is 1990.

Uncertainty estimates include uncertainty of the total emission as well as uncertainty of the trend. The estimated uncertainties are shown in Table 1.2. The uncertainty estimates include the sectors: stationary combustion, transport, industry and agriculture.

Table 1.2 Danish uncertainty estimates, 2006

Pollutant	Uncertainty Total emission [%]	Trend[2] 1990[1])-2006 [%]	Uncertainty Trend [%-age points]
SO_2	7	-86	±0.7
NO_x	31	-33	±4
NMVOC	32	-44	±12
CO	34	-22	±16
NH_3	24	-33	±15
TSP [1)]	277	+1.9	±64
As	119	-57	±10
Cd	335	-38	±128
Cr	180	-79	±29
Cu	727	-7	±208
Hg	259	-60	±63
Ni	124	-57	±31
Pb	230	-95	±42
Se	104	-57	±9
Zn	239	-8	±184
Benzo(b)fluoranthene	949	+68	±33
Benzo(k)fluoranthene	947	+173	±261
Benzo(a)pyrene	975	+103	±34
Indeno(1,2,3-c,d)	967	+76	±40

1. The base year for PM is 2000

2. Only including the emission sources for which uncertainty estimates have been estimated

1.7 General assessment of the completeness

The Danish emissions inventory due 15 February 2008 includes all sources identified by the EMEP/CORINAIR guidebook except the following:

1.7.1 Industrial processes

- Mineral products (NFR 2A): The inventory will be improved regarding completion of pollutants included. The methodology used for some of the pollutants from glass production is inconsistent and will be improved.
- Chemical industry (NFR 2B): The inventory covering the chemical industry is considered to be complete.
- Metal production (NFR 2C): The time-series for the included processes has been completed. For especially secondary aluminium and zinc production, potential emissions of heavy metals will be investigated.
- Other production (NFR 2D): The time-series for emission of NMVOC from the production of beer has been completed. Furthermore, production of bread and other food products are planned to be included.

1.7.2 Agriculture

It is planned to include the PM emission from stables the years 1985 to 1999.

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2 Trends in Emissions

2.1 Acidifying gases

Acid deposition of sulphur and nitrogen compounds mainly derives from emissions of SO_2, NO_X and NH_3. The effects of acidification are apparent in a number of ways, including defoliation and reduced vitality of trees, and declining fish stocks in acid-sensitive lakes and rivers.

SO_2 and NO_X can be oxidised into sulphate (SO_4^{--}) and nitrate (NO_3^-) - either in the atmosphere or after deposition - resulting in the formation of two and one H^+, respectively. NH_3 may react with H^+ to form ammonium (NH_4^+) and, by nitrification in soil, NH_4^+ is oxidised to NO_3^- and H^+ ions are formed.

Weighting the individual substances according to their acidification effect, total emissions in terms of acid equivalents can be calculated as:

$$Acidification\ index = \frac{m_{SO_2}}{M_{SO_2}} \cdot 2 + \frac{m_{NO_x}}{M_{NO_x}} + \frac{m_{NH_3}}{M_{NH_3}} = \frac{m_{SO_2}}{64} \cdot 2 + \frac{m_{NO_x}}{46} + \frac{m_{NH_3}}{17}$$

where m_i is the emission of pollutant *i* in tonnes

M_i is the mole weight [tonne/Mmole] of pollutant *i*

The actual effect of the acidifying substances depends on a combination of two factors: the amount of acid deposition and the natural capacity of the terrestrial or aquatic ecosystem to counteract the acidification. In areas where the soil minerals easily weather or have a high chalk content, acid deposition will be relatively easily neutralised.

Figure 2.1 shows the emission of Danish acidifying gases in terms of acid equivalents. In 1990, the relative contribution in acid equivalents was almost equal for the three gases. In 2006, the most important acidification factor in Denmark was ammonia nitrogen and the relative contributions for SO_2, NO_X and NH_3 were 8 %, 40 % and 52 %, respectively. However, with regard to long-range transport of air pollution, SO_2 and NO_X are still the most important pollutants.

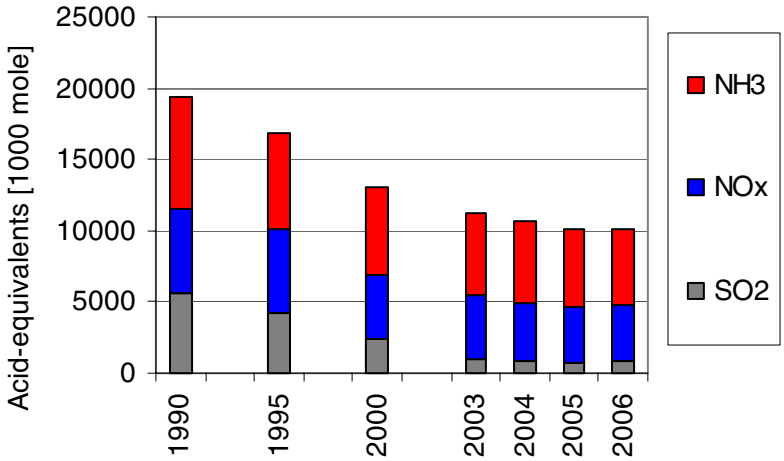


Figure 2.1 Emissions of NH_3, NO_X and SO_2 in acid equivalents

2.2 Description and interpretation of emission trends by gas

2.2.1 SO_2

The main part of the SO_2 emission originates from combustion of fossil fuels, i.e. mainly coal and oil, in public power and district heating plants. From 1980 to 2006, the total emission decreased by 94 %. The large reduction is largely due to installation of desulphurisation plant and use of fuels with lower content of sulphur in public power and district heating plants. Despite the large reduction of the SO_2 emissions, these plants make up 41 % of the total emission. Also emissions from industrial combustion plants, non-industrial combustion plants and other mobile sources are important. National sea traffic (navigation and fishing) contributes with about 7 % of the total SO_2 emission. This is due to the use of residual oil with high sulphur content.

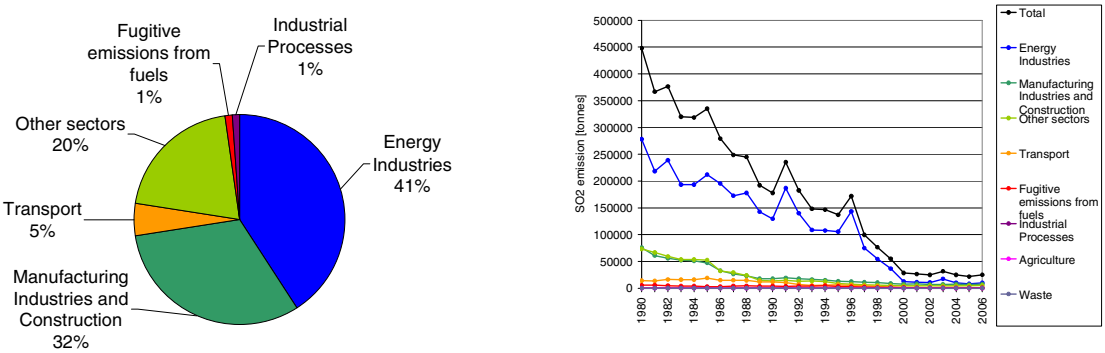


Figure 2.9 SO_2 emissions. Distribution according to the main sectors (2006) and time-series for 1990 to 2006.

2.2.2 NO_X

The largest sources of emissions of NO_X are other mobile sources followed by road transport and combustion in energy industries (mainly public power and district heating plants). The transport sector is the sec-

tor contributing the most to the emission of NO_X and, in 2006, 42% of the Danish emissions of NO_X stems from road transport, national navigation, railways and civil aviation. Also emissions from national fishing and off-road vehicles contribute significantly to the NO_X emission. For non-industrial combustion plants, the main sources are combustion of gas oil, natural gas and wood in residential plants. The emissions from public power plants and district heating plants have decreased by 57 % from 1985 to 2006. In the same period, the total emission decreased by 37%. The reduction is due to the increasing use of catalyst cars and installation of low-NO_X burners and denitrifying units in power and district heating plants.

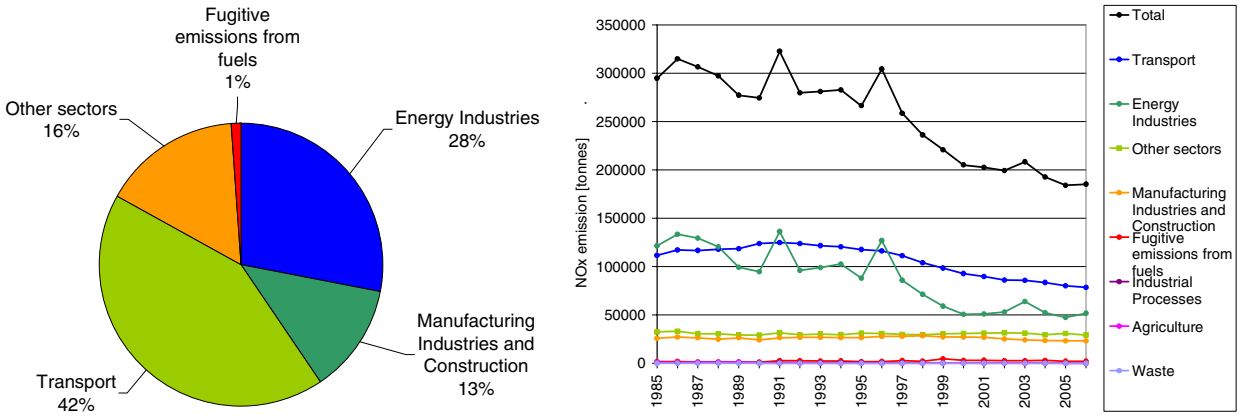


Figure 2.6 NO_X emissions. Distribution according to the main sectors (2006) and time-series for 1990 to 2006.

2.2.3 NH_3

Almost all atmospheric emissions of NH_3 result from agricultural activities. Only a minor fraction originates from road transport. This fraction is, however, increasing due to increasing use of catalyst cars. The major part of the emission from agriculture stems from livestock manure (78%) and the largest losses of ammonia occur during the handling of the manure in stables and in field application. Other contributions come from crops (16%), use of mineral fertilisers (6%), sewage sludge used as fertiliser and ammonia used for straw treatment (less than 1%). The total ammonia emission decreased by 36% from 1985 to 2006. This is due to the active national environmental policy efforts over the past twenty years. Due to the action plans for the aquatic environment and the Ammonia Action Plan, a series of measures to prevent loss of nitrogen in agricultural production has been initiated. The measures have included demands for improved utilisation of nitrogen in livestock manure, a ban against application of livestock manure in winter, prohibition of broad-spreading of manure is prohibited, requirements for establishment of catch crops, regulation of the number of livestock per hectare and a ceiling for the supply of nitrogen to crops. As a result, despite an increase in the production of pigs and poultry, the ammonia emission has been reduced considerably. The time-series graph is excluding field burning of agricultural waste from 1985 to 1989.

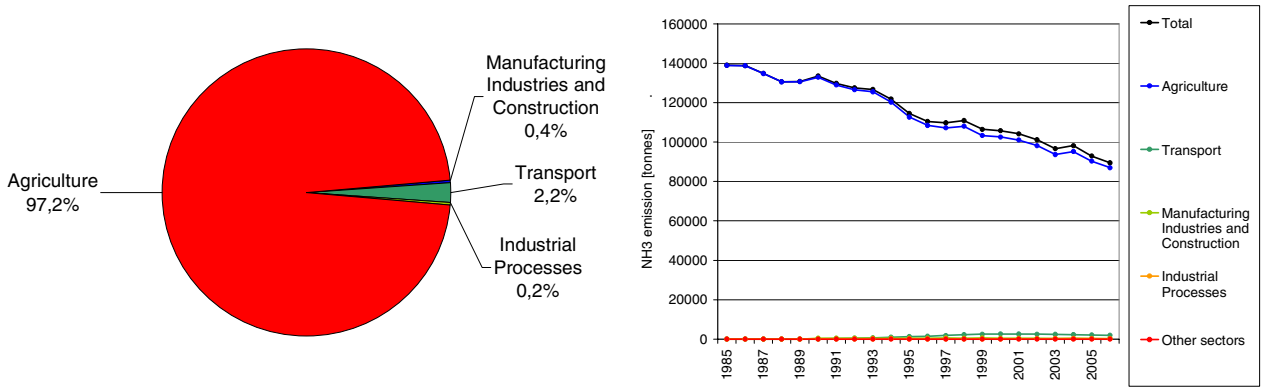


Figure 2.4 NH_3 emissions. Distribution on the main sectors (2006) and time-series for 1985 to 2006.

2.3 Other air pollutants

2.3.1 NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation vehicles are still the main contributors, even though the emissions have declined since the introduction of catalyst cars in 1990. The evaporative emissions mainly originate from the use of solvents. The emissions from the energy industries have increased during the nineties due to the increasing use of stationary gas engines, which have much higher emissions of NMVOC than conventional boilers. The total anthropogenic emissions have decreased by 37 % from 1985 to 2006, largely due to the increased use of catalyst cars and reduced emissions from use of solvents. The time-series graph is excluding field burning of agricultural waste from 1985 to 1989.

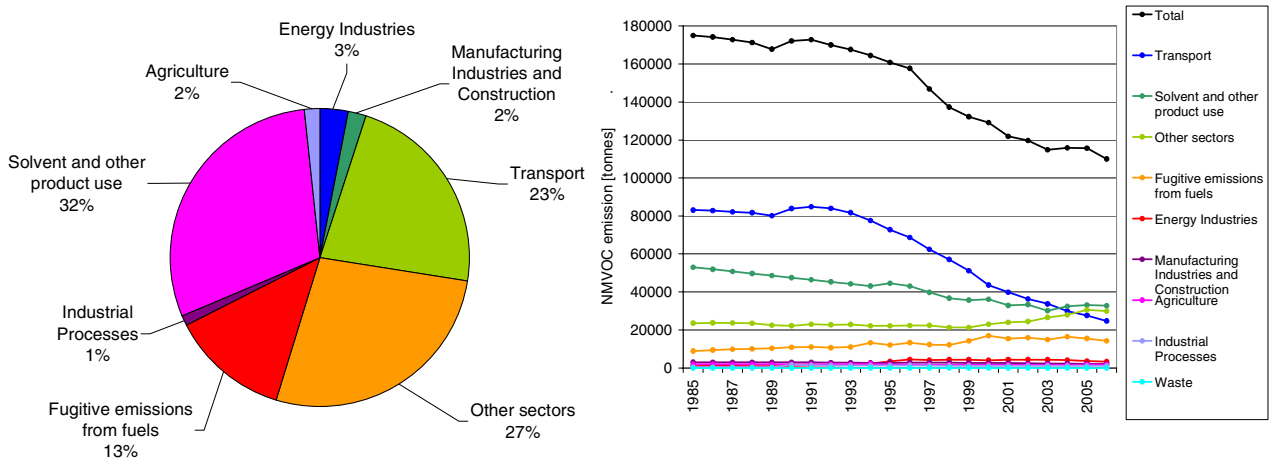


Figure 2.8 NMVOC emissions. Distribution according to the main sectors (2006) and time-series for 1985 to 2006.

2.3.2 CO

Other mobile sources and non-industrial combustion plants contribute significantly to the total emission of this pollutant. Transport is the sec-

ond largest contributor to the total CO emission. In 1990 a law forbidding the burning of agricultural waste on fields was implemented this caused significant reduction in CO emission. The emission decreased further by 22 % from 1990 to 2006, largely because of decreasing emissions from road transportation.

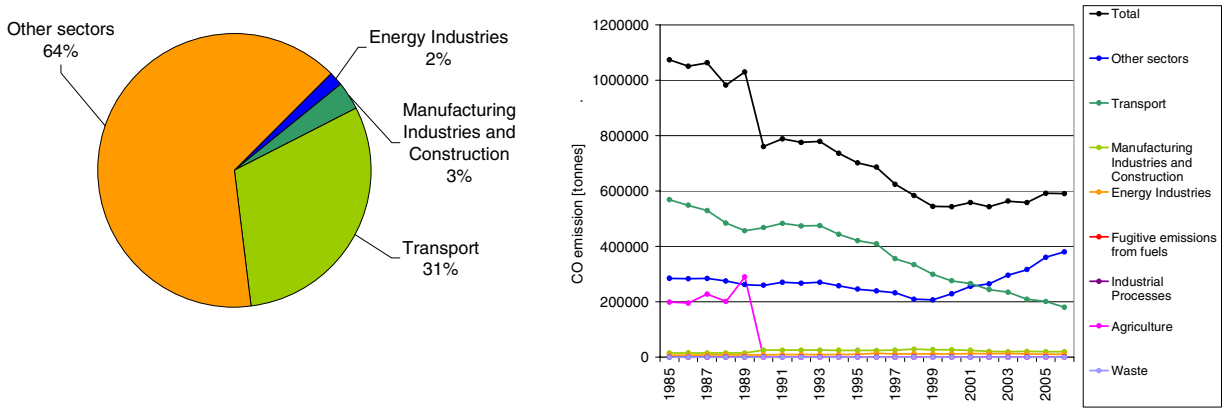


Figure 2.7 CO emissions. Distribution according to the main sectors (2006) and time-series for 1985 to 2006.

2.3.3 PAHs

The present emission inventory for PAH (polyaromatic hydrocarbons) includes the four PAHs reported to UNECE: benzo(a)pyrene, benzo(b)-fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd) pyrene. The most important sources of PAH emissions are combustion of wood in the residential sector and road transportation. The increasing emission trend is due to increasing combustion of wood in the residential sector.

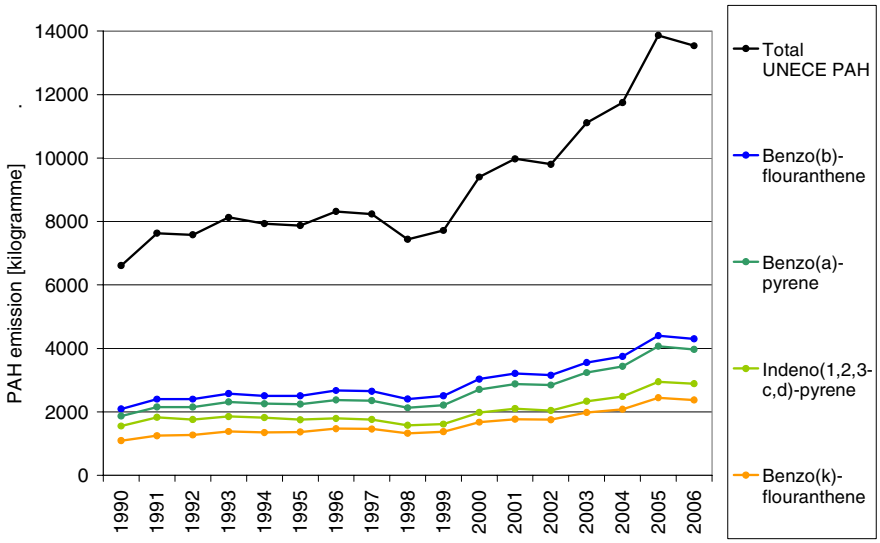


Figure 2.7 PAH emissions. Time-series for 1990 to 2006.

2.3.4 Particulate Matter

The particulate matter (PM) emission inventory has been reported for the years 2000-2006. The inventory includes the total emission of particles TSP (Total Suspended Particles), emission of particles smaller than 10 µm (PM_{10}) and emission of particles smaller than 2.5 µm ($PM_{2.5}$).

The largest $PM_{2.5}$ emission sources are the residential sector (64 %), road traffic (15 %) and other mobile sources (9 %). For the latter, the most im-

portant sources are off-road vehicles and machinery in the industrial sector and in the agricultural-/forestry sector (38 and 36% respectively). For the road transport sector, exhaust emissions account for the major part (77 %) of the emissions.

The largest TSP emission sources are the residential sector and the agricultural sector. The TSP emissions from transport are also important and include both exhaust emissions and the non-exhaust emissions from brake and tyre wear and road abrasion. The non-exhaust emissions account for 46 % of the TSP emission from road transport.

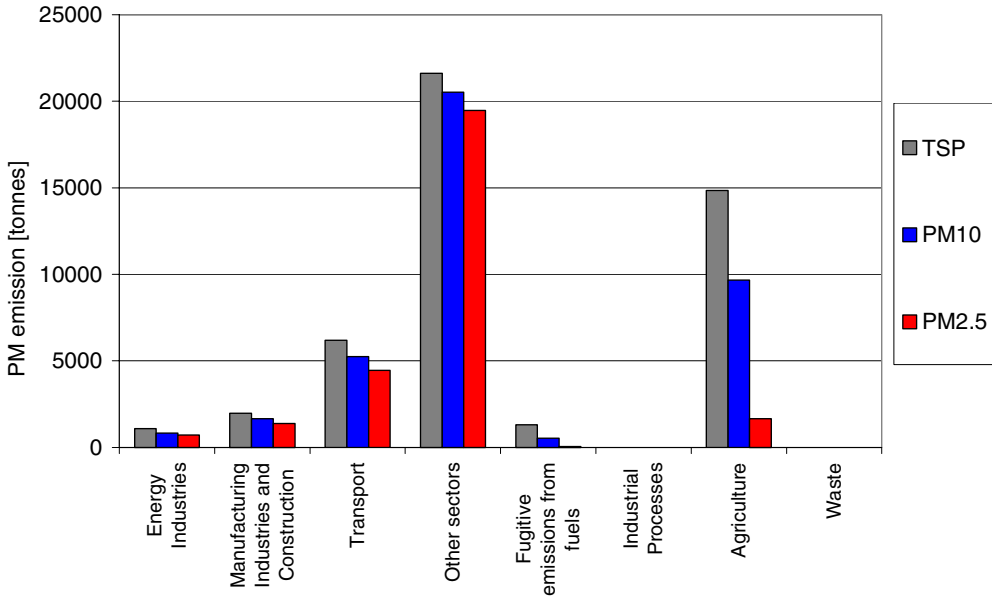


Figure 2.8 PM emissions for 2006.

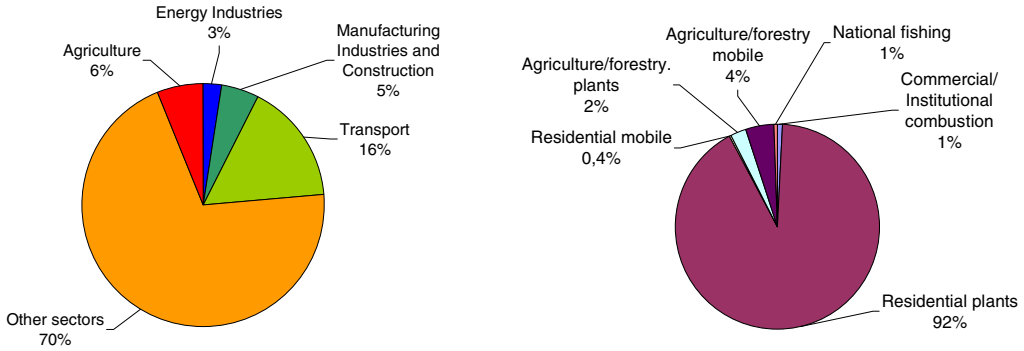


Figure 2.9 $PM_{2.5}$ emissions. Distribution by main sector and on sub-sectors for other fuels combustion for 2006.

Heavy metals

In general, the most important sources of heavy metal emissions are combustion of fossil fuels and waste. The heavy metal emissions have decreased substantially in recent years. The reductions span from 7% to 95% for Cu and Pb, respectively. The reason for the reduced emissions is mainly increased use of gas cleaning devices at power and district heating plants (including waste incineration plants). The large reduction in

the Pb emission is due to a gradual shift towards unleaded gasoline, the latter being essential for catalyst cars.

Table 2.1 Emissions of heavy metals.

(Kg)	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
1990	1.504	1.138	6.333	10.243	3.229	24.758	119.779	4.470	29.302
2005	653	711	1.354	9.542	1.279	10.718	6.152	1.906	27.005
Reduction in %	57	38	79	7	60	57	95	57	8

According to the UNECE Heavy Metal Protocol, the priority metals are Pb, Cd and Hg and the objective is to reduce emissions of these heavy metals.

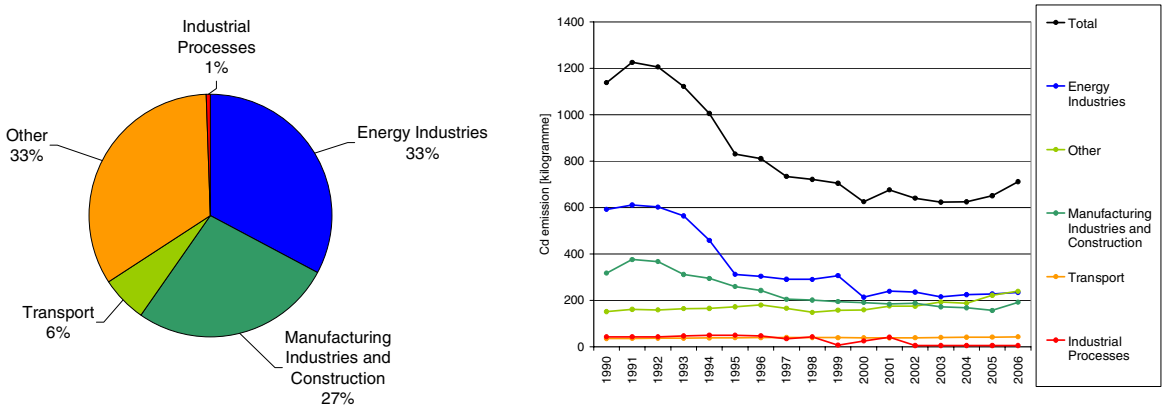


Figure 2.10 Cd emissions. Time-series for 1990 to 2006 and distribution by main sector for 2006.

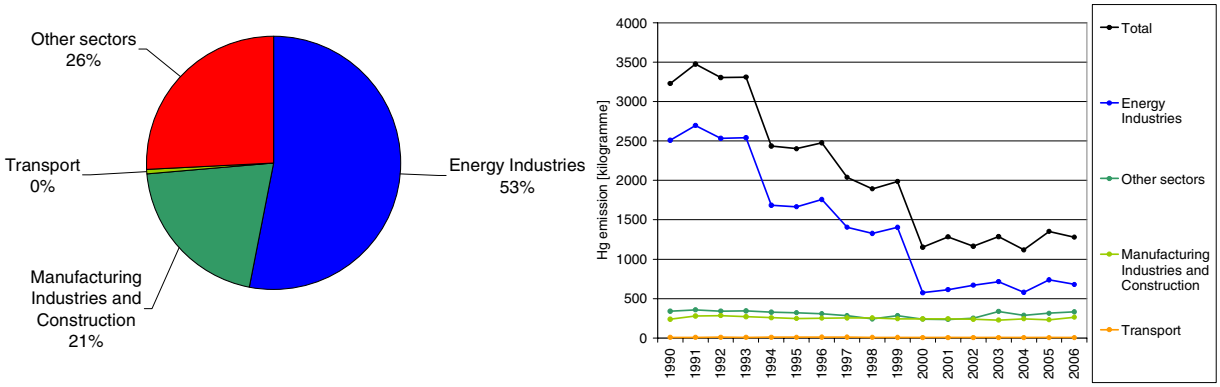


Figure 2.11 Hg emissions. Time-series for 1990 to 2006 and distribution by main sector for 2006.

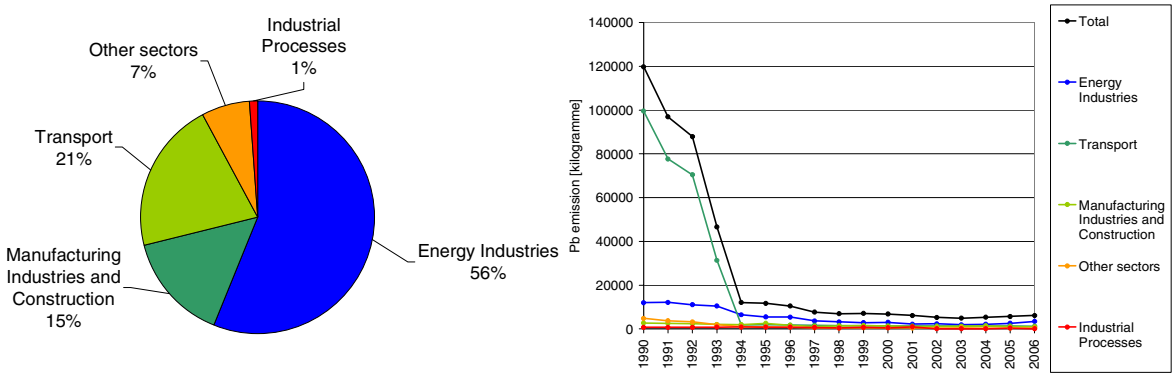


Figure 2.12 Pb emissions. Time-series for 1990 to 2006 and distribution by main sector for 2006.

3 Energy (NFR sector 1)

3.1 Overview of the sector

The energy sector is reported in three main chapters:

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

3.3 Transport (NFR sector 1A2, 1A3, 1A4 and 1A5)

3.4 Fugitive emissions (NFR sector 1B)

Although industrial combustion forms part of stationary combustion, detailed documentation for some of the specific industries is discussed in the industry chapters. The emissions are reported in NFR sector 1A2. Emissions from full fuel consumption in the industrial sector are included in the data presented in Chapter *3.2 Stationary Combustion*.

Table 3.1 shows detailed source categories for the energy sector and plant category in which the sector is discussed in this report.

Table 3.1 NFR source categories for the energy sector.

NFR id	NFR 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

Summary tables for the emissions from the energy sector are shown below.

Table 3.2 SO_2, NO_X, NMVOC, CO and PM emission from the energy sector, 2006

	NO_X Gg NO_2	CO Gg	NMVOC Gg	SO_X Gg SO_2	TSP Mg	PM_{10} Mg	$PM_{2.5}$ Mg
1A1 Energy Industries	51.9	10.3	3.3	10.2	1073	836	701
1A2 Manufacturing industries and Construction	23.3	19.5	2.2	7.9	1970	1663	1376
1A3 Transport	78.6	180.2	24.7	1.2	6178	5239	4450
1A4 Other Sectors	28.8	379.8	29.9	5.1	21 588	20 516	19 459
1A5 Other	0.6	0.4	0.1	0.0	21	21	21
1B1 Fugitive Emissions from fuels, Solid Fuels	NA	NA	NA	NA	1303	521	52
1B2 Fugitive Emissions from fuels, Oil and Natural gas	2.1	0.2	14.2	0.3	2	2	2
Energy, Total	185.3	590.3	74.3	24.8	32 135	28 798	26 060

Table 3.3 HM emissions from the energy sector, 2006

	Pb Mg	Cd Mg	Hg Mg	As Mg	Cr Mg	Cu Mg	Ni Mg	Se Mg	Zn Mg
1A1 Energy Industries	3.45	0.23	0.68	0.34	0.54	0.67	2.72	1.07	15.36
1A2 Manufacturing industries and Construction	0.92	0.19	0.26	0.23	0.46	0.72	6.23	0.60	1.60
1A3 Transport	1.31	0.04	0.01	0.01	0.21	7.02	0.77	0.07	4.18
1A4 Other Sectors	0.36	0.24	0.33	0.07	0.13	0.90	0.99	0.17	5.12
1A5 Other	0.05	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.04
1B1 Fugitive Emissions from fuels, Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA
1B2 Fugitive Emissions from fuels, Oil and Natural gas	NA	NA	NA	NA	NA	NA	NA	NA	NA
Energy, Total	6.08	0.71	1.28	0.65	1.35	9.37	10.71	1.91	26.30

Table 3.4 PAH emission from the energy sector, 2006

	benzo(a)-pyrene Mg	benzo(b)-fluoranthene Mg	benzo(k)-fluoranthene Mg	Indeno-(1,2,3-c,d)-pyrene Mg	Dioxin g I-Teq
1A1 Energy Industries	0,007	0,030	0,015	0,007	1,671
1A2 Manufacturing industries and Construction	0,031	0,103	0,021	0,012	0,198
1A3 Transport	0,054	0,073	0,081	0,063	0,252
1A4 Other Sectors	3,878	4,098	2,257	2,805	16,479
1A5 Other	0,000	0,000	0,000	0,000	0,001
1B1 Fugitive Emissions from fuels, Solid Fuels	NA	NA	NA	NA	NA
1B2 Fugitive Emissions from fuels, Oil and Natural gas	NA	NA	NA	NA	NA
Energy, Total	3,971	4,304	2,375	2,887	18,600

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

This chapter includes stationary combustion plants in the NFR sectors 1A1, 1A2 and 1A4. Further details of the inventories for stationary combustion are enclosed in Annex 2A.

3.2.1 Source category description

Emission source categories, fuel consumption data and emission data are presented in this chapter.

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 to the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP sectors. Aggregation to the NFR sector codes is based on a correspondence list between SNAP and NFR enclosed in Annex 2A. Stationary combustion is defined as combustion activities in the SNAP sectors 01-03.

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

Fuel consumption

In 2006 total fuel consumption for stationary combustion plants was 618 PJ of which 505 PJ was fossil fuels.

Fuel consumption distributed on the stationary combustion subsectors is shown in Figure 3.1 and Figure 3.2. The majority – 62 % - of all fuels is combusted in the sector, *Public electricity and heat production.* Other sectors with high fuel consumption are *Residential* and *Industry*.

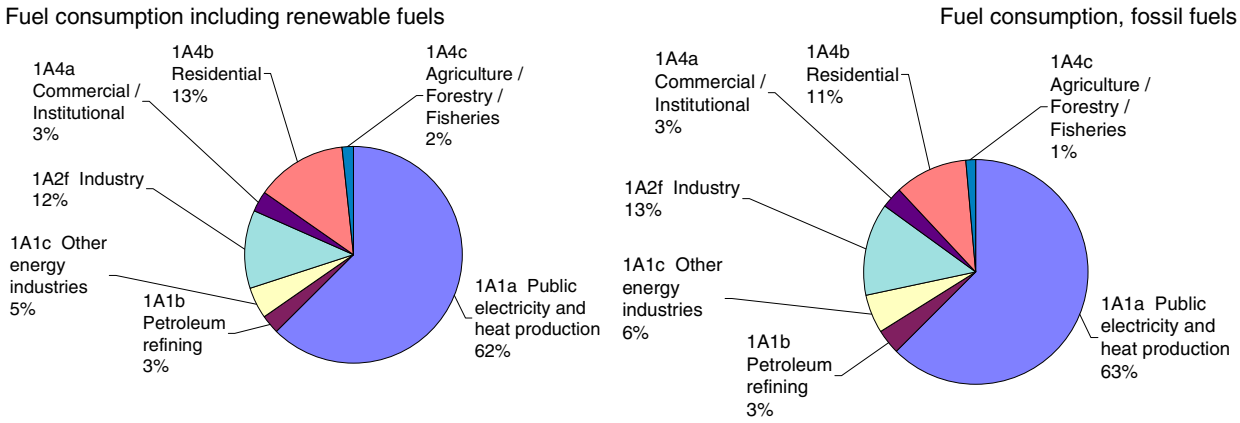


Figure 3.1 Fuel consumption rate of stationary combustion, 2006 (based on DEA 2007a)

Coal and natural gas are the most utilised fuels in 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.

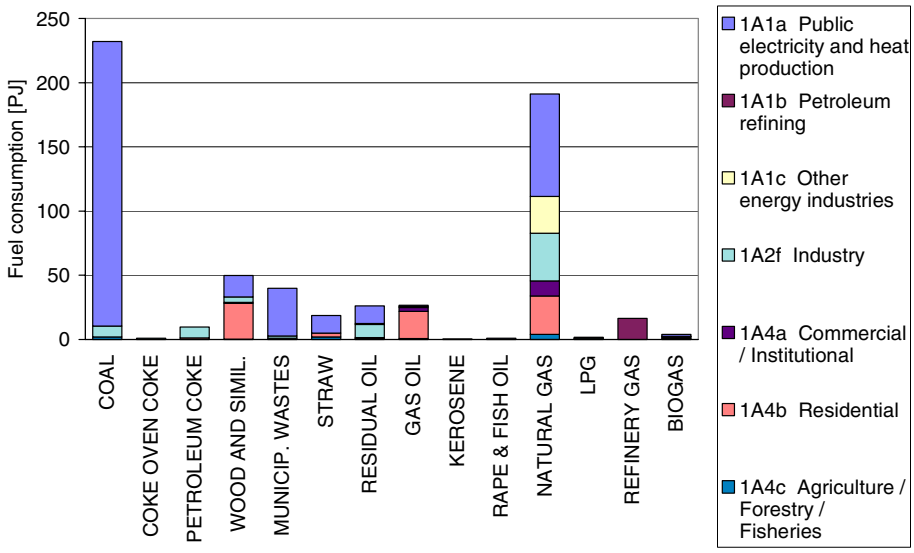


Figure 3.2 Fuel consumption in stationary combustion plants 2006 (based on DEA 2007a).

Fuel consumption time-series for stationary combustion plants are presented in Figure 3.3. The total fuel consumption has increased by 24% from 1990 to 2006, while the fossil fuel consumption has increased by 13.1%. The consumption of natural gas and renewable fuels has increased since 1990, whereas coal consumption has decreased.

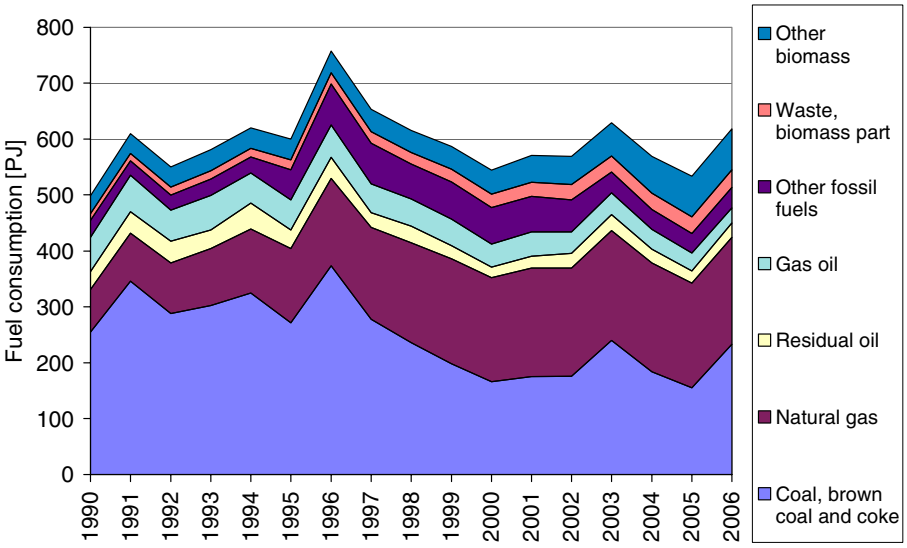


Figure 3.3 Fuel consumption time-series, stationary combustion (based on DEA 2007a)

The fluctuations in the time-series for fuel consumption are mainly a result 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 emissions are illustrated and compared in Figure 3.4. In 1990 the Danish electricity import was large causing relatively low fuel consump-

tion in Denmark's stationary combustion plants, whereas the fuel consumption was high in 1996 due to a large electricity export. In 2006 the net electricity export was 24 971 TJ in 2005 there had been a net import. The electricity export in 2006 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 3.4. The corrections are included here to explain the fluctuations in the emission time-series.

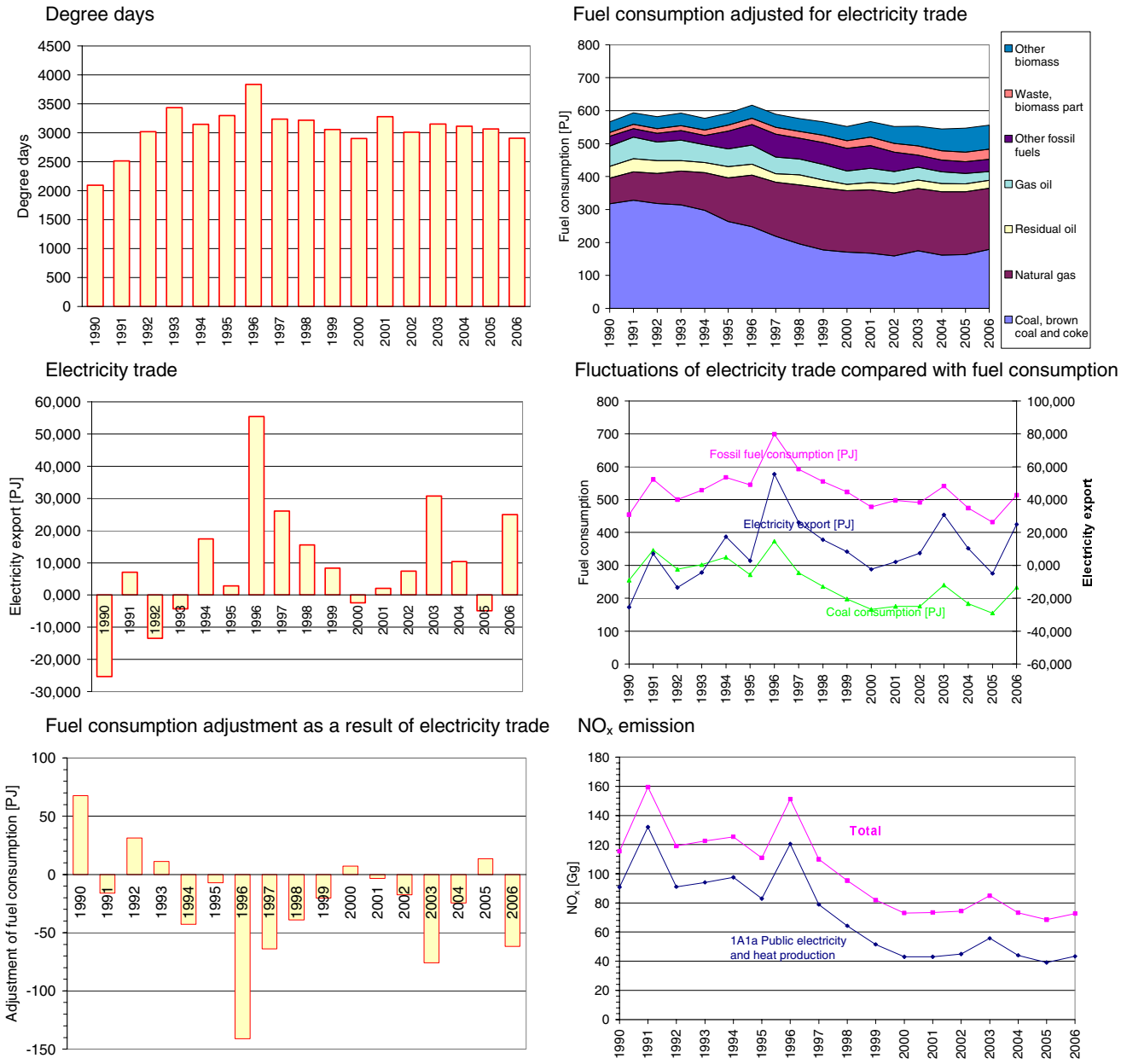


Figure 3.4 Comparison of time-series fluctuations for electricity trade, fuel consumption and NO_X emission (DEA 2007b).

3.2.2 Emissions

SO_2

In the 2005 inventory, stationary combustion is the most important emission source for SO_2 accounting for 90% of the total Danish emission. Table 3.5 shows the SO_2 emission inventory for the stationary combustion subsectors.

Electricity and heat production is the largest emission source accounting for 43 % of the emission. However, the SO_2 emission share is lower than the fuel consumption share for this sector, which is 62%. This is possible due to effective flue gas desulphurisation equipment installed in power plants combusting coal. The largest part (78%) of the emission in the subsector originates from power plants >300MW_{th}.

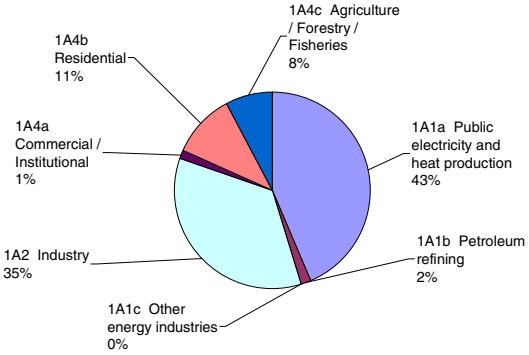
The SO_2 emission from *Industry* is 35%, a remarkably high emission share compared with fuel consumption. The main emission sources in the industrial sector are combustion of coal and residual oil, but emis-

sions from the cement industry also represent a considerable emission source.

Time-series for the SO_2 emission from stationary combustion are shown in Figure 3.5. The SO_2 emission from stationary combustion plants decreased by 95% from 1980 and 86% from 1990. The large emission decrease is mainly a result of the reduced emission from *Electricity and heat production*, made possible due to installation of desulphurisation plant and due to the use of fuels with lower sulphur content.

Table 3.5 SO_2 emission from stationary combustion plants 2006 [1)]

SO_2	2006	
1A1a Public electricity and heat production	9 832	Mg
1A1b Petroleum refining	407	Mg
1A1c Other energy industries	11	Mg
1A2 Industry	7 903	Mg
1A4a Commercial / Institutional	272	Mg
1A4b Residential	2 407	Mg
1A4c Agriculture / Forestry / Fisheries	1 754	Mg
Total	22 585	Mg



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

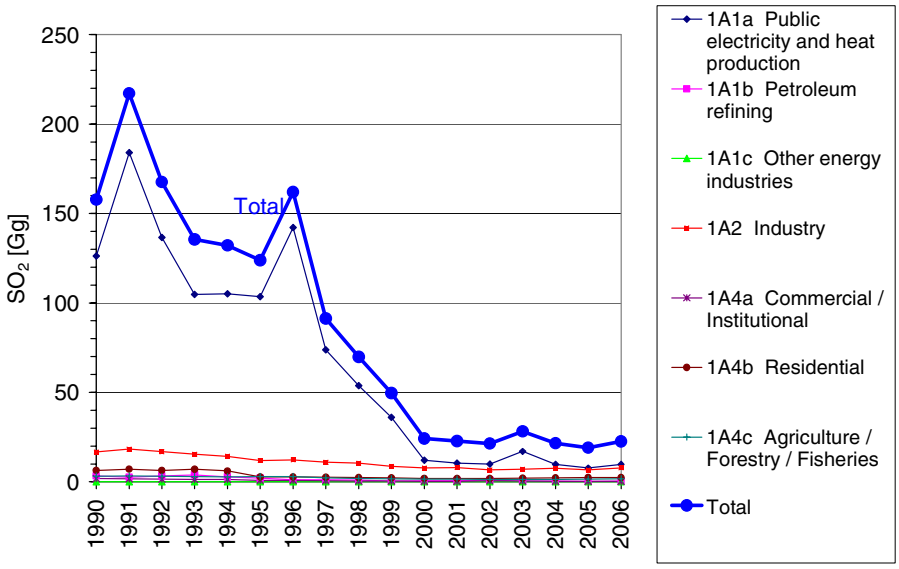


Figure 3.5 SO_2 emission time-series for stationary combustion

3.2.3 NO_X

Stationary combustion accounts for 39% of the total Danish NO_X emission. Table 3.6 shows the NO_X emission inventory for stationary combustion subsectors.

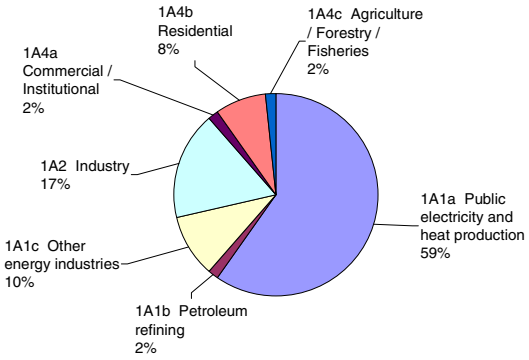
Electricity and heat production is the largest emission source, accounting for 59% of the emission from stationary combustion plants.

Industrial combustion plants are also an important emission source, accounting for 17 % of the emission. The main industrial emission source is cement production, accounting for 65 % of the emission.

Time-series for the NO_X emission from stationary combustion are shown in Figure 3.6. NO_X emissions from stationary combustion plants decreased by 51% from 1985 and 37% from 1990. 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 3.6 NO_X emission from stationary combustion plants 2006 [1)]

	2006	
1A1a Public electricity and heat production	43 306	Mg
1A1b Petroleum refining	1 366	Mg
1A1c Other energy industries	7 192	Mg
1A2 Industry	12 498	Mg
1A4a Commercial / Institutional	1 226	Mg
1A4b Residential	5 924	Mg
1A4c Agriculture / Forestry / Fisheries	1 138	Mg
Total	72 650	Mg



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

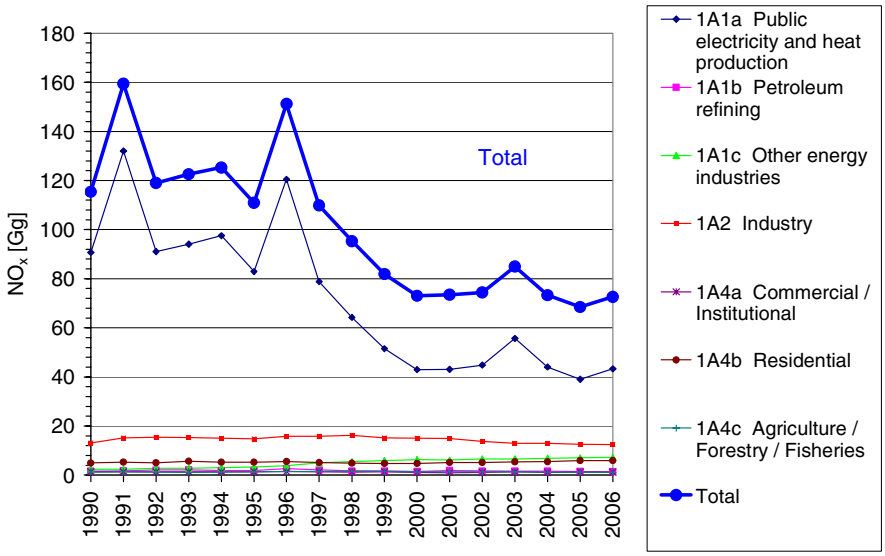


Figure 3.6 NO_X emission time-series for stationary combustion

3.2.4 NMVOC

Stationary combustion plants account for 21% of the total Danish NMVOC emission. Table 3.7 shows the NMVOC emission inventory for the stationary combustion subsectors.

Residential plants are the largest emission source accounting for 74 % of the total emission from stationary combustion plants. For residential

plants, NMVOC is mainly emitted from wood and straw combustion, see Figure 3.7.

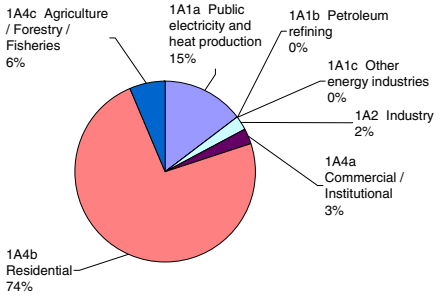
Electricity and heat production is also a considerable emission source, accounting for 16 % of the total emission. Lean-burn gas engines have a relatively high NMVOC emission factor and are the most important emission source in this subsector. The gas engines are either natural gas or biogas fuelled.

Time-series for the NMVOC emission from stationary combustion are shown in Figure 3.8. The emission has increased by 66% from 1985 and 70% from 1990. The increased emission is mainly a result of the increased use of lean-burn gas engines in CHP plants.

The emission from residential plants was 78% higher in 2006 than in 1990, but the NMVOC emission from wood combustion increased by 139% since 1990 due to increased wood consumption. However, the emission from straw combustion in farmhouse boilers has decreased over this period.

Table 3.7 NMVOC emission from stationary combustion plants 2006 [1)]

	2006	
1A1a Public electricity and heat production	3 282	Mg
1A1b Petroleum refining	0.5	Mg
1A1c Other energy industries	43	Mg
1A2 Industry	568	Mg
1A4a Commercial / Institutional	722	Mg
1A4b Residential	17 109	Mg
1A4c Agriculture / Forestry / Fisheries	1 458	Mg
Total	23 182	Mg



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

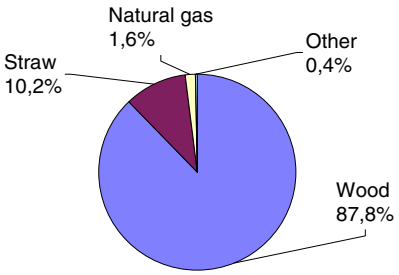


Figure 3.7 NMVOC emission from residential plants, 2006

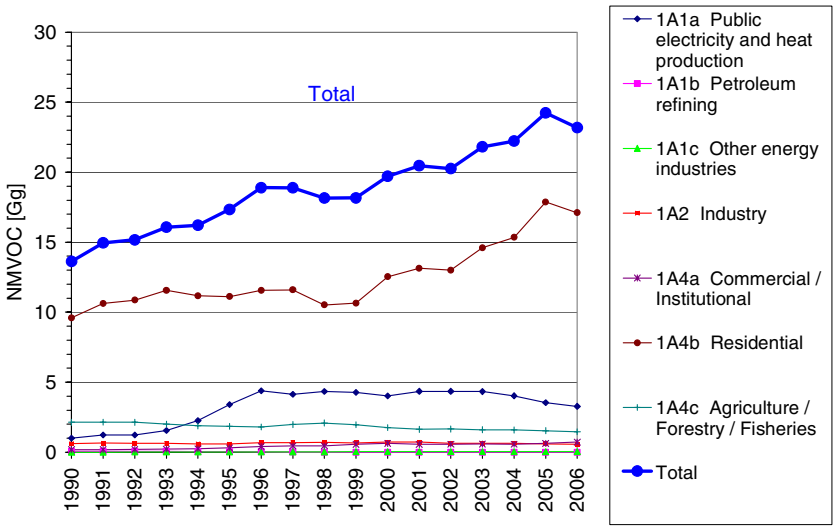


Figure 3.8 NMVOC emission time-series for stationary combustion

3.2.5 CO

Stationary combustion accounts for 50% of the total Danish CO emission. Table 3.8 presents the CO emission inventory for stationary combustion subsectors.

Residential plants represent the largest emission source, accounting for 90% of the emission. Wood combustion accounts for 95% of the emission from residential plants, see Figure 3.9. This is in spite of the fact that the fuel consumption share is only 33%. Combustion of straw also represents a considerable emission source, whereas the emission from other fuels used in residential plants is almost negligible.

Time-series for CO emission from stationary combustion are shown in Figure 3.10. The emission increased by 65% from 1985 and increased 62% from 1990. 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 212% 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.

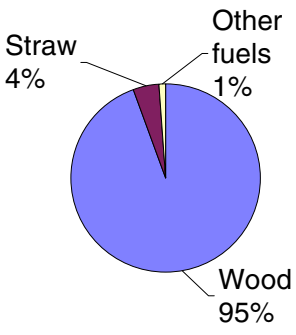
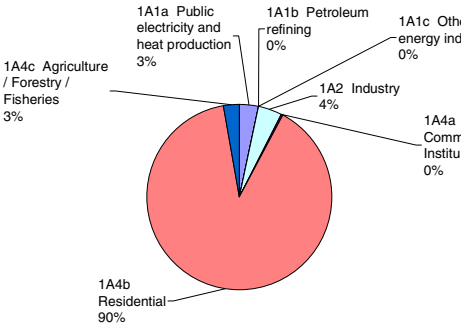


Figure 3.9 CO emission sources, residential plants, 2006

Table 3.8 CO emission from stationary combustion plants 2006 [1)]

	2006	
1A1a Public electricity and heat production	9 787	Mg
1A1b Petroleum refining	244	Mg
1A1c Other energy industries	219	Mg
1A2 Industry	12 028	Mg
1A4a Commercial / Institutional	924	Mg
1A4b Residential	265 888	Mg
1A4c Agriculture / Forestry / Fisheries	8 243	Mg
Total	297 333	Mg



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

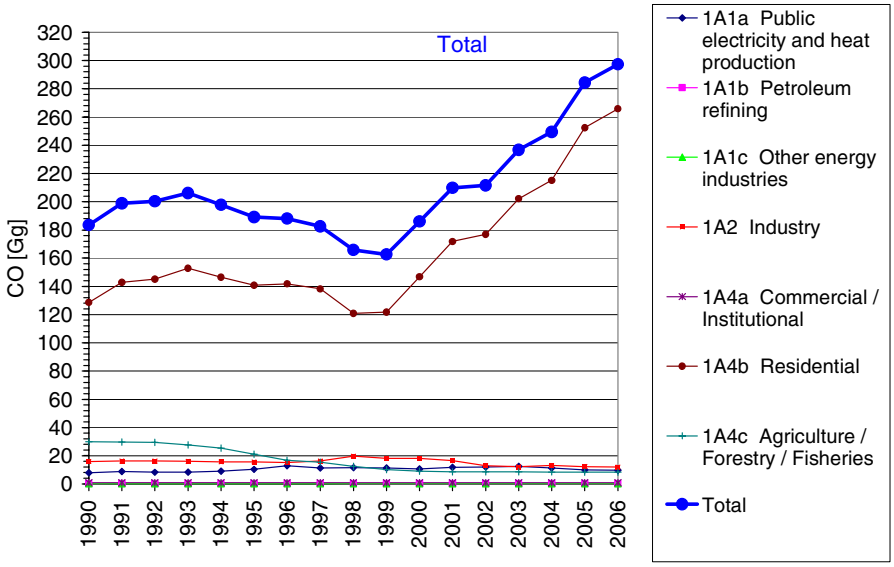


Figure 3.10 CO emission time-series for stationary combustion

3.2.6 PM

To date, PM emissions from stationary combustion, transport, agriculture and the industrial sector have been included in the Danish inventory. TSP from stationary combustion accounts for 48% of the total Danish emission. The emission shares for PM_{10} and $PM_{2.5}$ are 54% and 70%, respectively.

Table 3.9 shows the PM emission inventory for the stationary combustion subsectors. Residential plants represent the largest emission source, accounting for 91% of the $PM_{2.5}$ emission from stationary combustion plants.

Table 3.9 PM emission from stationary combustion plants, 2006

		TSP	PM_{10}	$PM_{2.5}$	
1A1a	Public electricity and heat production	957	728	596	Mg
1A1b	Petroleum refining	113	107	104	Mg
1A1c	Other energy industries	3	2	2	Mg
1A2	Industry	980	672	385	Mg
1A4a	Commercial / Institutional	166	162	152	Mg
1A4b	Residential	19 736	18 708	17 697	Mg
1A4c	Agriculture / Forestry / Fisheries	521	482	446	Mg
Total		22 476	20 861	19 382	Mg

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

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, 87% of the $PM_{2.5}$ emission from stationary combustion is emitted from residential wood combustion. This corresponds to 61% of the overall Danish emission.

A literature review (Nielsen et al. 2003) and a Nordic Project (Sternhufvud et al. 2004) have demonstrated that the emission factor uncertainty for residential combustion of wood in stoves and boilers is extremely high.

Emission inventories for PM have only been reported for the years 2000-2006 and the emission level has not changed considerably over this period.

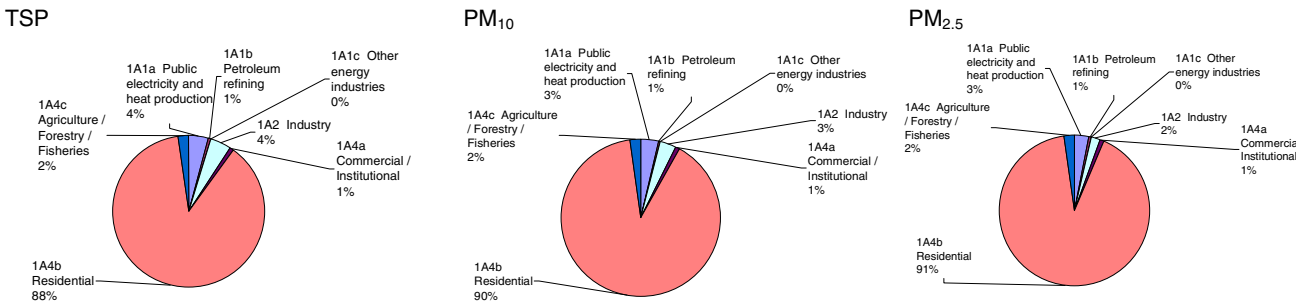


Figure 3.11 PM emission sources, stationary combustion plants, 2006

3.2.7 Heavy metals

Emission inventories for nine heavy metals are reported to the LRTAP Convention. Three of the metals are considered priority metals: Pb, Cd and Hg. The 2006 emissions are presented in Table 3.10.

Stationary combustion plants are the most important emission sources for heavy metals. For Cu, the emission share from stationary combustion plants is 12%, but for all other heavy metals the emission share is more than 77%.

The sectors *Electricity and heat production* and *Industry* have the highest emission shares. *Electricity and heat production* accounts for 66%, 37% and 58% of the emission of the priority metals Pb, Cd and Hg, respectively.

Table 3.10 Heavy metal emission from stationary combustion plants, 2006 [1)]

	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	
1A1a Public electricity and heat production	332	226	520	664	677	2323	3435	1067	15 355	kg
1A1b Petroleum refining	9	8	21	8	3	398	15	8	2	kg
1A1c Other energy industries	0	0	0	0	0	0	0	0	0	kg
1A2 Industry	230	188	448	204	264	6205	917	593	1302	kg
1A4a Commercial / Institutional	11	19	40	41	64	212	135	17	541	kg
1A4b Residential	32	199	31	224	237	146	166	102	4084	kg
1A4c Agriculture / Forestry / Fisheries	20	15	37	22	22	601	42	15	60	kg
Total	**633**	**655**	**1096**	**1163**	**1267**	**9885**	**4710**	**1802**	**21 344**	**kg**

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

Time-series for heavy metal emissions are provided in Figure 3.12. Emissions of all heavy metals except Zn have decreased considerably since 1990. Table 3.11 shows the decrease of each heavy metal since 1990. 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 being a further important emission source. The increasing Zn emission estimated in resent years might be a result of insufficient data.

Table 3.11 Decrease in heavy metal emission 1990-2006

Pollutant	Decrease since 1990
As	56 %
Cd	38 %
Cr	82 %
Cu	68 %
Hg	59 %
Ni	54 %
Pb	69 %
Se	58 %
Zn	-10 %

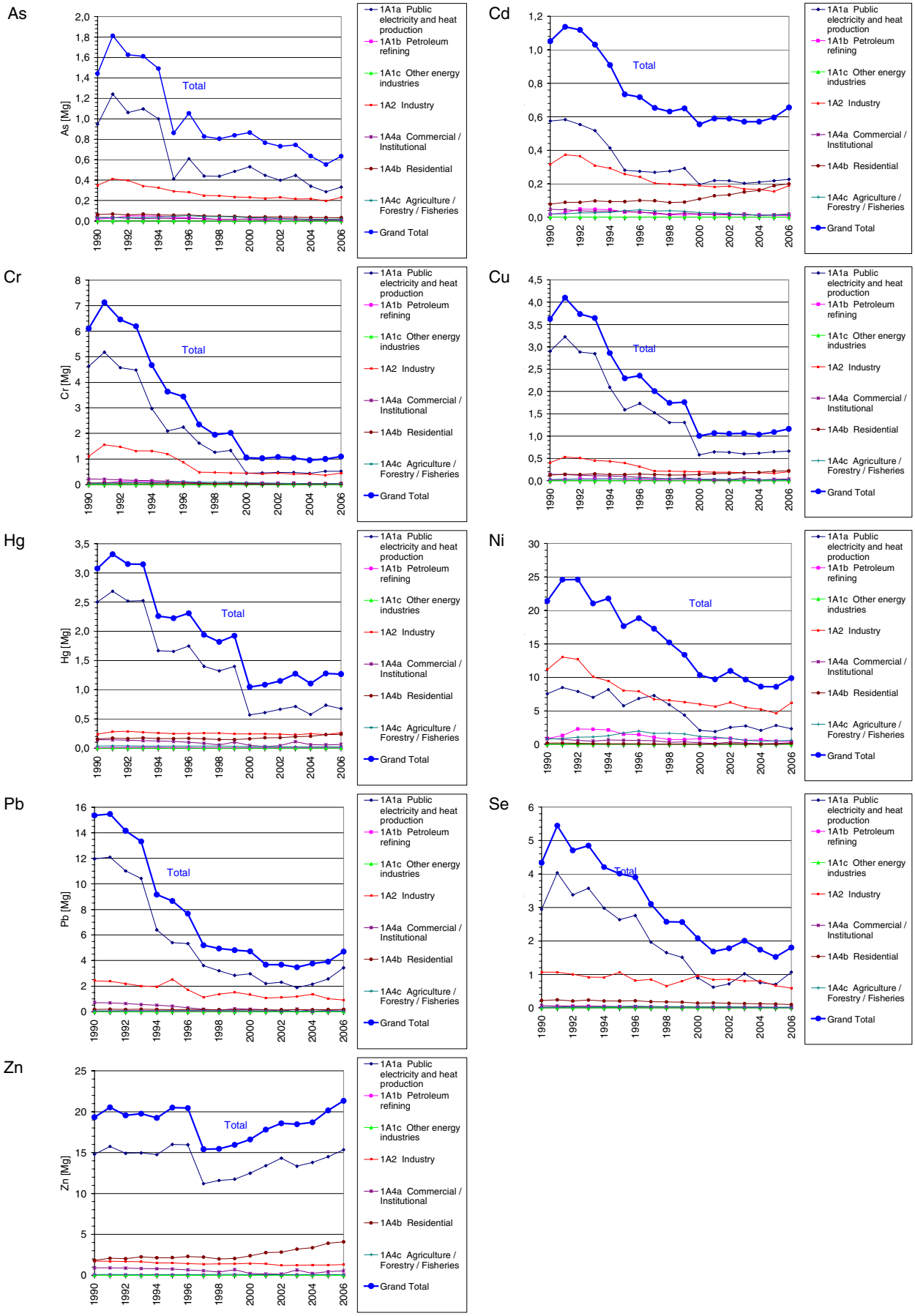


Figure 3.12 Heavy metal emission time-series, stationary combustion plants

3.2.8 PAH and dioxin

Emission inventories for 4 PAHs and for dioxin are reported to the LRTAP Convention. Stationary combustion plants account for more than 95% of the PAH emissions and for 79% of the dioxin emission in 2006.

Table 3.12 shows the PAH and dioxin emission inventory for the stationary combustion subsectors. Residential combustion is the largest emission source for both PAH and dioxin. Combustion of wood is the predominant source, accounting for more than 98% of the PAH emission in residential plants. The residential sector accounts for 79% of the dioxin emission from stationary combustion plants.

The increasing emission trend for PAH 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 3.14.

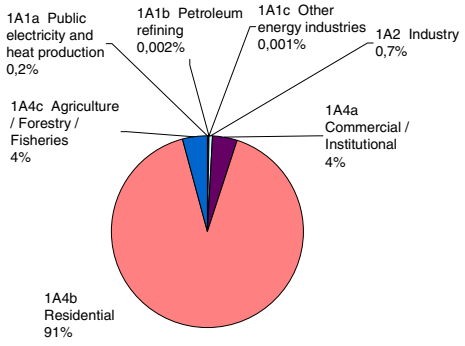
Dioxin emission decreased 61% since 1990 mainly due to installation of dioxin filters in MSW incineration plants. The emission from residential plants is increasing due to increased wood consumption in this sector.

Table 3.12 PAH emission from stationary combustion plants, 2005

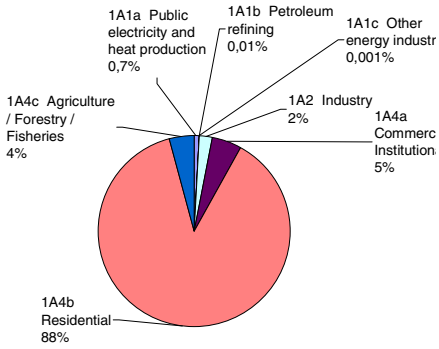
	Benzo(a)-Pyrene (Mg)	Benzo(b)-fluoranthene (Mg)	Benzo(k)-fluoranthene (Mg)	Indeno(1,2,3-c,d)pyrene (Mg)	Dioxin [g I-Tec]
1A1a Public electricity and heat production	7	30	15	7	1,7
1A1b Petroleum refining	0	0	0	0	0,0
1A1c Other energy industries	0	0	0	0	0,0
1A2 Industry	28	96	15	8	0,2
1A4a Commercial / Institutional	161	212	70	115	0,5
1A4b Residential	3551	3699	2153	2419	14,4
1A4c Agriculture / Forestry / Fisheries	161	174	25	259	1,4
Total	**3908**	**4211**	**2278**	**2808**	**18,2**

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

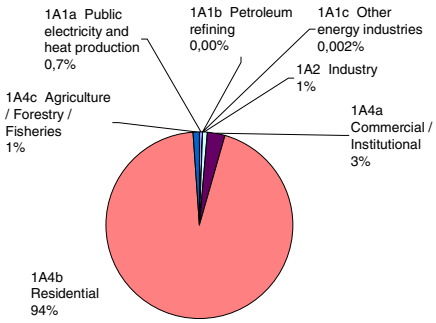
Benzo(a)pyrene



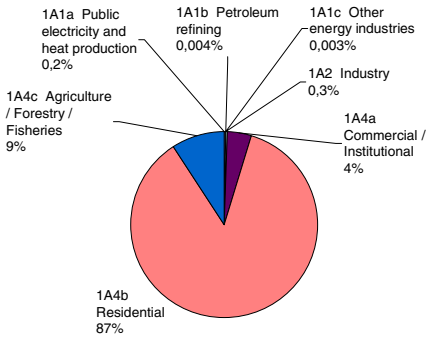
Benzo(b)fluoranthene



Benzo(k)fluoranthene



Indeno(1,2,3-c,d)pyrene



Dioxin

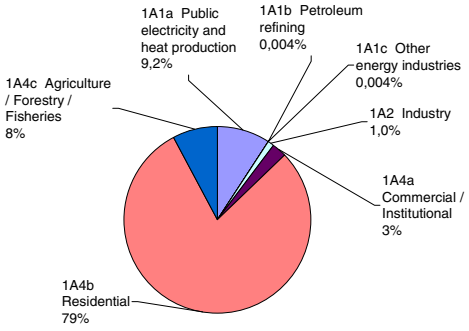


Figure 3.13 PAH emission sources, stationary combustion plants, 2006

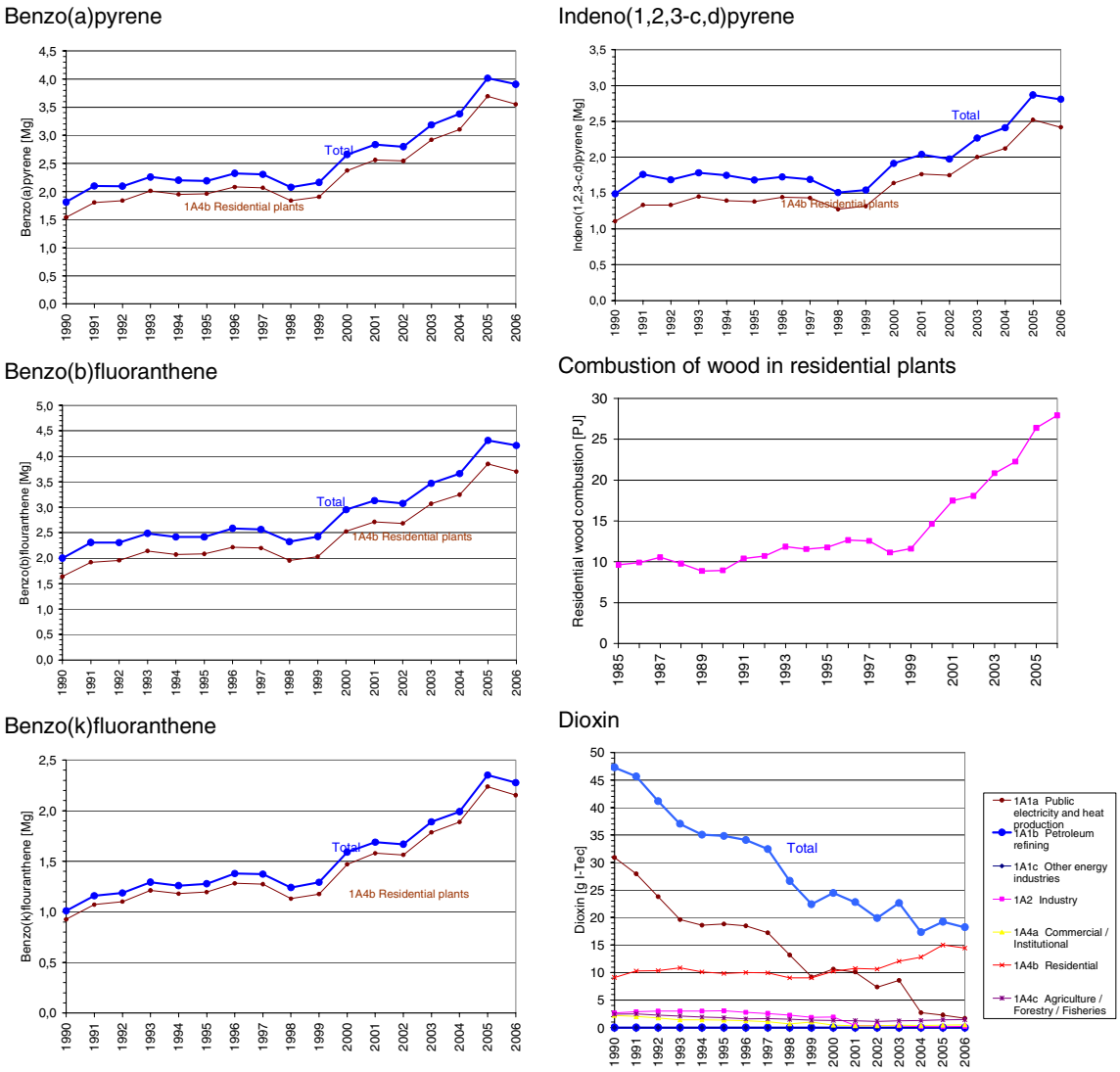


Figure 3.14 PAH emission time-series, stationary combustion plants. Comparison with wood consumption in residential plants.

3.2.9 Methodological issues

The Danish emissions inventory is based on the CORINAIR (CORe INventory on AIR emissions) system, which is a European programme for air emission inventories. CORINAIR includes the methodology structure and software for inventories. The methodology is described in the "EMEP/Corinair Emission Inventory Guidebook", 3rd edition 2007 update, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (EMEP/Corinair 2007). 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.

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 2006, 75 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 criteria for selection of point sources consist of the following:

- All centralised power plants, including smaller units.
- All units with a capacity of above 25 MW_e.
- All district heating plants with an installed effect of 50 MW or above and a significant fuel consumption
- All waste incineration plants included in the Danish law "Bekendtgørelse om visse listevirksomheders pligt til at udarbejde grønt regnskab".
- Industrial plants
    - With an installed effect of 50 MW or above and significant fuel consumption.
    - With a significant process-related emission.

The fuel consumption of stationary combustion plants registered as large point sources is 383 PJ (2006). This corresponds to 62% of the overall fuel consumption for stationary combustion.

Further details on large point sources are shown in Annex 2A. The number of large point sources registered in the databases increased from 1990 to 2006. In the emission databases for the years before 1990, only one large point source was registered.

If plant-specific emission factors are not available, general area source emission factors are used. 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 a 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 datasets. Emission data from annual environmental reports are, in general, based on emission measurements, but some emissions have potentially been calculated from general emission factors.

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.

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 2007a). Some fuel types in the official Danish energy statistics are added to obtain a less detailed fuel aggregation level, see Annex 2A. The calorific values on which the energy statistics are based are also enclosed in Annex 2A.

The fuel consumption of the NFR 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. To date, disaggregation into specific industries has only been estimated for reporting to the Climate Convention. Disaggregation for LRTAP Convention reporting is planned in the future.

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

Petroleum coke purchased abroad and combusted in Danish residential plants (border trade of 628 TJ) 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 2007c).

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. 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 about 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 NFR Energy sector (source categories *1A1*, *1A2* and *1A4)*.

Fuel consumption data are presented in Chapter 3.2.1.

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 2007) and the IPCC reference manual (IPCC 1996).

A complete list of emission factors for 2006, time-series for emission factors and detailed references are enclosed in Annex 2A. The area source emission factors in 2006 for SO_2, NO_X, NMVOC and CO are shown in Table 3.13.

Table 3.13 SO_2, NO_X, NMVOC and CO emission factors 2006

Fuel	NFR sector	SNAP	SO_2 [g/GJ]	NO_X [g/GJ]	NMVOC [g/GJ]	CO [g/GJ]
COAL	1A1a	010101, 010102, 010103	37	109	1.5	10
COAL	1A1a, 1A2f, 1A4c	010202, 010203, 0301, 0203	574	95	15	10
COAL	1A4b	0202	574	95	15	2 000
BROWN COAL BRI.	1A4b	0202	574	95	15	2 000
COKE OVEN COKE	1A2f	0301	574	95	15	10
COKE OVEN COKE	1A4b	0202	574	95	15	2 000
PETROLEUM COKE	1A2f	0301	605	95	1.5	61
PETROLEUM COKE	1A4a, 1A4b, 1A4c	0201, 0202, 0203	605	50	1.5	1 000
WOOD AND SIMIL.	1A1a	010102, 010103, 010104	1.74	69	3.3	79
WOOD AND SIMIL.	1A1a	010105	25	130	48	50
WOOD AND SIMIL.	1A1a, 1A2f	010202, 010203, 0301, 030102, 030103	25	130	48	240
WOOD AND SIMIL.	1A4a, 1A4c	0201, 020105, 0203	25	130	600	240
WOOD AND SIMIL.	1A4b	0202	25	120	538	9 000
MUNICIP. WASTES	1A1a	010102, 010103, 010104, 010105	23.9	124	0.98	7.4
MUNICIP. WASTES	1A1a, 1A2f, 1A4a	010203, 030102, 0201, 020103	67	164	9	10
STRAW	1A1a	010102, 010103	47.1	131	0.8	63
STRAW	1A1a, 1A2f, 1A4c	010202, 010203, 030105, 020302	130	153	50	325
STRAW	1A4b, 1A4c	0201, 0203	130	153	600	4 000
RESIDUAL OIL	1A1a	0101, 010101, 010102, 010103, 010104, 010105	308	109	3	15
RESIDUAL OIL	1A1a, 1A4a, 1A4b, 1A4c	010202, 010203, 0201, 0202, 0203, 020302	344	142	3	30
RESIDUAL OIL	1A1b	010306	537	142	3	30
RESIDUAL OIL	1A2f	0301, 030102, 030103	344	130	3	30
RESIDUAL OIL	1A2f	030104	344	130	3	15
RESIDUAL OIL	1A2f	030105	344	130	3	100
RESIDUAL OIL	1A4c	020304	344	142	3	100
GAS OIL	1A1a	0101, 010101, 010102	23	249	1.5	15
GAS OIL	1A1a, 1A2f	Gas turbines: 010104, 030104	23	350	2	15
GAS OIL	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Engines: 010105, 010205, 010505, 030105, 020105, 020304	23	700	100	100
GAS OIL	1A1a	010103	23	65	1.5	15
GAS OIL	1A1a, 1A1b, 1A2f	010202, 010203, 010306, 0301, 030102, 030103, 030106	23	65	1.5	30
GAS OIL	1A4a, 1A4c	0201, 020103, 0203	23	52	3	30
GAS OIL	1A4b	0202	23	52	3	43
KEROSENE	all	all	5	50	3	20
FISH & RAPE OIL	1A1a	010103	1	220	1.5	15
FISH & RAPE OIL	1A1a	010202, 010203	1	65	1.5	15
FISH & RAPE OIL	1A2f, 1A4c	030105, 020304	1	700	100	100
ORIMULSION	1A1a	010101	12	86	3	15
NATURAL GAS	1A1a	0101, 010101, 010102	0.3	97	2	15
NATURAL GAS	1A1a, 1A2f, 1A4a, 1A4c	Gas turbines: 010104, 030104, 020104, 020303	0.3	124	1.4	6.2
NATURAL GAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	Gas engines: 010105, 010205, 010505, 030105, 020105, 020204, 020304	0.3	148	105	115
NATURAL GAS	1A1a, 1A2f	010103, 010202, 010203, 0301, 030103, 030106	0.3	42	2	28
NATURAL GAS	1A1c	010504	0.3	250	1.4	6.2
NATURAL GAS	1A4a, 1A4c	0201, 020103, 0203	0.3	30	2	28
NATURAL GAS	1A4b	0202, 020202	0.3	30	4	20
LPG	1A1a, 1A2f	010203, 0301	0.13	96	2	25
LPG	1A4a, 1A4c	0201, 0203	0.13	71	2	25
LPG	1A4b	0202	0.13	47	2	25
REFINERY GAS	1A1b	010304	1	170	1.4	6.2
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	010102, 010103, 010203, 0301, 0201, 020103, 0203	25	28	4	36
BIOGAS	1A1a, 1A1c, 1A2f, 1A4a, 1A4c	Gas engines: 010105, 010505, 030105, 020105, 020304	19.2	540	14	273
BIOGAS	1A2f	030102	25	59	4	36

Most country-specific emission factors refer to:

- Danish legislation
- A emission measurement programme for decentralised CHP plants
- Other Danish research reports
- Calculations based on plant-specific emissions from a considerable number of power plants
- Calculations based on plant-specific emissions from a considerable number of municipal waste incineration plants

SO_2 and NO_X emissions from large point sources are often plant specific i.e. based on emission measurements. Emissions of CO, NMVOC, PM and heavy metals are also plant specific in some cases.

Some of the area source emission factors for power plants and municipal waste CHP plants take into account that large plants are included in the inventory as large point sources with plant-specific emission data. Thus, some area source emission factors are default values which assume that the remaining fuel consumption is combusted in smaller units with less effective flue gas cleaning. The area source emission factors are, therefore, not necessarily average values for these plant categories.

3.2.10 Uncertainties and time-series consistency

Time-series for fuel consumption and emission are shown and discussed in Chapter 3.2.1.

Methodology

The applied methodology for uncertainty estimates refers to Pulles & Aardenne (2001). 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 the year 2006 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 uncertainty estimates for activity rates and emission factors are default values referring to Pulles & Aardenne 2001. The uncertainty for PM is, however, estimated by NERI. The default uncertainty estimates for emission factors are given in letter codes representing an uncertainty range. It has been assumed that the uncertainty estimates were in the lower end of the range for all sources and pollutants. The values applied for emission factors are listed in Table 3.14. The uncertainty for fuel consumption in stationary combustion plants was assumed to be 2%.

Table 3.14 Uncertainty values 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	1 000	1 000
03	10	20	50	20	50	100	100

Results

Uncertainty estimates include uncertainty regarding the total emission as well as uncertainty relating to the trend. The estimated uncertainties for

stationary combustion emission inventories are shown in Table 3.15. Detailed calculation sheets are shown in Annex 2A.

The total emission uncertainty is 7% for SO_2, 16% for NO_X, 42% for NMVOC and 46% for CO. For PM, heavy metals, and PAH, the uncertainty estimate is greater than 100%.

Table 3.15 Danish uncertainty estimates, 2006

Pollutant	Uncertainty Total emission [%]	Trend 1990-2006 [%]	Uncertainty Trend [%-age points]
SO_2	7	-86	±0.8
NO_X	16	-37	±2.5
NMVOC	42	+70	±8
CO	46	+62	±6
TSP [1)]	454	+33	±30
PM_{10} [1)]	464	+34	±28
$PM_{2.5}$ [1)]	472	+35	±24
As	118	-56	±9
Cd	358	-38	±136
Cr	118	-82	±10
Cu	254	-68	±53
Hg	262	-59	±62
Ni	119	-54	±9
Pb	105	-69	±4
Se	101	-58	±5
Zn	231	+10	±82
Benzo(b)fluoranthene	970	+70	±6
Benzo(k)fluoranthene	987	+191	±86
Benzo(a)pyrene	991	+106	±6
Indeno(1,2,3-c,d)	995	+79	±14

1. The base year for PM is year 2000

3.2.11 Source specific QA/QC and verification

A QA/QC plan is implemented. A thorough description can be found in Denmark's National Inventory Report (Nielsen et al. 2008a)

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 1.6% (1990-2006). The reference approach is further discussed in annex 2A.
- 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[1] both run accredited laboratories for emission measurements.

3.2.12 Source specific recalculations

Improvements and recalculations since the 2007 emission inventory include:

- Update of fuel rates according to the latest energy statistics. The update included the years 1980-2005.
- Emission factors for NO_x, CO and NMVOC for natural gas powered gas engines has been updated based on new research.

3.2.13 Source specific planned improvements

The planned improvements of the inventory include:

1) Improved documentation for 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.
2) QA/QC and validation
   The QA/QC and validation of the inventories for stationary combustion will be further expanded as part of the ongoing work that for the Danish inventory as a whole. The work is documented in Denmark's National Inventory Report (Nielsen et al. 2008a)
3) 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.
4) Other improvements
   HM emission factors should be compared with new Danish legislation and updated if necessary.

3.3 Transport and other mobile sources (NFR sector 1A2, 1A3, 1A4 and 1A5)

The emission inventory basis for mobile sources is fuel use information from the Danish energy statistics. In addition, background data for road transport (fleet and mileage), air traffic (aircraft type, flight numbers, origin and destination airports) and non-road machinery (engine no., engine size, load factor and annual working hours) are used to make the

[1] Now FORCE

emission estimates sufficiently detailed. Emission data mainly comes from the EMEP/CORINAIR Emission Inventory Guidebook. However, for railways, measurements specific to Denmark are used.

In the Danish emission database, all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution), according to the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP sectors. The aggregation to the sector codes used for both the UNFCCC and UN-ECE Conventions is based on a correspondence list between SNAP and NFR classification codes shown in Table 3.16 below (mobile sources only).

Table 3.16 SNAP – NFR correspondence table for transport

SNAP classification	NFR classification
07 Road transport	1A3b Transport-Road
0801 Military	1A5 Other
0802 Railways	1A3c Railways
0803 Inland waterways	1A3d Transport-Navigation
080402 National sea traffic	1A3d Transport-Navigation
080403 National fishing	1A4c Agriculture/forestry/fisheries
080404 International sea traffic	1A3d Transport-Navigation (international)
080501 Dom. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation
080502 Int. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation (international)
080503 Dom. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation
080504 Int. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation (international)
0806 Agriculture	1A4c Agriculture/forestry/fisheries
0807 Forestry	1A4c Agriculture/forestry/fisheries
0808 Industry	1A2f Industry-Other
0809 Household and gardening	1A4b Residential

Military transport activities (land and air) refer to the NFR sector Other (1A5), while the Transport-Navigation sector (1A3d) comprises national sea transport (ship movements between two Danish ports) and small boats and pleasure craft. The working machinery and equipment in industry is grouped in Industry-Other (1A2f), while agricultural and forestry machinery is accounted for in the Agriculture/forestry/fisheries (1A4c) sector together with fishing activities.

3.3.1 Source category description

The following description of source categories explains the development in fuel consumption and emissions for road transport and other mobile sources.

Fuel consumption

Table 3.17 Fuel use (PJ) for domestic transport in 2006 in NFR sectors

NFR ID	Fuel use (PJ)
Industry-Other (1A2f)	13.9
Civil Aviation (1A3a)	2.0
Road (1A3b)	171.5
Railways (1A3c)	3.1
Navigation (1A3d)	6.1
Residential (1A4b)	3.2
Ag./for./fish. (1A4c)	21.6
Military (1A5)	1.7
Total	223.1

Table 3.17 shows the fuel use for domestic transport based on DEA statistics for 2006 in NFR sectors. The fuel use figures in time-series 1985-2006 are given in Annex 2.B.15 (NFR format) and are shown for 2006 in Annex 2.B.14 (CollectER format). Road transport has a major share of the fuel consumption for domestic transport. In 2006 this sector's fuel consumption share is 77%, while the fuel consumption shares for Agriculture/forestry/fisheries and Industry-Other are 10 and 6%, respectively. For the remaining sectors the total fuel consumption share is 7%.

From 1985 to 2006, diesel and gasoline fuel use has increased by 47% and 23%, respectively, and in 2006 the fuel use shares for diesel and gasoline were 63% and 36%, respectively (Figures 3.15 and 3.16). Other fuels only have a 1% share of the domestic transport total. Almost all gasoline is used in road transportation vehicles. Gardening machinery and recreational craft are merely small consumers. Regarding diesel, there is considerable fuel use in most of the domestic transport categories, whereas a more limited use of residual oil and jet fuel is being used in the navigation sector and by aviation (civil and military flights), respectively.

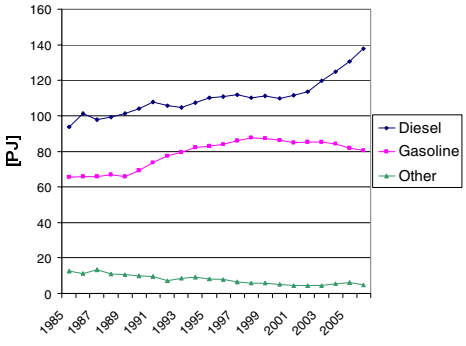


Figure 3.15 Fuel consumption per fuel type for domestic transport 1985-2006

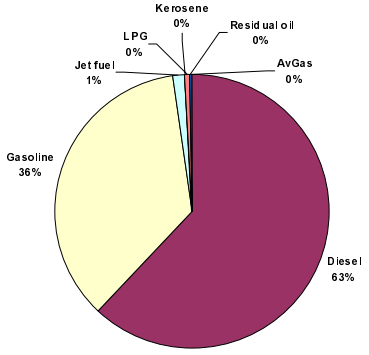


Figure 3.16 Fuel use share per fuel type domestic transport in 2006

Road transport

As shown in Figure 3.17, the energy use for road transport has generally increased from except from a small fuel consumption decline noted in 2000. The fuel consumption development is due to a slight decreasing trend in the use of gasoline fuels from 1999 onwards combined with a steady growth in the use of diesel. Within sub-sectors, passenger cars represent the most fuel-consuming vehicle category, followed by heavy-

duty vehicles, light duty vehicles and 2-wheelers, in decreasing order (Figure 3.18).

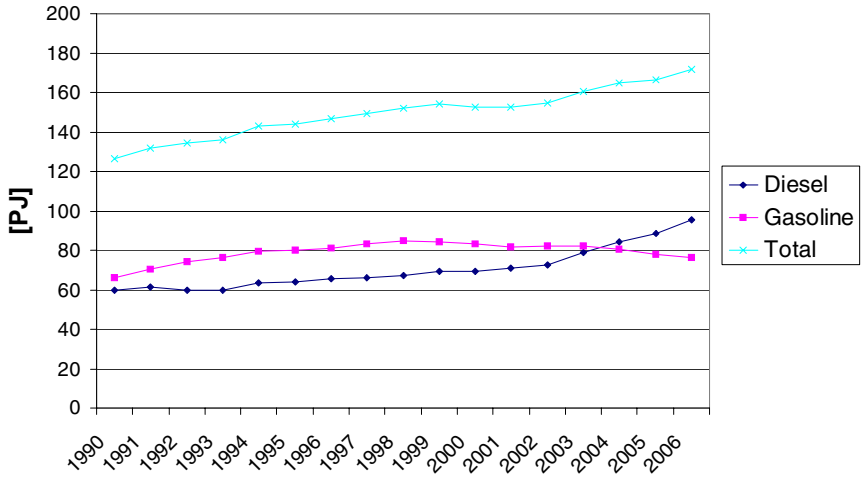


Figure 3.17 Fuel consumption per fuel type and as totals for road transport 1990-2006

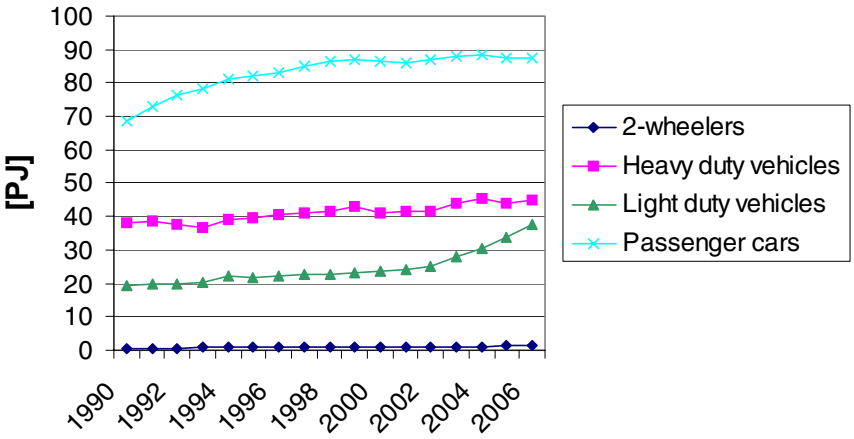


Figure 3.18 Total fuel consumption per vehicle type for road transport 1990-2006

As shown in Figure 3.19, fuel consumption for gasoline passenger cars dominates the overall gasoline consumption trend. The development in diesel fuel consumption in recent years (Figure 3.20) is characterised by increasing fuel consumption for diesel passenger cars and light duty vehicles, while the fuel consumption for trucks and buses (heavy-duty vehicles), since 1999, has fluctuated. The sudden increase in fuel consumption for heavy-duty vehicles in 2003 is, however, significant.

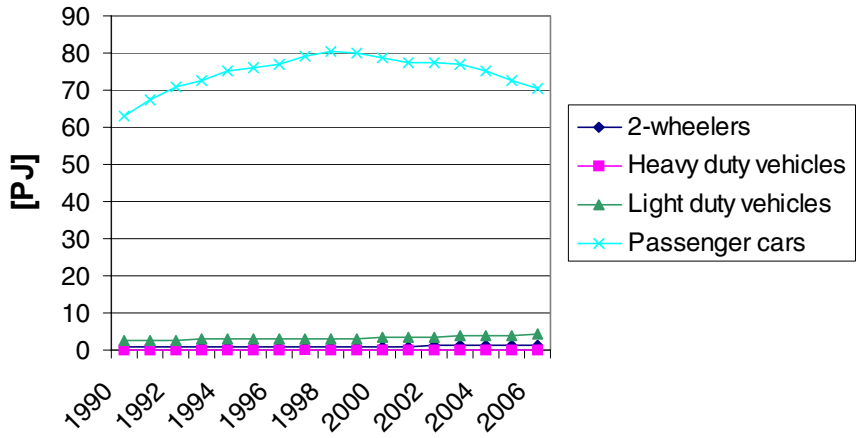


Figure 3.19 Gasoline fuel consumption per vehicle type for road transport 1990-2006

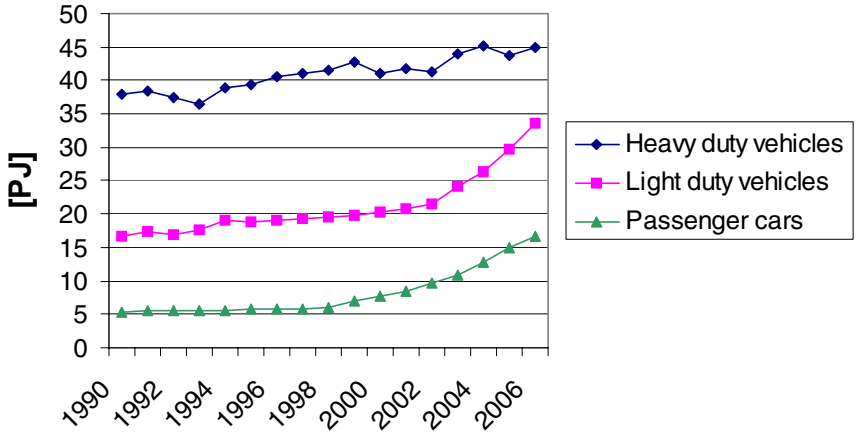


Figure 3.20 Diesel fuel consumption per vehicle type for road transport 1990-2006

In 2006, fuel consumption shares for gasoline passenger cars, heavy-duty vehicles, diesel light duty vehicles, diesel passenger cars and gasoline light duty vehicles were 41, 26, 20, 10 and 2%, respectively (Figure 3.21).

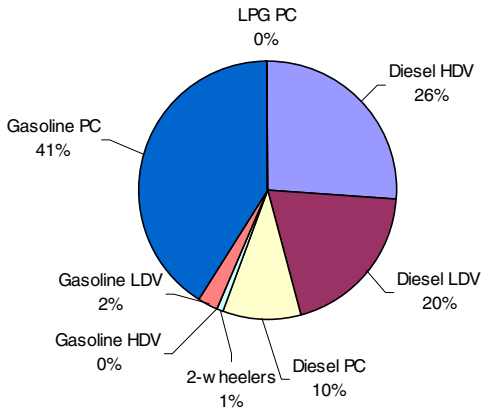


Figure 3.21 Fuel consumption share (PJ) per vehicle type for road transport in 2006

Other mobile sources

It must be noted that the fuel consumption figures behind the Danish inventory for mobile equipment in the agriculture, forestry, industry, household and gardening (residential), and inland waterways (part of navigation) sectors, are less certain than for other mobile sectors. For these types of machinery, the DEA statistical figures do not directly provide fuel consumption information, and fuel consumption totals are subsequently estimated from activity data and fuel consumption factors. For 2006 no new stock information has been gathered for recreational craft, and thus the 2004 total stock information is repeated for this year.

As seen in Figure 3.22, classified according to CRF the most important sectors are Agriculture/forestry/fisheries (1A4c), Industry-other (mobile machinery part of 1A2f) and Navigation (1A3d). Minor fuel consuming sectors are Civil Aviation (1A3a), Railways (1A3c), Other (military mobile fuel consumption: 1A5) and Residential (1A4b).

The 1985-2006 time-series are shown per fuel type in Figures 3.23-3.26 for diesel, gasoline and jet fuel, respectively.

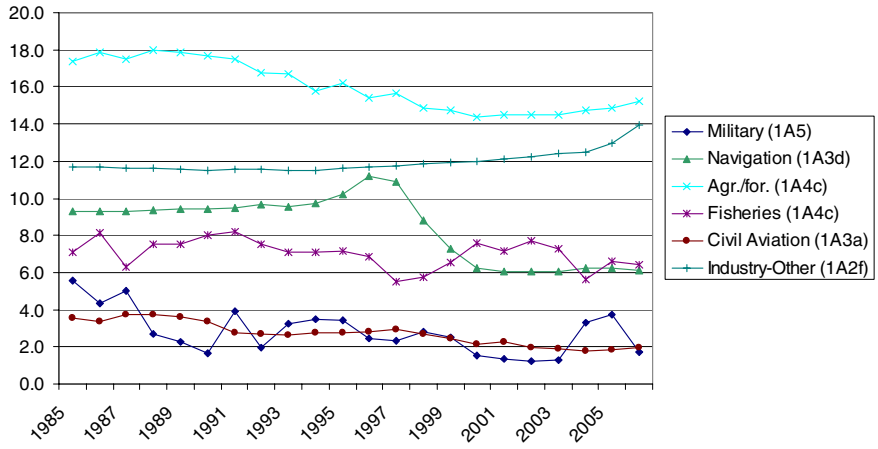


Figure 3.22 Total fuel consumption in CRF sectors for other mobile sources 1985-2006

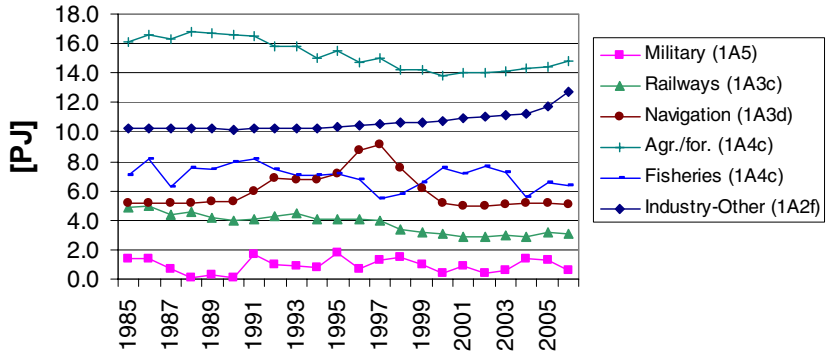


Figure 3.23 Diesel fuel consumption in CRF sectors for other mobile sources 1985-2006

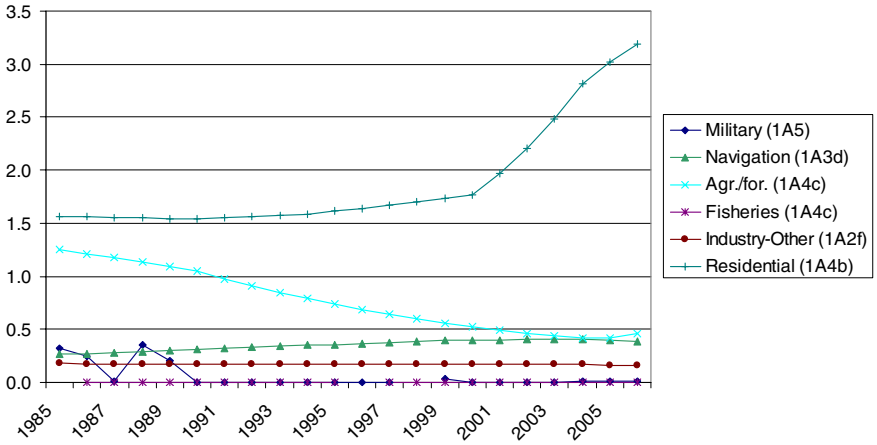


Figure 3.24 Gasoline fuel consumption in CRF sectors for other mobile source 1985-2006

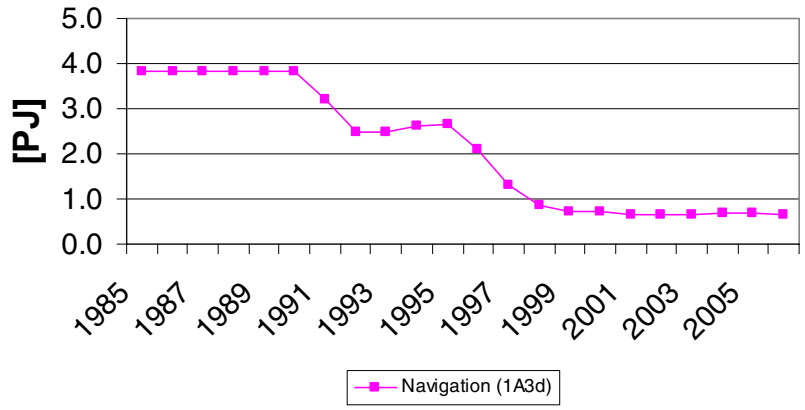


Figure 3.25 Residual oil fuel consumption in CRF sectors for other mobile sources 1985-2006

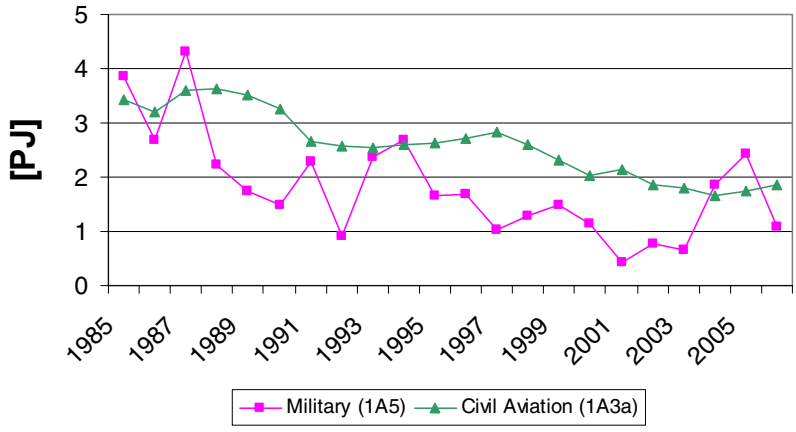


Figure 3.26 Jet fuel consumption in CRF sectors for other mobile sources 1985-2006

In terms of diesel, the fuel consumption decreases for agricultural machines until 2000, due to fewer numbers of tractors and harvesters. After that, the increase in the engine sizes of new sold machines has more than outbalanced the trend towards smaller total stock numbers. The fuel consumption for industry has increased from the beginning of the 1990's,

due to an increase in the activities for construction machinery. The fuel consumption increase has been very pronounced in 2005 and 2006. For fisheries, the development in fuel consumption reflects the activities in this sector.

The Navigation sector comprises national sea transport (fuel consumption between two Danish ports) and recreational craft. For the latter category, fuel consumption has increased significantly from 1990 to 2004 due to the rising number diesel-fuelled private boats. For national sea transport, the diesel fuel consumption curve reflects the combination of traffic and ferries in use for regional ferries. From 1998 to 2000, a significant decline in fuel consumption is apparent. The most important explanation here is the closing of ferry service routes in connection with the opening of the Great Belt Bridge in 1997. For railways, the gradual shift towards electrification explains the lowering trend in diesel fuel consumption and the emissions for this transport sector. The fuel consumed (and associated emissions) to produce electricity is accounted for in the stationary source part of the Danish inventories.

The largest gasoline fuel use is found for household and gardening machinery in the Residential (1A4b) sector. Especially from 2001-2006, a significant fuel consumption increase is apparent due to considerable growth in the machinery stock. The decline in gasoline fuel consumption for Agriculture/forestry/fisheries (1A4c) is due to the gradual phasing out of gasoline-fuelled agricultural tractors.

In terms of residual oil there has been a substantial decrease in the fuel consumption for regional ferries. The fuel consumption decline is most significant from 1990-1992 and from 1997-1999.

The considerable variations from one year to another in military jet fuel consumption are due to planning and budgetary reasons, and the passing demand for flying activities. Consequently, for some years, a certain amount of jet fuel stock-building might disturb the real picture of aircraft fuel consumption. Civil aviation has decreased since the building of the Great Belt Bridge, both in terms of number of flights and total jet fuel consumption.

Bunkers

The residual oil and diesel oil fuel use fluctuations reflect the quantity of fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, transport to Greenland and the Faroe Islands, tank vessels and foreign fishing boats. For jet petrol, the sudden fuel use drop in 2002 is explained by the recession in the air traffic sector due to the events of September 11, 2001 and structural changes in the aviation business.

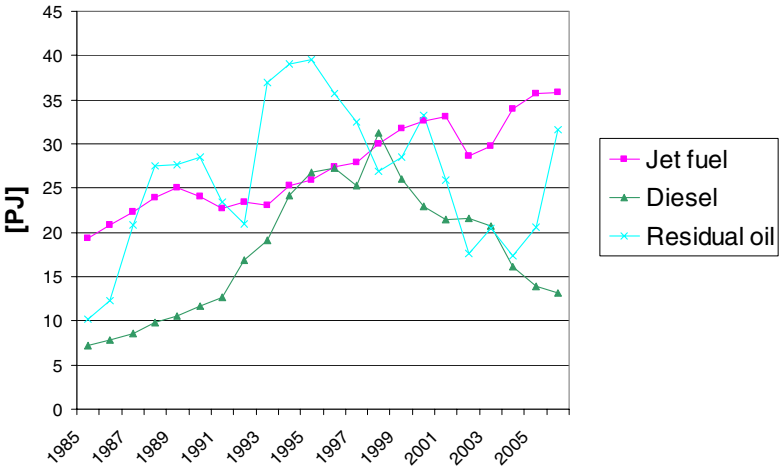


Figure 3.27 Bunker fuel use 1985-2006

Emissions of SO_2, NO_X, NMVOC, CO, NH_3, TSP, PM_{10} and $PM_{2.5}$

In Table 3.18 the SO_2, NO_X, NMVOC, CO NH_3, TSP, PM_{10} and $PM_{2.5}$ emissions for road transport and other mobile sources are shown for 2006 in NFR sectors. For particulate matter (PM; TSP, PM_{10} and $PM_{2.5}$), only the exhaust emission contributions are included in Table 3.18. Non-exhaust TSP, PM_{10} and $PM_{2.5}$ emissions are treated in a separate section below. The emission figures in the time-series 1985-2006 are given in Annex 2.B.15 (NFR format) and are shown for 2006 in Annex 2.B.14 (CollectER format).

From 1985 to 2006, the road transport emissions of SO_2, NO_X, NMVOC, CO and PM (all size fractions) have decreased by 28, 71, 69 and 30%, respectively (Figures 3.28-3.32), whereas the NH_3 emissions have increased by 3065% during the same time period (Figure 3.33).

For other mobile sources, the emission changes for SO_2, NO_X, NMVOC, CO and PM (all size fractions) are -88, -14, -12, -9 and -56%, respectively (Figures 3.35-3.39). The NH_3 emissions have increased by 8% during the same time period (Figure 3.40).

Table 3.18 Emissions of SO_2, NO_X, NMVOC, CO NH_3, TSP, PM_{10} and $PM_{2.5}$ in 2006 for road transport and other mobile sources

NFR ID	SO_2 [tons]	NO_x [tons]	NMVOC [tons]	CO [tons]	NH_3 [tons]	TSP [tons]	PM_{10} [tons]	$PM_{2.5}$ [tons]
Industry-Other (1A2f)	30	10807	1583	7515	2	991	991	991
Civil Aviation (1A3a)	45	596	155	838	0	3	3	3
Railways (1A3c)	1	3542	230	626	1	120	120	120
Navigation (1A3d)	1089	7436	1195	7192	0	291	289	288
Residential (1A4b)	1	275	8037	87744	0	79	79	79
Ag./for./fish. (1A4c)	632	20199	2541	16976	3	1086	1084	1084
Military (1A5)	26	619	56	391	0	21	21	21
Total other mobile	1824	43475	13796	121282	7	2590	2587	2585
Road (1A3b)	79	66993	23171	171521	1951	3101	3101	3101
Total mobile	1904	110468	36967	292803	1958	5691	5688	5687

Road transport

The step-wise lowering of the sulphur content in diesel fuel has given rise to a substantial decrease in the road transport emissions of SO_2 (Fig-

ure 3.28). In 1999, the sulphur content was reduced from 500 ppm to 50 ppm (reaching gasoline levels), and for both gasoline and diesel the sulphur content was reduced to 10 ppm in 2005. Since Danish diesel and gasoline fuels have the same sulphur percentages, at present, the 2006 shares for SO_2 emissions and fuel use for passenger cars, heavy-duty vehicles, light-duty vehicles and 2-wheelers are the same in each case: 50, 27, 22 and 1%, respectively (Figure 3.34).

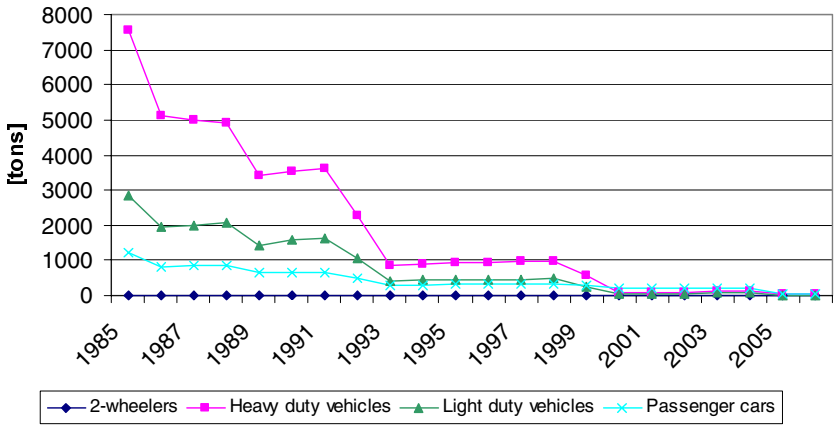


Figure 3.28 SO_2 emissions (tonnes) per vehicle type for road transport 1985-2006

Historically, the emission totals of NMVOC and CO have been very dominated by the contributions coming from private cars, as shown in Figures 3.30-3.31. However, the NMVOC and CO (and NO_x) emissions from this vehicle type have shown a steady decreasing tendency since the introduction of private catalyst cars in 1990 (EURO I) and the introduction of even more emission-efficient EURO II and III private cars (introduced in 1997 and 2001, respectively).

In the case of NO_x, the real traffic emissions for heavy duty vehicles do not follow the reductions as intended by the EU emission legislation. This is due to the so-called engine cycle-beating effect. Outside the legislative test cycle stationary measurement points, the electronic engine control for heavy duty Euro II and III engines switches to a fuel efficient engine running mode, thus leading to increasing NO_x emissions (Figure 3.29).

Exhaust particulate emissions from road transportation vehicles are well below $PM_{2.5}$. The emissions from light- and heavy-duty vehicles have significantly decreased since the mid-1990s due to gradually stricter EURO emission standards. The environmental benefit of introducing diesel private cars with lower particulate emissions since 1990 is more or less outbalanced by an increase in sales of new vehicles in recent years (Figure 3.32).

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of NH_3 from the first two generations of catalyst cars (Euro 1 and 2) compared to conventional cars. The emission factors for later catalytic converter technologies are considerably lower than the ones for Euro 1 and 2, thus causing the emissions to decrease from 2001 onwards (Figure 3.30).

The 2006 emission shares for heavy-duty vehicles, passenger cars, light-duty vehicles and 2-wheelers for NO_x (54, 29, 17 and 0%), NMVOC (7, 63, 13 and 17%), CO (5, 76, 8, 11%), PM (32, 45, 21 and 2%) and NH_3 (1, 95, 4 and 0%), are also shown in Figure 3.34.

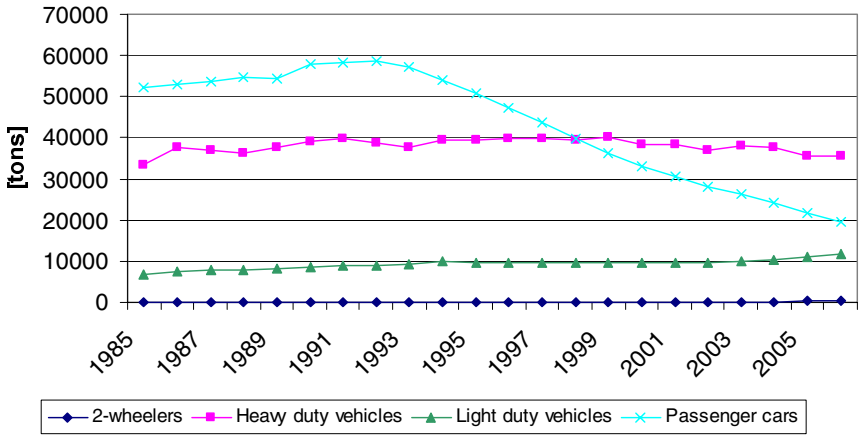


Figure 3.29 NO_X emissions (tonnes) per vehicle type for road transport 1985-2006

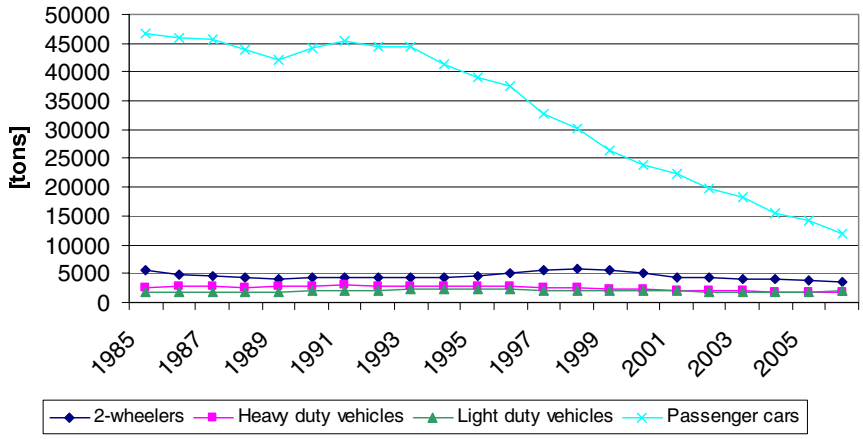


Figure 3.30 NMVOC emissions (tonnes) per vehicle type for road transport 1985-2006

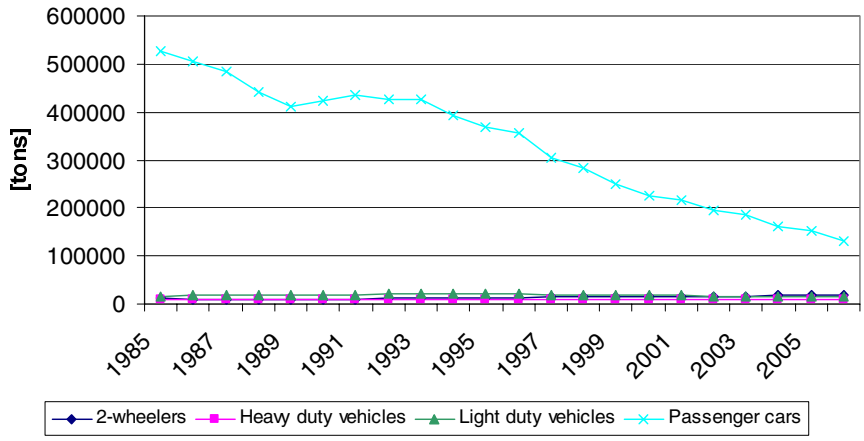


Figure 3.31 CO emissions (tonnes) per vehicle type for road transport 1985-2006

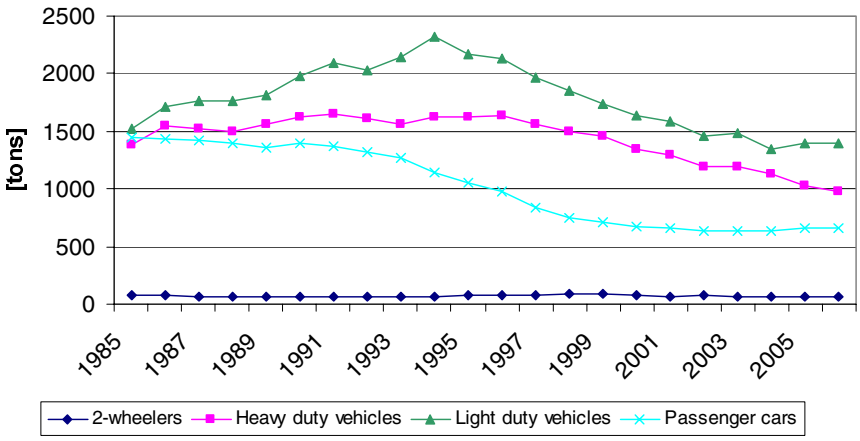


Figure 3.32 PM emissions (tonnes) per vehicle type for road transport 1985-2006

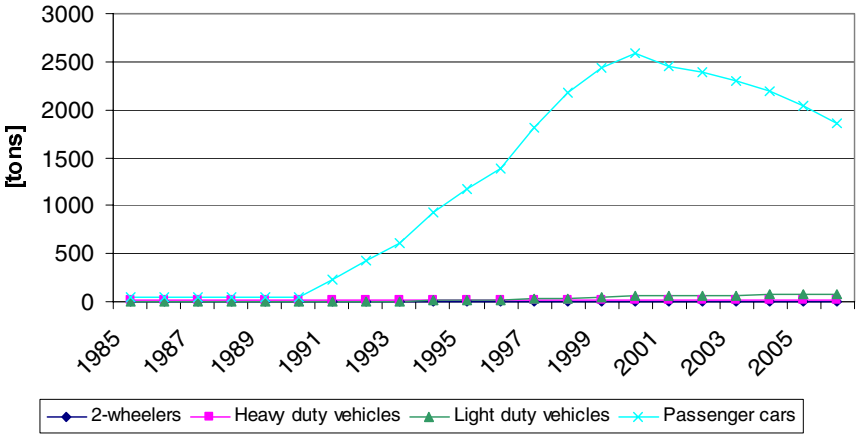


Figure 3.33 NH_3 emissions (tonnes) per vehicle type for road transport 1985-2006

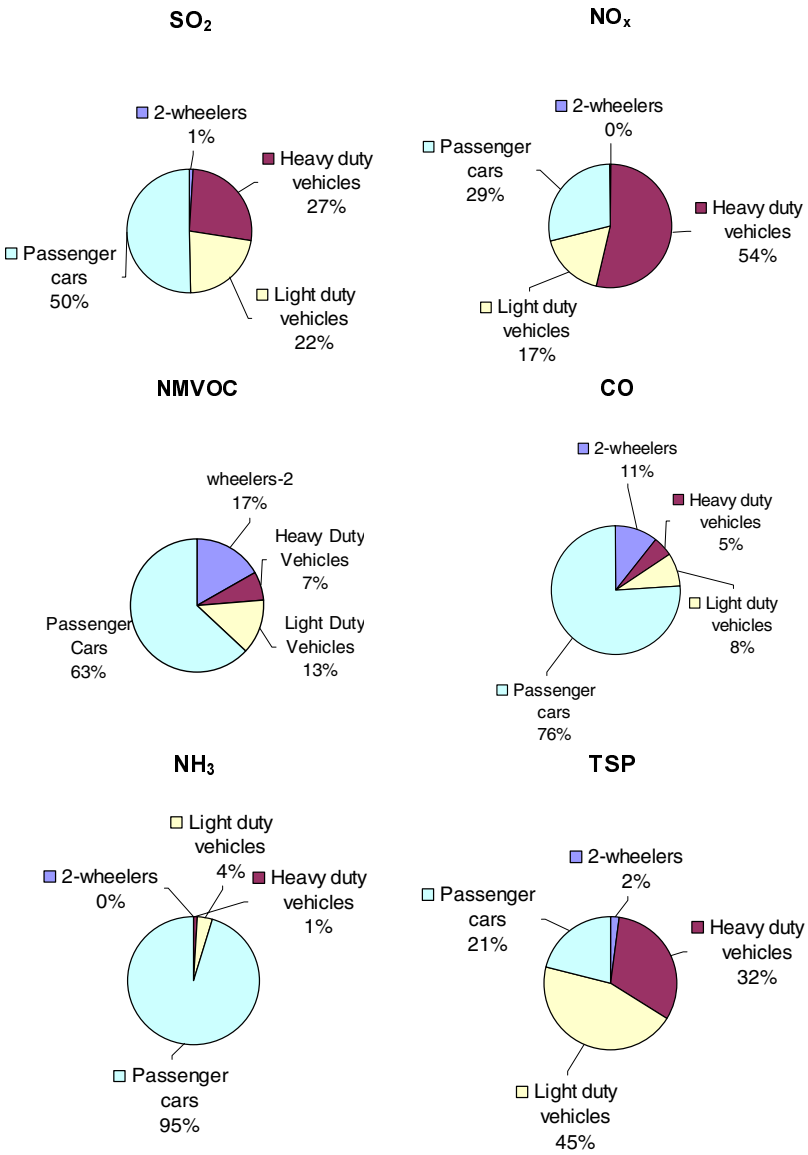


Figure 3.34 SO_2, NO_X, NMVOC, CO, NH_3 and PM emission shares per vehicle type for road transport in 2006

Other mobile sources

For SO_2 the trends in the Navigation (1A3d) emissions shown in Figure 3.35 mainly follow the development of the heavy fuel consumption (Figure 3.25). Though, from 1993 to 1995 relatively higher contents of sulphur in the fuel (estimated from sales) cause a significant increase in the emissions of SO_2. The SO_2 emissions for Fisheries (1A4c) correspond with the development in the consumption of marine gas oil. The main explanation for the development of the SO_2 emission curves for Railways (1A3c) and non-road machinery in Agriculture/forestry (1A4c) and Industry (1A2f), are the stepwise sulphur content reductions for diesel used by machinery in these sectors.

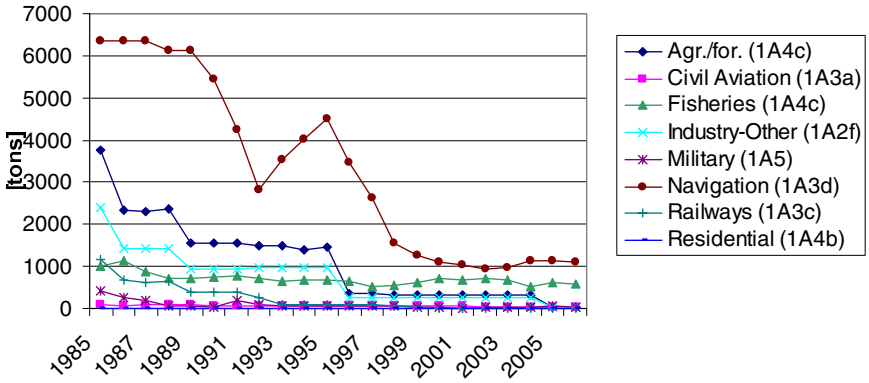


Figure 3.35 SO_2 emissions (k-tonnes) in NFR sectors for other mobile sources 1985-2006

In general, the emissions of NO_X, NMVOC and CO from diesel-fuelled working equipment and machinery in agriculture, forestry and industry have decreased slightly since the end of the 1990s due to gradually strengthened emission standards given by the EU emission legislation directives.

NO_X emissions mainly come from diesel machinery, and the most important sources are Agriculture/forestry/fisheries (1A4c), Industry (1A2f), Navigation (1A3d) and Railways (1A3c), as shown in Figure 3.34. The 2005 emission shares are 47, 25, 17 and 8%, respectively (Figure 3.37). Minor emissions come from the sectors, Civil Aviation (1A3a), Military (1A5) and Residential (1A4b).

The NO_X emission trend for Navigation, Fisheries and Agriculture is determined by fuel use fluctuations for these sectors, and the development of emission factors. For ship engines the emission factors tend to increase for new engines until mid 1990's. After that, the emission factors gradually reduce until 2000, bringing them to a level comparable with the emission limits for new engines in this year. For agricultural machines, there have been somewhat higher NO_x emission factors for 1991-stage I machinery, and an improved emission performance for stage I and II machinery since the late 1990s.

The emission development for industry NO_x is the product of a slight fuel-use increase from 1985 to 2006 and a development in emission factors as explained for agricultural machinery. For railways, the gradual shift towards electrification explains the declining trend in diesel fuel use and NO_X emissions for this transport sector until 2001.

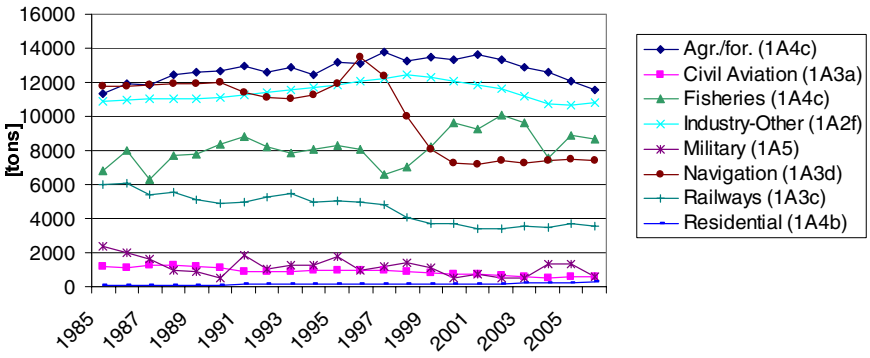


Figure 3.36 NO_X emissions (tonnes) in NFR sectors for other mobile sources 1985-2006

The 1985-2006 time-series of NMVOC and CO emissions are shown in Figures 3.35 and 3.36 for other mobile sources. The 2006 sector emission shares are shown in Figure 3.41. For NMVOC, the most important sectors are Residential (1A4b), Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d), with 2006 emission shares of 58, 19, 11 and 9%, respectively. The same four sectors also contribute with most of the CO emissions in the same consecutive order; the emission shares are 72, 14, 6 and 6%, respectively. Minor NMVOC and CO emissions come from Railways (1A3c), Civil Aviation (1A3a) and Military (1A5).

For NMVOC and CO, the significant emission increases for the residential sector after 2000 are due to the increased number of gasoline working machines. Improved NMVOC emission factors for diesel machinery in agriculture and gasoline equipment in forestry (chain saws) are the most important explanations for the NMVOC emission decline in the Agriculture/forestry/fisheries sector. This explanation also applies for the industrial sector, which is dominated by diesel-fuelled machinery. From 1997 onwards, the NMVOC emissions from Navigation decrease due to the gradually phase-out of the 2-stroke engine technology for recreational craft. The main reason for the significant 1985-2005 CO emission decrease for Agriculture/forestry/fisheries is the phasing out of gasoline tractors.

As shown in Figure 3.41, for other mobile sources the largest TSP contributors in 2006 are Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d), with emission shares of 42, 38 and 11%, respectively. The remaining sectors: Railways (1A3c), Civil aviation (1A3a), Military (1A5) and Residential (1A4b) represent only minor emission sources.

The 1985-2006 TSP emissions for navigation and fisheries are determined by the fuel use fluctuations in these years, and the development of the emission factors, which to a major extent is a function of the fuel sulphur content. The emission development for Agriculture/forestry is determined by the generally decreasing total diesel fuel use and gradually reducing emission factors over the time period.

The TSP emission development for industrial non-road machinery is the product of a slight fuel use increase from 1985 to 2006 and a develop-

ment in emission factors, as explained for agricultural machinery. The TSP emission explanations for railways are the same as for NO_x (Figure 3.36).

The amounts of NH_3 emissions calculated for other mobile sources are very small. The largest emission sources are Agriculture/forestry-/fisheries (1A4c), Industry (1A2f) and Railways (1A3c), with emission shares of 44, 34 and 8%, respectively.

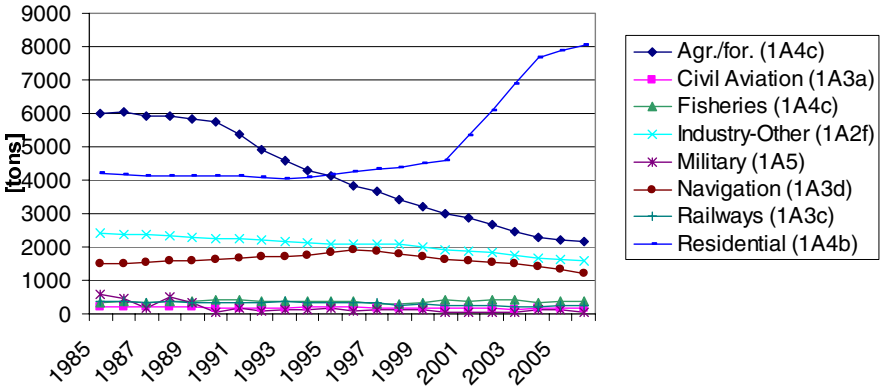


Figure 3.37 NMVOC emissions (tonnes) in NFR sectors for other mobile sources 1985-2006

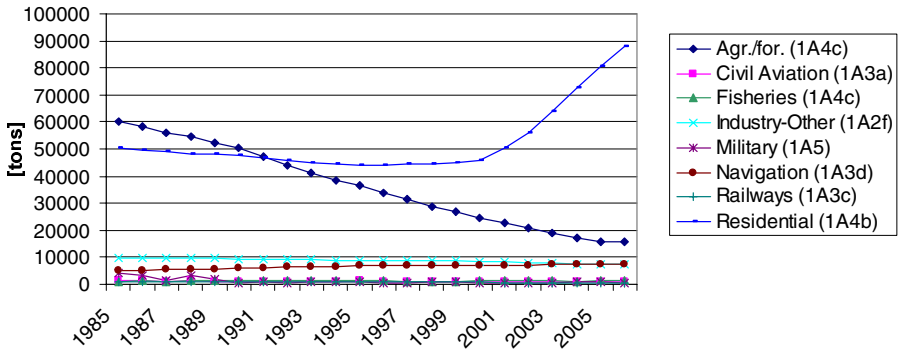


Figure 3.38 CO emissions (tonnes) in NFR sectors for other mobile sources 1985-2006

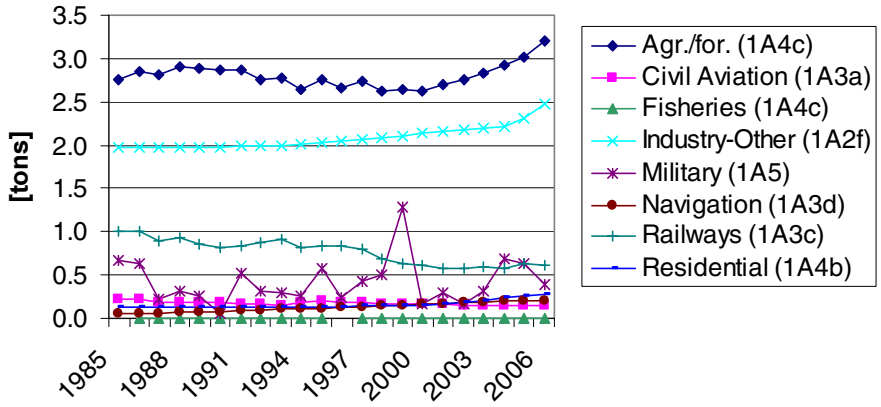


Figure 3.39 NH_3 emissions (tonnes) in NFR sectors for other mobile sources 1985-2006

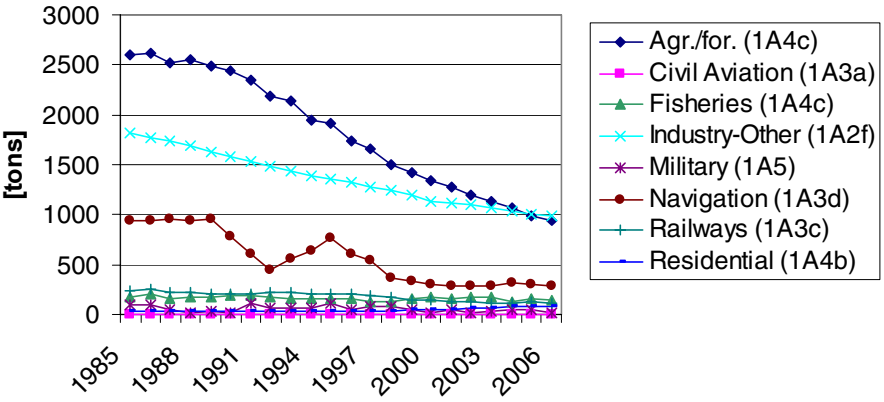


Figure 3.40 TSP emissions (tonnes) in NFR sectors for other mobile sources 1985-2006

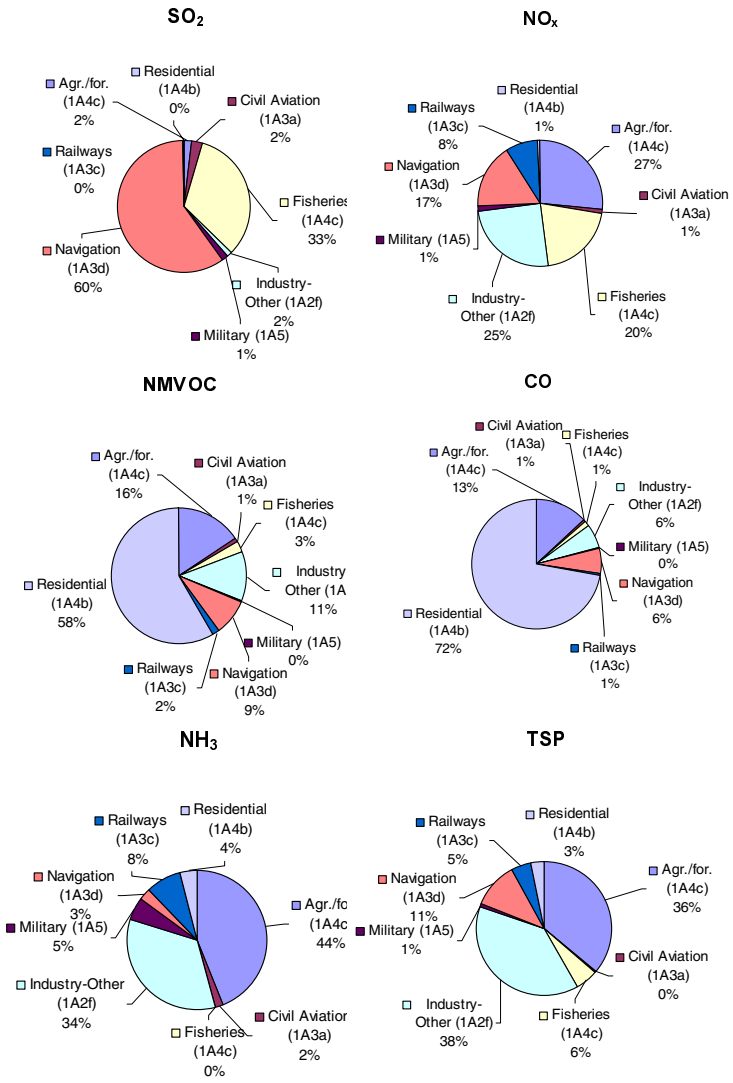


Figure 3.41 SO_2, NO_X, NMVOC, CO, NH_3 and PM emission shares per vehicle type for other mobile sources in 2006

Non-exhaust emissions of TSP, PM_{10} and $PM_{2.5}$

Apart from the exhaust emission estimates of particulate matter (PM), the Danish emission inventories also comprise the non-exhaust PM emissions coming from road transport brake and tyre wear, and road abrasion.

In Table 3.19, the non-exhaust TSP, PM_{10} and $PM_{2.5}$ emissions for road transport are shown for 2006 in NFR sectors. The activity data, emission factors are also shown in Annex 2.B.14.

Table 3.19 Emissions of TSP, PM_{10} and $PM_{2.5}$ in 2006 from road transport and other mobile sources

NFR Sector	TSP [tonnes]	PM_{10} [tonnes]	$PM_{2.5}$ [tonnes]
Road brake wear	623	611	243
Road tyre wear	957	574	402
Road abrasion	1083	542	292
Total Road non-exhaust	2663	1726	937

The respective source category distributions for TSP, PM_{10} and $PM_{2.5}$ emissions are identical for each of the non-exhaust emission type's brake

wear, tyre wear and road abrasion, and, hence, only the PM_{10} distributions are shown in Figure 3.42. For brake and tyre wear, passenger cars caused the highest emissions in 2006, followed by light-duty vehicles, trucks, buses and 2-wheelers. Trucks cause higher road abrasion emissions than light-duty vehicles, but apart from this, the size order of emission sources is the same as for brake and tyre wear.

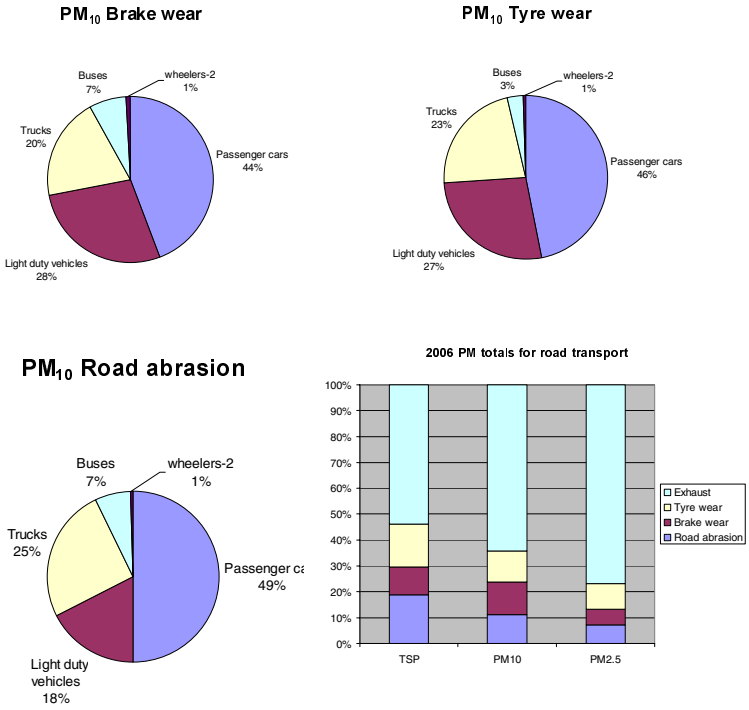


Figure 3.42 Brake and tyre wear and road abrasion PM_{10} emission shares and PM exhaust/non-exhaust distributions for road traffic in 2006

Figure 3.42 also shows the exhaust/non-exhaust distribution of the total particulate emissions from road transport, for each of the size classes TSP, PM_{10} and $PM_{2.5}$. The exhaust emission shares of total road transport TSP, PM_{10} and $PM_{2.5}$ are 54, 64 and 77%, respectively, in 2006. For brake and tyre wear and road abrasion the TSP shares are 11, 17 and 19%, respectively. The same three sources have PM_{10} shares of 13, 12 and 11%, respectively, and $PM_{2.5}$ shares of 6, 10 and 7%, respectively. In general, the non-exhaust shares of total particulate emissions are expected to increase in the future as total exhaust emissions decline. The latter emission trend is due to the stepwise strengthening of exhaust emission standards for all vehicle types.

Heavy metals

In Table 3.20, the heavy metal emissions for road transport and other mobile sources are shown for 2006 in NFR sectors. The emission figures in the time-series 1990-2006 are given in Annex 2.B.15 (NFR format) and are shown for 1990 and 2006 in Annex 2.B.14 (CollectER format).

Table 3.20 Heavy metal emissions in 2005 for road transport and other mobile sources

NFR Sector	As [kg]	Cd [kg]	Cr [kg]	Cu [kg]	Hg [kg]	Ni [kg]	Pb [kg]	Se [kg]	Zn [kg]
Industry-Other (1A2f)		3	15	513		21	0	3	302
Civil Aviation (1A3a)	0	0	2	76	0	3	1245	0	45
Railways (1A3c)		1	4	122		5		1	72
Navigation (1A3d)	13	2	9	67	5	482	13	26	94
Residential (1A4b)		1	4	124		5	2	1	73
Ag./for./fish. (1A4c)	7	5	24	613	7	35	15	33	431
Military (1A5)	0	0	2	68	0	3	47	0	40
Total other mobile	20	12	59	1583	13	555	1322	64	1056
Road (1A3b)		40	199	6750		278	52	40	3971
Total mobile	20	52	257	8334	13	833	1375	104	5027

The road transport emissions of Cd, Cr, Cu and Zn account for around two thirds of the total for all mobile sources in 2006. No road transport emissions occur for As and Hg. Instead, the emissions of these species come from the use of marine diesel oil and residual oil in fisheries and navigation. The latter sector also contributes with a high emission of Ni (from residual oil), whereas the Se emission comes from agriculture/forestry/fisheries, road transport and navigation, in almost equal shares. The Figures 3.43 and 3.44 show the heavy metal emission distributions into vehicle categories and other mobile sectors, respectively.

The heavy metal emission factors are fuel related, and are taken from the EMEP/CORINAIR guidebook. The emission factors are constant throughout the 1990-2006 periods, except for Pb where national data exists. For road transport, the emission factors for Cd, Cu, Ni, Se and Zn are the same for gasoline and diesel, and hence the emission distributions between vehicle categories are the same as for total fuel consumption contribution. The emission distributions for Cr and Pb are caused by higher emission factors for gasoline than for diesel (Cr), and no diesel related emissions (for Pb)

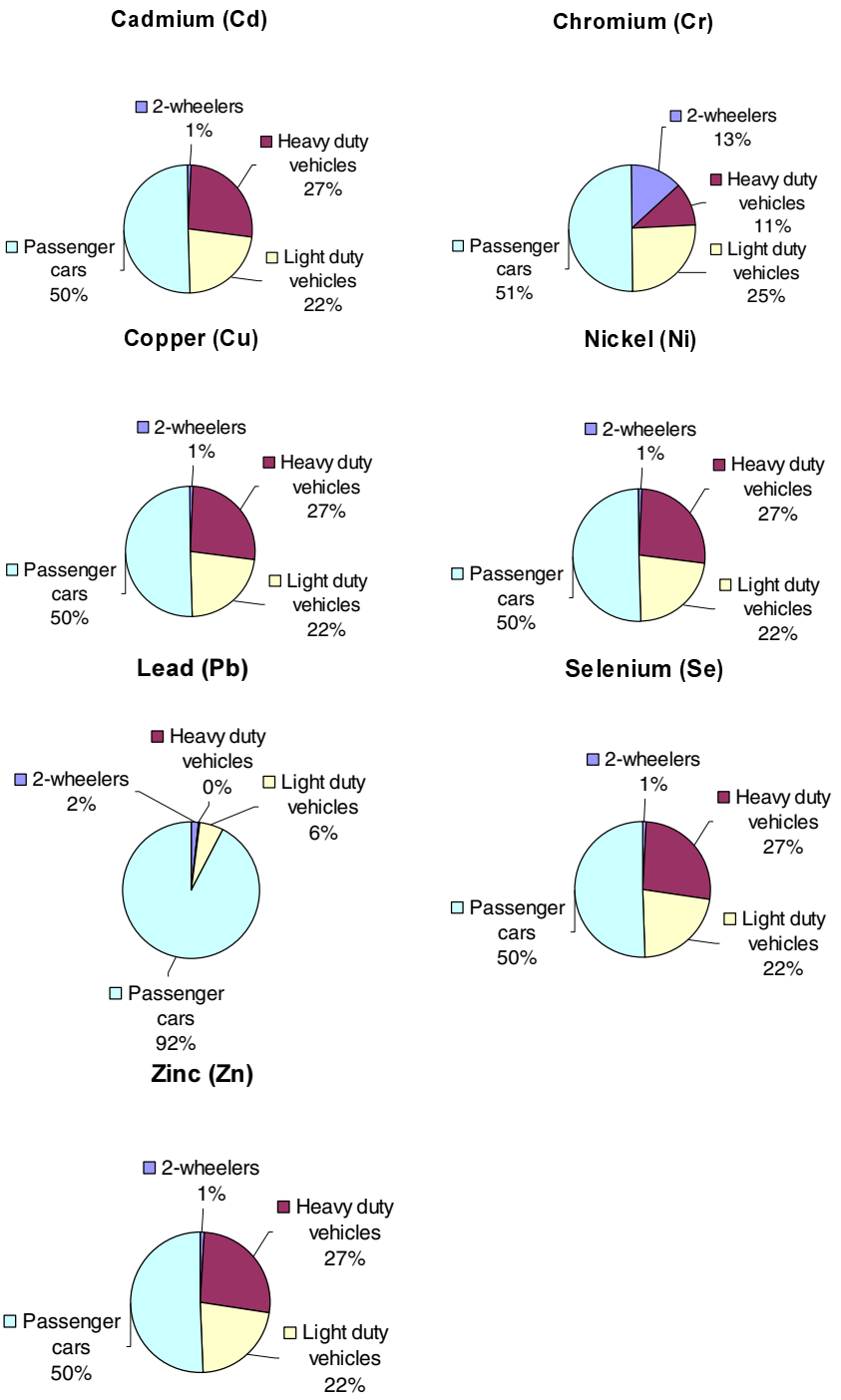


Figure 3.43 Heavy metal emission shares for road transport in 2006

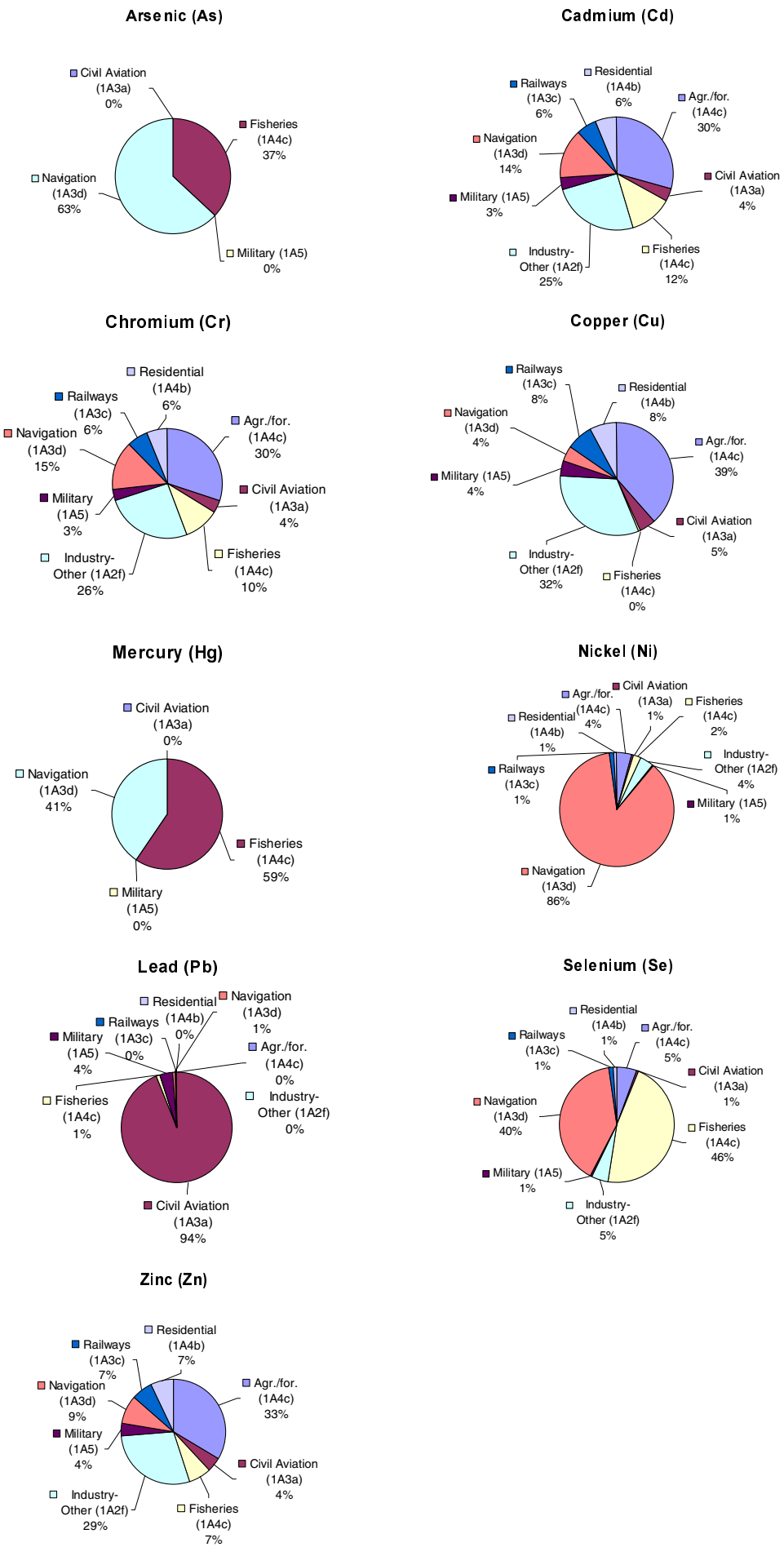


Figure 3.44 Heavy metal emission shares for other mobile sources in 2006

Since the heavy metal emission factors (except Pb) are constant throughout the 1990-2006 periods, as a consequence, the emission development follows the trends in fuel use. The road transport emissions have increased by 36% from 1990 to 2006. For Pb, however, there has been an almost 100% emission decline, due to the phasing out of leaded gasoline fuels in 1994 (Figure 3.45).

For other mobile sources, heavy metal emissions generally decrease throughout the time period. The gasoline used by road transportation vehicles and non road engines is the same, and hence a large decrease in Pb emissions (79%) is calculated for other mobile sources also. In absolute figures, the largest emission declines are noted for the main gasoline fuel consumers, household and gardening equipment and recreational craft. In addition, from 1990 to 2006, gasoline fuel use reached zero for agricultural tractors. Lead is added to aviation gasoline used by piston engine aircraft, causing Civil aviation (1A3a) to be the largest mobile source of Pb emissions (Figure 3.46). The 81% decline in Ni emissions is due to lower residual fuel use in navigation.

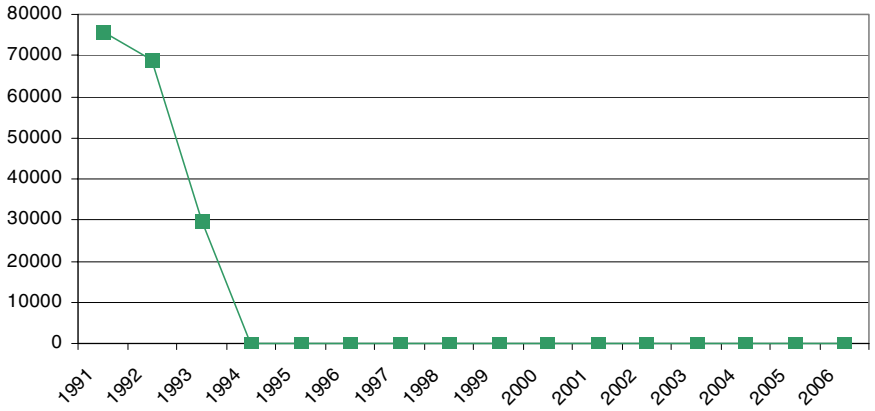


Figure 3.45 Pb emissions (kg) in NFR sectors for road transport 1990-2006

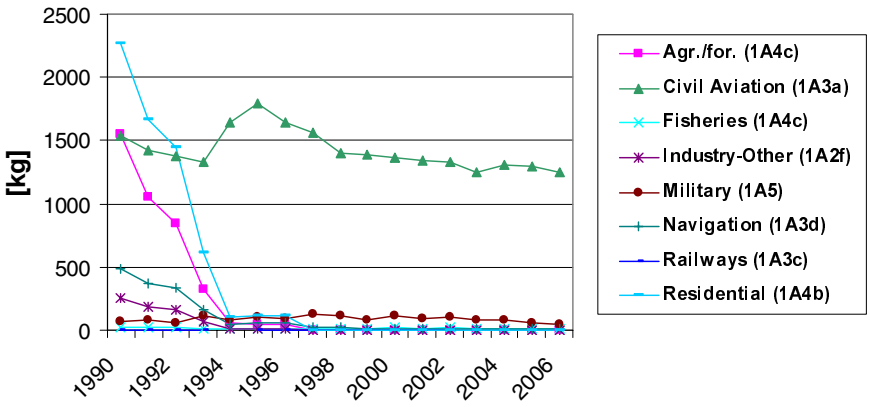


Figure 3.46 Pb emissions (kg) in NFR sectors for other mobile sources 1990-2006

Dioxin and PAH

In Table 3.21, the dioxin and PAH emissions for road transport and other mobile sources are shown for 2006 in NFR sectors. The emission figures in the time-series 1990-2006 are given in Annex 2.B.15 (NFR format) and are shown for 1990 and 2006 in Annex 2.B.14 (CollectER format).

Table 3.21 Dioxin and PAH emissions in 2006 for road transport and other mobile sources

NFR ID	Dioxins/ Furans	Flouranthene	Benzo(b) flouranthene	Benzo(k) flouranthene	Benzo(a) pyrene	Benzo(g,h,i) perylene	Indeno (1,2,3-c,d) pyrene
	[g]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Industry-Other (1A2f)	0.01	56	7	6	3	6	3
Civil Aviation (1A3a)	0.00	0	0	0	0	0	0
Railways (1A3c)	0.00	4	1	1	0	0	0
Navigation (1A3d)	0.06	40	3	2	1	7	5
Residential (1A4b)	0.02	14	1	0	0	2	1
Ag./for./fish. (1A4c)	0.09	114	12	9	5	16	12
Military (1A5)	0.00	3	0	0	0	0	0
Total other mobile	0.18	231	24	19	10	32	21
Road (1A3b)	0.19	712	69	78	53	100	58
Total mobile	0.37	942	92	97	63	132	79

For mobile sources, road transport displays the largest emission of dioxins and PAH. The dioxin emission share for road transport is 51% of all mobile emissions in 2006, whereas Agriculture/forestry/fisheries and Navigation have smaller shares of 24 and 16%. For the different PAH components, road transport shares are around two thirds or more of total emissions for mobile sources. The remaining emissions almost solely come from Agriculture/forestry-/fisheries, Navigation and Industry with Agriculture/forestry/fisheries as the largest source.

The Figures 3.47 and 3.48 show the dioxin and PAH emission distributions into vehicle categories and other mobile sectors, respectively.

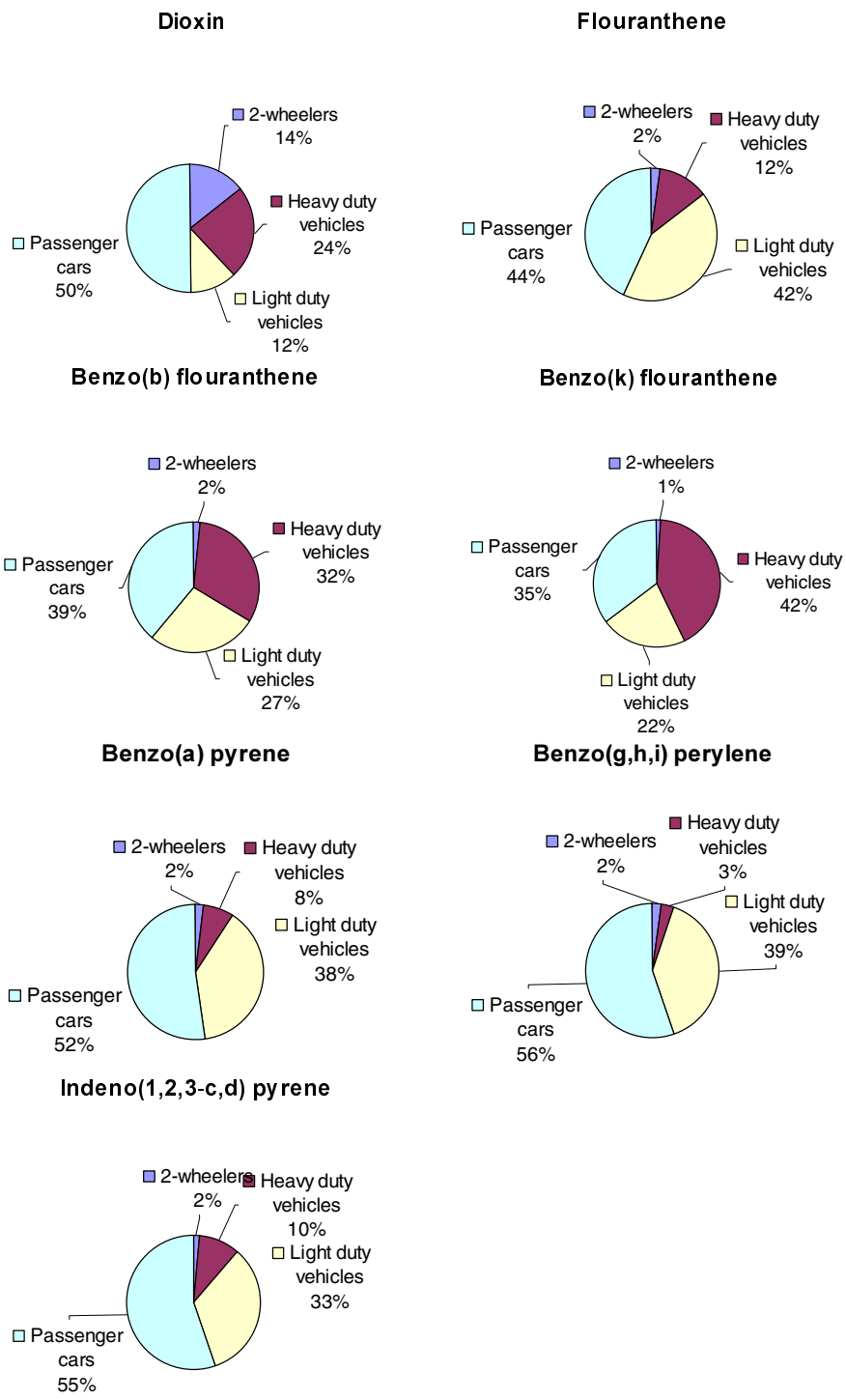


Figure 3.47 Dioxin and PAH emission shares for road transport in 2006

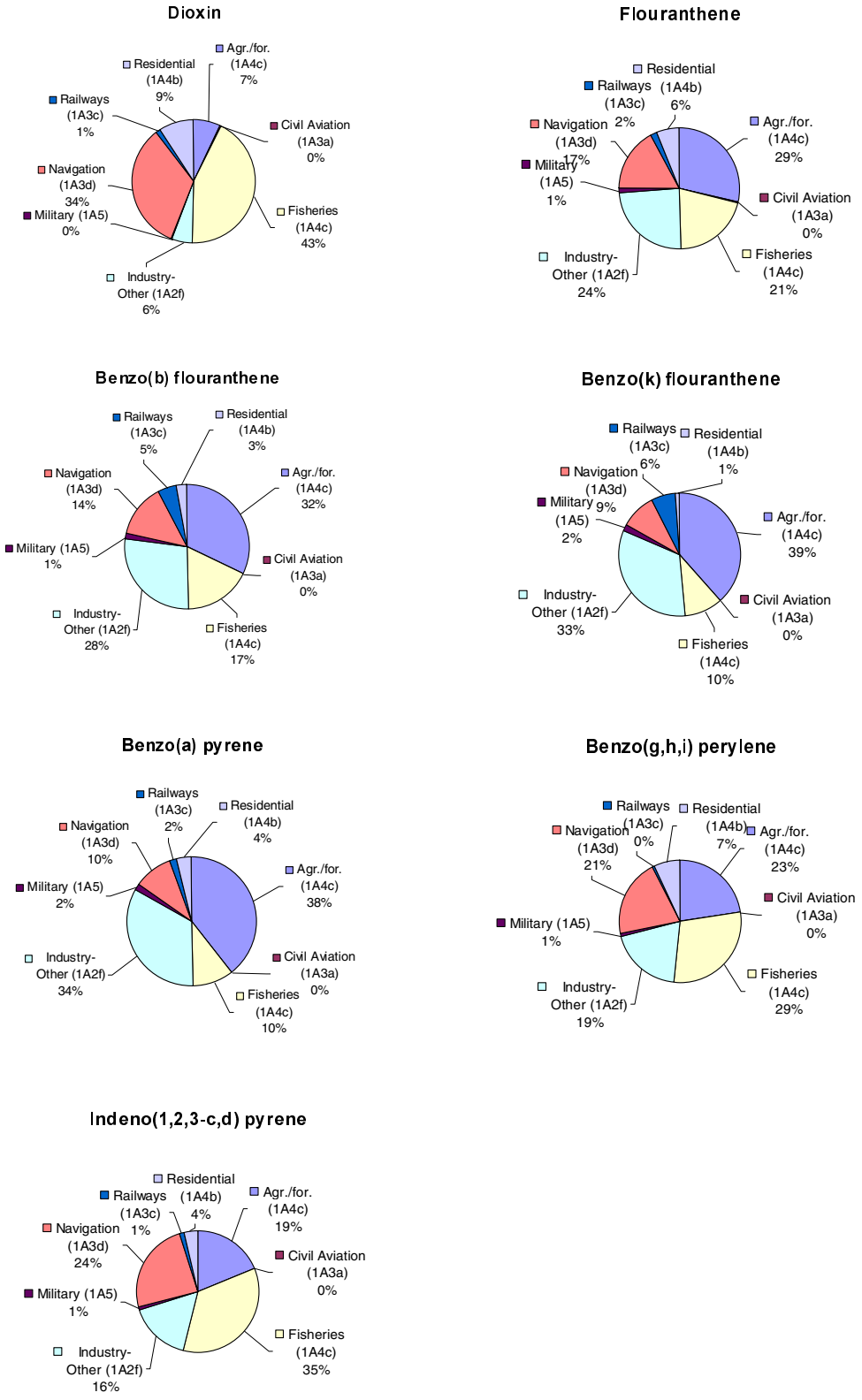


Figure 3.48 Dioxin and PAH emission shares for other mobile sources in 2006

Bunkers

The most important emissions from bunker fuel use (fuel use for international transport) are SO_2, NO_X and CO_2 (and TSP, not shown). However, compared with the Danish national emission total (all sources), the greenhouse gas emissions from bunkers are small. The bunker emission totals are shown in Table 3.22 for 2006, split into sea transport and civil

aviation. All emission figures in the 1985-2006 time-series are given in Annex 2.B.16 (NFR format). In Annex 2.B.14, the emissions are also given in CollectER format for 2006.

The most important emissions from bunker fuel consumption (fuel consumption for international transport) are SO_2, NO_X and CO_2 (and TSP, not shown). However, compared with the Danish national emission total (all sources), the greenhouse gas emissions from bunkers are small. The bunker emission totals are shown in Table 3.22 for 2006, split into sea transport and civil aviation. All emission figures in the 1990-2006 time-series are given in Annex 3.B.15 (CRF format). In Annex 3.B.14, the emissions are also given in CollectER format for 2006.

Table 3.22 Emissions in 2006 for international transport and national totals

CRF sector	SO_2 [tonnes]	NO_X [tonnes]	NMVOC [tonnes]	CH_4 [tonnes]	CO [tonnes]	CO_2 [k-tonnes]	N_2O [tonnes]
Navigation int. (1A3d)	52936	84716	2643	82	8719	3433	216
Civil Aviation int. (1A3a)	825	11175	492	52	1871	2583	89
International total	53761	95891	3135	134	10589	6016	305

The differences in emissions between navigation and civil aviation are much larger than the differences in fuel consumption (and derived CO_2 emissions), and display a poor emission performance for international sea transport. In broad terms, the emission trends shown in Figure 3.49 are similar to the fuel-use development.

However, for navigation minor differences occur for the emissions of SO_2, NO_X and CO_2 due to varying amounts of marine gas oil and residual oil, and for SO_2 and NO_X the development in the emission factors also have an impact on the emission trends. For civil aviation, apart from the annual consumption of jet fuel, the development of the NO_X emissions is also due to yearly variations in LTO/aircraft type (earlier than 2001) and city-pair statistics (2001 onwards).

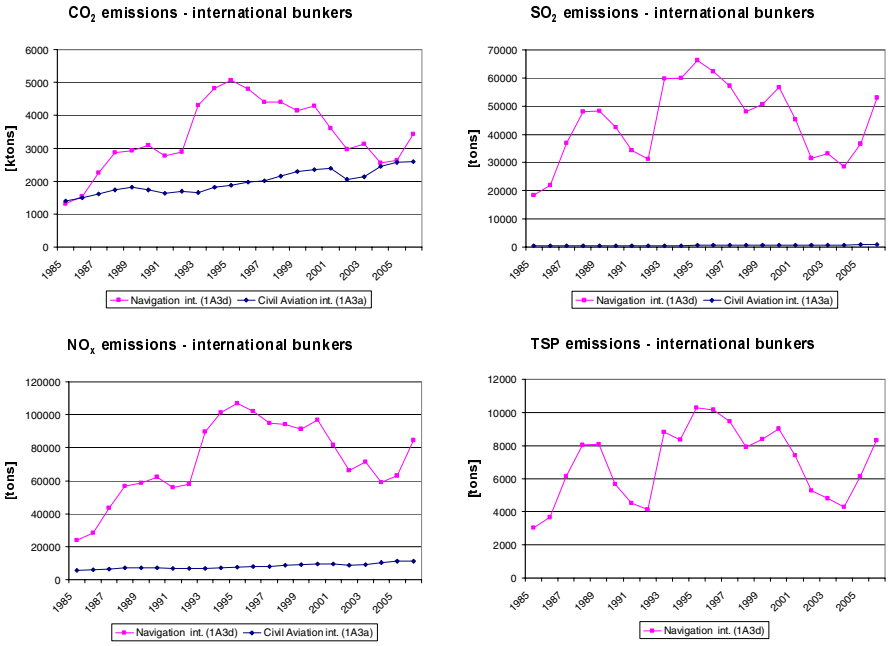


Figure 3.49 CO_2, SO_2, NO_X and TSP emissions for international transport 1990-2006

3.3.2 Methodological issues

The description of methodologies and references for the transport part of the Danish inventory is given in two sections: one for road transport and one for the other mobile sources.

Methodology and references for Road Transport

For road transport, the detailed methodology is used to make annual estimates of the Danish emissions, as described in the EMEP/CORINAIR Emission Inventory Guidebook (EMEP/CORINAIR, 2007). The actual calculations are made with a model developed by NERI, using the European COPERT III model methodology, and updated fuel use and emission factors from the latest version of COPERT - COPERT IV. The latter model approach is explained in (EMEP/CORINAIR, 2007). In COPERT, fuel use and emission simulations can be made for operationally hot engines, taking into account gradually stricter emission standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated.

Vehicle fleet and mileage data

Corresponding to the COPERT III fleet classification, all present and future vehicles in the Danish fleet are grouped into vehicle classes, subclasses and layers. The layer classification is a further division of vehicle sub-classes into groups of vehicles with the same average fuel use and emission behaviour, according to EU emission legislation levels. Table 3.23 gives an overview of the different model classes and sub-classes, and the layer level with implementation years are shown in Annex 2.B.1.

Table 3.23 Model vehicle classes and sub-classes, trip speeds and mileage split

			Trip speed [km/h]			Mileage split [%]		
Vehicle classes	Fuel type	Engine size/weight	Urban	Rural	Highway	Urban	Rural	Highway
PC	Gasoline	< 1.4 l.	40	70	100	35	46	19
PC	Gasoline	1.4 – 2 l.	40	70	100	35	46	19
PC	Gasoline	> 2 l.	40	70	100	35	46	19
PC	Diesel	< 2 l.	40	70	100	35	46	19
PC	Diesel	> 2 l.	40	70	100	35	46	19
PC	LPG		40	70	100	35	46	19
PC	2-stroke		40	70	100	35	46	19
LDV	Gasoline		40	65	80	35	50	15
LDV	Diesel		40	65	80	35	50	15
Trucks	Gasoline		35	60	80	32	47	21
Trucks	Diesel	3.5 – 7.5 tonnes	35	60	80	32	47	21
Trucks	Diesel	7.5 – 16 tonnes	35	60	80	32	47	21
Trucks	Diesel	16 – 32 tonnes	35	60	80	19	45	36
Trucks	Diesel	> 32 tonnes	35	60	80	19	45	36
Urban buses	Diesel		30	50	70	51	41	8
Coaches	Diesel		35	60	80	32	47	21
Mopeds	Gasoline		30	30	-	81	19	0
Motorcycles	Gasoline	2 stroke	40	70	100	47	39	14
Motorcycles	Gasoline	< 250 cc.	40	70	100	47	39	14
Motorcycles	Gasoline	250 – 750 cc.	40	70	100	47	39	14
Motorcycles	Gasoline	> 750 cc.	40	70	100	47	39	14

New total mileage data for passenger cars, light duty trucks, heavy duty trucks and buses produced by the Danish vehicle inspection programme is used for the years 1990-2004. For 2005, total mileage data is provided by the Danish Road Directorate in a format similar to the 1990-2004 format (Foldager, 2007). For 2006, the information for 2005 is used, due to lack of data.

The new Danish mileage data is distributed into annual mileage per first registration year for the different vehicle categories in the inventory, by using the baseline vehicle stock and annual mileage information obtained from the Danish Road Directorate (Ekman, 2005). Fleet numbers in total vehicle categories for 2006 has been obtained from Statistics Denmark (Dalbro, 2007), and data are split into vehicle categories-first registration years, by using the 2004 distribution matrix.

The data set from Ekman (2005) which underpinned the Danish 2004 emission inventory, covers data for the number of vehicles and annual mileage per first registration year for all vehicle sub-classes, and mileage split between urban, rural and highway driving, and the respective average speeds. Additional data for the moped fleet and motorcycle fleet disaggregation information is given by The National Motorcycle Association (Markamp, 2007).

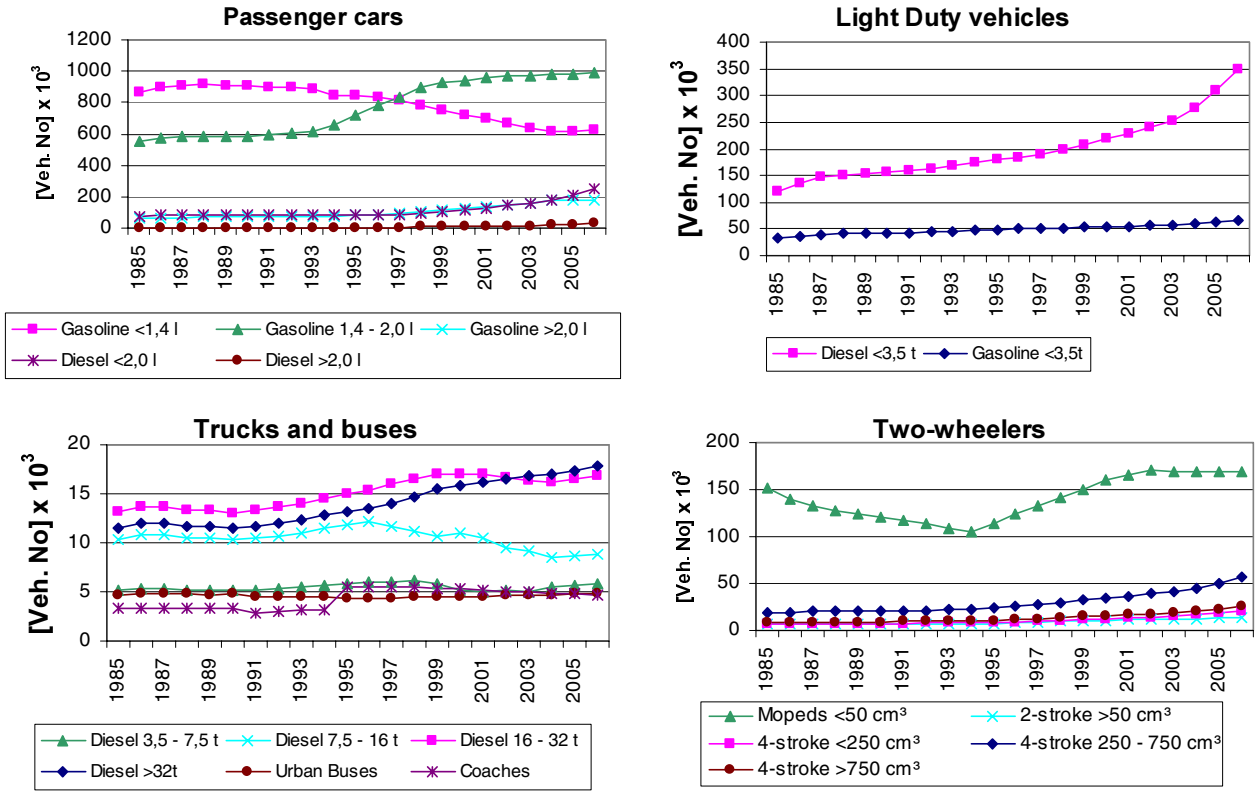


Figure 3.50 Number of vehicles in sub-classes in 1985-2006

The vehicle numbers per sub-class are shown in Figure 3.50. It must be noted that for 2005 and 2006, the 2004 stock shares are used to distribute the fleet into the different vehicle sub-categories for passenger cars and heavy duty trucks. Consequently, it gives less meaning to explain the fleet curves beyond 2004 for these vehicle types.

For passenger cars, the engine size differentiation is associated with some uncertainty. The increase in the total number of passenger cars is mostly due to a growth in the number of gasoline cars with engine sizes between 1.4 and 2 litres (from 1990-2002) and an increase in the number of gasoline cars (>2 litres) and diesel cars (< 2 litres). In the later years, there has been a decrease in the number of cars with an engine size smaller than 1.4 litres.

There has been a considerable growth in the number of diesel light-duty vehicles from 1985 to 2005. The two largest truck sizes have also increased in numbers during the 1990s. From 2000 onwards, this growth has continued for trucks larger than 32 tonnes, whereas the number of trucks with gross vehicle weights between 16 and 32 tonnes has decreased slightly.

The number of urban buses has been almost constant between 1985 and 2006. The sudden change in the level of coach numbers from 1994 to 1995 is due to uncertain fleet data.

The reason for the significant growth in the number of mopeds from 1994 to 2002 is the introduction of the so-called Moped 45 vehicle type. For motorcycles, the number of vehicles has grown in general through-

out the entire 1985-2005 period. The increase is, however, most visible from the mid-1990s and onwards.

The vehicle numbers are summed up in layers for each year (Figure 3.51) by using the correspondence between layers and first year of registration:

$$N_{j,y} = \sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \quad (1)$$

Where N = number of vehicles, j = layer, y = year, i = first year of registration.

Weighted annual mileages per layer are calculated as the sum of all mileage driven per first registration year divided by the total number of vehicles in the specific layer.

$$M_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y}} \quad (2)$$

Vehicle numbers and weighted annual mileages per layer are shown in Annex 2.B.1 and 3.B.2 for 1985-2006. The trends in vehicle numbers per layer are also shown in Figure 3.51. The latter figure shows how vehicles complying with the gradually stricter EU emission levels (EURO I, II, III, IV etc.) have been introduced into the Danish motor fleet.

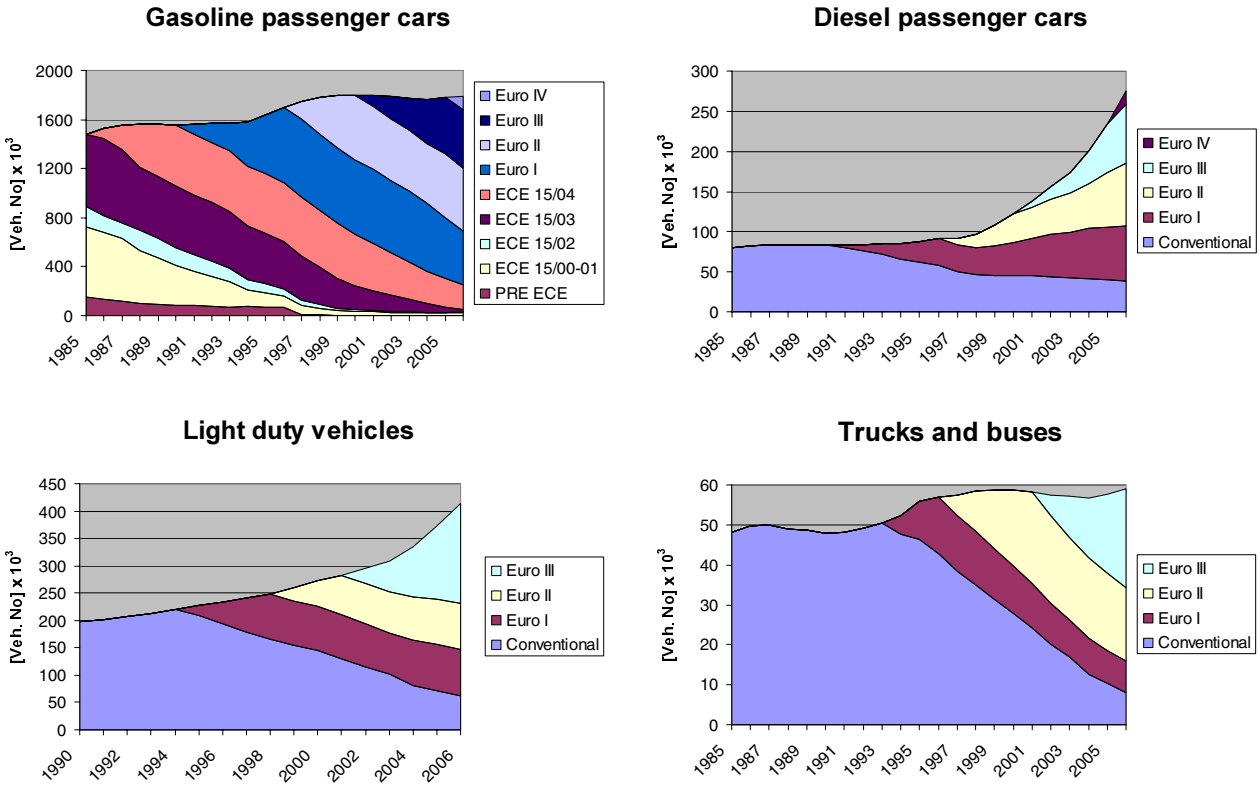


Figure 3.51 Layer distribution of vehicle numbers per vehicle type in 1985-2006

Emission legislation

For Euro 1-4 passenger cars and light duty trucks, the chassis dynamometer test cycle used in the EU for emission approval is the NEDC (New European Driving Cycle), see Nørgaard and Hansen (2004). The test cycle is also used also for fuel use measurements. The NEDC cycle consists of two parts, the first part being a 4-time repetition (driving length: 4 km) of the ECE test cycle. The latter test cycle is the so-called urban driving cycle[2] (average speed: 19 km/h). The second part of the test is the run-through of the EUDC (Extra Urban Driving Cycle) test driving segment, simulating the fuel use under rural and highway driving conditions. The driving length of EUDC is 7 km at an average speed of 63 km/h. More information regarding the fuel measurement procedure can be found in the EU-directive 80/1268/EØF.

For NOx, VOC (NMVOC + CH4), CO and PM, the emissions from road transport vehicles have to comply with the different EU directives listed in Table 3.24. The emission directives distinguish between three vehicle classes according to vehicle reference mass[3]: Passenger cars and light duty trucks (<1305 kg), light duty trucks (1305-1760 kg) and light duty trucks (>1760 kg).The specific emission limits are shown in Annex 2.B.3.

[2] For Euro 3 and on, the emission approval test procedure was slightly changed. The 40 s engine warm up phase before start of the urban driving cycle was removed.

[3] Reference mass: net vehicle weight + mass of fuel and other liquids + 100 kg.

Table 3.24 Simplified overview of the existing EU emission directives for road transport vehicles

Vehicle category	Emission layer	EU directive	First reg. year Start
Passenger cars (gasoline)	PRE ECE		0
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1991[e]
	Euro II	94/12	1997
	Euro III	98/69	2001
	Euro IV	98/69	2006
	Euro V	715/2007	2011
	Euro VI	715/2007	2015
Passenger cars (diesel and LPG)		Conventional	0
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1991[e]
	Euro II	94/12	1997
	Euro III	98/69	2001
	Euro IV	98/69	2006
	Euro V	715/2007	2011
	Euro VI	715/2007	2015
Light duty trucks (gasoline and diesel)		Conventional	0
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	93/59	1995
	Euro II	96/69	1999
	Euro III	98/69	2002
	Euro IV	98/69	2007
	Euro V	715/2007	2012
	Euro VI	715/2007	2016
Heavy duty vehicles		Conventional	0
	Euro 0	88/77	1991
	Euro I	91/542	1994
	Euro II	91/542	1997
	Euro III	1999/96	2002
	Euro IV	1999/96	2007
	Euro V	1999/96	2010
Mopeds		Conventional	0
	Euro I	97/24	2000
	Euro II	2002/51	2004
Motor cycles		Conventional	0
	Euro I	97/24	2000
	Euro II	2002/51	2004

a,b,c,d: Expert judgement suggest that Danish vehicles enter into the traffic before EU directive first registration dates. The effective inventory starting years are a: 1970; b: 1979; c: 1981; d: 1986.
e: The directive came into force in Denmark in 1991 (EU starting year: 1993).

In practice, the emissions from vehicles in traffic are different from the legislation limit values and, therefore, the latter figures are considered to

be too inaccurate for total emission calculations. A major constraint is that the emission approval test conditions reflect only to a small degree the large variety of emission influencing factors in the real traffic situation, such as cumulated mileage driven, engine and exhaust after treatment maintenance levels and driving behaviour.

Therefore, in order to represent the Danish fleet and to support average national emission estimates, emission factors must be chosen which derive from numerous emissions measurements, using a broad range of real world driving patterns and a sufficient number of test vehicles. It is similar important to have separate fuel use and emission data for cold-start emission calculations and gasoline evaporation (hydrocarbons).

For heavy-duty vehicles (trucks and buses), the emission limits are given in g/kWh and the measurements are carried out for engines in a test bench, using the EU ESC (European Stationary Cycle) and ETC (European Transient Cycle) test cycles, depending on the Euro norm and exhaust gas after-treatment system installed. A description of the test cycles is given by Nørgaard and Hansen, 2004). Measurement results in g/kWh from emission approval tests cannot be directly used for inventory work. Instead, emission factors used for national estimates must be transformed into g/km, and derived from a sufficient number of measurements which represent the different vehicle size classes, Euro engine levels and real world variations in driving behaviour.

In terms of the sulphur content in the fuels used by road transportation vehicles, the EU directive 2003/17/EF describes the fuel quality standards agreed by the EU. In Denmark, the sulphur content in gasoline and diesel was reduced to 10 ppm in 2005, by means of a fuel tax reduction for fuels with 10 ppm sulphur contents.

Fuel consumption and emission factors

Trip-speed dependent basis factors for fuel consumption and emissions are taken from the COPERT model using trip speeds as shown in Table 3.23. The factors are listed in Annex 2.B.4. For EU emission levels not represented by actual data, the emission factors are scaled according to the reduction factors given in Annex 2.B.5.

The fuel consumption and emission factors used in the Danish inventory come from the COPERT IV model. The scientific basis for COPERT IV is fuel consumption and emission information from the European 5th framework research projects ARTEMIS and Particulates. In cases where no updates are made for vehicle categories and fuel consumption/emission components, COPERT IV still uses COPERT III data; the source for these data are various European measurement programmes. In general the COPERT data are transformed into trip-speed dependent fuel consumption and emission factors for all vehicle categories and layers.

For passenger cars, real measurement results are behind the emission factors for Euro 1-4 vehicles (updated figures), and those earlier (COPERT III data). For light duty trucks the measurements represent Euro 1 and prior vehicle technologies from COPERT III. For mopeds and motorcycles, updated fuel consumption and emission figures are behind the conventional and Euro 1-3 technologies.

The experimental basis for heavy-duty trucks and buses is updated computer simulated emission factors for Euro 0-V engines. In COPERT IV the number of heavy duty vehicle categories has increased substantially, and from the traffic data side it is not possible to support all these new vehicle categories with consistent fleet and mileage data. Thus, the COPERT III vehicle size classification still remains as the Danish inventory basis for heavy duty vehicles.

However, in order to use the new COPERT IV fuel consumption and emission information, the decision is to calculate average fuel consumption and emission factors per technology level (Euro O-V) from COPERT IV. The average factors comprise the specific COPERT IV size categories in overlap with a given COPERT III size category. Next, these average COPERT IV factors are scaled with the ratio of fuel consumption factors between COPERT III and "average COPERT IV" in order to end up with vehicle sizes corresponding to COPERT III weight classes.

For all vehicle categories/technology levels not represented by measurements, the emission factors are produced by using reduction factors. The latter factors are determined by assessing the EU emission limits and the relevant emission approval test conditions, for each vehicle type and Euro class.

Deterioration factors

For three-way catalyst cars the emissions of NO_X, NMVOC and CO gradually increase due to catalyst wear and are, therefore, modified as a function of total mileage by the so-called deterioration factors. Even though the emission curves may be serrated for the individual vehicles, on average, the emissions from catalyst cars stabilise after a given cut-off mileage is reached due to OBD (On Board Diagnostics) and the Danish inspection and maintenance programme.

For each forecast year, the deterioration factors are calculated per first registration year by using deterioration coefficients and cut-off mileages, as given in EMEP/CORINAIR (2007), for the corresponding layer. The deterioration coefficients are given for the two driving cycles: ”Urban Driving Cycle” (UDF) and ”Extra Urban Driving Cycle” (EUDF: urban and rural), with trip speeds of 19 and 63 km/h, respectively.

Firstly, the deterioration factors are calculated for the corresponding trip speeds of 19 and 63 km/h in each case determined by the total cumulated mileage less than or exceeding the cut-off mileage. The Formulas 3 and 4 show the calculations for the ”Urban Driving Cycle”:

$$UDF = U_A \cdot MTC + U_B \text{ , MTC} < U_{MAX} \quad (3)$$

$$UDF = U_A \cdot U_{MAX} + U_B \text{ , MTC} >= U_{MAX} \quad (4)$$

where UDF is the urban deterioration factor, U_A and U_B the urban deterioration coefficients, MTC = total cumulated mileage and U_{MAX} urban cut-off mileage.

In the case of trip speeds below 19 km/h the deterioration factor, DF, equals UDF, whereas for trip speeds exceeding 63 km/h, DF=EUDF. For trip speeds between 19 and 63 km/h the deterioration factor, DF, is

found as an interpolation between UDF and EUDF. Secondly, the deterioration factors, one for each of the three road types, are aggregated into layers by taking into account vehicle numbers and annual mileage levels per first registration year:

$$DF_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y}} \quad (5)$$

where DF is the deterioration factor.

For NH_3, COPERT IV takes into account deterioration as a linear function of mileage for gasoline fuelled EURO 1-4 passenger cars and light duty vehicles. The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/CORINAIR (2007), for the corresponding layer. A cut-off mileage of 120.000 km (pers. comm. Ntziachristos, 2007) is behind the calculation of the modified emission factors, and for the Danish situation the low sulphur level interval is assumed to be most representative.

Emissions and fuel consumption for hot engines

Emissions and fuel-use results for operationally hot engines are calculated for each year and for layer and road type. The procedure is to combine fuel consumption and emission factors (and deterioration factors for catalyst vehicles), number of vehicles, annual mileage levels and the relevant road-type shares given in Table 3.23. For non-catalyst vehicles this yields:

$$E_{j,k,y} = EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \quad (6)$$

Here E = fuel consumption/emission, EF = fuel consumption/emission factor, S = road type share and k = road type.

For catalyst vehicles the calculation becomes:

$$E_{j,k,y} = DF_{j,k,y} \cdot EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \quad (7)$$

Extra emissions and fuel consumption for cold engines

Extra emissions of NO_X, VOC, CH_4, CO, PM, NH_3 and fuel consumption from cold start are simulated separately. For SO_2, the extra emissions are derived from the cold start fuel consumption results.

In terms of cold start data for NO_X, VOC, CO, PM and fuel consumption no updates are made to the COPERT IV methodology, and the calculation approach is the same as in COPERT III. Each trip is associated with a certain cold-start emission level and is assumed to take place under urban driving conditions. The number of trips is distributed evenly across the months. First, cold emission factors are calculated as the hot emission factor times the cold:hot emission ratio. Secondly, the extra emission factor during cold start is found by subtracting the hot emission factor from the cold emission factor. Finally, this extra factor is applied on the frac-

tion of the total mileage driven with a cold engine (the β-factor) for all vehicles in the specific layer.

The cold:hot ratios depend on the average trip length and the monthly ambient temperature distribution. The Danish temperatures for 2006, 2005 and 2004 are given in Cappelen et al. (2007, 2006, 2005). For 2000-2003, 1990-1999 and 1980-1989 the temperature data are from Cappelen (2004, 2000 and 2003). The cold:hot ratios are equivalent for gasoline fuelled conventional passenger cars and vans and for diesel passenger cars and vans, respectively, see Ntziachristos et al. (2000). For conventional gasoline and all diesel vehicles the extra emissions become:

$$CE_{j,y} = \beta \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr - 1) \quad (8)$$

Where CE is the cold extra emissions, β = cold driven fraction, CEr = Cold:Hot ratio.

For catalyst cars, the cold:hot ratio is also trip speed dependent. The ratio is, however, unaffected by catalyst wear. The Euro I cold:hot ratio is used for all future catalyst technologies. However, in order to comply with gradually stricter emission standards, the catalyst light-off temperature must be reached in even shorter periods of time for future EURO standards. Correspondingly, the β-factor for gasoline vehicles is reduced step-wise for Euro II vehicles and their successors.

For catalyst vehicles the cold extra emissions are found from:

$$CE_{j,y} = \beta_{red} \cdot \beta_{EUROI} \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr_{EUROI} - 1) \quad (9)$$

where β_{red} = the β reduction factor.

For CH_4, specific emission factors for cold driven vehicles are included in COPERT IV. The β and β_{red} factors for VOC is used to calculate the cold driven fraction for each relevant vehicle layer. The NMVOC emissions during cold start are found as the difference between the calculated results for VOC and CH_4.

For NH_3, specific cold start emission factors are also proposed by COPERT IV. For catalyst vehicles, however, just like in the case of hot emission factors, the emission factors for cold start are functions of cumulated mileage (emission deterioration). The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/CORINAIR (2007), for the corresponding layer. For cold start, the cut-off mileage and sulphur level interval for hot engines are used, as described in the deterioration factors paragraph.

Evaporative emissions from gasoline vehicles

For each year, evaporative emissions of hydrocarbons are simulated in the forecast model as hot and warm running losses, hot and warm soak loss and diurnal emissions. For evaporation, no updates are made to the COPERT IV methodology, and the calculation approach is the same as in COPERT III. All emission types depend on RVP (Reid Vapour Pressure) and ambient temperature. The emission factors are shown in Ntziachristos et al. (2000).

Running loss emissions originate from vapour generated in the fuel tank while the vehicle is running. The distinction between hot and warm running loss emissions depends on engine temperature. In the model, hot and warm running losses occur for hot and cold engines, respectively. The emissions are calculated as annual mileage (broken down into cold and hot mileage totals using the β-factor) times the respective emission factors. For vehicles equipped with evaporation control (catalyst cars), the emission factors are only one tenth of the uncontrolled factors used for conventional gasoline vehicles.

$$R_{j,y} = N_{j,y} \cdot M_{j,y} \cdot ((1-\beta) \cdot HR + \beta \cdot WR) \quad (10)$$

where R is running loss emissions and HR and WR are the hot and warm running loss emission factors, respectively.

In the model, hot and warm soak emissions for carburettor vehicles also occur for hot and cold engines, respectively. These emissions are calculated as number of trips (broken down into cold and hot trip numbers using the β-factor) times respective emission factors:

$$S_{j,y}{}^{C} = N_{j,y} \cdot \frac{M_{j,y}}{l_{trip}} \cdot ((1-\beta) \cdot HS + \beta \cdot WS) \quad (11)$$

where S^C is the soak emission, l_{trip} = the average trip length, and HS and WS are the hot and warm soak emission factors, respectively. Since all catalyst vehicles are assumed to be carbon canister controlled, no soak emissions are estimated for this vehicle type. Average maximum and minimum temperatures per month are used in combination with diurnal emission factors to estimate the diurnal emissions from uncontrolled vehicles $E^d(U)$:

$$E_{j,y}{}^{d}(U) = 365 \cdot N_{j,y} \cdot e^{d}(U) \quad (12)$$

Each year's total is the sum of each layer's running loss, soak loss and diurnal emissions.

Fuel use balance

The calculated fuel consumption in COPERT III must equal the statistical fuel sale totals according to the UNFCCC and UNECE emissions reporting format. The statistical fuel sales for road transport are derived from the Danish Energy Authority data (see DEA, 2007). The DEA data are further processed for gasoline in order to account for e.g. non road and recreational craft fuel consumption, which are not directly stated in the statistics, please refer to paragraph 1.1.4 for further information regarding the transformation of DEA fuel data.

The standard approach to achieve a fuel balance in annual emission inventories is to multiply the annual mileage with a fuel balance factor derived as the ratio between simulated and statistical fuel figures for gasoline and diesel, respectively. This method is also used in the present model.

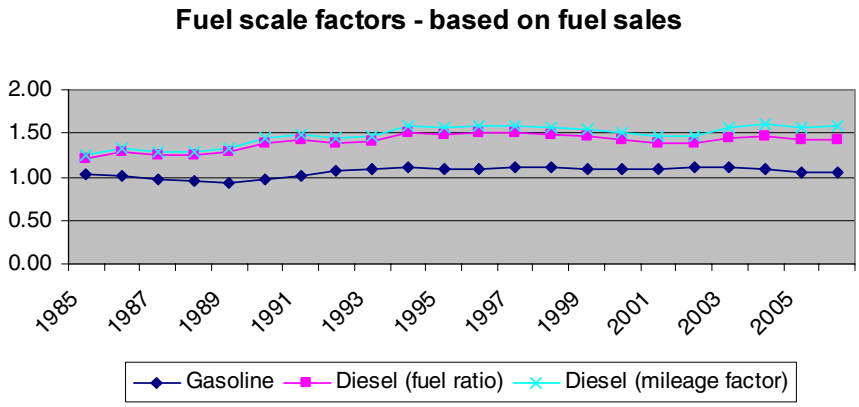


Figure 3.52 DEA:NERI Fuel ratios and diesel mileage adjustment factor based on DEA fuel sales data and NERI fuel consumption estimates

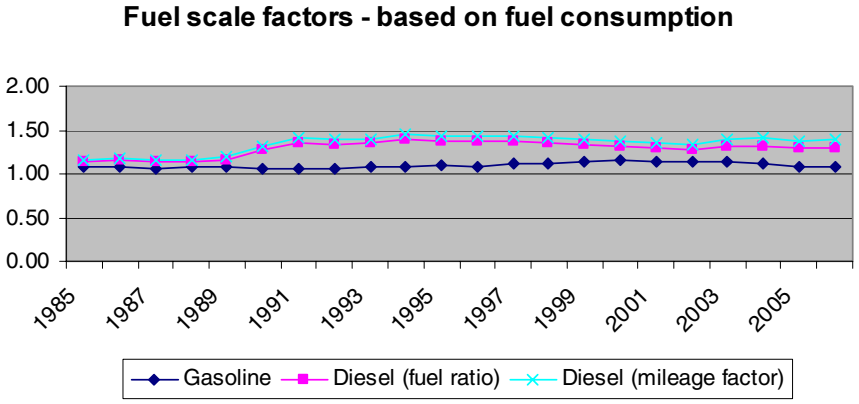


Figure 3.53 DEA:NERI Fuel ratios and diesel mileage adjustment factor based on DEA fuel consumption data and NERI fuel consumption estimates

In the figures 3.52 and 3.53 the COPERT IV:DEA gasoline and diesel fuel use ratios are shown for fuel sales and fuel consumption from 1985-2006. The data behind the figures are also listed in Annex 3.B.8. The fuel consumption figures are related to the traffic on Danish roads.

For gasoline vehicles all mileage numbers are equally scaled in order to obtain gasoline fuel equilibrium, and hence the gasoline mileage factor used is the reciprocal value of the COPERT IV:DEA gasoline fuel use ratio.

For diesel the fuel balance is made by adjusting the mileage for light and heavy-duty vehicles and buses, given that the mileage and fuel consumption factors for these vehicles are regarded as the most uncertain parameters in the diesel engine emission simulations. Consequently, the diesel mileage factor used is slightly higher than the reciprocal value of the COPERT IV:DEA diesel fuel use ratio.

From the Figures 3.52 and 3.53 it appears that the inventory fuel balances for gasoline and diesel would be improved, if the DEA statistical figures for fuel consumption were used instead of fuel sale numbers. The fuel difference for diesel is, however, still significant. The reasons for this inaccuracy are a combination of the uncertainties related to COPERT IV

fuel use factors, allocation of vehicle numbers in sub-categories, annual mileage, trip speeds and mileage splits for urban, rural and highway driving conditions.

For future inventories it is intended to use improved fleet and mileage data and improved data for trip speed and mileage split for urban, rural and highway driving. The update of road traffic fleet and mileage data will be made as soon as this information is provided from the Danish Ministry of Transport and Energy in a COPERT IV model input format.

The final fuel use and emission factors are shown in Annex 2.B.6 for 1990-2006. The total fuel use and emissions are shown in Annex 2.B.7, per vehicle category and as grand totals, for 1990-2006 (and NFR format in Annex 2.B.15). In Annex 2.B.14, fuel-use and emission factors as well as total emissions are given in CollectER format for 2006.

In Table 3.25, the aggregated emission factors for SO_2, NO_X, NMVOC and TSP are shown in CollectER format for Danish road transport.

Table 3.25 Fuel-based emission factors for SO_2, NO_X, NMVOC, CO, NH_3 and TSP for road transport in Denmark (2006)

SNAP ID	Category	Fuel type	Mode	Emission factors[1] [g/GJ]					
				SO_2	NO_X	NMVOC	CO	NH_3	TSP
70101	Passenger cars	Diesel	Highway driving	0.47	319.73	8.50	43.43	0.47	32.38
70101	Passenger cars	Gasoline 2-stroke	Highway driving	2.28	288.90	2357.34	3490.86	0.80	48.15
70101	Passenger cars	Gasoline conventional	Highway driving	0.46	1343.32	329.92	2679.96	0.89	10.34
70101	Passenger cars	Gasoline catalyst	Highway driving	0.46	139.28	29.28	765.90	32.76	0.70
70101	Passenger cars	LPG	Highway driving	0.00	1151.70	187.09	3914.25	0.00	10.06
70102	Passenger cars	Diesel	Rural driving	0.47	298.46	11.92	70.03	0.52	24.88
70102	Passenger cars	Gasoline 2-stroke	Rural driving	2.28	352.84	2476.82	2594.44	0.69	41.51
70102	Passenger cars	Gasoline conventional	Rural driving	0.46	1160.25	451.68	3105.49	0.98	11.56
70102	Passenger cars	Gasoline catalyst	Rural driving	0.46	108.34	31.59	581.58	42.19	0.65
70102	Passenger cars	LPG	Rural driving	0.00	1248.46	305.18	1146.38	0.00	14.49
70103	Passenger cars	Diesel	Urban driving	0.47	277.96	29.76	153.91	0.38	38.96
70103	Passenger cars	Gasoline 2-stroke	Urban driving	2.28	51.89	4470.04	7400.54	0.33	19.72
70103	Passenger cars	Gasoline conventional	Urban driving	0.46	635.40	867.63	7933.84	0.64	11.15
70103	Passenger cars	Gasoline catalyst	Urban driving	0.46	140.53	226.74	2522.10	15.58	0.74
70103	Passenger cars	LPG	Urban driving	0.00	615.77	445.18	1341.15	0.00	11.72
70201	Light duty vehicles	Diesel	Highway driving	0.47	302.09	29.56	174.62	0.36	40.25
70201	Light duty vehicles	Gasoline conventional	Highway driving	0.46	1370.99	170.51	2991.20	0.81	16.19
70201	Light duty vehicles	Gasoline catalyst	Highway driving	0.46	106.70	12.03	470.62	24.66	0.53
70202	Light duty vehicles	Diesel	Rural driving	0.47	318.07	33.03	159.08	0.39	36.08
70202	Light duty vehicles	Gasoline conventional	Rural driving	0.46	1190.37	262.92	2319.12	0.76	15.27
70202	Light duty vehicles	Gasoline catalyst	Rural driving	0.46	93.87	17.05	352.33	27.04	0.43
70203	Light duty vehicles	Diesel	Urban driving	0.47	332.66	55.23	189.77	0.28	47.26
70203	Light duty vehicles	Gasoline conventional	Urban driving	0.46	624.60	724.30	7474.97	0.44	8.84
70203	Light duty vehicles	Gasoline catalyst	Urban driving	0.46	107.04	125.85	2939.26	7.88	0.42
70301	Heavy duty vehicles	Diesel	Highway driving	0.47	773.65	26.25	156.24	0.32	20.35
70301	Heavy duty vehicles	Gasoline	Highway driving	0.46	1039.09	475.21	7620.01	0.28	55.42
70302	Heavy duty vehicles	Diesel	Rural driving	0.47	797.33	34.88	162.64	0.32	20.65
70302	Heavy duty vehicles	Gasoline	Rural driving	0.46	1143.00	821.44	8382.01	0.30	60.96
70303	Heavy duty vehicles	Diesel	Urban driving	0.47	795.53	47.24	191.53	0.26	24.77
70303	Heavy duty vehicles	Gasoline	Urban driving	0.46	457.20	696.98	7112.01	0.20	40.64
704	Mopeds	Gasoline		0.46	84.85	9268.55	10303.28	1.19	145.15
70501	Motorcycles	Gasoline	Highway driving	0.46	251.88	1057.65	15344.14	1.22	24.67
70502	Motorcycles	Gasoline	Rural driving	0.46	196.38	1301.93	14874.44	1.51	30.51
70503	Motorcycles	Gasoline	Urban driving	0.46	109.11	1740.26	13446.79	1.51	30.60

[1] References. SO_2: Country specific; NO_X and NMVOC: COPERT III (conventional passenger cars, light duty trucks, LPG passenger cars); PM: COPERT III (conventional diesel passenger cars, light duty diesel trucks) and COPERT IV (remaining vehicle layers).

Non-exhaust particulate emissions from road transport

The TSP, PM_{10} and $PM_{2.5}$ emissions arising from tyre and brake wear (SNAP 0707) and road abrasion (SNAP 0708) are estimated for the years 2000-2006 as prescribed by the UNECE convention reporting format. The emissions are calculated by multiplying the total annual mileage per vehicle category with the correspondent average emission factors for each source type. The calculation procedure is consistent with the COPERT III model approach used to estimate the Danish national emissions coming from exhaust. A more thorough explanation of the calculations is given by Winther (2004), and emission factors are taken from EMEP/-CORINAIR (2007). The emission factors and total emissions for 2006 are shown in Annex 2.B.14.

Methodologies and references for other mobile sources

Other mobile sources are divided into several sub-sectors: sea transport, fishery, air traffic, railways, military, and working machinery and materiel in the industry, forestry, agriculture and household and gardening sectors. The emission calculations are made using the detailed method as described in the EMEP/CORINAIR Emission Inventory Guidebook (EMEP/CORINAIR, 2007) for air traffic, off-road working machinery and equipment, and ferries, while for the remaining sectors the simple method is used.

3.3.3 Activity data

Air traffic

The activity data for air traffic consists of air traffic statistics provided by the Danish Civil Aviation Agency (CAA-DK) and Copenhagen Airport. For 2001 onwards, per flight records are provided by CAA-DK as data for aircraft type, and origin and destination airports. For inventory years prior to 2001, detailed LTO/aircraft type statistics are obtained from Copenhagen Airport (for this airport only), while information of total take-off numbers for other Danish airports is provided by CAA-DK. Fuel statistics for jet fuel use and aviation gasoline are obtained from the Danish energy statistics (DEA, 2007).

Prior to emission calculations, the aircraft types are grouped into a smaller number of representative aircraft groups, for which fuel use and emission data exist in the EMEP/CORINAIR databank. In this procedure, actual aircraft types are classified according to their overall aircraft type (jets, turbo props, helicopters and piston engines). Secondly, information on the aircraft MTOM (Maximum Take Off Mass) and number of engines are used to append a representative aircraft to the aircraft type in question. A more thorough explanation is given in Winther (2001a, b).

Non-road working machinery and equipment

Non-road working machinery and equipment are used in agriculture, forestry and industry, for household/gardening purposes and in inland waterways (recreational craft). Information on the number of different types of machines, their respective load factors, engine sizes and annual working hours has been provided by Winther et al. (2006). The stock development from 1985-2005 for the most important types of machinery are shown in Figures 3.54-3.61 below. The stock data are also listed in Annex 2.B.10, together with figures for load factors, engine sizes and annual working hours. As regards stock data for the remaining machinery types, please refer to (Winther et al., 2006).

For agriculture, the total number of agricultural tractors and harvesters per year are shown in the Figures 3.54-3.55, respectively. The Figures clearly show a decrease in the number of small machines, these being replaced by machines in the large engine-size ranges.

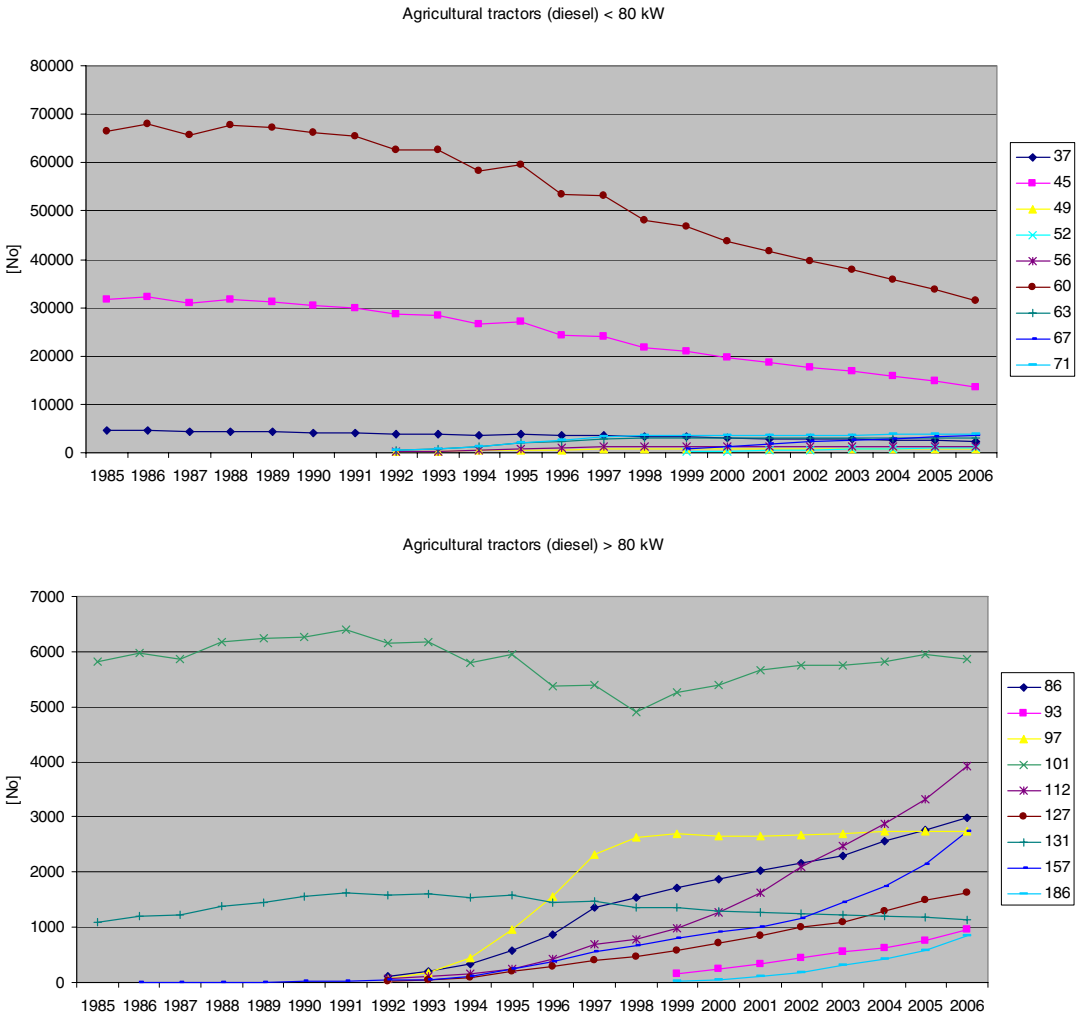


Figure 3.54 Total numbers in kW classes for tractors from 1985 to 2006

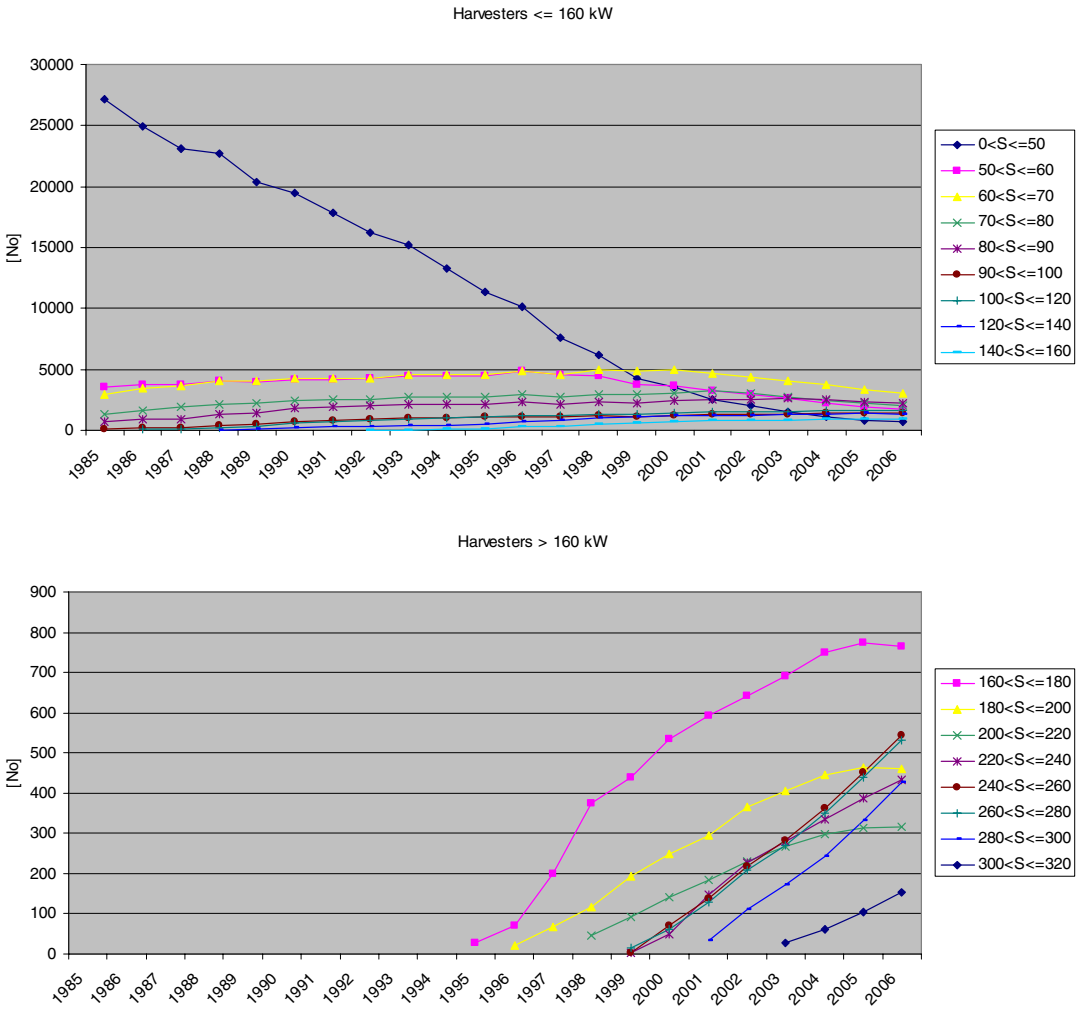


Figure 3.55 Total numbers in kW classes for harvesters from 1985 to 2006

The tractor and harvester developments towards fewer vehicles and larger engines, shown in Figure 3.56, are very clear. From 1985 to 2006, tractor and harvester numbers decrease by around 20% and 48%, respectively, whereas the average increase in engine size for tractors is 21%, and 125% for harvesters, in the same time period.

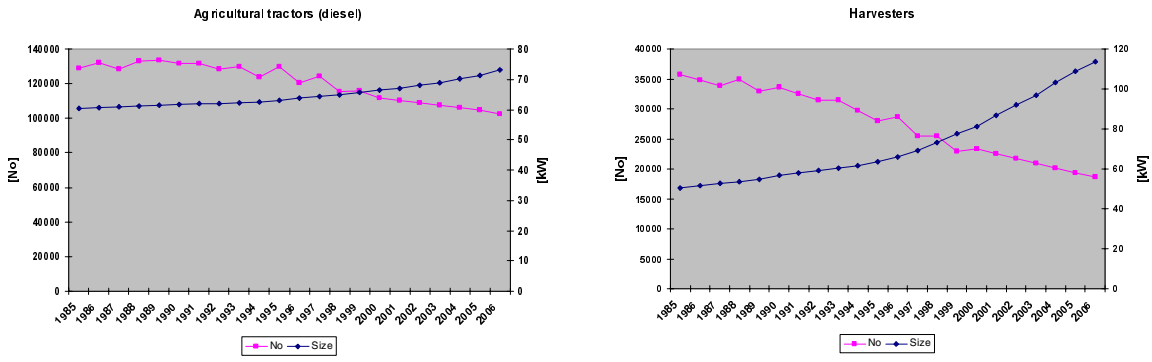


Figure 3.56 Total numbers and average engine size for tractors and harvesters (1985 to 2006)

The most important machinery types for industrial use are different types of construction machinery and fork lifts. The Figures 3.57 and 3.58

show the 1985-2005 stock development for specific types of construction machinery and diesel fork lifts. Due to lack of data, the construction machinery stock for 1990 is used also for 1985-1989. For most of the machinery types there is an increase in machinery numbers from 1990 onwards, due to increased construction activities. It is assumed that track type excavators/ wheel type loaders (0-5 tonnes), and telescopic loaders first enter into use in 1991 and 1995, respectively.

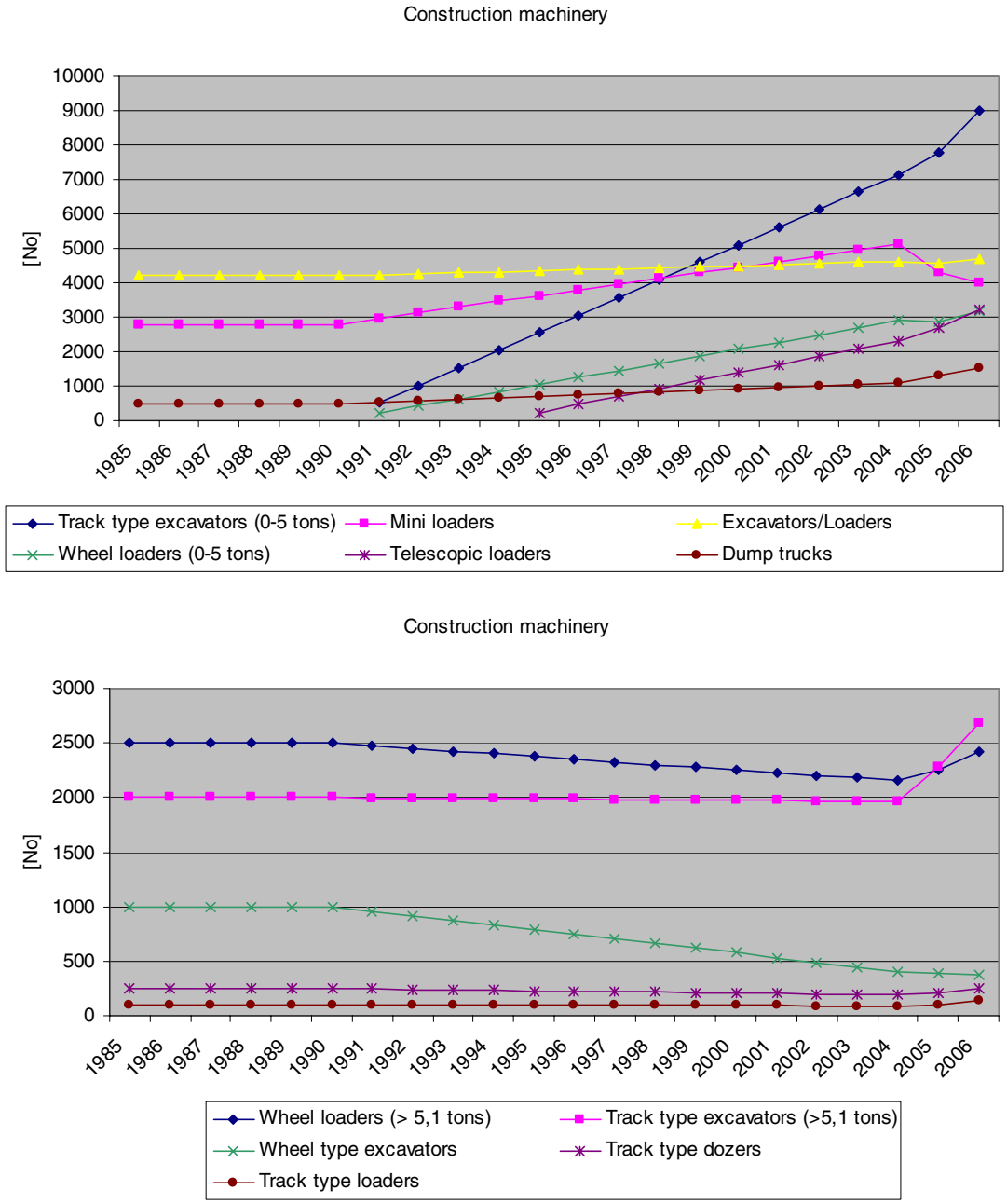


Figure 3.57 1985-2006 stock development for specific types of construction machinery

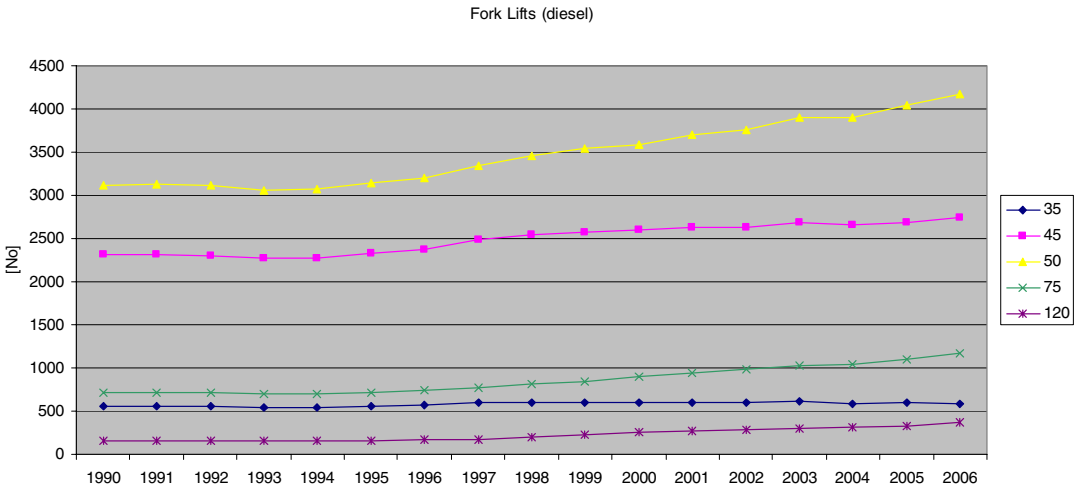


Figure 3.58 Total numbers of diesel fork lifts in kW classes from 1985 to 2006

The emission level shares for tractors, harvesters, construction machinery and diesel fork lifts are shown in Figure 3.59, and present an overview of the penetration of the different pre-Euro engine classes, and engine stages complying with the gradually stricter EU stage I and II emission limits. The average lifetimes of 30, 25, 20 and 10 years for tractors, harvesters, fork lifts and construction machinery, respectively, influence the individual engine technology turn-over speeds.

The EU emission directive Stage I and II implementation years relate to engine size, and for all four machinery groups the emission level shares for the specific size segments will differ slightly from the picture shown in Figure 3.59. Due to scarce data for construction machinery, the emission level penetration rates are assumed to be linear and the general technology turnover pattern is as shown in Figure 3.59.

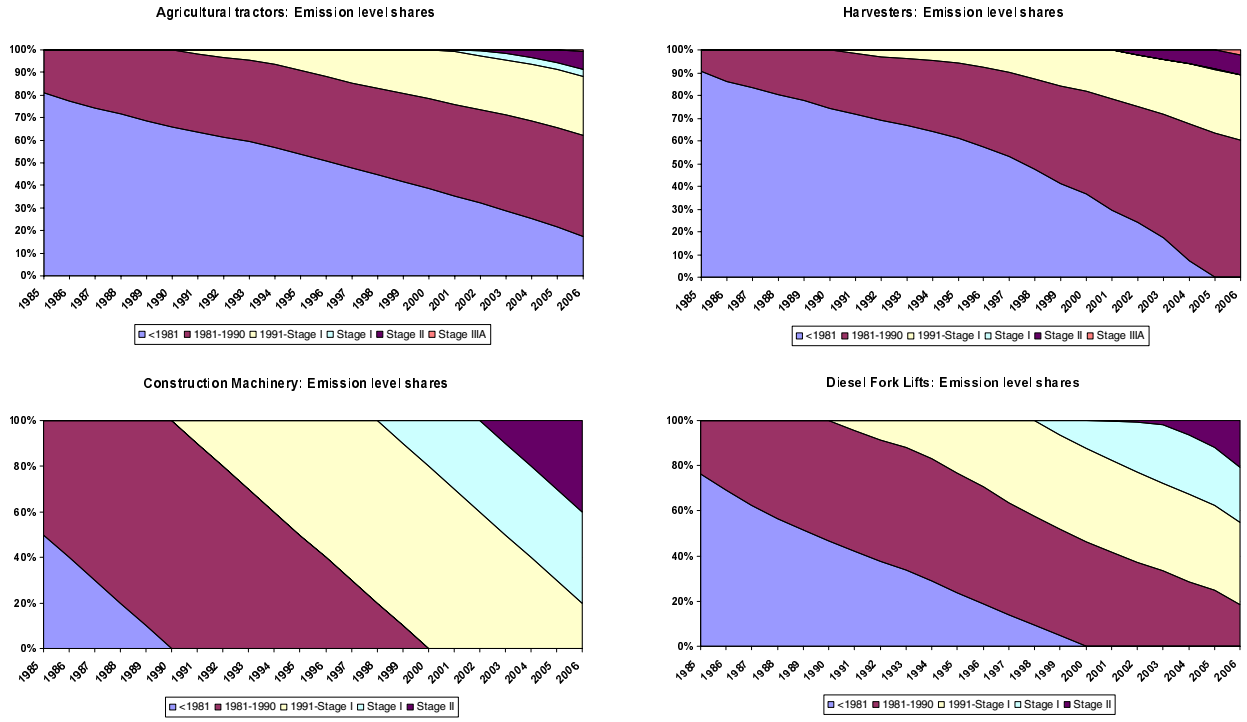


Figure 3.59 Emission level shares for tractors, harvesters, construction machinery and diesel fork lifts (1985 to 2006)

The 1985-2005 stock development for the most important household and gardening machinery types is shown in Figure 3.60.

For lawn movers and cultivators, the machinery stock remains the same for all years, whereas the stock figures for riders, chain saws, shrub clearers, trimmers and hedge cutters increase from 1990 onwards. The yearly stock increases, in most cases, become larger after 2000. The life-times for gasoline machinery are short and, therefore, there new emission levels (not shown) penetrate rapidly.

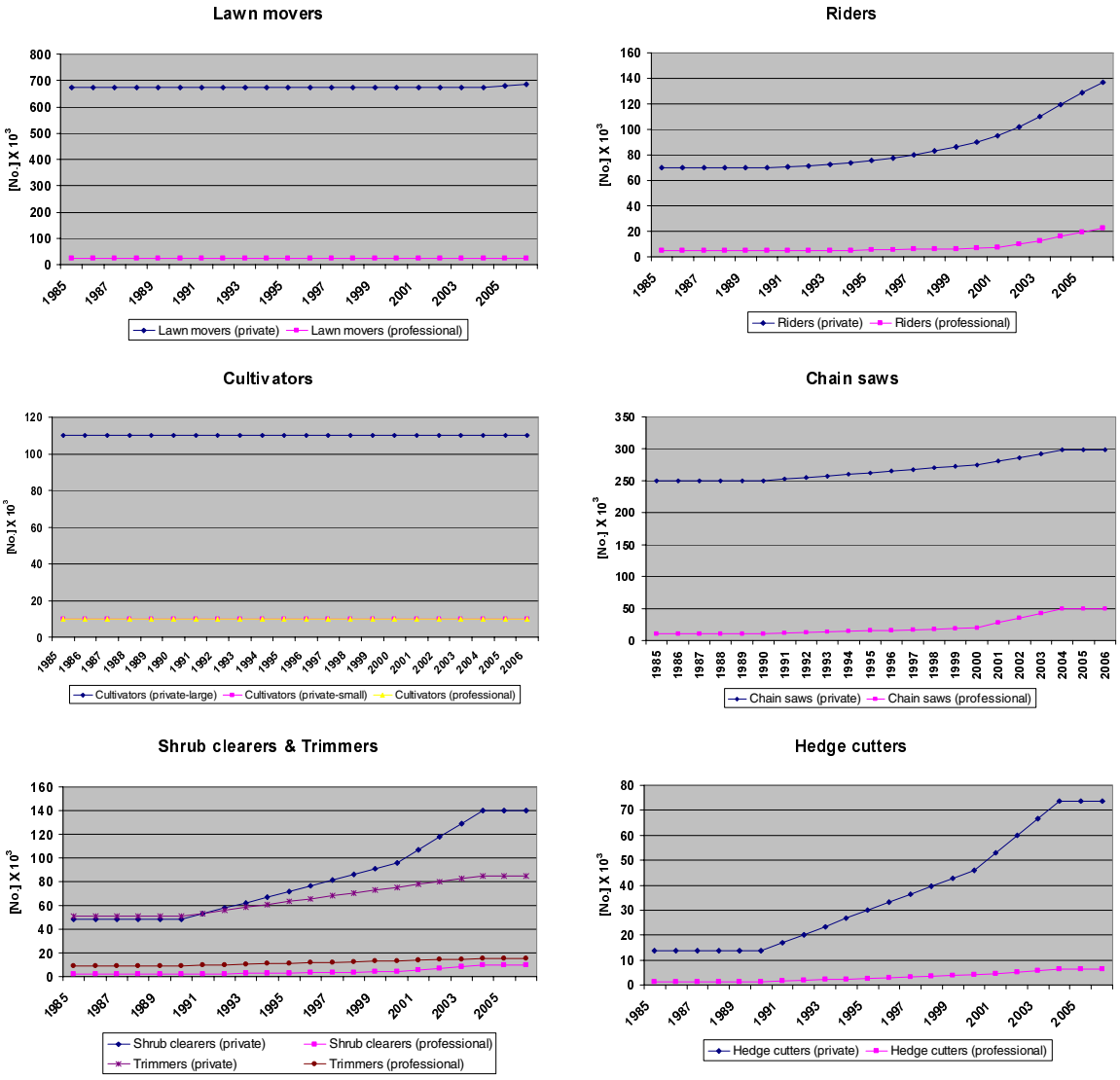


Figure 3.60 Stock development 1985-2006 for the most important household and gardening machinery types

Figure 3.61 shows the development in numbers of different recreational craft from 1985-2005. The 2004 stock data for recreational craft are repeated for 2005 and 2006, since no new fleet information has been obtained.

For diesel boats, increases in stock and engine size are expected during the whole period, except for the number of motor boats (< 27 ft.) and the engine sizes for sailing boats (<26 ft.), where the figures remain unchanged. A decrease in the total stock of sailing boats (<26 ft.) by 21% and increases in the total stock of yawls/cabin boats and other boats (<20 ft.) by around 25% are expected. Due to a lack of information specific to Denmark, the shifting rate from 2-stroke to 4-stroke gasoline engines is based on a German non-road study (IFEU, 2004).

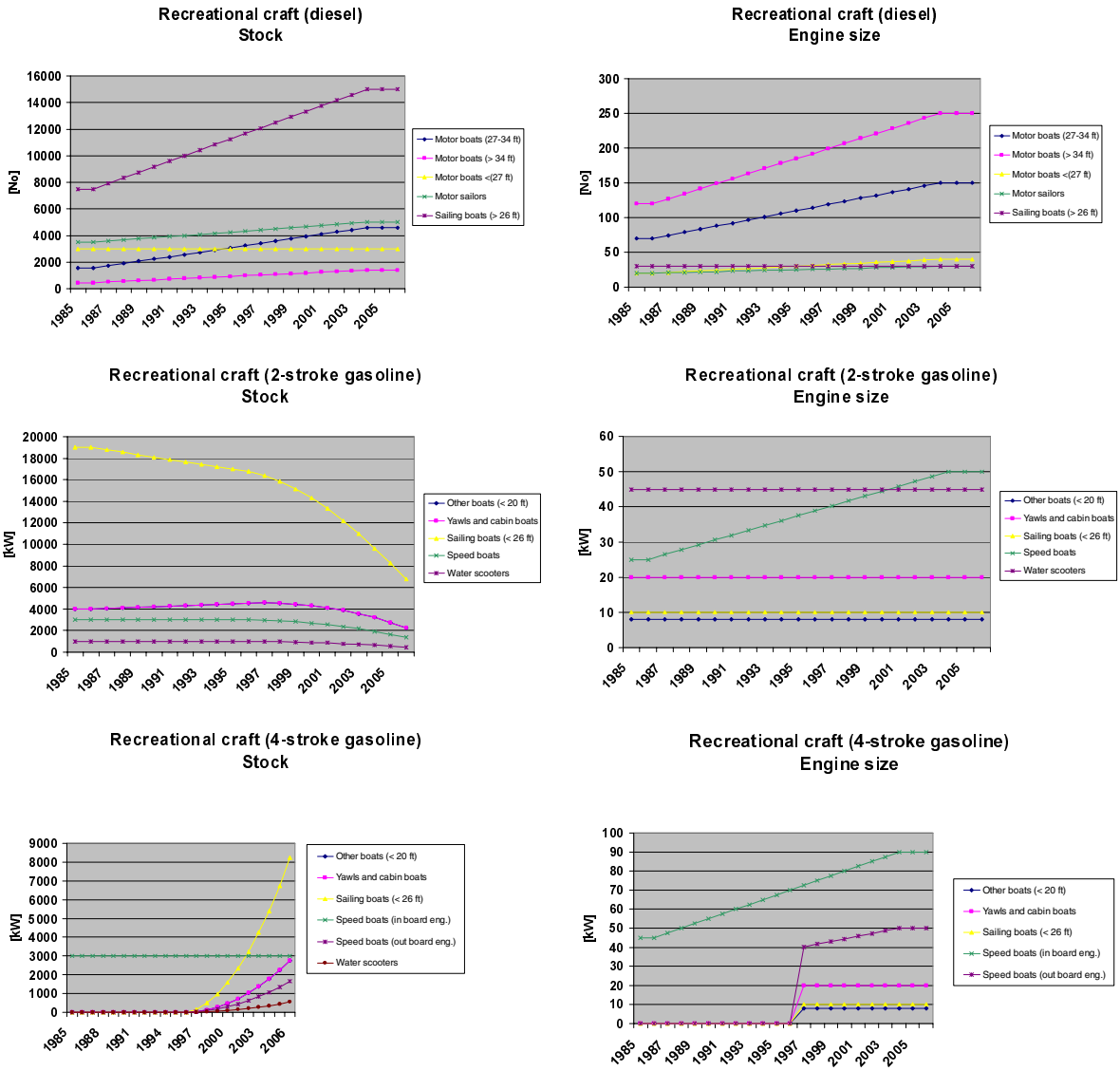


Figure 3.61 1985-2006 Stock and engine size development for recreational craft

National sea transport

A new methodology is used to estimate the fuel consumption figures for national sea transport, based on fleet activity estimates for regional ferries, local ferries and other national sea transport (Winther, 2008).

Table 3.26 lists the most important domestic ferry routes in Denmark in the period 1990-2006. For these ferry routes the following detailed traffic and technical data have been gathered: Ferry name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxiliary engine size and sailing time (single trip).

Table 3.26 Ferry routes comprised in the present project

Ferry service	Service period
Halsskov-Knudshoved	1990-1999
Hundested-Grenaa	1990-1996
Kalundborg-Juelsminde	1990-1996
Kalundborg-Samsø	1990-
Kalundborg-Århus	1990-
Korsør-Nyborg, DSB	1990-1997
Korsør-Nyborg, Vognmandsruten	1990-1999
København-Rønne	1990-2004
Køge-Rønne	2004-
Sjællands Odde-Ebeltoft	1990-
Sjællands Odde-Århus	1999-
Tårs-Spodsbjerg	1990-

The number of round trips per ferry route is shown in Figure 3.62. The traffic data are also listed in Annex 3.B.11, together with different ferry specific technical and operational data.

For each ferry, Annex 3.B.12 lists the relevant information as regards ferry route, name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxillary engine size and sailing time (single trip). There is a lack of historical traffic data for 1985-1989, and hence, data for 1990 is used for these years, to support the fuel use and emission calculations.

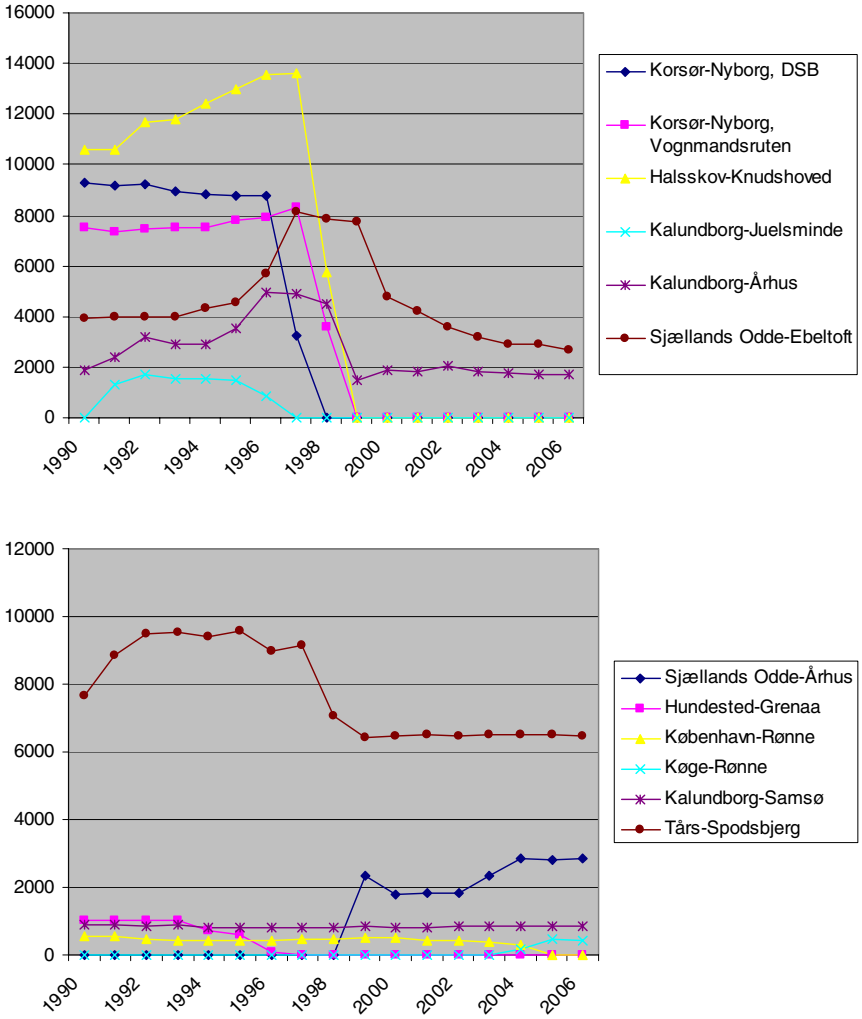


Figure 3.62 No. of round trips for the most important ferry routes in Denmark 1990-2006

It is seen from Table 3.26 (and Figure 3.62) that several ferry routes were closed in the time period from 1996-1998, mainly due to the opening of the Great Belt Bridge (connecting Zealand and Funen) in 1997. Hundested-Grenaa and Kalundborg-Juelsminde was closed in 1996, Korsør-Nyborg (DSB) closed in 1997, and Halsskov-Knudshoved and Korsør-Nyborg (Vognmandsruten) was closed in 1998. The ferry line København-Rønne was replaced by Køge-Rønne in 2004 and from 1999 a new ferry connection was opened between Sjællands Odde and Århus.

For the local ferries, a bottom-up estimate of fuel consumption for 1996 has been taken from the Danish work in Wismann (2001). The latter project calculated fuel consumption and emissions for all sea transport in Danish waters in 1995/1996 and 1999/2000. In order to cover the entire 1990-2006 inventory period, the fuel figure for 1996 has been adjusted according to the developments in local ferry route traffic shown in Annex 3.B.11.

For the remaining part of the traffic between two Danish ports, other national sea transport, new bottom-up estimates for fuel consumption have been calculated for the years 1995 and 1999 by Wismann (2007). The calculations use the database set up for Denmark in the Wismann (2001) study, with actual traffic data from the Lloyd's LMIS database (not in-

cluding ferries). The database was split into three vessel types: bulk carriers, container ships, and general cargo ships; and five size classes: 0-1000, 1000-3000, 3000-10000, 10000-20000 and >20000 DTW. The calculations assume that bulk carriers and container ships use heavy fuel oil, and that general cargo ships use gas oil. For further information regarding activity data for local ferries and other national sea transport, please refer to Winther (2008).

The fleet activity data for regional ferries, and the fleet activity based fuel consumption estimates for local ferries and other national sea transport provided by Winther (2008) replace the previous fuel based activity data which originated directly from the DEA statistics.

Other sectors

The activity data for military, railways, international sea transport and fishery consists of fuel consumption information from DEA (2007). For international sea transport, the basis is fuel sold in Danish ports for vessels with a foreign destination, as prescribed by the IPCC guidelines.

For fisheries, the calculation methodology described by Winther (2008) remains fuel based. However, the input fuel data differ from the fuel sales figures previously used. The changes are the result of further data processing of the DEA reported gas oil sales for national sea transport and fisheries, prior to inventory input. For years when the fleet activity estimates of fuel consumption for national sea transport are smaller than reported fuel sold, fuel is added to fisheries in the inventory. Conversely, lower fuel sales in relation to bottom-up estimates for national sea transport means that fuel is being subtracted from the original fisheries fuel sales figure in order to make up the final fuel consumption input for fisheries.

The updated fuel consumption time series for national sea transport lead, in turn, to changes in the energy statistics for fisheries (gas oil) and industry (heavy fuel oil), so the national energy balance can remain unchanged.

For all sectors, fuel-use figures are given in Annex 2.B.14 for 2006 in CollectER format.

Emission legislation

For non-road working machinery and equipment, and recreational craft and railway locomotives/motor cars, the emission directives list specific emission limit values (g/kWh) for CO, VOC, NO_x (or VOC + NO_x) and TSP, depending on engine size (kW for diesel, ccm for gasoline) and date of implementation (referring to engine market date).

For diesel, the directives 97/68 and 2004/26 relate to non-road machinery other than agricultural and forestry tractors, and the directives have different implementation dates for machinery operating under transient and constant loads. The latter directive also comprises emission limits for railway machinery. For tractors the relevant directives are 2000/25 and 2005/13. For gasoline, the directive 2002/88 distinguishes between hand-held (SH) and not hand-held (NS) types of machinery.

For engine type approval, the emissions (and fuel use) are measured using various test cycles (ISO 8178). Each test cycle consists of a number of measurement points for specific engine loads during constant operation. The specific test cycle used depends on the machinery type in question and the test cycles are described in more details in the directives.

Table 3.27 Overview of EU emission directives relevant for diesel fuelled non-road machinery

Stage/Engine size [kW]	CO	VOC	NO_x	VOC+NO_x	PM	Diesel machinery			Tractors	
							Implement. date		EU	Implement.
		[g/kWh]				EU Directive	Transient	Constant	directive	date
Stage I										
37<=P<75	6.5	1.3	9.2	-	0.85	97/68	1/4 1999	-	2000/25	1/7 2001
Stage II										
130<=P<560	3.5	1	6	-	0.2	97/68	1/1 2002	1/1 2007	2000/25	1/7 2002
75<=P<130	5	1	6	-	0.3		1/1 2003	1/1 2007		1/7 2003
37<=P<75	5	1.3	7	-	0.4		1/1 2004	1/1 2007		1/1 2004
18<=P<37	5.5	1.5	8	-	0.8		1/1 2001	1/1 2007		1/1 2002
Stage IIIA										
130<=P<560	3.5	-	-	4	0.2	2004/26	1/1 2006	1/1 2011	2005/13	1/1 2006
75<=P<130	5	-	-	4	0.3		1/1 2007	1/1 2011		1/1 2007
37<=P<75	5	-	-	4.7	0.4		1/1 2008	1/1 2012		1/1 2008
19<=P<37	5.5	-	-	7.5	0.6		1/1 2007	1/1 2011		1/1 2007
Stage IIIB										
130<=P<560	3.5	0.19	2	-	0.025	2004/26	1/1 2011	-	2005/13	1/1 2011
75<=P<130	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
56<=P<75	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
37<=P<56	5	-	-	4.7	0.025		1/1 2013	-		1/1 2013
Stage IV										
130<=P<560	3.5	0.19	0.4	-	0.025	2004/26	1/1 2014		2005/13	1/1 2014
56<=P<130	5	0.19	0.4	-	0.025		1/10 2014			1/10 2014

Table 3.28 Overview of the EU Emission Directive 2002/88 for gasoline fuelled non-road machinery

	Category	Engine size [ccm]	CO [g/kWh]	HC [g/kWh]	NO_x [g/kWh]	HC+NO_x [g/kWh]	Implementation date
	Stage I						
Hand held	SH1	S<20	805	295	5.36	-	1/2 2005
	SH2	20=<S<50	805	241	5.36	-	1/2 2005
	SH3	50=<S	603	161	5.36	-	1/2 2005
Not hand held	SN3	100=<S<225	519	-	-	16.1	1/2 2005
	SN4	225=<S	519	-	-	13.4	1/2 2005
	Stage II						
Hand held	SH1	S<20	805	-	-	50	1/2 2008
	SH2	20=<S<50	805	-	-	50	1/2 2008
	SH3	50=<S	603	-	-	72	1/2 2009
Not hand held	SN1	S<66	610	-	-	50	1/2 2005
	SN2	66=<S<100	610	-	-	40	1/2 2005
	SN3	100=<S<225	610	-	-	16.1	1/2 2008
	SN4	225=<S	610	-	-	12.1	1/2 2007

For recreational craft, Directive 2003/44 comprises the emission legislation limits for diesel engines, and for 2-stroke and 4-stroke gasoline engines, respectively. The CO and VOC emission limits depend on engine size (kW) and the inserted parameters presented in the calculation formulas in Table 3.29. For NO_x, a constant limit value is given for each of the three engine types. For TSP, the constant emission limit regards diesel engines only.

Table 3.29 Overview of the EU Emission Directive 2003/44 for recreational craft

Engine type	Impl. date	$CO=A+B/P^n$			$HC=A+B/P^n$			NO_x	TSP
		A	B	n	A	B	n		
2-stroke gasoline	1/1 2007	150.0	600.0	1.0	30.0	100.0	0.75	10.0	-
4-stroke gasoline	1/1 2006	150.0	600.0	1.0	6.0	50.0	0.75	15.0	-
Diesel	1/1 2006	5.0	0.0	0	1.5	2.0	0.5	9.8	1.0

Tabel 3.30 Overview of the EU Emission Directive 2004/26 for railway locomotives and motorcars

	Engine size [kW]		CO [g/kWh]	HC [g/kWh]	NOx [g/kWh]	HC+NO_X [g/kWh]	PM [g/kWh]	Implementation date
Locomotives	Stage IIIA							
	130<=P<560	RL A	3.5	-	-	4	0.2	1/1 2007
	560<P	RH A	3.5	0.5	6	-	0.2	1/1 2009
	2000<=P and piston displacement >= 5 l/cyl.	RH A	3.5	0.4	7.4	-	0.2	1/1 2009
	Stage IIIB	RB	3.5	-	-	4	0.025	1/1 2012
Motor cars	Stage IIIA							
	130<P	RC A	3.5	-	-	4	0.2	1/1 2006
	Stage IIIB							
	130<P	RC B	3.5	0.19	2	-	0.025	1/1 2012

Aircraft engine emissions of NO_x, CO, VOC and smoke are regulated by ICAO (International Civil Aviation Organization). The engine emission certification standards are contained in Annex 16 — Environmental Protection, Volume II — Aircraft Engine Emissions to the Convention on International Civil Aviation (ICAO Annex 16, 1993). The emission standards relate to the total emissions (in grams) from the so-called LTO (Landing and Take Off) cycle divided by the rated engine thrust (kN). The ICAO LTO cycle contains the idealised aircraft movements below 3000 ft (915 m) during approach, landing, airport taxiing, take off and climb out.

For smoke all aircraft engines manufactured from 1th of January 1983 have to meet the emission limits agreed by ICAO. For NO_x, CO, VOC The emission legislation is relevant for aircraft engines with a rated engine thrust larger than 26.7 kN. In the case of CO and VOC, the ICAO regulations apply for engines manufactured from from 1th of January 1983.

For NO_x, the emission regulations fall in four categories

a) For engines of a type or model for which the date of manufacture of the first individual production model is on or before 31th of December 1995, and for which the production date of the individual engine is on or before 31th December 1999.
b) For engines of a type or model for which the date of manufacture of the first individual production model is after 31th of December 1995, or for individual engines with a production date after 31th December 1999.
c) For engines of a type or model for which the date of manufacture of the first individual production model is after 31th of December 2003.
d) For engines of a type or model for which the date of manufacture of the first individual production model is after 31th of December 2007.

A further description of the technical definitions in relation to engine certification, the emission certification limits, as well as actual engine exhaust emission measurement data can be found in the ICAO Engine Exhaust Emission Database. The latter database is accessible from http://www.caa.co.uk, kept by the UK Civil Aviation Authority.

For seagoing vessels, NO_x emissions are regulated as explained in Marpol 73/78 Annex VI, formulated by IMO (International Maritime Organisation). The legislation is relevant for diesel engines with a power output higher than 130 kW, which are installed on a ship constructed on or after 1 January 2000 and diesel engines with a power output higher than 130 kW which undergo major conversion on or after 1 January 2000.

The NO_x emission limits for ship engines in relation to their rated engine speed (n) given in RPM (Revolutions Per Minute) are the following:

- 17 g/kWh, $n < 130$ RPM
- 45 x n-0.2 g/kWh, $130 \leq n < 2000$ RPM
- 9,8 g/kWh, $n \geq 2000$ RPM

Fuel legislation

Table 3.31 shows the current legislation in relation to sulphur content in heavy fuel and marine gas oil used by ship engines.

Table 3.31 Current legislation in relation to marine fuel quality

Legislation		Heavy fuel oil		Gas oil	
		S-%	Impl. date	S-%	Impl. date
EU-directive 93/12		None		0.2[1]	1.10.1994
EU-directive 1999/32		None		0.2	1.1.2000
EU-directive 2005/33	SECA - Baltic sea	1.5	11.08.2006	0.1	1.1.2008
	SECA - North sea	1.5	11.08.2007	0.1	1.1.2008
	Outside SECA's	None		0.1	1.1.2008
MARPOL Annex VI	SECA – Baltic sea	1.5	19.05.2006		
	SECA – North sea	1.5	21.11.2007		
	Outside SECA	4.5	19.05.2006		

[1] Sulphur content limit for fuel sold inside EU

For non road machinery, the EU directive 2003/17/EC gives a limit value of 50 ppm sulphur in diesel (from 2005).

Emission factors

The SO_2 emission factors are fuel related, and rely on the sulphur contents given in the relevant EU fuel directives or in the Danish legal announcements. However, for jet fuel the default factor from IPCC (1996) is used. Road transport diesel is assumed to be used by engines in military and railways, and road transport gasoline is assumed to be used by non road working machinery and recreational craft. Hence, these types of machinery have the same SO_2 emission factors, as for road transport.

For all mobile sources, the emission factor source for NH_3, heavy metals and PAH is the EMEP/CORINAIR guidebook (CORINAIR, 2007).

For military ground equipment, aggregated emission factors for gasoline and diesel are derived from road traffic emission simulations. For piston engine aircraft using aviation gasoline, aggregated emission factors for conventional cars are used.

For railways, specific Danish measurements from the Danish State Railways (DSB) (Næraa, 2007) are used to calculate the emission factors of NO_x, VOC, CO and TSP, and a NMVOC/CH_4 split is made based on own judgment.

For agriculture, forestry, industry, household gardening and inland waterways, the NO_x, VOC, CO and TSP emission factors are derived from various European measurement programmes; see IFEU (2004) and Winther et al. (2006). The NMVOC/CH_4 split is taken from USEPA (2004).

For national sea transport and fisheries, the NO_x emission factors predominantly come from the engine manufacturer MAN Diesel, as a function of engine production year. The CO, VOC and TSP emission factors come from the Danish TEMA2000 emission model (Trafikministeriet, 2000), whereas the PM_{10} and $PM_{2.5}$ size fractions are obtained from MAN

Diesel. The VOC/CH_4 split are taken from EMEP/CORINAIR (2007). For ship engines, the basis emission factors are shown in Annex 2.B.12.

The source for aviation (jet fuel) emission factors is the EMEP/CORINAIR guidebook (CORINAIR, 2007).

For all sectors, emission factors are given in CollectER format in Annex 2.B.14 for 2006. Table 3.32 shows the emission factors for SO_2, NO_X, NMVOC, CO, NH_3 and TSP in CollectER format used to calculate the emissions from other mobile sources in Denmark.

Factors for deterioration, transient loads and gasoline evaporation for non road machinery

The emission effects of engine wear are taken into account for diesel and gasoline engines by using the so-called deterioration factors. For diesel engines alone, transient factors are used in the calculations, to account for the emission changes caused by varying engine loads. The evaporative emissions of NMVOC are estimated for gasoline fuelling and tank evaporation. The factors for deterioration, transient loads and gasoline evaporation are taken from IFEU(2004), and are shown in Annex 2.B.9. For more details regarding the use of these factors, please refer to paragraph 3.1.4 or Winther et al. (2006).

Table 3.32 Fuel based emission factors for SO_2, NO_X, NMVOC, CO, NH_3 and TSP for other mobile sources in Denmark (2006)

					Emission factors[1] [g/GJ]					
SNAP ID	NFR ID	Category	Fuel type	Mode	SO_2	NO_X	NMVOC	CO	NH3	TSP
801	1A5	Military	Diesel		0.47	538.08	35.10	158.94	0.34	30.51
801	1A5	Military	Jet fuel	< 3000 ft	22.99	250.57	24.94	229.89	0.00	1.16
801	1A5	Military	Jet fuel	> 3000 ft	22.99	250.57	24.94	229.89	0.00	1.16
801	1A5	Military	Gasoline		0.46	206.69	260.01	2050.72	25.15	2.58
801	1A5	Military	Av. gasoline		22.99	859.00	1242.60	6972.00	1.60	10.00
802	1A3c	Railways	Diesel		0.47	1155.92	74.96	204.41	0.20	39.02
803	1A3d	Inland waterways	Diesel		93.68	868.57	168.09	450.77	0.17	103.58
803	1A3d	Inland waterways	Gasoline		0.46	446.85	2050.43	15870.55	0.09	90.85
80402	1A3d	National sea traffic	Residual oil		948.66	1748.91	59.46	196.16		88.60
80402	1A3d	National sea traffic	Diesel		93.68	1288.42	50.25	136.65		23.21
80402	1A3d	National sea traffic	Kerosene		2.30	50.00	3.00	20.00		5.00
80402	1A3d	National sea traffic	LPG			1249.00	384.94	443.00		0.20
80403	1A4c	Fishing	Residual oil		1101.71	1393.60	56.90	180.90		139.40
80403	1A4c	Fishing	Diesel		93.68	1355.43	56.36	185.92		23.21
80403	1A4c	Fishing	Kerosene		2.30	50.00	3.00	20.00		5.00
80403	1A4c	Fishing	Gasoline		2.28	64.34	10809.60	18485.10	0.10	23.25
80403	1A4c	Fishing	LPG			1249.00	384.94	443.00		0.20
80404	Memo item	International sea traffic	Residual oil		1638.14	2053.70	60.73	200.35		253.29
80404	Memo item	International sea traffic	Diesel		93.68	1516.56	55.34	182.57		23.21
80501	1A3a	Air traffic, other airports	Jet fuel	Dom. < 3000 ft	22.99	287.66	27.15	148.43		1.16
80501	1A3a	Air traffic, other airports	Av. gasoline		22.83	859.00	1242.60	6972.00	1.60	10.00
80502	Memo item	Air traffic, other airports	Jet fuel	Int. < 3000 ft	22.99	289.45	33.27	200.52		1.16
80502	Memo item	Air traffic, other airports	Av. gasoline		22.83	859.00	1242.60	6972.00	1.60	10.00
80503	1A3a	Air traffic, other airports	Jet fuel	Dom. > 3000 ft	22.99	279.30	20.57	127.01		1.16
80504	Memo item	Air traffic, other airports	Jet fuel	Int. > 3000 ft	22.99	238.63	8.64	62.41		1.16
806	1A4c	Agriculture	Diesel		2.34	779.40	83.90	420.46	0.18	62.65
806	1A4c	Agriculture	Gasoline		0.46	107.59	1143.22	21833.70	1.41	29.26
807	1A4c	Forestry	Diesel		2.34	650.75	50.31	296.03	0.18	34.88
807	1A4c	Forestry	Gasoline		0.46	73.12	6684.07	16521.92	0.08	76.48
808	1A2f	Industry	Diesel		2.34	738.43	93.38	414.76	0.18	77.29
808	1A2f	Industry	Gasoline		0.46	197.21	1491.92	13052.28	0.10	13.85
808	1A2f	Industry	LPG		0.00	1328.11	146.09	104.85	0.21	4.89
809	1A4b	Household and gardening	Gasoline		0.46	86.20	2522.22	27536.91	0.09	24.90
80501	1A3a	Air traffic, Copenhagen airport	Jet fuel	Dom. < 3000 ft	22.99	275.95	35.84	193.29		1.16
80501	1A3a	Air traffic, Copenhagen airport	Av. gasoline		22.83	859.00	1242.60	6972.00	1.60	10.00
80502	Memo item	Air traffic, Copenhagen airport	Jet fuel	Int. < 3000 ft	22.99	341.71	44.14	223.20	0.00	1.16
80502	Memo item	Air traffic, Copenhagen airport	Av. gasoline		22.83	859.00	1242.60	6972.00	1.60	10.00
80503	1A3a	Air traffic, Copenhagen airport	Jet fuel	Dom. > 3000 ft	22.99	274.14	18.44	66.15	0.00	1.16
80504	Memo item	Air traffic, Copenhagen airport	Jet fuel	Int. > 3000 ft	22.99	315.36	11.20	34.29	0.00	1.16

[1] References. SO_2: Country-specific; Military: Aggregated emission factors for road transport; Railways (NO_x, NMVOC and TSP): Danish State Railways; Agriculture, forestry, industry, household gardening and inland waterways (NO_x, VOC and TSP): IFEU (2004); National sea transport and fishing: MAN B&W (NO_x) and TEMA2000 (NMVOC, TSP); Aviation - jet fuel (NO_X, NMVOC and TSP): EMEP/CORINAIR; Aviation - av.gasoline: Aggregated emission factors for conventional gasoline cars

3.3.4 Calculation method

Air traffic

For aviation, the estimates are made separately for landing and take-off (LTOs < 3000 ft), and cruising (> 3000 ft). From 2001, the estimates are made on a city-pair level, by combining activity data and emission factors and subsequently grouping the emission results into domestic and international totals. The overall fuel precision in the model is around 0.8, derived as the fuel ratio between model estimates and statistical sales. The fuel difference is accounted for by adjusting cruising fuel use and emissions in the model according to domestic and international cruising fuel shares.

Prior to 2001, the calculation procedure was first to estimate each year's fuel use and emissions for LTO. Secondly, total cruising fuel use was found year by year as the statistical fuel use total minus the calculated fuel use for LTO. Lastly, the cruising fuel use was split into a domestic and international part by using the results from a Danish city-pair emission inventory in 1998 (Winther, 2001a). For more details of this latter fuel allocation procedure, see Winther (2001b).

Non-road working machinery and recreational craft

Prior to adjustments for deterioration effects and transient engine operations, the fuel use and emissions in year X, for a given machinery type, engine size and engine age, are calculated as:

$$E_{Basis}(X)_{i,j,k} = N_{i,j,k} \cdot HRS_{i,j,k} \cdot P \cdot LF_i \cdot EF_{y,z} \quad (13)$$

where E_{Basis} = fuel use/emissions in the basic situation, N = number of engines, HRS = annual working hours, P = average rated engine size in kW, LF = load factor, EF = fuel use/emission factor in g/kWh, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level. The basic fuel use and emission factors are shown in Annex 2.B.9.

The deterioration factor for a given machinery type, engine size and engine age in year X depends on the engine-size class (only for gasoline), y, and the emission level, z. The deterioration factors for diesel and gasoline 2-stroke engines are found from:

$$DF_{i,j,k}(X) = \frac{K_{i,j,k}}{LT_i} \cdot DF_{y,z} \quad (14)$$

where DF = deterioration factor, K = engine age, LT = lifetime, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level.

For gasoline 4-stroke engines the deterioration factors are calculated as:

$$DF_{i,j,k}(X) = \sqrt{\frac{K_{i,j,k}}{LT_i}} \cdot DF_{y,z} \quad (15)$$

The deterioration factors inserted in (14) and (15) are shown in Annex 2.B.9. No deterioration is assumed for fuel use (all fuel types) or for LPG engine emissions and, hence, DF = 1 in these situations.

The transient factor for a given machinery type, engine size and engine age in year X, relies only on emission level and load factor, and is denominated as:

$$TF_{i,j,k}(X) = TF_z \quad (16)$$

Where i = machinery type, j = engine size, k = engine age and z = emission level.

The transient factors inserted in (16) are shown in Annex 2.B.9. No transient corrections are made for gasoline and LPG engines and, hence, TF_z = 1 for these fuel types.

The final calculation of fuel use and emissions in year X for a given machinery type, engine size and engine age, is the product of the expressions 13-16:

$$E(X)_{i,j,k} = E_{Basis}(X)_{i,j,k} \cdot TF(X)_{i,j,k} \cdot (1 + DF(X)_{i,j,k}) \quad (17)$$

The evaporative hydrocarbon emissions from fuelling are calculated as:

$$E_{Evap,fueling,i} = FC_i \cdot EF_{Evap,fueling} \quad (18)$$

Where $E_{Evap,fueling}$, = hydrocarbon emissions from fuelling, i = machinery type, FC = fuel consumption in kg, $EF_{Evap,fueling}$ = emission factor in g NMVOC/kg fuel.

For tank evaporation, the hydrocarbon emissions are found from:

$$E_{Evap,tank,i} = N_i \cdot EF_{Evap,tank,i} \quad (19)$$

Where $E_{Evap,tank,i}$ = hydrocarbon emissions from tank evaporation, N = number of engines, i = machinery type and $EF_{Evap,fueling}$ = emission factor in g NMVOC/year.

Ferries, other national sea transport and fisheries

The fuel use and emissions in year X, for regional ferries are calculated as:

$$E(X) = \sum_i N_i \cdot T_i \cdot S_{i,j} \cdot P_i \cdot LF_j \cdot EF_{k,l,y} \quad (20)$$

Where E = fuel use/emissions, N = number of round trips, T = sailing time per round trip in hours, S = ferry share of ferry service round trips, P = engine size in kW, LF = engine load factor, EF = fuel use/emission factor in g/kWh, i = ferry service, j = ferry, k = fuel type, l = engine type, y = engine year.

For the remaining navigation categories, the emissions are calculated using a simplified approach:

$$E(X) = \sum_i EC_{i,k} EF_{k,l,y} \quad (21)$$

Where E = fuel use/emissions, EC = energy consumption, EF = fuel use/emission factor in g/kg fuel, i = category (local ferries, other national sea, fishery, international sea), k = fuel type, l = engine type, y = average engine year.

The emission factor inserted in (21) is found as an average of the emission factors representing the engine ages which are comprised by the average lifetime in a given calculation year, X:

$$EF_{k,l,y} = \frac{\sum_{year=X}^{year=X-LT} EF_{k,l}}{LT_{k,l}} \quad (22)$$

Other sectors

For military and railways, the emissions are estimated with the simple method using fuel-related emission factors and fuel use from the DEA:

$$E = FC \cdot EF \quad (23)$$

where E = emission, FC = fuel consumption and EF = emission factor. The calculated emissions for other mobile sources are shown in CollectER format in Annex 2.B.14 for the years 2006 and as time-series 1985-2006 in Annex 2.B.15 (NFR format).

Energy balance: DEA statistics and NERI estimates

Following convention rules, the DEA statistical fuel sales figures are behind the full Danish inventory. However, in some cases for mobile sources the DEA statistical sectors do not fully match the inventory sectors. This is the case for non road machinery, where relevant DEA statistical sectors also include fuel consumed by stationary sources.

In other situations, fuel consumption figures estimated by NERI from specific bottom-up calculations are regarded as more reliable than DEA reported sales. This is the case for national sea transport.

In the following the transferral of fuel consumption data from DEA statistics into inventory relevant categories is explained for national sea transport and fisheries, non road machinery and recreational craft, and road transport. A full list of all fuel consumption data, DEA figures as well as intermediate fuel consumption data, and final inventory input figures is shown in Annex 2.B.13.

National sea transport and fisheries

For national sea transport in Denmark, the new fuel consumption estimates obtained by NERI (Winther, 2008) are regarded as much more accurate than the DEA fuel sales data, since the large fluctuations in reported fuel sales cannot be explained by the actual development in the traffic between different national ports. As a consequence, the new bottom-up estimates replace the previous fuel based figures for national sea transport.

There are different potential reasons for the differences between estimated fuel consumption and reported sales for national sea transport in Denmark. According to the DEA, the latter fuel differences are most likely explained by inaccurate costumer specifications made by the oil suppliers. This inaccuracy can be caused by a sector misallocation in the sales statistics between national sea transport and fisheries for gas oil, and between national sea transport and industry for heavy fuel oil (Peter Dal, DEA, personal communication, 2007).

Following this, for fisheries and industry the updated fuel consumption time series for national sea transport lead, in turn, to changes in the fuel activity data for fisheries (gas oil) and industry (heavy fuel oil), so the national energy balance can remain unchanged.

For fisheries, fuel investigations made prior to the initiation of the work made by Winther (2008) have actually pointed out a certain area of inaccuracy in the DEA statistics. No engines installed in fishing vessels use heavy fuel oil, even though a certain amount of heavy fuel oil is listed in the DEA numbers for some statistical years (H. Amdissen, Danish Fishermen's Association, personal communication, 2006). Hence, for fisheries small amounts of fuel oil are transferred to national sea transport, and in addition small amounts of gasoline and diesel are transferred to recreational craft.

Non road machinery and recreational craft

For diesel and LPG, the non-road fuel consumption estimated by NERI is partly covered by the fuel-use amounts in the following DEA sectors: agriculture and forestry, market gardening, and building and construction. The remaining quantity of non-road diesel and LPG is taken from the DEA industry sector.

For gasoline, the DEA residential sector, together with the DEA sectors mentioned for diesel and LPG, contribute to the non-road fuel consumption total. In addition, a certain amount of fuel from road transport is needed to reach the fuel-use goal.

The amount of diesel and LPG in DEA industry not being used by non-road machinery is included in the sectors, "Combustion in manufacturing industry" (0301) and "Non-industrial combustion plants" (0203) in the Danish emission inventory.

For recreational craft, the calculated fuel-use totals for diesel and gasoline are subsequently subtracted from the DEA fishery sector. For gasoline, the DEA reported fuel consumption for fisheries is far too small to fill the fuel gap, and hence the missing fuel amount is taken from the DEA road transport sector.

Bunkers

The distinction between domestic and international emissions from aviation and navigation should be in accordance with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For the national emission inventory this, in principle, means that fuel sold (and associated emissions) for flights/sea transportation starting from a seaport/airport in the Kingdom of Denmark, with destinations inside or

outside the Kingdom of Denmark, are regarded as domestic or international, respectively.

Aviation

For aviation, the emissions associated with flights inside the Kingdom of Denmark are counted as domestic. The flights from Denmark to Greenland and the Faroe Islands are classified as domestic flights in the inventory background data. In Greenland and the Faroe Islands, the jet fuel sold is treated as domestic. This decision can be considered sensible since in the real world almost no fuel is bunkered in Greenland/Faroe Islands by flights other than those going to Denmark.

Navigation

In DEA statistics, the domestic fuel total consists of fuel sold to Danish ferries and other ships sailing between two Danish ports. The DEA international fuel total consists of the fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, transport to Greenland and the Faroe Islands, tank vessels and foreign fishing boats.

In Greenland, all marine fuel sales are treated as domestic. In the Faroe Islands, fuel sold in Faroese ports for Faroese fishing vessels and other Faroese ships is treated as domestic. The fuel sold to Faroese ships bunkering outside Faroese waters and the fuel sold to foreign ships in Faroese ports or outside Faroese waters is classified as international (Lastein and Winther, 2003).

To comply with the IPCC classification rules, the fuel used by vessels sailing to Greenland and the Faroe Islands should form part of the domestic total. To improve the fuel data quality for Greenland and the Faroe Islands, the fuel sales should be grouped according to vessel destination and IPCC classifications subsequently be made.

Conclusively, the domestic/international fuel split (and associated emissions) for navigation is not determined with the same precision as for aviation. It is considered, however, that the potential of incorrectly allocated fuel quantities is only a small part of the total fuel sold for navigational purposes in the Kingdom of Denmark.

3.3.5 Uncertainties and time-series consistency

Emission uncertainty estimates are made for road transport and other mobile sources using the guidelines formulated in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). However, for TSP the latter source indicates no uncertainty factor and, instead, this factor is based on own judgement.

The activity data uncertainty factor is assumed to be 2 and 10% for road transport and other mobile sources, respectively, based on own judgement.

The uncertainty estimates should be regarded as preliminary only and may be subject to changes in future inventory documentation. The calculations are shown in Annex 2.B.16 for all emission components.

Table 3.33 Uncertainties for activity data, emission factors and total emissions in 2006 and as a trend

	Emission factor uncertainties [%]		Emission uncertainties [%]	
Pollutant	Road	Other	Overall 2006	Trend
SO_2	50	50	49	4
NO_x	50	100	50	7
NMVOC	50	100	49	10
CO	50	100	51	12
NH_3	1000	1000	996	2759
TSP	50	100	47	10
PM_{10}	50	100	48	8
$PM_{2.5}$	50	100	50	7
Arsenic	1000	1000	1000	5
Cadmium	1000	1000	803	177
Chromium	1000	1000	804	187
Copper	1000	1000	832	99
Mercury	1000	1000	1000	10
Nickel	1000	1000	745	101
Lead	1000	1000	963	17
Selenium	1000	1000	727	180
Zinc	1000	1000	817	126
Dioxins	1000	1000	707	124
Flouranthene	1000	1000	794	4
Benzo(b) flouranthene	1000	1000	786	52
Benzo(k) flouranthene	1000	1000	827	78
Benzo(a) pyrene	1000	1000	859	54
Benzo(g,h,i) perylene	1000	1000	797	49
indeno(1,2,3-c,d) pyrene	1000	1000	778	150

As regards time-series consistency, background flight data cannot be made available on a city-pair level from 2000 or earlier. However, aided by LTO/aircraft statistics for these years and the use of proper assumptions, a sound level of consistency is still obtained in this part of the transport inventory.

The time-series of emissions for mobile machinery in the agriculture, forestry, industry, household and gardening (residential), and inland waterways (part of navigation) sectors are less certain than time-series for other sectors, since DEA statistical figures do not explicitly provide fuel use information for working equipment and machinery.

3.3.6 Quality assurance/quality control (QA/QC)

It is the intention to publish annually a sector report for road transport and other mobile sources. The last sector report concerned the 2004 inventory.

The QA/QC descriptions of the Danish emission inventories for transport are given in Nielsen et al. (2008).

3.3.7 Recalculations

The following recalculations and improvements of the emission inventories have been made since the emission reporting in 2007.

Road transport

An error in the distribution of the total mileage between passenger cars and vans has been corrected from 1985 to 2005, and this change in input data has given slight emission changes. The mileage for passenger cars has been reduced in the new situation, and due to the fuel balance in the calculation model for diesel more fuel has been allocated to vans and heavy duty vehicles which in general have higher fuel related emission factors.

Also changes have been made to the gasoline fuel consumption input data for the NERI model, throughout the 1985-2005 periods. The gasoline fuel consumption generally increases, due to a reduced gasoline consumption calculated for non road working machinery in the same years. This latter fuel amount is being subtracted from the road transport sales of gasoline reported by the DEA, prior to NERI road transport model input.

The emission factors for NMVOC have been updated in the model. NMVOC is derived as the difference between VOC and CH_4, and the latter emission factors have been revised due to updates in the COPERT IV background data, both for cold start and operationally hot engines.

For NH_3, The hot start emission factors for passenger cars and vans have been updated in the NERI model, and in addition a new cold start calculation module has been implemented. The NERI model changes are based on the updated COPERT IV methodology and emission data.

National sea transport

Based on new research findings, the fuel consumption of heavy oil and gas oil for national sea transport is now calculated directly by NERI. Fuel adjustments are made in the fishery sector (gas oil) and stationary industry sources (heavy fuel oil) in order to maintain the grand national energy balance. The fuel consumption changes for national sea transport cause the emissions to change from 1985 to 2005.

Fishery

Fuel adjustments are made for gas oil, which affects the emissions for this sector. The emission changes for fisheries are followed by the opposite emission changes in national sea transport of approximately the same absolute values.

Military

Emission factors derived from the new road transport simulations have caused minor emission changes from 1985-2005.

Residential

The emissions somewhat decrease due to a smaller amount of fuel used by gasoline fuelled working machinery.

Agriculture

Updated stock information for ATV's (All Terrain Vehicles) 2002-2005, has given a small fuel use and emissions increase for these years.

Military
Emission factors derived from the new road transport simulations have caused minor changes in the emissions from 1985-2005.

Railways
No changes have been made.

Aviation
No changes have been made.

3.3.8 Improvements

Heavy metals and POPs
It is the intention this year to update the heavy metal and POP emission inventories for mobile sources.

QA/QC
Based on the improved inventory QA/QC description for mobile sources, a list of work is planned to be carried out this year. For more information, please refer to Illerup et al., (2007).

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3.4 Fugitive emissions (CRF sector 1B)

3.4.1 Source category description

Fugitive emission from solid fuels, CRF sector 1B1c

Coal mining is not occurring in Denmark and no emissions are estimated for solid fuel.

Fugitive emissions from oil (1B2a)

The category "Fugitive emissions from oil (1B2a)" includes emissions from offshore activities and refineries.

Fugitive emissions from natural gas, transmission and distribution (CRF sector 1B2b)

In the year 2006, the length of transmission pipelines excluding offshore pipeline was 860 km. The length of distribution pipelines was 18959 km in 2006 (cast iron 0 km, steel 1896 km, plastics 17063 km). Two natural gas storage facilities are in operation in Denmark. In 2006 the gas input was 727 Mm^3 and the withdrawal was 596 Mm^3. Emission from gas storage is included in transmission.

Flaring, gas (CRF sector 1B2c, Flaring ii)

Offshore flaring of natural gas is the main source of emissions in the Fugitive emission sector. Flaring in gas treatment and gas storage plants are, however, also included in the sector.

3.4.2 Methodological issues

Fugitive emissions from oil (1B2a)

Offshore activities

Emissions from offshore activities include emissions from extraction of oil and gas, onshore oil tanks, onshore and offshore loading of ships.

The total emission can then be expressed as:

$$E_{total} = E_{extraction} + E_{ship} + E_{oil\,\tan ks} \tag{3.5.1}$$

Fugitive emissions from extraction

According to the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) the total fugitive emissions of VOC from extraction can be estimated by means of Equation 3.5.2.

$$E_{VOC,fugitive} = 40.2 \cdot N_P + 1.1 \cdot 10^{-2} P_{gas} + 8.5 \cdot 10^{-6} \cdot P_{oil} \tag{3.5.2}$$

where N_P is the number of platforms, P_{gas} (10^6 Nm^3) is the production of gas and P_{oil} (10^6 tons) is the production of oil.

It is assumed that the VOC contains 75% methane and 25% NMVOC, meaning that the total emission of CH_4 and NMVOC for extraction of oil and gas can be calculated as:

$$\begin{aligned} E_{extraction,NMVOC} &= E_{fugitive,NMVOC} + E_{flaring,NMVOC} \\ &= 0.25(40.2 \cdot N_P + 1.1 \cdot 10^{-2} P_{gas} + 8.5 \cdot 10^{-6} \cdot P_{oil}) + F_P \cdot EMF_{flaring,NMVOC} \end{aligned} \tag{3.5.3}$$

$$\begin{aligned} E_{extraction,CH4} &= E_{fugitive;CH4} + E_{flaring,CH4} \\ &= 0.75(40.2 \cdot N_P + 1.1 \cdot 10^{-2} P_{gas} + 8.5 \cdot 10^{-6} \cdot P_{oil}) + F_P \cdot EMF_{flaring,CH4} \end{aligned} \tag{3.5.4}$$

In Denmark, the venting of gas is assumed to be negligible because controlled venting enters the gas flare system.

Ships

This source includes the transfer of oil from storage tanks or directly from the well into a ship. This activity also includes losses during transport. When oil is loaded hydrocarbon vapour will be displaced by oil and new vapour will be formed, both leading to emissions. The emissions from ships are calculated by equation 3.5.5.

$$E_{ships} = EMF_{ships} \cdot L_{oil} \tag{3.5.5}$$

where EMF_{ships} is the emission factor for loading of ships off-shore and on-shore and L_{oil} is the amount of oil loaded.

Oil tanks

The emissions from storage of raw oil are calculated by equation 3.5.6.

$$E_{\tan ks} = EMF_{\tan ks} \cdot T_{oil} \tag{3.5.6}$$

where EMF_{tanks} is the emission factor for storage of raw oil in tanks.

Activity data

Activity data used in the calculations of the emissions is shown in Table 3.33 and is based on information from the Danish Energy Authority (Danish Energy Authority, 2007d) or from the green accounts from the Danish gas transmission company DONG (DONG, 2007).

Table 3.33 Activity data for 2006

Activity	Symbols	Year	
		2006	Ref.
Number of platforms	N_p	50	Danish Energy Agency (2007d)
Produced gas (10^6Nm3)	P_{gas}	10878	Danish Energy Agency (2007d)
Produced oil(10^3m3)	$P_{oil,vol}$	19847	Danish Energy Agency (2007d)
Produced oil (10^3ton)	P_{oil}	17068	Danish Energy Agency (2007d)
Oil loaded (10^3m3)	$L_{oil\ off\text{-}shore}$	2957	Danish Energy Agency (2007d)
Oil loaded (10^3ton)	$L_{oil\ off\text{-}shore}$	2543	Danish Energy Agency (2007d)
Oil loaded (10^3m3)	$L_{oil\ on\text{-}shore}$	13100	DONG (2007)
Oil loaded (10^3ton)	$L_{oil\ on\text{-}shore}$	11266	DONG (2007)

Mass weight raw oil = 0.86 ton/m^3

In the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) emission factors for different countries are given. In the Danish emission inventory the Norwegian emission factors are used (EMEP/CORINAIR, 2007, Table 8.15). The emissions for storage of oil are given in the green accounts from DONG for 2006 (DONG, 2007) and the emission factor is calculated on the basis of the amount of oil transported in pipeline.

Table 3.34 Emission factors.

	CH_4	NMVOC	Unit	Reference.
Ships off-shore	0.00005	0.001	Fraction of loaded	EMEP/CORINAIR, 2007
Ships on-shore	0.000002	0.0002	Fraction of loaded	EMEP/CORINAIR, 2007
Oil tanks	112,43	245,56	kg/10^3m^3	DONG, 2007

From the activity data in Table 3.33 and the emission factors in Table 3.34 the emissions for NMVOC and CH_4 are calculated in Table 3.35.

Table 3.35 CH_4 and NMVOC emissions for 2006 (tonnes)

	CH_4	NMVOC
Extraction (fugitive)	1589	530
Oil tanks	1900	4150
Offshore loading of ships	127	2543
Onshore loading of ships	23	2253
Total	3639	9476

Oil Refineries

Petroleum products processing: in the production process at refineries, a part of the volatile hydrocarbons (VOC) is emitted to the atmosphere. It is assumed that CH_4 accounts for 1% and NMVOC for 99% of the emissions. The VOC emissions from the petroleum refinery processes cover non-combustion emissions from feedstock handling/storage, petroleum products processing, product storage/handling and flaring. SO_2 is also emitted from the non-combustion processes and includes emissions from products processing and sulphur recovery plants. The emission calculations are based on information from the Danish refineries and the energy statistics.

Table 3.36 Oil Refineries. Processed crude oil, emissions and emission factors

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Crude oil (1000 Mg)	7263	7798	8232	8356	8910	9802	10522	7910	7906	8106
CH_4 emission (Mg)	37	39	42	43	57	48	62	45	45	45
CH_4 emission factor (g/Mg)	5	5	5	5	6	5	6	6	6	6
NMVOC emission (Mg)	3667	3937	4203	4219	5855	4546	5875	4547	4558	4558
NMVOC emission factor (g/Mg)	505	505	511	505	657	464	558	575	577	562
	2000	2001	2002	2003	2004	2005	2006			
Crude oil (1000 Mg)	8406	8284	8045	8350	8264	8264	8020			
CH_4 emission (Mg)	50	44	43	37	613	613	636			
CH_4 emission factor (g/Mg)	6	5	5	4	74	74	79			
NMVOC emission (Mg)	4983	4338	4302	3708	3732	3732	3563			
NMVOC emission factor (g/Mg)	593	524	535	444	451	451	444			

Fugitive emissions from natural gas, transmission and distribution (CRF sector 1B2b)

Inventories of NMVOC emission from gas transmission and distribution are based on annual environmental reports from DONG and on a Danish emission inventory for the years 1999-2006 reported by the Danish gas sector (transmission and distribution companies) (Karll 2003, Karll 2005, Oertenblad 2006 & Oertenblad 2007). The inventories estimated by the Danish gas sector are based on the work carried out by Marcogas and the International Gas Union (IGU).

In the 1990-1999 inventories, fugitive NMVOC emissions from storage facilities and the gas treatment plant are included in the emission factor for transmission. In the 2000-2006, emission inventories transmission, gas storage and gas treatment are registered separately and added.

Gas transmission data are shown in Table 3.37. Emissions from gas storage facilities and venting in the gas treatment plant are shown in Table 3.38. Gas distribution data are shown in Table 3.39.

Table 3.37 NMVOC emission from natural gas transmission

TRANSMISSION		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Transmission rate Mm^3	1)	2739	3496	3616	3992	4321	4689	5705	6956	6641	6795
NMVOC emission Mg	2)		94	28	57	46	163	56	72	45	56
NMVOC IEF kg/Mm^3	3)	27.018	27.018	7.821	14.220	10.665	34.839	10.976	10.300	6.776	8.241

Continued		2000	2001	2002	2003	2004	2005	2006
Transmission rate Mm^3	1)	7079	7289	7287	7275	7384	7600	7600
NMVOC emission Mg	2)	26	48	24	27	26	43	46
NMVOC IEF kg/Mm^3	3)	3.704	6.567	3.263	3.688	3.510	5.656	6.098

1) In 1990-1997 transmission rates refer to Danish energy statistics, in 1998 the transmission rate refers to the annual environmental report of DONG, in 1999-2006 emissions refer to DONG/Danish Gas Technology Centre (Karll 2003, Karll 2005, Oertenblad 2006 & Oertenblad 2007)

2) In 1991-95 NMVOC emissions are based on the annual environmental report from DONG for the year 1995. In 1996-99 the NMVOC emission refers to the annual environmental reports from DONG for the years 1996-99. In 2000-2006 the NMVOC emission refers to DONG/Danish Gas Technology Centre (Karll 2003, Karll 2005, Oertenblad 2006 & Oertenblad 2007)

3) IEF=Emission/transmission rate. In 1990 the IEF is assumed to be the same as in 1991.

Table 3.38 Additional fugitive NMVOC emissions from natural gas storage facilities and venting in gas treatment plant (Mg)

	2000	2001	2002	2003	2004	2005	2006
Gas treatment plant	2	0	0	0	0	0	0
Gas storage facilities	23	22	20	21	26	16	20

Table 3.39 NMVOC emission from natural gas distribution

DISTRIBUTION		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Distribution rate Mm^3	1)	1574	1814	1921	2185	2362	2758	3254	3276	3403	3297
NMVOC emission Mg	2)										13
NMVOC IEF kg/Mm^3	3)	4.439	4.439	4.439	4.439	4.439	4.439	4.439	4.439	4.439	3.976

Continued		2000	2001	2002	2003[4)5)]	2004[4)]	2005[4)]	2006[4)]
Distribution rate Mm^3	1)	3181	3675	3420	3420	3248	2983	3319
NMVOC emission Mg	2)	15	17	12	12	43	19	29
NMVOC IEF kg/Mm^3	3)	4.696	4.646	3.468	3.468	13.329	6.292	8.861

1) In 1999-2006 distribution rates refer to DONG / Danish Gas Technology Centre / Danish gas distribution companies (Karll 2005, Oertenblad 2006 & Oertenblad 2007), In 1990-98 distribution rates are estimated from the Danish energy statistics. Distribution rates are assumed to equal total Danish consumption rate minus the consumption rates of sectors that receive the gas at high pressure. The following consumers are assumed to receive high pressure gas: town gas production companies, production platforms and power plants.

2) Danish Gas Technology Centre / DONG/ Danish gas distribution companies (Karll 2003)

3) In the years 1999-2006 IEF=NMVOC emission / distribution rate. In 1990-1998 an average of the IEF in 1999-2001 is assumed.

4) Data from Naturgas Fyn not included (data not complete)

5) Assumed same emission as in 2002

Flaring, gas (CRF sector 1B2c, Flaring ii)

Emissions from offshore flaring are estimated based on data for fuel consumption from the Danish Energy Authority (2007d) and emission factors for flaring. The emissions from flaring in gas treatment and gas storage plants are estimated based on the annual environmental reports of the plants.

The fuel consumption rates are shown in Table 3.40. Flaring rates in gas treatment and gas storage plants are not available until 1995.

The emission factors for offshore flaring are shown in Table 3.41. The CO_2 emission factor follows the same time-series as natural gas combusted in stationary combustion plants. All other emission factors are constant in 1990-2006.

The time-series for the CO_2 emission from gas flaring fluctuates due to the fluctuation of offshore flaring rates as shown in Figure 3.61.

Table 3.40 Natural gas flaring rate (Danish Energy Authority, 2007d & Dong 2007)

Year	Flaring, offshore [TJ]	Gas treatment and gas storage [TJ]
1990	4218	-
1991	8692	-
1992	8977	-
1993	7819	-
1994	7709	-
1995	5964	43
1996	6595	30
1997	9629	35
1998	7053	29
1999	15509	32
2000	10023	29
2001	10806	36
2002	8901	44
2003	9333	33
2004	10299	25
2005	7269	42
2006	7157	39

Table 3.41 Emission factors for offshore flaring of natural gas

Pollutant	Emission factor	
CO_2	56,78	kg/GJ
CH_4	5	g/GJ
N_2O	1	g/GJ
SO_2	0,3	g/GJ
NO_x	300	g/GJ
NMVOC	3	g/GJ
CO	25	g/GJ

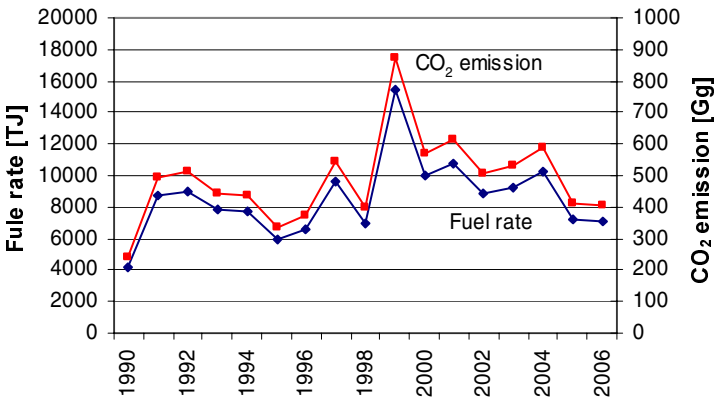

Figure 3.61 Time-series for off shore gas flaring and the CO_2 emission in sector 1B2c ii Flaring, gas

The fuel consumption for offshore flaring was higher in 1999 due to the opening of new gas fields.

Besides 1999, consumption has been fairly stable for a number of years. The decrease from 15390 TJ in 1999 to 7157 TJ in 2006 represents a decrease of around 53%.

3.4.3 Uncertainties and time-series consistency

Uncertainty estimates are included in the uncertainty estimate for stationary combustion plants.

3.4.4 Source-specific QA/QC and verification

No source-specific QA/QC and verification have been performed.

3.4.5 Source-specific recalculations

No recalculations have been carried out.

3.4.6 Source-specific planned improvements

No source-specific improvements are planned.

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4 Industrial processes (NFR sector 2)

4.1 Overview of the sector

The present sector *"Industrial processes"* (NFR sector 2) comprises combustion processes combined with *"process emissions"* (combustion in manufacturing industry - processes with contact) as well as process emissions without any contact with energy-related emissions. This means that the energy source may be power from central power plants or process heat from e.g. natural gas-fired boilers, turbines or stationary engines. The presentation is outlined as follows:

- Mineral products (NFR 2A) including "Other" (NFR 1A2f)
- Chemical industry (NFR 2B)
- Metal production (NFR 2C) including "Iron and steel" (NFR 1A2a) and "Non-ferrous metals" (NFR 1A2b)
- Other production (NFR 2D)

The industrial processes included in the Danish inventory are those in large companies, e.g. cement factories or steelworks, as well as a number of smaller companies e.g. iron foundries. Furthermore, asphalt concrete plants are to be included in future.

Table 4.1 presents a survey of sources and groups of pollutants included in the present survey as well as pollutants and sources that will be included in the survey. Explanations to the abbreviations are given below the table.

Table 4.1 indicates that some groups of substances are planned to be included in the inventory. In addition to the indicated groups of substances some groups do not include all relevant substances or the time-series are not complete. Detailed information on this subject can be found in the following table with an indication of which substances that will be completed/improved in the inventory.

Table 4.1 Survey of industrial sector with SNAP-code and NFR-code included in the Danish inventory.

Industrial sector	SNAP	NFR	Energy	SO_X/ NO_X/ NH_3	NMVOC/CO	TSP/ $PM_{10/2.5}$	HM	POP
Grey iron foundries	030303	1A2a	ie	+	+	x	x	-
Secondary lead production	030307	1A2b	ie	-	-	x	x	-
Secondary zinc production	030308	1A2b	ie	-	-	x	+	-
Secondary aluminium production	030310	1A2b	ie	-	-	x	+	-
Cement	030311	1A2f	y	x	x	x	x	-
Lime (incl. iron, steel and paper pulp industry)	030312	1A2f	ie	+	-	x	+	-
Asphalt concrete plants	030313	1A2f	+	+	+	+	-	+/?
Container glass	030315	1A2f	y	x	x	x	x	-
Glass wool	030316	1A2f	ie	x/+	-	x	+	-
Mineral wool	030318	1A2f	y	x/+	x	x	+	-
Paper mill industry	030321	1A2d	y	-	+	x	-	-
Electric arc furnace	040207	2C1	-	-	-	x	x	+/?
Allied metal manufacturing	040306	2C5	-	-	-	+	x	-
Sulphuric acid	040401	2B5	-	x	-	-	-	-
Nitric acid	040402	2B2	y	x	-	x	-	-
NPK-fertiliser	040407	2B5	-	x	ie	x	ie	-
Other (catalysts)	040416	2B5	y	x	-	x	-/?	-
Pesticide production	040525	2B5	-	+	x	+	-	+/?
Bread	040605	2D2	-	-	+	-	-	
Beer	040607	2D2	-	-	x	-	-	
Roof covering with asphalt materials	040610	2A5	-	-	x	-	-	+/?
Road paving with asphalt	040611	2A6	-	+	x	-	-	+/?
Cement (decarbonising)	040612	2A1	-	ie	-	-	+	-
Glass (decarbonising)	040613	2A7	-	ie	-	-	+	-
Lime (decarbonising)	040614	2A2	-	ie	-	-	+	-
Other (sugar, chemical ingredients, slaughterhouse waste)	040617	2A7	y	x/+	x	x	-	+/?
Limestone and dolomite use	040618	2A3	-	ie	+	ie	ie	-

x Included in the present inventory.
+ Will be included.
- Not included/not relevant.
ie Included elsewhere.
y Included in the present inventory.

4.2 Mineral products (NFR 1A2f/2A)

4.2.1 Source category description

The sub-sector *Mineral products* (NFR 1A2f/2A) cover the following processes:

- Production of cement (SNAP 030311/040612)
- Production of lime (quicklime) (SNAP 030312/040614)
- Production of container glass/glass wool (SNAP 030315/030316/ 040613)
- Production of mineral wool (SNAP 030318)
- Limestone and dolomite use (SNAP 040618)
- Roof covering with asphalt (SNAP 040610)
- Road paving with asphalt (SNAP 040611)
- Other (SNAP 040617; Danisco sugar/Danisco ingredients/ Slaughterhouse waste)

The time-series for emission of acidifying substances, heavy metals, NMVOC and particulate matter from *Mineral products* (NFR 1A2f/2A) are presented in Table 4.2 and Table 4.3.

The emission of SO_2, NO_X and CO from the production of cement depends on raw materials, fuels and combustion conditions. Emissions of NO_X are, among other things, a consequence of high temperature processes and the emission shows only minor fluctuations. The emission follows the activity, with a minor decrease in recent years. The emission of SO_2 depends on the S-content in fuels and raw materials. However, the process acts as a sink for acidifying gases due to the alkaline conditions in the rotary kiln. The emission of CO displays significant fluctuations that cannot be explained by known factors.

The emission of NO_X from production of container glass is increasing slightly until 2004 and the decreasing significantly whereas the emission of CO is decreasing in the period 1990-2006. In the same period of time, the activity is nearly constant. Emissions of both substances are related to combustion/process conditions and will be investigated further. Emissions of the heavy metals lead, selenium and zinc are related to the raw materials used. Recycled glass constitutes a considerable part of raw materials and, therefore, the quality/purity of the glass is a determining factor. Emission of lead shows a decreasing trend that is in accordance with the attempts to avoid lead in glass as well as in wine bottle seals.

Production of glass wool is expected to result in emission of approximately the same pollutants as in production of container glass. NH_3 shows a decreasing trend from 1996-2006 as can be verified by the decreasing emission per amount produced. Potential emissions of NO_X, CO and heavy metals are planned to be investigated and included in the inventory.

Table 4.2 Time-series for pollutants from *Mineral products 1A2f* (combustion/process emissions; metals: kg and other pollutants: tonnes).

Pollutants	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SO_2	2 128	2 467	2 655	2 680	2 682	2 706	2 804	3 631	3 372	2 186
NO_x	6 953	8 468	9 329	9 450	9 443	9 569	10 138	10 306	10 478	9 583
NMVOC	98.3	116	124	125	131	136	132	136	129	113
NH_3	489	489	489	489	489	489	475	561	552	560
CO	12 260	12 601	12 795	12 822	12 820	12 848	12 462	13 506	16 993	15 353
TSP										
PM_{10}										
$PM_{2.5}$										
As	52.1	78.1	79.1	78.6	80.9	82.1	68.0	57.4	58.3	54.5
Cd	35.9	61.7	59.0	57.9	60.8	58.0	38.0	19.1	19.4	18.0
Cr	410	783	718	697	743	697	362	29.3	29.9	28.0
Cu	115	211	196	191	203	194	111	30.1	30.7	28.8
Hg	105	136	147	149	150	152	154	165	167	155
Ni	344	644	595	579	616	582	318	58.5	59.5	55.7
Pb	1 180	1 101	950	879	879	1 540	730	205	452	594
Se	339	316	276	255	271	464	227	290	91.8	236
Zn	245	243	227	211	217	292	200	171	187	184

Continued	2000	2001	2002	2003	2004	2005	2006
SO_2	1 692	2 156	1 431	1 470	1 929	1 827	2 209
NO_x	10 451	10 300	9 417	8 624	8 685	8 660	8 378
NMVOC	118	108	107	89	102	103	105
NH_3	497	444	358	334	363	335	337
CO	15 302	13 545	10 340	9 574	10 754	9 927	9 654
TSP	532	567	446	429	422	368	427
PM_{10}	467	497	386	373	369	321	374
$PM_{2.5}$	270	287	235	234	232	203	224
As	55.3	56.0	56.5	53.1	59.8	56.5	59.3
Cd	18.4	18.7	19.0	17.9	20.1	19.0	20.0
Cr	28.3	28.6	28.8	27.1	30.5	28.8	30.2
Cu	29.1	29.4	29.4	27.6	31.1	29.4	30.8
Hg	158	161	163	154	173	164	172
Ni	56.4	57.1	57.4	54.0	60.8	57.4	60.2
Pb	362	204	204	302	470	179	45.0
Se	359	290	290	252	245	126	79.3
Zn	198	167	168	160	177	168	175

Table 4.3 Time-series for pollutants from *Mineral products 2A* (process emissions; tonnes).

Polluntants	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4	16.0	16.0	16.8	17.5	15.8	16.3	16.3	16.3	14.3	15.5
CO	241	241	252	263	237	245	245	245	215	234
NMVOC	654	655	656	658	654	655	656	648	654	617
NH_3	24.2	32.4	32.2	35.1	32.1	31.5	31.2	30.0	31.4	36.3
TSP										
PM_{10}										
$PM_{2.5}$										
Continued	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**			
CH_4	14.8	13.0	13.0	13.3	18.5	18.2	18.2			
CO	223	196	196	199	278	275	274			
NMVOC	594	565	563	561	578	576	577			
NH_3	34.0	31.9	47.9	157	167	132	96.4			
TSP	191	189	172	-[1]	-[1]	-[1]	-[1]			
PM_{10}	47.8	47.3	43.0	-[1]	-[1]	-[1]	-[1]			
$PM_{2.5}$	7.64	7.56	6.88	-[1]	-[1]	-[1]	-[1]			

1. Emission of TSP, PM_{10}, $PM_{2.5}$ are related to energy consumption from 2003.

The emission of NMVOC from production of chemical ingredients shows a decreasing trend and can probably be explained by the decreasing emission per amount produced.

4.2.2 Methodological issues

The emissions of SO_2, NO_X, CO and TSP from the production of cement are measured yearly from 1997 to 2006 (TSP from 2000 to 2006). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). For the years 1990-1996, the emission has been estimated from the production of cement, expressed as TCE (total cement equivalents[4]), and emission factors from the company Aalborg Portland (Aalborg Portland, 2007). The emissions of heavy metals are measured in 1997 (Illerup et al., 1999) and estimated for the other years from emission factors (based on the measurements) and TCE. The activity has varied from 1.6 million tonne TCE in 1990 to 2.8 million tonne TCE in 2006.

The emission of NO_X, CO, TSP, lead, selenium, and zinc from production of container glass is measured yearly from 1997 to 2006 (TSP from 2000 to 2006) (Rexam Glass Holmegaard, 2007). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). For 1990 to 1996, emissions of arsenic, cadmium, chromium, copper, mercury and nickel are estimated from standard emission factors and activity data. For 1997 to 2006, the energy related emissions are estimated from emission factors and the actual energy consumption. This change in methodology results in inconsistency in the emission trend that cannot be explained by natural factors. Emission factors for lead, selenium, and zinc from 1990 to 1996 are estimated by interpolation from the 1990 and 1997 figures (Illerup et al., 1999).

[4] TCE (total cement equivalent) express the total amount of cement produced for sale and the theoretical amount of cement from the produced amount of clinker for sale.

The emission of NH_3 and TSP from the production of glass wool has been measured yearly from 1996 to 2006 (TSP from 2000 to 2006) (Saint-Gobain Isover, 2007). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). The activity has varied between 33,600 and 42,735 tonnes glass wool from 1996 to 2006 and, during the same period, the emission decreased from approximately 300 to 123 tonne NH_3.

The emission of NMVOC from production of chemical ingredients has been measured from 1996 to 2006 (Danisco Grindsted, 2007). The emission has decreased from 100 to 15 tonnes NMVOC in this period. However, no explanation can be given on these conditions, as information on activity is not available.

The emissions from asphalt roofing and road paving have been estimated from production statistics compiled by Statistics Denmark and default emission factors presented by IPCC/Corinair. The default emission factors are presented in Table 4.4.

Table 4.4 Default emission factors for application of asphalt products.

		Road paving with asphalt	Use of cutback asphalt	Asphalt Roofing
CH_4	g/tonnes	5	0	0
CO	g/tonnes	75	0	10
NMVOC	g/tonnes	15	64 935	80
Carbon content fraction of NMVOC	%	0.667	0.667	0.8

4.2.3 Uncertainties and time-series consistency

The time-series are presented in Table 4.2 and Table 4.3. The methodologies applied for the different sources within *Mineral products* are considered to be consistent either as measurements or emission factors based on the measurements. However, not all the sources are considered to be complete regarding pollutants and these are expected to be completed in the next inventory, either by use of company-specific information or by application of general emission factors.

The time-series for emissions from production of cement are based on measurements combined with emissions factors based on the measurements.

4.2.4 Source-specific QA/QC and verification

The emission factors have been verified and the order of magnitude confirmed by comparison with standard emission factors (EMEP/CORINAIR, 2007; CEPMEIP, 2003). Detailed discussion of QA/QC can be found in Nielsen et al. (2008).

4.2.5 Source-specific recalculations

The inventory has been completed with emissions from roof covering with asphalt and road paving with asphalt.

4.2.6 Source-specific planned improvements

The inventory will be improved regarding coverage of pollutants included. Especially glass wool, mineral wool, chemical ingredients and production of sugar will be extended. The incomplete time-series will also be completed. The inconsistent methodology applied for emission of As, Cd, Cr, Cu, Hg, and Ni from glass production will be improved.

4.3 Chemical industry (NFR 2B)

4.3.1 Source category description

The sub-sector *Chemical industry* (NFR 2B) covers the following processes:

- Production of nitric acid/fertiliser (SNAP 040402/040407)
- Production of catalysts/fertilisers (SNAP 040416/040407)
- Production of pesticides (SNAP 040525)

The time-series for emission of acidifying substances, NMVOC and particulate matter from *Chemical industry* (NFR 2B) are presented in Table 4.5.

Table 4.5 Time-series for pollutants from *Chemical industry 2B* (tonnes).

Pollutant	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SO_2	636	496	600	461	514	406	247	397	408	487
NO_x	842	778	691	619	636	648	543	611	472	509
NH_3	25.0	35.0	48.0	62.0	104	75.0	75.0	50.0	25.0	33.0
NMVOC	390	150	62.0	40.0	54.0	57.0	113	44.0	40.0	41.0
TSP										
PM_{10}										
$PM_{2.5}$										
Continued	2000	2001	2002	2003	2004	2005	2006			
SO_2	421	449	436	321	340	402	258			
NO_x	447	422	419	475	302	30.2	37.0			
NH_3	27.0	101	93.0	113	101	79.0	88.0			
NMVOC	29.0	29.0	26.7	25.4	31.4	25.7	25.3			
TSP	362	346	310	323	192	-[1]	-[1]			
PM_{10}	290	277	248	258	153	-[1]	-[1]			
$PM_{2.5}$	217	208	186	194	115	-[1]	-[1]			

1. Nitric acid production ceased in 2004.

The time-series for SO_2 follows the amount of sulphuric acid produced, i.e. the fluctuation follows the activity until the activity ceased in 1997. The same is the case for NO_X from production of nitric acid; however, the emission of NO_X per amount produced is decreasing from 1994 to 2004. The emission of NH_3 does not follow the activity as it appears from the fluctuation in the emission per amount produced. The production of nitric acid and fertiliser stopped in the middle of 2004.

The emission of NO_X from production of catalysts/fertilisers decreases from 1996 to 2006, whereas the emission of NH_3 increases. Fluctuations and the increase in the "emission factor" can explain the increase in NH_3 emission.

The emission of NMVOC from production of pesticides reduced significantly from 1990 to 2006. The decrease can probably be explained by introduction of flue gas cleaning equipment rather than any decrease in activity. The emission of SO_2 is from the sulfur regeneration plant (Claus plant).

The time-series will be explained further in the following section.

4.3.2 Methodological issues

The emission of SO_2, NO_X, NH_3 and TSP from production of sulfuric acid, nitric acid and fertiliser is measured yearly or estimated, from 1990 to 2004 (TSP from 2000 to 2004) (Kemira GrowHow, 2005). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). The emission for SO_2 and NO_X for 1991 to 1993 was estimated by using interpolated emission factors and activity data. Production of sulphuric acid was stopped in 1997. The emission factor for SO_2 fluctuated and the emission factor for NO_X decreased from 1990 to 2004. Production of sulphuric acid decreased from approximately 150,000 to 60,000 tonnes from 1990 to 1996, and production of nitric acid decreased from approximately 450,000 to 229,000 tonnes from 1990 to 2004. Overall, production of fertiliser decreased from approximately 800,000 to approximately 395,000 tonnes from 1990 to 2004.

The emission of NH_3, NO_X and TSP from production of catalysts and fertilisers is measured yearly from 1996 to 2006 (TSP from 2000 to 2006) (Haldor Topsøe, 2007). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). The process-related NO_X emission has been estimated as 80% of the total NO_X emission; Haldor Topsøe reports this assumption in their environmental report. The emission of NH_3 shows an increasing trend and varies between 13 and 88 tonne from 1990 to 2006. In the same period, the production of catalysts and fertilisers increased from approximately 33,000 to 45,000 tonnes.

The emission of NMVOC from production of pesticides is measured yearly from 1990 to 2000 (Cheminova, 2007) and estimated for 2001 to 2006. An emission factor based on 2000 figures is used for estimation of 2001 to 2006 emissions. The emission of NMVOC shows a decreasing trend from 1990 to 2006.

4.3.3 Uncertainties and time-series consistency

The time-series are either based on specific measurements or by using company-specific emission factors and activity data. Therefore, the time-series are considered to be consistent.

4.3.4 Source-specific QA/QC and verification

The emission factors for production of nitric acid and sulphuric acid have been verified by comparison with standard emission factors (EMEP/CORINAIR, 2007). Detailed discussion of QA/QC can be found in Nielsen et al. (2008).

4.3.5 Source-specific recalculations

SO_2 emission from sulphur regeneration plant has been included in the inventory.

4.3.6 Source-specific planned improvements

No source-specific improvements are planned.

4.4 Metal production (NFR 1A2/2C)

4.4.1 Source category description

The sub-sector *Metal production* (NFR 1A2/2C) covers the following processes:

- Steelworks (SNAP 040207)
- Iron foundries (SNAP 030303)
- Secondary lead production (SNAP 030307)
- Secondary zinc production (SNAP 030308)
- Secondary aluminium production (SNAP 030310)
- Allied metal manufacturing (SNAP 040306)

The time-series for emission of heavy metals and particulate matter from *Metal production* (NFR 1A2/2C) are presented in Table 4.6 and Table 4.7.

The emission inventory for metal production is based on specific emissions from steelworks and secondary aluminium manufacturing as well as average emission factors for iron foundries, secondary lead and zinc manufacturing, and allied metal manufacturing. Regarding the steelworks that use iron and steel scrap as raw material, the emissions to a large degree depend on the quality of the scrap. This fact may result in large annual variations for one or more of the heavy metals. This may be the case for iron foundries, as they also use scrap as raw material, but they have not been subject to the same requirements to analyse emissions of heavy metals to air.

Table 4.6 Time-series for pollutants from *Metal production 1A2ab* (combustion/process emissions; metals: kg and other pollutants: tonnes).

Pollutant	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TSP										
PM_{10}										
$PM_{2.5}$										
As	30.9	30.1	29.3	28.6	27.8	27.1	26.3	25.5	25.7	25.8
Cd	14.5	14.1	13.8	13.4	13.1	12.7	12.3	12.0	12.1	12.1
Cr	113	110	108	105	102	99.2	96.4	93.6	94.4	94.6
Cu	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Hg	ne	ne	ne	ne	ne	ne	ne	ne	ne	ne
Ni	134	131	127	124	121	117	114	111	112	112
Pb	750	732	713	695	676	658	639	621	627	628
Se	515	502	489	477	464	451	438	426	429	430
Zn	515	502	489	477	464	451	438	426	429	430

Continued	2000	2001	2002	2003	2004	2005	2006
TSP	227	206	207	200	204	205	192
PM_{10}	88.7	82.6	81.8	75.6	74.9	79.7	78.7
$PM_{2.5}$	22.8	22.0	21.3	18.6	17.8	20.6	21.7
As	28.9	25.7	26.2	26.2	27.2	26.2	23.6
Cd	13.6	12.1	12.3	12.3	12.8	12.3	11.1
Cr	106	94.3	96.0	96.0	100	96.0	86.4
Cu	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Hg	ne	ne	ne	ne	ne	ne	ne
Ni	125	111	113	113	118	113	102
Pb	703	626	637	637	661	637	574
Se	482	429	437	437	453	436	393
Zn	482	429	437	437	453	436	393

ne not estimated

Table 4.7 Time-series for pollutants from *Metal production 2C* (process emissions; metals: kg and other pollutants: tonnes).

Pollutant	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TSP										
PM_{10}										
$PM_{2.5}$										
Cd	42.6	42.7	42.8	46.3	49.8	49.5	46.4	34.5	42.6	6.96
Cr	6.75	6.75	6.75	7.35	7.95	7.89	7.00	0.00	1.00	0.00
Cu	39.0	39.9	40.8	41.7	42.6	43.5	44.0	45.3	45.3	45.3
Hg	136	136	136	148	160	158	147	84.0	60.6	49.5
Ni	272	272	272	296	320	318	294	228	112	86.1
Pb	731	733	734	795	856	851	794	704	441	735
Zn	5 891	5 905	5 917	6 404	6 892	6 852	6 398	5 656	3 050	2 755
Continued	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**			
TSP	41.0	93.0	-[1]	-[1]	-[1]	32.5	-[1]			
PM_{10}	39.0	88.0	-[1]	-[1]	-[1]	30.8	-[1]			
$PM_{2.5}$	25.0	56.0	-[1]	-[1]	-[1]	19.6	-[1]			
Cd	24.5	40.5	4.53	4.53	4.53	4.53	4.53			
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Cu	45.3	45.3	45.3	45.3	45.3	45.3	45.3			
Hg	90.0	184	-[1]	-[1]	-[1]	63.9	-[1]			
Ni	60.0	123	-[1]	-[1]	-[1]	42.6	-[1]			
Pb	508	939	68.0	68.0	68.0	370	68.0			
Zn	2 024	3 420	634	634	634	1 600	634			

1. Steelwork was closed 2002-2004 and in 2006.

The steelworks closed in the beginning of 2002 and re-opened at the end of 2004.

4.4.2 Methodological issues

The emission of heavy metals and TSP from the production of steel bars and sheets from steel scrap are based on measurements from the company Stålvalseværket (Stålvalseværket, 2002). PM_{10} and $PM_{2.5}$ are estimated from the distribution between TSP, PM_{10} and $PM_{2.5}$ from CEPMEIP (2003). The distribution of metals for 1995/96 (Illerup et al., 1999) is used in estimation of the different metals for the following years. The activity has varied between approximately 600,000 and 800,000 tonnes from 1990 to 2001. The production ceased in the beginning of 2002 and restarted at the end of 2004 with regard to melting of steel scrap in the electric arc furnace. The production of steel bars at the steelwork is assumed to be 1/3 of the production in 2001; the steelwork has been closed from end of 2005/beginning of 2006.

The emission of heavy metals from iron foundries is based on standard emission factors and yearly production statistics from The Association of Danish Foundries. The emission of TSP and distribution between TSP, PM_{10} and $PM_{2.5}$ is obtained from CEPMEIP (2003).

The emission of heavy metals from production of secondary lead and allied metal manufacturing is based on average emission factors for Danish producers (Illerup et al., 1999) and activity data from Statistics Denmark. The emission of TSP and distribution between TSP, PM_{10} and $PM_{2.5}$ is obtained from CEPMEIP (2003).

4.4.3 Uncertainties and time-series consistency

The time-series are either based on specific measurements, company-specific emission factors combined with activity data or on standard emission factors combined with public statistics. The same methodology has been applied for the entire time-series and, therefore, the time-series are considered to be consistent.

4.4.4 Source specific recalculations

No source-specific recalculation has been performed for the sector *Metal production*.

4.4.5 Source-specific QA/QC and verification

Detailed discussion of QA/QC can be found in Nielsen et al. (2008)

4.4.6 Source-specific planned improvements

The time-series will be completed and new emission factors for the latest years will be established, if possible. Especially for secondary aluminium and zinc production, potential emissions of heavy metals will be investigated.

4.5 Other production (NFR 2D)

4.5.1 Source category description

The sub-sector *Other production* (NFR 2D) covers the following process:

- Beer (SNAP 040607)

The time-series for emission of NMVOC from *Other production* (NFR 2D) is presented in Table 4.8.

Table 4.8 Time-series for emission of NMVOC from *Other production 2D2* (tonnes).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NMVOC	582	604	611	590	588	619	599	574	503	502
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**			
NMVOC	466	452	513	522	534	543	511			

The emission of NMVOC from production of beer follows the activity as the same emission factor has been used for the entire period.

4.5.2 Methodological issues

The emission of NMVOC from breweries is estimated from production statistics (Statistics Denmark) and standard emission factors from the IPCC guidelines (IPCC (1997) Vol. 3, Table 2-24).

4.5.3 Uncertainties and time-series consistency

The time-series is based on the same methodology throughout, using public statistics and standard emission factors. Therefore, the time-series is considered to be consistent.

4.5.4 Source-specific recalculations

Detailed discussion of QA/QC can be found in Nielsen et al. (2008)

4.5.5 Source-specific QA/QC and verification

No source-specific QA/QC and verification has been performed for the sector *Other production*.

4.5.6 Source-specific planned improvements

The time-series for emission of NMVOC from production of beer is planned to be completed. Furthermore, production of bread and other food products are planned to be included in the next inventory.

4.6 Uncertainty estimates

Uncertainty estimates for industrial processes (SNAP 04) are presented in Table 4.9. The uncertainty estimates are based on standard uncertainty factors (EMEP/CORINAIR, 2007).

Table 4.9 Uncertainty estimates for industrial processes (%).

	Activity data uncertainty	Emission factor uncertainty	Overall 2005	Trend
SO_2	2	20	20.100	0.365
NO_x	2	50	50.040	0.124
NMVOC	2	50	50.040	2.492
CO	50	100	50.040	3.222
NH_3	2	1000	1000.002	10.59
Cadmium	2	1000	1000.002	0.299
Copper	2	1000	1000.002	3.291
Lead	2	1000	1000.002	0.064
Zinc	2	1000	1000.002	0.149

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5 Solvents and other product use (CRF Sector 3)

5.1 Overview of the sector

Use of solvents and other organic compounds in industrial processes and households are important sources of evaporation of NMVOCs, and are related to the source categories Paint application (CRF sector 3A), Degreasing and dry cleaning (CRF sector 3B), Chemical products, manufacture and processing (CRF sector 3C) and Other (CRF sector 3D). In this section the methodology for the Danish NMVOC emission inventory for solvent use is presented and the results for the period 1995 – 2006 are summarised. The method is based on a chemical approach, and this implies that the SNAP category system is not directly applicable. Instead emissions will be related to specific chemicals, products, industrial sectors and households and to the CRF sectors mentioned before.

5.2 Paint application (CRF Sector 3A), Degreasing and dry cleaning (CRF Sector 3B), Chemical products, Manufacture and processing (CRF Sector 3C) and Other (CRF Sector 3D)

5.2.1 Source category description

Table 5.1 and Figure 5.1 show the emissions of chemicals from 1985 to 2006, where the used amounts of single chemicals have been assigned to specific products and CRF sectors. The methodological approach for finding emissions in the period 1995 - 2006 is described in the following section. A linear extrapolation is made for the period 1985 – 1994. A general decrease is seen throughout the sectors. Table 5.2 shows the used amounts of chemicals for the same period. Table 5.1 is derived from Table 5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 5.3 showing the used amount of products is derived from Table 5.2, by assessing the amount of chemicals that is comprised within products belonging to each of the four source categories. The conversion factors are rough estimates, and more thorough investigations are needed in order to quantify the used amount of products more accurately.

In Table 5.4 the emission for 2006 is split into individual chemicals. The most abundantly used solvents are methanol, propylalcohol and turpentine, or white spirit defined as a mixture of stoddard solvent and solvent naphtha. Methanol is primarily used as intermediate (monomer), solvent in thinners, degreasers et al. and as disinfecting and conserving agent. Propylalcohol is used as flux agents for soldering, as solvent and thinner and as windscreen washing agent. Turpentine is used as thinner for paints, lacquers and adhesives. Household emissions are dominated by propane and butane, which are used as aerosols in spray cans, primarily in cosmetics. For some chemicals the emission factors are precise but for most chemicals they are rough estimates from SFT (1994) and from vari-

ous other sources. High emission factors are assumed for use of chemicals (products) and lower factors for industrial production processes.

Table 5.1 Emission of chemicals in Gg pr year

Total emissions Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Paint application (3A)	21,8	21,3	20,9	20,4	19,9	19,5	19,0	18,6	18,1	17,6	16,1
Degreasing and dry cleaning (3B)	9,04	8,87	8,69	8,51	8,33	8,15	7,97	7,80	7,62	7,44	6,86
Chemical products, manufacturing and processing (3C)	3,34	3,32	3,31	3,29	3,27	3,25	3,24	3,22	3,20	3,18	3,55
Other (3D)	18,8	18,4	17,9	17,5	17,1	16,6	16,2	15,8	15,3	14,9	18,1
Total NMVOC	53,0	51,9	50,8	49,7	48,6	47,5	46,4	45,3	44,2	43,1	44,6
Total CO_2[a]	165	162	158	155	152	148	145	141	138	134	139

Continued	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Paint application (3A)	17,2	17,9	15,7	14,6	15,5	14,0	13,1	12,1	12,9	13,1	12,7
Degreasing and dry cleaning (3B)	7,63	6,91	6,24	6,82	6,60	5,65	6,06	5,73	5,71	5,46	5,29
Chemical products, manufacturing and processing (3C)	3,50	3,04	2,95	3,01	2,83	2,76	3,07	2,37	3,06	3,31	3,49
Other (3D)	14,8	12,0	11,8	11,3	11,2	10,5	11,2	10,0	10,8	11,3	11,2
Total NMVOC	43,1	39,8	36,7	35,7	36,1	32,9	33,4	30,1	32,4	33,1	32,7
Total CO_2[a]	134	124	114	111	113	102	104	94	101	103	102

[a] 0.85*3.67*total NMVOC

Table 5.2 Used amounts of chemicals in Gg pr year

Used amounts of chemical Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Paint application (3A)	45,2	46,6	48,0	49,4	50,8	52,1	53,5	54,9	56,3	57,7	57,1
Degreasing and dry cleaning (3B)	27,2	27,3	27,3	27,4	27,5	27,5	27,6	27,7	27,7	27,8	28,6
Chemical products, manufacturing and processing (3C)	68,9	71,9	74,8	77,8	80,7	83,7	86,6	89,6	92,5	95,5	105
Other (3D)	27,6	28,6	29,6	30,6	31,6	32,6	33,6	34,6	35,6	36,6	46,7
Total NMVOC	169,0	174,4	179,8	185,2	190,6	196,0	201,3	206,7	212,1	217,5	237

Continued	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Paint application (3A)	61,5	96,2	60,5	53,8	57,4	52,3	52,6	58,4	77,9	90,5	82,9
Degreasing and dry cleaning (3B)	29,5	28,7	25,4	29,0	28,5	26,1	27,5	26,5	28,8	29,3	30,5
Chemical products, manufacturing and processing (3C)	103	108	102	107	114	116	117	101	122	136	144
Other (3D)	40,4	42,1	37,0	36,4	39,1	39,6	38,3	39,1	49,2	51,5	57,4
Total NMVOC	235	275	225	226	239	234	236	225	277	307	315

Table 5.3 Used amounts of products in Gg pr year

Used amounts of products Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Paint application (3A)	301	311	320	329	338	348	357	366	375	385	381
Degreasing and dry cleaning (3B)	54	55	55	55	55	55	55	55	55	56	57
Chemical products, manufacturing and processing (3C)	345	359	374	389	404	418	433	448	463	477	524
Other (3D)	138	143	148	153	158	163	168	173	178	183	234
Total products	839	868	897	926	955	984	1013	1042	1071	1100	1195

Continued	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Paint application (3A)	410	642	403	359	383	349	351	389	519	603	553
Degreasing and dry cleaning (3B)	59	57	51	58	57	52	55	53	58	59	61
Chemical products, manufacturing and processing (3C)	517	540	512	536	569	580	586	504	608	678	722
Other (3D)	202	210	185	182	196	198	191	195	246	257	287
Total products	1188	1449	1152	1134	1204	1179	1184	1142	1431	1597	1622

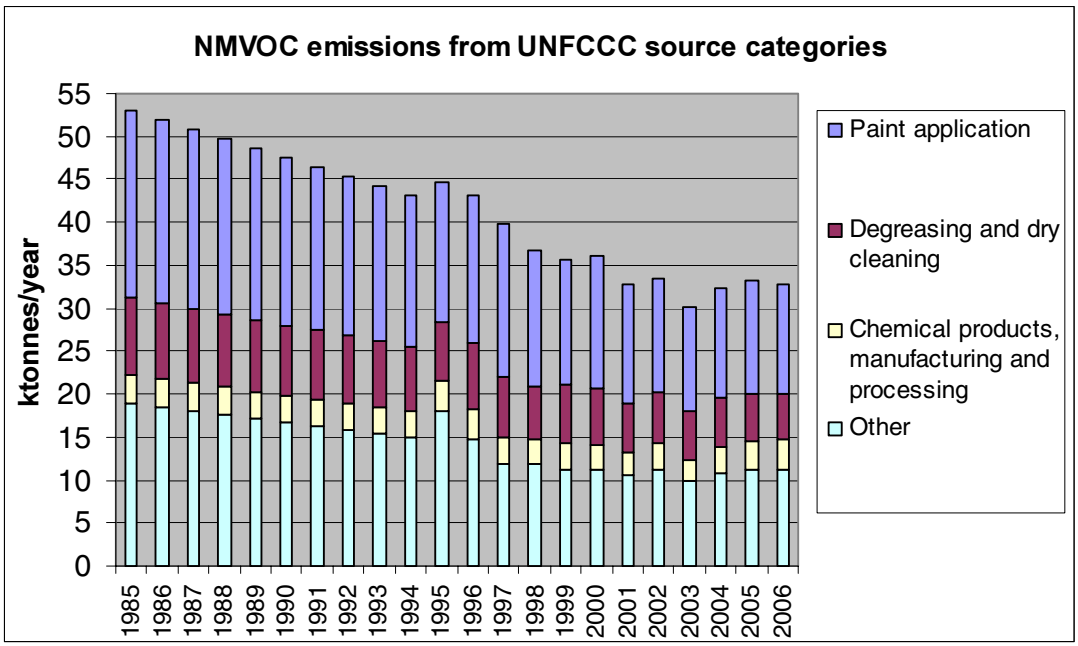

Figure 5.1 Emissions of chemicals in ktonnes pr year (equal to Gg pr year). The methodological approach for finding emissions in the period 1995 – 2006 is described in the text, and a linear extrapolation is made for 1985 – 1994. Figures can be seen in Table 5.1

Table 5.4 Chemicals with highest emissions 2006

Chemical	Emissions 2006 (tonnes/year)
methanol	4777
propylalcohol	4167
turpentine (white spirit: stoddard solvent and solvent naphtha)	3940
aminooxygengroups	2865
glycerol	2630
pentane	2331
ethanol	2166
naphthalene	1768
acetone	1297
propane	1000
butane	1000
butanone	676
glycolethers	622
ethylenglycol	610
formaldehyde	503
cyclohexanones	482
propylenglycol	479
1-butanol	240
butanoles	227
xylene	202
toluendiisocyanate	199
phenol	129
methyl methacrylate	74.8
toluene	66.6
acyclic aldehydes	65.1
dioctylphthalate	60.6
acyclic monoamines	51.3
styrene	49.6
tetrachloroethylene	26.1
triethylamine	11.9
diethylenglycol	10.3
diamines	0,018
Total 2006	**32726**

5.2.2 Other use (N_2O)

This year's solvent use emission inventory includes N_2O emissions for the first time. Five companies sell N_2O in Denmark and only one company produces N_2O. N_2O is primarily used in anaesthesia by dentists, veterinarians and in hospitals and in minor use as propellant in spray cans and in the production of electronics. Due to confidentiality no data on produced amount are available and thus the emissions related to N_2O production are unknown. An emission factor of 1 is assumed for all uses, which equals the sold amount to the emitted amount.

Three companies have reported their sale and the sale for one company has been estimated. The total sold (emitted) amounts are:

2005: 0.045 Gg N_2O

2006: 0.12 Gg N_2O

5.2.3 Uncertainties and time-series consistency

An estimate of the overall uncertainty in EMEP/CORINAIR of 165% is used.

5.2.4 Methodological issues

The emissions of Non-Methane Volatile Organic Compounds (NMVOC) from industrial use and production processes and household use in Denmark have been assessed. Until 2002 the NMVOC inventory in Denmark was based on questionnaires and interviews with different industries, regarding emissions from specific activities, such as lacquering, painting impregnation etc. However, this approach implies large uncertainties due to the diverse nature of many solvent-using processes. For example, it is inaccurate to use emission factors derived from one printwork in an analogue printwork, since the type and combination of inks may vary considerably. Furthermore the employment of abatement techniques will result in loss of validity of estimated emission factors.

A new approach has been introduced, focusing on single chemicals instead of activities. This will lead to a clearer picture of the influence from each specific chemical, which will enable a more detailed differentiation on products and the influence of product use on emissions.

The procedure is to quantify the use of the chemicals and estimate the fraction of the chemicals that is emitted as a consequence of use. Mass balances are simple and functional methods for calculating the use and emissions of chemicals

$$use = production + import - export - destruction/disposal - hold\ up \quad \text{(Eq.1)}$$

$$emission = use * emission\ factor \quad \text{(Eq.2)}$$

where "hold up" is the difference in the amount in stock in the beginning and at the end of the year of inventory.

A mass balance can be made for single substances or groups of substances, and the total amount of emitted chemical is obtained by summing up the individual contributions. It is important to perform an in-depth investigation in order to include all relevant emissions from the large amount of chemicals. The method for a single chemical approach is shown in Figure 5.2.

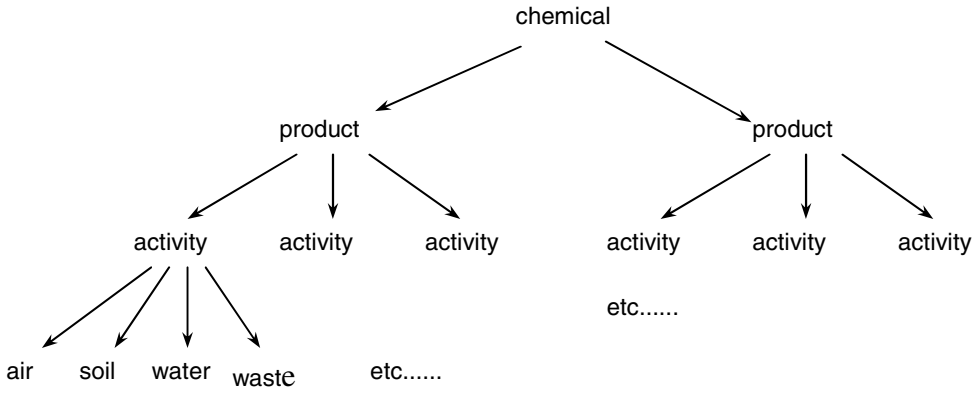

Figure 5.2 Methodological flow in a chemical based emission inventory.

The tasks in a chemical focused approach are

- Definition of chemicals to be included
- Quantification of use amounts from Eq.1
- Quantification of emission factors for each chemical

In principle all chemicals that can be classified as NMVOC must be included in the analysis, which implies that it is essential to have an explicit definition of NMVOC. The definition of NMVOC is, however, not consistent; In the EMEP-guidelines for calculation and reporting of emissions, NMVOC is defined as "all hydrocarbons and hydrocarbons where hydrogen atoms are partly or fully replaced by other atoms, e.g. S, N, O, halogens, which are volatile under ambient air conditions, excluding CO, CO_2, CH_4, CFCs and halons". The amount of chemicals that fulfil these criteria is large and a list of 650 single chemicals and a few chemical groups described in "National Atmospheric Emission Inventory", cf. Annex 3.F, is used. It is probable that the major part will be insignificant in a mass balance, but it is not correct to exclude any chemicals before a more detailed investigation has been made. It is important to be aware that some chemicals are comprised in products and will not be found as separate chemicals in databases, e.g. di-ethylhexyl–phthalate (DEHP), which is the predominant softener in PVC. In order to include these chemicals the product use must be found and the amount of chemicals in the product must be estimated. It is important to distinguish the amount of chemicals that enters the mass balance as pure chemical and the amount that is associated to a product, in order not to overestimate the use.

Production, import and export figures are extracted from Statistics Denmark, from which a list of 427 single chemicals, a few groups and products is generated. For each of these a *use* amount in tonnes pr. year (from 1995 to 2006) is calculated. It is found that 44 different NMVOCs comprise over 95 % of the total use, and it is these 44 chemicals that are investigated further.

In the Nordic SPIN database (Substances in Preparations in Nordic Countries) information for industrial use categories and products specified for individual chemicals, according to the NACE coding system is available. This information is used to distribute the *use* amounts of individual chemicals to specific products and activities. The product amounts are then distributed to the CRF sectors 3A – 3D.

Emission factors, cf. Eq. 2, are obtained from regulators or the industry and can be provided on a site by site basis or as a single total for whole sectors. Emission factors can be related to production processes and to use. In production processes the emissions of solvents typically are low and in use it is often the case that the entire fraction of chemical in the product will be emitted to the atmosphere. Each chemical will therefore be associated with two emission factors, one for production processes and one for use.

Outputs from the inventory are

- a list where the 44 most predominant NMVOCs are ranked according to emissions to air,

- specification of emissions from industrial sectors and from households,
- contribution from each NMVOC to emissions from industrial sectors and households,
- yearly trend in NMVOC emissions, expressed as total NMVOC and single chemical, and specified in industrial sectors and households.

5.2.5 Uncertainties and time-series consistency

Important uncertainty issues related to the mass-balance approach are

(i) Identification of chemicals that qualify as NMVOCs. The definition is vague, and no approved list of agreed NMVOCs is available. Although a tentative list of 650 chemicals from the "National Atmospheric Emission Inventory" has been used, it is possible that relevant chemicals are not included.

(ii) Collection of data for quantifying production, import and export of single chemicals and products where the chemicals are comprised. For some chemicals no data are available in Statistics Denmark. This can be due to confidentiality or that the amount of chemicals must be derived from products wherein they are comprised. For other chemicals the amount is the sum of the single chemicals *and* product(s) where they are included. The data available in Statistics Denmark is obtained from Danish Customs & Tax Authorities and they have not been verified in this assessment.

(iii) Distribution of chemicals on products, activities, sectors and households. The present approach is based on amounts of single chemicals. To differentiate the amounts into industrial sectors it is necessary to identify and quantify the associated products and activities and assign these to the industrial sectors and households. No direct link is available between the amounts of chemicals and products or activities. From the Nordic SPIN database it is possible to make a relative quantification of products and activities used in industry, and combined with estimates and expert judgement these products and activities are differentiated into sectors. The contribution from households is also based on estimates. If the household contribution is set too low, the emission from industrial sectors will be too high and vice versa. This is due to the fact that the total amount of chemical is constant. A change in distribution of chemicals between industrial sectors and households will, however, affect the total emissions, as different emission factors are applied in industry and households, respectively.

A number of activities are assigned as "other", i.e. activities that can not be related to the comprised source categories. This assignment is based on expert judgement but it is possible that the assigned amount of chemicals may more correctly be included in other sectors. More detailed information from the industrial sectors is continuously being implemented.

(iv) Rough estimates and assumed emission factors are used for many compounds. For some compounds more reliable information has been obtained from the literature and from communication with industrial

sectors. In some cases it is more appropriate to define emission factors for sector specific activities rather than for the individual chemicals.

A quantitative measure of the uncertainty has not been assessed. Single values have been used for emission factors and activity distribution ratios etc. In order to perform a stochastic evaluation more information is needed.

5.2.6 QA/QC and verification

Please refer to the Danish National Inventory Report reported to the UNFCCC (Illerup et al., 2006)

5.2.7 Recalculations

The previous method was based on results from an agreement between the Danish Industry and the Danish Environmental Protection Agency (DEPA). The emissions from various industries were reported to the Danish EPA. The reporting was not annual and linear interpolation was used between the reporting years. It is important to notice that not all use of solvents was included in this agreement and no activity data were available. It is not possible to perform direct comparison of methodologies or to make corrections to the previous method, due to the fundamental differences in structure. But an increase in total emissions was expected due to the more comprehensive list of chemicals.

Improvements and additions are continuously being implemented in the new approach, due to the comprehensiveness and complexity of the use and application of solvents in industries and households. The main improvements in the 2006 reporting include revisions of the following

- Propane and butane is used as aerosol in spraying cans primarily in households. The mean volume of a can is set to 200 ml according to information from e.g. trade associations. This reduces the propane and butane emissions compared to previous inventories.
- Propylalcohol used as windscreen washing agent is reallocated from autopaint and repair to household use.
- Emission factor for propylalcohol used as windscreen washing agent, corresponding to approximately 80% of the annually used amount, is changed to 1.0 for use. Approximately 20% of the annual propylalcohol use is used in closed industrial processes. This amount is assigned a low emission factor of 0.01.
- N_2O emission is introduced in the solvents emission inventory. N_2O is used mainly in anaesthesia.

5.2.8 Planned improvements

Selected branches will be addressed for further adjustments in the following inventory. More detailed information will be obtained for selected industries with respects to used products and chemicals and emission factors related to the activities.

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6 Agriculture

6.1 Overview

6.1.1 Ammonia

The majority of the Danish ammonia emission, corresponding to 97%, originates from the agricultural sector. The remaining 3% originates from traffic and industrial process. Figure 6.1 shows the distribution of sources of NH_3 emission from the agricultural sector 2006. The main part of the agricultural emission is related to manure management, corresponding to 78%. Emissions from use of synthetic fertiliser and crops contribute with 6% and 16%, respectively. Emissions from "Other" as ammonia-treated straw and sewage sludge used as fertiliser amount to less than 1%.

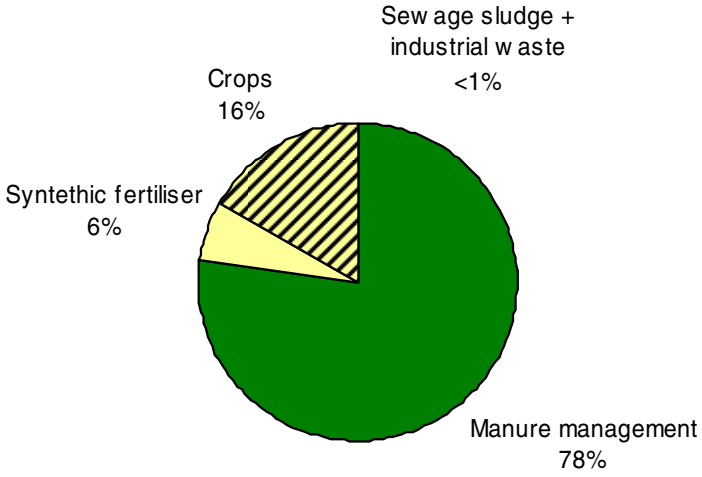

Figure 6.1 Ammonia emissions from the agricultural sector (2006)

From 1985 to 2006, the emission of ammonia from the agricultural sector decreased from 139.24 Gg NH_3 to 87.11 Gg NH_3, which corresponds to a 37% reduction (Table 6.1). This is due to the active national environmental policy of the last twenty years. A series of measures have been introduced to prevent loss of nitrogen from agriculture to the aquatic environment. The measures include improved utilisation of nitrogen in livestock manure, requirements with regard to storage and application of livestock manure, increased area with winter green fields to catch nitrogen, a maximum number of animals per hectare and maximum nitrogen application rates to agricultural crops.

The main part of the emission from the agricultural sector is related to livestock production and, hence, the management of manure. The result of the active environmental policy has brought about a decrease in the N-excretion, a decrease of emission per produced animal and a fall in use of mineral fertilizer, which all has reduced the overall ammonia emission significant.

Table 6.1 Total ammonia emissions from the agricultural sector 1985 to 2006 [Gg NH_3]

NRF		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Gg NH_3										
4.	**Agricultural Sector - total**	**139.24**	**139.29**	**135.33**	**130.98**	**131.28**	**132.95**	**129.03**	**126.60**	**125.65**	**120.37**	**112.81**
4B	Manure Management	103.58	102.69	98.06	95.85	93.94	93.37	91.32	90.61	90.20	84.81	79.58
4D	Agricultural Soils - total	35.61	36.29	36.97	34.88	37.00	39.51	37.64	35.90	35.34	35.47	33.12
	Synthetic Fertiliser	9.57	8.90	8.92	8.69	9.06	10.54	10.25	9.57	9.21	9.56	9.25
	Grassing animals	3.15	3.08	2.96	2.92	2.91	2.94	3.00	3.01	3.06	2.99	3.04
	Crops	16.03	15.98	15.90	15.80	15.73	15.83	15.72	15.64	15.48	14.80	14.18
	NH_3 treated straw	6.55	8.05	8.94	7.26	9.01	10.21	8.66	7.69	7.59	8.12	6.65
4F	Field burning of Agricultural Waste	0.31	0.27	0.25	0.20	0.29	NO	NO	NO	NO	NO	NO
4G	Other - Sewage Sludge used as fertiliser	0.05	0.05	0.05	0.05	0.06	0.07	0.07	0.09	0.11	0.10	0.11

NRF		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
		Gg NH_3										
4.	**Agricultural Sector - total**	**108.54**	**107.30**	**108.11**	**103.42**	**102.62**	**101.15**	**98.22**	**93.73**	**95.30**	**90.36**	**87.05**
4B	Manure Management	77.96	77.77	79.38	77.34	76.46	76.22	74.74	70.73	72.37	67.50	64.58
4D	Agricultural Soils - total	30.48	29.44	28.65	26.00	26.08	24.86	23.40	22.92	22.85	22.79	22.40
	Synthetic Fertiliser	8.08	7.51	7.58	7.04	6.79	6.26	5.64	5.40	5.62	5.56	5.43
	Grassing animals	3.06	2.97	2.96	2.88	2.88	2.94	2.82	2.76	2.71	2.65	2.63
	Crops	14.27	14.47	14.41	14.00	13.93	14.04	14.01	13.96	13.99	14.32	14.35
	NH_3 treated straw	5.07	4.49	3.71	2.08	2.47	1.62	0.94	0.80	0.53	0.26	0.00
4F	Field burning of Agricultural Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4G	Other - Sewage Sludge used as fertiliser	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07

Particulate matter

In NRF, the emission of particulate matter (PM) is registered for the years 2000 to 2006. The emission from the agricultural sector includes the emission of dust from ventilated animal housing systems, which include emission from cattle, pigs, poultry and horses.

Change in emission factor has been preformed due to updated information in the EMEP-CLRTAP Emission Inventory Guidebook. Chapter B1100 covers PM emission from animal husbandry and recommended emission factor for Swine, poultry, cattle and horses. These categories are subdivided into subcategories and into solid- or slurry based stable systems.

Due to lack of data the PM emission not includes emission from plant production, which means activities related to field operations as harvesting and cultivation of the soil. At present, first draft to guidelines is preformed (Hinz 2004, Hinz 2006). When the final paper is confirmed, the PM emission will be implemented in the inventory and registered under NFR Tables 4.D Agricultural soils.

Given in TSP, emission from animal housing systems contributes with 32 % of the national PM emission in 2006.

From 2000 to 2006 the PM emission from agricultural activities, given in TSP, has decreased by 6% due to a fall in the production of broilers (Figure 6.2). The same emission factor is used for all years. The changes in the total emission for each livestock category is mainly reflected the

changes in number of animal, but also effected by the distribution of the subcategories and changes in the stable type.

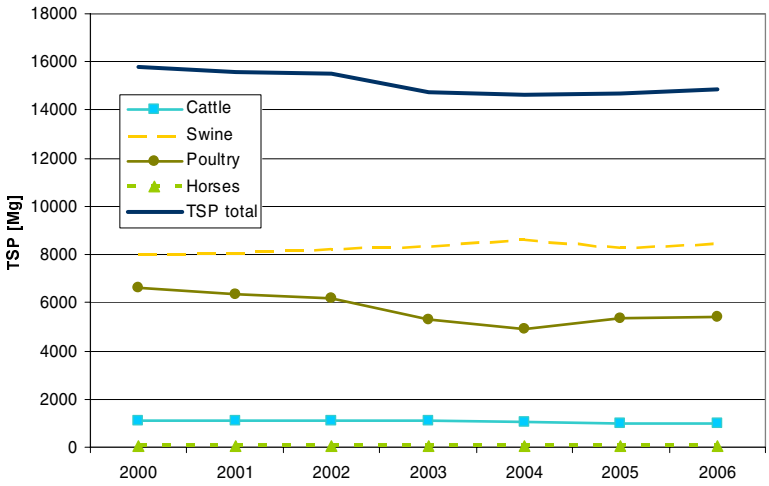

Figure 6.2 Emission of particulate matter (TSP) from the agricultural sector 2000 to 2006

6.1.2 References – sources of information

Data on activity and emissions are collected, evaluated and discussed in cooperation with Statistics Denmark, the Danish Institute of Agricultural Sciences, the Danish Agricultural Advisory Centre, Danish Environmental Protection Agency and the Danish Plant Directorate. It means that both the data and the methods used are evaluated continuously according to latest knowledge and information. Table 6.2 shows the source of data input from the different institutes.

Table 6.2 List of institutes involved in the emission inventory

References	Abbreviation	Data / information
National Environmental Research Institute, University of Aarhus (http://www.dmu.dk)	NERI	-reporting -data collecting
Statistics Denmark - Agricultural Statistics (http://www.dst.dk)	DS	-livestock production -milk yield -slaughtering data -land use
Faculty of Agricultural Sciences, University of Aarhus (http://www.agrsci.dk)	FAS	-N-excretion -feeding situation -NH_3 emissions factor -PM emissions factor
The Danish Agricultural Advisory Centre (http://www.lr.dk)	DAAC	-stable type -grazing situation -manure application time and methods
Danish Environmental Protection Agency (http://www.mst.dk)	EPA	-sewage sludge used as fertiliser
The Danish Plant Directorate (http://www.plantedirektoratet.dk)	PD	-organic farming -synthetic fertiliser -stable type (from 2005)

6.1.3 Methods

The calculation of the emission is based on the EMEP-CLRTAP Emission Inventory Guidebook.

The emissions from agricultural activities include NRF Table 4B Manure Management and Table 4D Agricultural Soils. Table 4F with regard to field burning of agricultural wastes is only registered until 1989. Burning of straw has been prohibited since 1989 and may only take place in connection with cultivation of seed grass. It is assumed that the emission is insignificant and, hence, is not included in the emission inventory from 1990.

The emission is calculated as the sum of activities (a_i) multiplied by the implied emission factor (IEF) for each activity, *i*.

$$E_{total} = \sum a_i \bullet IEF_i$$

The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called DIEMA (Danish Integrated Emission Model for Agriculture). This model, as shown in Figure 6.3, is implemented in great detail and it is used to cover emissions of ammonia, particulate matter and greenhouse gases (N_2O and CH_4). Thus, there is direct coherence between the ammonia emission and the emission of N_2O. A more detailed description is published in Mikkelsen et al. (2006).

The National Environmental Research Institute (NERI), which is responsible for the emission inventory, has established data agreements with the institutes and organisations to assure that the necessary data is available for timely completion of the emission inventory. The main part of the emission is related to livestock production and much of the data is based on Danish standards. The Faculty of Agricultural Sciences, University of Aarhus (FAS) delivers Danish standards relating to feeding consumption, manure type in different stable types, nitrogen content in manure, etc. Previously, the standards were updated and published every third or fourth year – the last one is Poulsen et al. from 2001. From year 2001, NERI receives updated data annually directly from FAS in the form of spreadsheets. These standards have been described and published in English in Poulsen & Kristensen (1998).

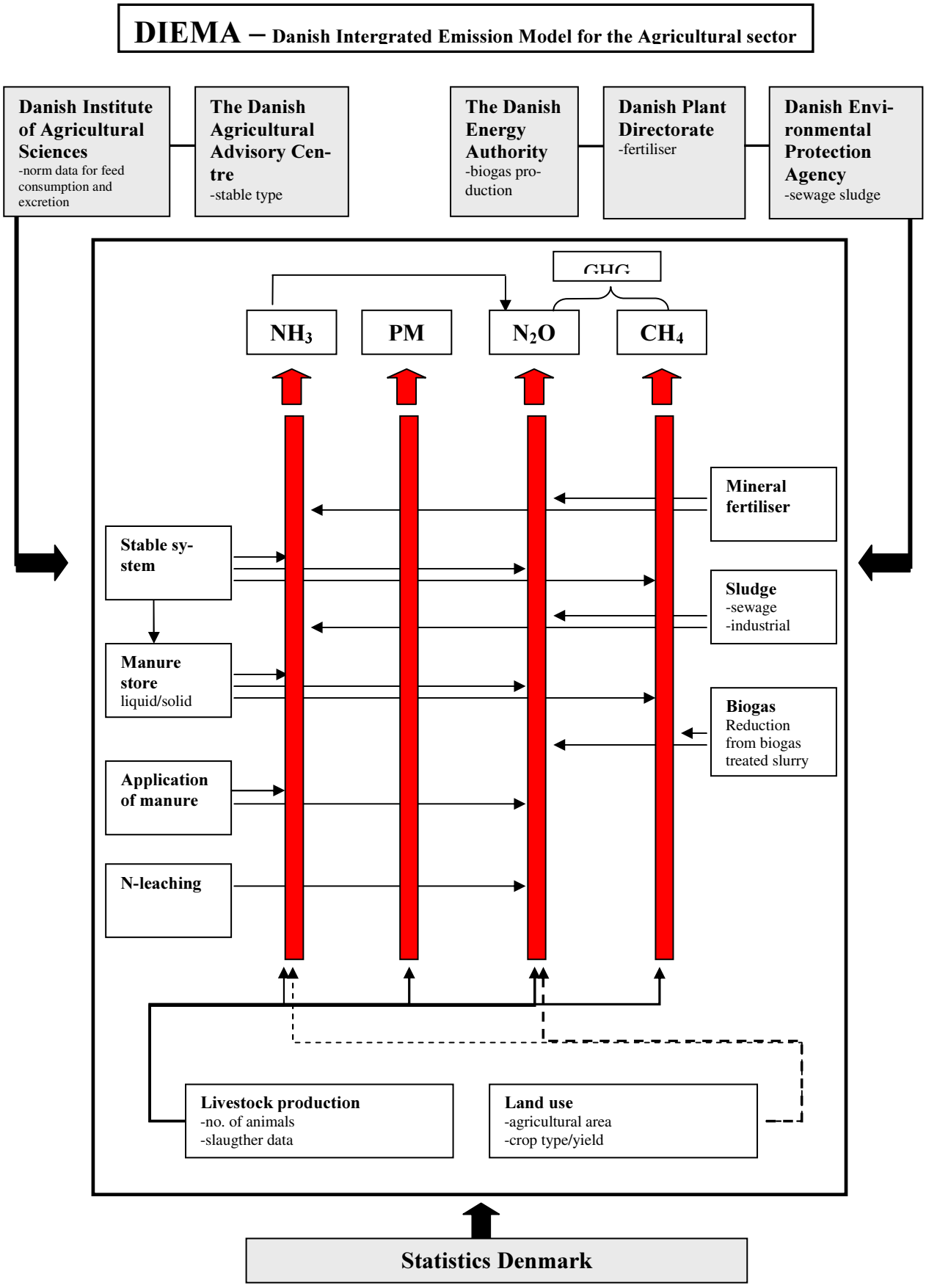

Figure 6.3 DIEMA – Danish Integrated Emission Model for Agriculture

DIEMA includes approximately 30 different livestock categories, dependent on livestock category, weight class and age. Each of these subcategories is subdivided according to stable type and manure type, which results in the region of 100 different combinations of subcategories and stable type (Table 6.3). The emission is calculated from each of these subcategories and then aggregated in accordance with the livestock categories given in the NFR. It is important to point out that changes in the emission and the implied emission factor over the years are not only a result of changes in the number of animals, but also depend on changes in the allocation of subcategories, changes in feed consumption, changes in stable type and changed practices with regard to the handling of livestock manure in relation to storage and application.

Table 6.3 Livestock categories and subcategories.

NFR 4B	Animal categories	Includes	No. of subcategories in DIEMA (animal type/stable system)
4B 1a	Dairy Cattle[1]	Dairy Cattle (heavy breeding and Jersey)	9
4B 1b	Non-dairy Cattle[1]	Calves, heifers, bulls, suckling cattle (heavy breeding and Jersey)	26
4B 3	Sheep	including lambs	1
4B 4	Goats	Including kids	1
4B 6	Horses	400 kg, 600 kg, 800 kg	3
4B 8	Swine	Sows, piglets, slaughtering pigs	17
4B 9	Poultry	Hens, pullet, broilers, turkey, geese, ducks	16
4B 13	Other	Fur farming + Sewage sludge	4

[1]For all subcategories distinguish between large breed and the smaller Jersey cattle

6.2 NH_3 emission from Manure Management – NRF 4.B

6.2.1 Description

Figure 6.4 shows the emission from manure management (NRF category 4.B) distributed according to the different livestock categories in 2006. The main part of the emission is related to cattle and pig production, corresponding to 82%

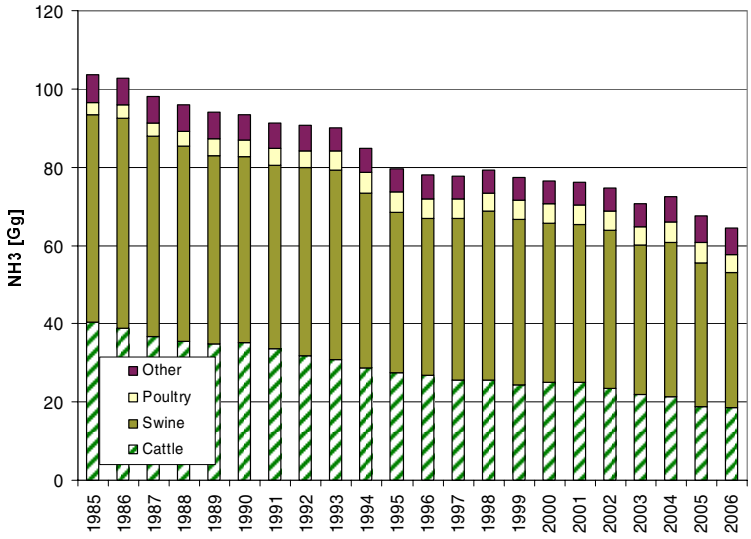

Figure 6.4 Ammonia emission from manure management 1985 to 2006

6.2.2 Methodological issues

Activity data

Table 6.4 shows the development in livestock production 1985-2006 based on the Agricultural Statistics (Statistics Denmark). The emission from pigs and poultry is based on slaughter data from the Agricultural Statistics. Only farms larger than 5 hectares are included in the annual census. An approximation of number of the horses, goats and sheep on small farms is added to the numbers in the Agricultural Statistics, in agreement with DAAC. The largest difference is found for horses. In the agricultural census, the number of horses is estimated at 52 900 in 2006. The total number of horses in 2006, however, including horses placed at small farms and riding schools, is approximately 156 500.

Since 1985, the production of pigs has increased practically. This is contrary to the production of cattle, which has decreased as a result of rising milk yields. Buffalo, camels and llamas, mules and donkeys do not occur in Denmark.

Table 6.4 Livestock production 1985 to 2006 [1000 head] - NRF category 4B

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NRF	Animal category											
4B 1a	Dairy Cattle	896	864	811	774	759	753	742	712	714	700	702
4B 1b	Non-dairy cattle	1721	1631	1540	1488	1462	1486	1480	1478	1481	1405	1388
4B 3	Sheep*	40	52	59	73	83	92	107	102	88	80	81
4B 4	Goats*	8	8	8	8	8	8	9	9	9	9	9
4B 6	Horses*	140	139	138	137	136	135	137	138	140	141	143
4B 8	Swine	9 089	9 321	9 266	9 217	9 190	9 497	9 783	10 455	11 568	10 923	11 084
4B 9	Poultry	15 219	15 220	15 540	15 524	17 194	16 249	15 933	19 041	19 898	19 852	19 619
4B 13	Other (fur farming)	1 906	2 194	2 402	2 877	3 055	2 264	2 112	2 283	1 537	1 828	1 850
		1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
NRF	Animal category											
4B 1a	Dairy Cattle	701	670	669	640	636	623	610	596	563	564	550
4B 1b	Non-dairy cattle	1 393	1 334	1 308	1 247	1 232	1 284	1 187	1 128	1 082	1 006	984
4B 3	Sheep*	94	78	83	83	81	92	74	83	79	94	102
4B 4	Goats*	9	10	10	10	10	11	11	12	12	14	13
4B 6	Horses*	144	146	147	149	150	152	153	155	155	156	157
4B 8	Swine	10 842	11 383	12 095	11 626	11 922	12 608	12 732	12 949	13 233	13 534	13 361
4B 9	Poultry	19 888	18 994	18 674	21 010	21 830	21 236	20 580	17 796	16 598	17 530	17 249
4B 13	Other (fur farming)	1 918	2 212	2 345	2 089	2 199	2 304	2 422	2 361	2 471	2 552	2 708

* Includes animals on small farms (less than 5 ha), which are not included in Statistics Denmark figures.

Implied emission factor

Table 6.5 shows the implied emission factor for each NFR livestock category from 1990 to 2006. The implied emission factor expresses the average emission of ammonia per animal (from the census) per year. The implied emission factor is changing from year to year depending on a combination of several factors, such as:

- change in the livestock production level or change in the share of different subcategories
- change in fodder condition and N-excretion
- change in stable type
- change in handling of manure in relation to storage and application

In Annex 2C1, more detailed information about N-excretion and stable type for each livestock category, 1990–2006, used in the Danish emission inventory are given. Furthermore, tables show the Danish standards for emission factors used to calculate the ammonia emission in stables and in relation to storage and application of manure.

For most of the animal categories, the implied emission factor has decreased from 1985 to 2006, which is the result of measures in relation to implementation of the action plans for the aquatic environment and the Ammonia Action Plan. Increasingly strict requirements to improve the utilisation of nitrogen in manure have resulted in reduction of N-excretion, especially for slaughter pigs. Changes in manure management in relation to spreading are another important factor which has reduced the emission. Measures include a requirement for a minimum 9-month manure storage capacity, requirement that manure applied to soil be ploughed down within 6 hours, a ban on the spreading of manure in winter and, from 1 August 2003, broad spreading is no longer allowed.

Table 6.5 Implied emission factor from – manure management 1985 to 2006 [kg NH_3/hd/yr] (NRF category 4B)

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NFR	Animal category											
4b 1a	Dairy cattle	30.40	30.72	31.04	31.36	31.69	31.97	30.98	30.00	29.03	28.07	27.12
4b 1b	Non-dairy cattle	7.73	7.62	7.56	7.47	7.42	7.48	7.18	6.96	6.73	6.43	6.16
4B 3	Sheep	1.92	1.90	1.88	1.87	1.85	1.86	1.87	1.87	1.88	1.88	1.89
4B 4	Goats	1.92	1.90	1.88	1.87	1.85	1.86	1.87	1.87	1.88	1.88	1.89
4B 6	Horses	8.37	8.30	8.23	8.17	8.10	7.90	7.71	7.51	7.32	7.13	6.94
4B 8	Swine	5.81	5.74	5.51	5.42	5.24	4.99	4.81	4.60	4.19	4.09	3.70
4B 9	Poultry	0.21	0.22	0.22	0.25	0.25	0.27	0.27	0.24	0.25	0.27	0.26
4B 13	Other animals (fur farming)	3.01	2.57	2.30	1.89	1.73	2.30	2.40	2.21	3.21	2.66	2.59
		1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
NFR	Animal category											
4b 1a	Dairy cattle	26.32	26.42	26.53	26.34	27.07	26.96	26.34	26.00	26.41	25.27	25.49
4b 1b	Non-dairy cattle	6.07	5.99	5.95	6.13	6.40	6.43	6.10	5.79	5.84	4.48	4.43
4B 3	Sheep	1.74	1.58	1.43	1.29	1.45	1.43	1.41	1.37	1.37	1.37	1.38
4B 4	Goats	1.74	1.58	1.43	1.29	1.45	1.43	1.36	1.33	1.32	1.32	1.33
4B 6	Horses	6.92	6.89	6.85	7.01	6.87	6.77	6.69	6.50	6.49	6.49	6.49
4B 8	Swine	3.71	3.63	3.57	3.61	3.40	3.19	3.18	2.94	3.00	2.71	2.60
4B 9	Poultry	0.25	0.26	0.26	0.24	0.23	0.24	0.24	0.27	0.31	0.30	0.26
4B 13	Other animals (fur farming)	2.49	2.16	2.03	2.25	2.09	2.05	2.00	1.98	2.12	2.23	2.15

6.2.3 Time-series

The emission of NH_3 from manure management is estimated to 64.58 Gg NH_3 in 2006 (Table 6.6). From 1985 to 2006, the emission is reduced by 38%. As mentioned, this development is mainly due to an active environmental policy to reduce nitrogen losses in agricultural production.

The number of cattle has decreased as a result of a growth in milk yield. In 2006, cattle production contributes with 31% of the total emission from manure management. The pig production contributes with a still increases share of the emission – in 2006, 52% of the total emission from manure management. The production of slathering pigs has decreased by more than 50% compared with 1985. However, despite this develop-

ment the emission from pigs is still decreasing. This is due to measures focused on the biological development and improvement in fodder efficiency.

Table 6.6 Emission of NH_3 from manure management 1985 to 2006 [Gg NH_3]

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NFR	Animal category											
4b 1a	Dairy cattle	27.25	26.55	25.17	24.29	24.07	24.08	22.97	21.36	20.73	19.64	19.05
4b 1b	Non-dairy cattle	13.30	12.43	11.64	11.11	10.85	11.11	10.63	10.28	9.97	9.03	8.55
4B 3	Sheep	0.08	0.10	0.11	0.14	0.15	0.17	0.20	0.19	0.17	0.15	0.15
4B 4	Goats	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4B 6	Horses	1.17	1.15	1.14	1.12	1.10	1.07	1.05	1.04	1.02	1.01	0.99
4B 8	Swine	52.85	53.51	51.06	49.93	48.19	47.40	47.05	48.11	48.48	44.69	40.98
4B 9	Poultry	3.18	3.30	3.39	3.81	4.28	4.31	4.32	4.56	4.90	5.41	5.05
4B 13	Other - fur farming	5.73	5.64	5.53	5.45	5.29	5.21	5.08	5.05	4.93	4.87	4.79
	Manure Management - total emission	103.58	102.69	98.06	95.85	93.94	93.37	91.32	90.61	90.20	84.81	79.58
		1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
NFR	Animal category											
4b 1a	Dairy cattle	18.44	17.71	17.75	16.86	17.20	16.81	16.06	15.49	14.88	14.26	14.03
4b 1b	Non-dairy cattle	8.45	7.98	7.79	7.64	7.89	8.25	7.23	6.54	6.32	4.50	4.36
4B 3	Sheep	0.16	0.12	0.12	0.11	0.12	0.13	0.10	0.11	0.11	0.13	0.14
4B 4	Goats	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
4B 6	Horses	1.00	1.00	1.01	1.04	1.03	1.03	1.02	1.00	1.01	1.01	1.02
4B 8	Swine	40.19	41.27	43.14	42.02	40.59	40.23	40.47	38.01	39.69	36.67	34.71
4B 9	Poultry	4.93	4.89	4.81	4.95	5.01	5.03	4.98	4.88	5.10	5.22	4.49
4B 13	Other - fur farming	4.78	4.77	4.75	4.70	4.60	4.72	4.85	4.68	5.25	5.69	5.82
	Manure Management - total emission	77.96	77.77	79.38	77.34	76.46	76.22	74.74	70.73	72.37	67.50	64.58

Figure 6.5 shows the percentage distribution of the NH_3 emission in stables, storage, spreading of manure in fields and in deposits to grass. The main part of the reduction in ammonia emission has taken place in connection with the spreading of manure in fields, due to changes in manure application practice. There has been a reduction in emissions in relation to storage as a result of improved covering of slurry tanks. From 1985 to 2006, the emission relating to manure management in stables increased from 36% to 50%. In future, the possibilities for ammonia reduction will be likely to be focused on measurements in stables.

It should be mentioned here that the emission from manure deposited by grazing animals is included in the emission from agricultural soils (NRF – 4.D).

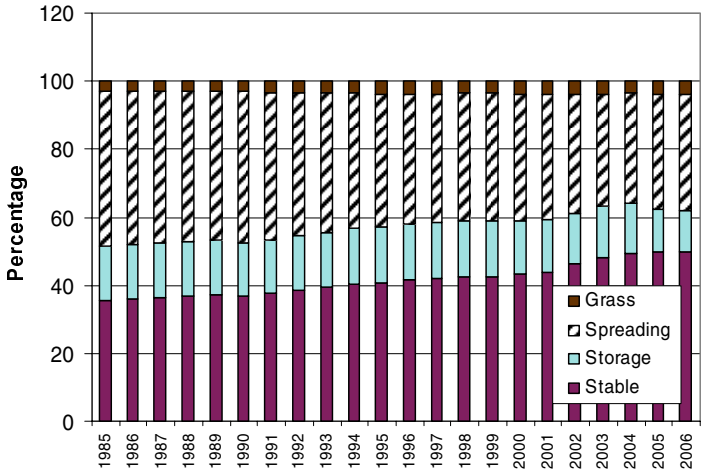

Figure 6.5 The percentage distribution of the NH_3 emission in the agricultural production 1985 to 2006

6.3 NH_3 emission from Agricultural Soils – NRF 4.D

6.3.1 Description

Figure 6.6 shows the different emission sources from agricultural soils (NFR Table 4.D). The majority of the ammonia emission from agricultural soils originates from crops, which in 2006 corresponds to 64%. Another 24% is related to use of synthetic fertiliser and the remaining part comes from nitrogen deposited by grazing animals and from ammonia-treated straw used as feed.

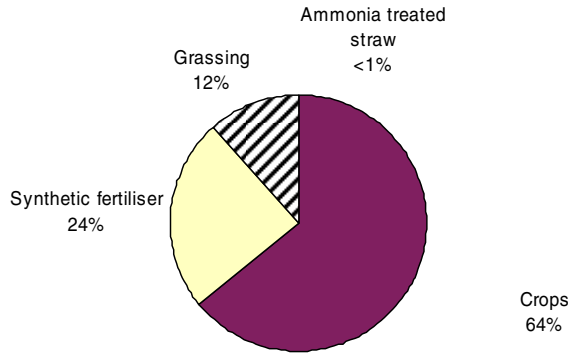

Figure 6.6 Ammonia emissions from agricultural soils 2006

6.3.2 Methodological issues

More detailed description covering the calculation of the different emission sources and information about activity data and emission factors used is given in Annex 2C2.

Activity data

At present, farmed area covers about 60% of the total land area in Denmark. In recent decades, farmed area has decreased, being replaced by forest, semi-natural, road and built-up areas and this development is expected to continue. Table 6.7 shows the activity data used in calculation of the ammonia emission from agricultural soils. Information on farmed area and cultivation of different crop types is collected by Statistics

Denmark. The amount of nitrogen used in synthetic fertiliser is based on information from the Danish Plant Directorate. The use of fertiliser has decreased considerably – consumption in 2006 is nearly half that in 1985.

Table 6.7 Activity data used to estimate the NH_3 emission from agricultural soils 1985 to 2006

NFR 4.D	Unit	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Activity data												
Cultivated area	1000 ha	2 834	2 819	2 798	2 787	2 774	2 788	2 770	2 756	2 739	2 691	2 726
N in fertiliser	M kg N	398	382	381	367	377	400	395	370	333	326	316
N deposit on grass	M kg N	37	36	35	34	34	34	35	35	36	35	36
NH_3 treated straw	M kg N	10	12	14	11	14	16	13	12	12	12	10
NFR 4.D	**Unit**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Activity data												
Cultivated area	1000 ha	2 716	2 688	2 672	2 644	2 647	2 676	2 666	2 658	2 645	2 707	2 711
N in fertiliser	M kg N	291	288	283	263	251	234	211	201	207	206	192
N deposit on grass	M kg N	36	35	35	34	34	34	33	32	32	31	31
NH_3 treated straw	M kg N	8	7	6	3	4	2	1	1	1	0	0

Implied emission factor

The implied emission factors, 1985-2006, in relation to agricultural soils are given in Table 6.8.

The implied emission factors relating to crops are expressed as total emission divided by total area under cultivation, and are decreasing due to the growth in set-a-side area. The implied emission factors relating to use of synthetic fertiliser depend on consumption and type of fertiliser and remain almost the same for all years. The implied emission factors for grazing animals and ammonia used for straw treatment remain unaltered.

Table 6.8 Implied emission factors used to estimate the NH_3 emission from agricultural soils

NFR 4.D	Unit	1985	1985	1987	1988	1999	1990	1991	1992	1993	1994	1995
Source												
Crops	Kg NH_3 per hectare	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.5	5.2
Fertiliser	% of total N	2.0	1.9	1.9	1.9	2.0	2.2	2.1	2.1	2.3	2.4	2.4
N grass	% of total N	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
NH_3. straw	% of total NH_3-N	65	65	65	65	65	65	65	65	65	65	65
NFR 4.D	**Unit**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Source												
Crops	Kg NH_3 per hectare	5.3	5.4	5.4	5.3	5.3	5.2	5.3	5.3	5.3	5.3	5.3
Fertiliser	% of total N	2.3	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.3
N grass	% of total N	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
NH_3. straw	% of total NH_3-N	65	65	65	65	65	65	65	65	65	65	65

6.3.3 Time-series

From 1985 to 2006 the ammonia emission from agricultural soils decreased from 35.61 Gg NH_3 to 22.40 Gg NH_3, which corresponds to a 40% reduction (Table 6.9). A considerable increase in the use of fertiliser and ammonia used for straw treatment has, in particular, been important for this development.

As mentioned, there has been an active effort in recent decades to reduce nitrogen leaching by means of action plans. This focus on environmental impact in agricultural production has led to an improvement in the utili-

sation of nitrogen in manure. A consequence of this development is that the use of fertiliser and, in turn, the NH_3 emission has been reduced.

Table 6.9 Emission of NH_3 from Agricultural Soils from 1985 to 2006 [Gg NH_3]

NFR 4.D	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Agricultural Soils											
Crops	16,03	15,98	15,90	15,80	15,73	15,83	15,72	15,64	15,48	14,80	14,18
Use of fertiliser	9,57	8,90	8,92	8,69	9,06	10,54	10,25	9,57	9,21	9,56	9,25
N deposit on grass	3,15	3,08	2,96	2,92	2,91	2,94	3,00	3,01	3,06	2,99	3,04
NH_3 treated straw	6,55	8,05	8,94	7,26	9,01	10,21	8,66	7,69	7,59	8,12	6,65
Emission - total	**35,61**	**36,29**	**36,97**	**34,88**	**37,00**	**39,51**	**37,64**	**35,90**	**35,34**	**35,47**	**33,12**
NFR 4.D	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Agricultural Soils											
Crops	14.27	14.47	14.41	14.00	13.93	14.04	14.01	13.96	13.99	14.32	14.35
Use of fertiliser	8.08	7.51	7.58	7.04	6.79	6.26	5.64	5.40	5.62	5.56	5.43
N deposit on grass	3.06	2.97	2.96	2.88	2.88	2.94	2.82	2.76	2.71	2.65	2.63
NH_3 treated straw	5.07	4.49	3.71	2.08	2.47	1.62	0.94	0.80	0.53	0.26	0.00
Emission - total	**30.48**	**29.44**	**28.65**	**26.00**	**26.08**	**24.86**	**23.40**	**22.92**	**22.85**	**22.79**	**22.40**

6.4 NH_3 emission from sewage sludge – NRF 4.G

Around half of the sludge from wastewater treatment is used as fertiliser and applied on agricultural soils. The NH_3 emission from sewage sludge is included under the NFR category 4G "Other". The emission from sewage sludge contributes with less than ½% of the total emission from agricultural emissions.

Information on amount of sludge, N-content and ammonia emission factor is obtained from reports prepared by the Danish Protection Agency. It is assumed that the ammonia emission is 1.9 kg NH3-N/kg N. The amount of sewage sludge has increased from 1985 until 1995. In the following years to 2006 the amount of sludge used as fertiliser has fallen as a result of increasing request from the industrial sector. The sludge is used in industrial process e.g. in the cement production and production of sandblasting material.

Table 6.10 Emission of NH_3 from sewage sludge 1985 to 2006 [Gg NH_3]

NFR 4.G		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Sewage sludge	Unit											
Amount of sludge applied on soil	Tonnes of dry matter	50 000	50 000	52 380	58 200	69 840	77 883	80 181	96 174	123 382	111 155	112 235
N-content	Percent	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4,00	4.00	4.13
N applied on soil	Kg N	2 000	2 000	2 095	2 328	2 794	3 115	3 207	3 847	4 935	4 446	4 635
Emission - total	Gg NH3	46	46	48	53	64	71	73	88	113	101	106
NFR 4.G		**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Sewage sludge	Unit											
Amount of sludge applied on soil	Tonnes of dry matter	104 010	90 701	87 209	85 733	83 727	80 877	81 623	81 000	70 000	70 000	65 000
N-content	Percent	4.37	4.38	4.30	4.28	4.33	4.35	4.41	4.41	4.41	4.41	4.41
N applied on soil	Kg N	4 545	3 973	3 750	3 669	3 625	3 518	3 600	3 572	3 087	3 087	2 867
Emission - total	Gg NH3	104	91	86	84	83	80	82	81	70	70	65

6.5 PM emission from stables – NRF 4.B

6.5.1 Description

Investigations have shown that farmers, as well as livestock, are subject to an increased risk of developing lung and respiratory related diseases due to the particulate emissions (Hartung og Seedorf. 1999). This is since the particles are able to carry bacteria, viruses and other organic compounds. Presently, only the emission from 2000 to 2006 is given in NRF.

In 2006 the PM emission from stables, given in TSP, is estimated to 14838. Of this, 57% relates to swine production. The emission from poultry and cattle contributes with 36% and 7%, respectively.

6.5.2 Methodological issues

The estimation of PM emission is based on the EMEP-CLRTAP Emission Inventory Guidebook chapter B1010, where the scientific data mainly is based on an investigation of PM emission in North European stables (Takai et al. 1998).

The particle emission includes primary particles in the form of dust from ventilated stables. Three main types of stables cattle, swine and poultry stables are included in this inventory (Table 6.11). These are divided into subcategories and for each category it is distinguished between solid and slurry based stable systems.

The PM emission is related to the number of stable places and to the time the animal is housed. The PM emission from grassing animals is considered as negligible.

Table 6.11 Livestock categories used in the PM emission inventory

Livestock categories as given in NFR	Subcategories as given in the EMEP-CLRTAP Emission Inventory Guidebook	Danish inventory	Grassing days
Cattle			
Dairy Cattle	Dairy cattle	Dairy cattle	55
Non-Dairy Cattle	Calves	Calves < ½ yr	0
	Beef cattle	Bulls	0
		Heifer	196
		Suckling cattle	224
Swine	Sows	Sows (incl piglets until 7 kg)	0
	Weaners	Weaners (7-30 kg)	0
	Fattening pigs	Fattening pigs (30-105 kg)	0
Poultry	Laying hens	Laying hens	0
	Broilers	Broilers	0
Horses	Horses	Horses	184

Due to considerable uncertainties and lack of data, this inventory only includes emission from stables. The PM emission from the handling of fertiliser and crops in the field are not taken into account. This will be included when preformed draft on PM chapter of new guidelines is final committed (Hinz 2004, Hinz 2006).

Activity data

Livestock production data is based on Statistics Denmark, Agricultural Statistics (www.dst.dk) – Table 6.12.

Table 6.12 Livestock production 2000 – 2006 [1000 head]

NRF	Animal category	2000	2001	2002	2003	2004	2005	2006
4B 1a	Dairy Cattle	636	623	610	596	563	564	550
4B 1b	Non-dairy cattle	1 868	1 907	1 796	1 724	1 646	1 570	1 535
4B 6	Horses	150	152	153	155	155	156	157
4B 8	Swine[1]	10 489	10 489	10 706	10 826	11 257	10 886	11 166
4B9	Poultry[2]	20 982	20 347	19 734	17 152	16 136	17 074	16 826

[1] Includes sows. weaners (7-30 kg) and fattening pigs (30-105 kg)

[2] Includes laying hens and broilers

Emission factor

Emission factor for PM_{10} and $PM_{2.5}$ recommended in the EMEP-CLRTAP emission inventory guidebook Table 4.1 are used. The same emissions factors are used for all years.

In Takai et al. (1998), dust emission from stables is estimated as "inhalable dust". This is defined as particles that can be transported into the body via the respiratory system. Approximately, "inhalable dust" equates to TSP (Hinz. T. 2002 and ISO/CEN. 1993). Estimation of TSP is based on the transformation factors for the conversion of inhalable dust into PM_{10} given in inventory guidebook Table B3 in appendix B.

Table 6.13 Emission factor for particle emission from animal housing system

Livestock category	Stable system	Emission factor PM_{10} [kg/hd/yr]	Emission factor $PM_{2.5}$ [kg/hd/yr]	Emission factor TSP [kg/hd/yr]	Transformation factor PM_{10} to TSP [kg/hd/yr]
Cattle:					
Dairy cattle	Solid	0.36	0.23	0.78	0.46
	Slurry	0.70	0.45	1.52	0.46
Calves < ½ yr	Solid	0.16	0.10	0.35	0.46
	Slurry	0.15	0.10	0.33	0.46
Beef cattle	Solid	0.24	0.16	0.52	0.46
	Slurry	0.32	0.21	0.70	0.46
Heifer[1]	Solid	0.26	0.17	0.57	0.46
	Slurry	0.43	0.28	0.93	0.46
Suckling cattle[2]	Solid	0.24	0.16	0.52	0.46
	Slurry	0.32	0.21	0.70	0.46
Swine:					
Sows	Solid	0.58	0.094	1.29	0.45
	Slurry	0.45	0.073	1.00	0.45
Weaners	Solid[3]	0.18	0.029	0.40	0.45
	Slurry	0.18	0.029	0.40	0.45
Fattening pigs	Solid	0.50	0.081	1.11	0.45
	Slurry	0.42	0.069	0.93	0.45
Poultry:					
Laying hens	Solid	0.017	0.0021	0.017	1.0
	Slurry	0.27	0.052	0.27	1.0
Broilers	Solid	0.35	0.045	0.35	1.0
Horses	Solid	0.18	0.12	0.39	0.46

[1] Average of “calves” and “dairy cattle”

[2] Assumed the same value as “Beef cattle”

[3] Same as slurry based systems

6.5.3 Time-series

Table 6.14 shows the PM emission, given in TSP, PM_{10} and $PM2_{.5}$ for each animal category in the period 2000 to 2006. It is seen that the main part of the emission originates from swine stables. In the period 2000 to 2006, the total agricultural emission has decreased by 6% due to a fall in production of broilers.

Table 6.14 PM emission 2000 – 2006 [Mg PM_{10}, $PM_{2.5}$ and TSP]

	Mg TSP	2000	2001	2002	2003	2004	2005	2006
NFR	Animal Category							
4B 1a	Dairy	706	704	700	700	669	651	635
4B 1b	Non-dairy	400	424	395	378	364	341	334
4B 6	Horses	29	30	30	30	30	31	31
4B 8	Swine	8 024	8 051	8 228	8 316	8 622	8 292	8 430
4B9	Poultry	6 605	6 359	6 171	5 300	4 936	5 373	5 409
	TSP total	15 765	15 567	15 524	14 724	14 621	14 688	14 838
	Mg PM_{10}	2000	2001	2002	2003	2004	2005	2006
NFR	Animal Category							
4B 1a	Dairy	325	324	322	322	308	299	292
4B 1b	Non-dairy	184	195	182	174	167	157	154
4B 6	Horses	14	14	14	14	14	14	14
4B 8	Swine	3 611	3 623	3 702	3 742	3 880	3 732	3 794
4B9	Poultry	6 605	6 359	6 171	5 300	4 936	5 373	5 409
	PM_{10} total	10 738	10 514	10 391	9 552	9 305	9 575	9 662
	Mg $PM_{2.5}$	2000	2001	2002	2003	2004	2005	2006
NFR	Animal Category							
4B 1a	Dairy	209	208	207	207	198	192	188
4B 1b	Non-dairy	118	125	117	112	108	101	99
4B 6	Horses	9	9	9	9	9	9	9
4B 8	Swine	589	591	604	611	633	609	619
4B9	Poultry	911	873	848	746	696	767	751
	$PM_{2.5}$ total	1 836	1 807	1 785	1 684	1 644	1 679	1 666

6.6 Uncertainties

Table 6.15 shows the estimated uncertainties for ammonia sources. The figures are primarily based on the expert judgement of the Faculty of Agricultural Sciences, University of Aarhus. The uncertainties for the number of animals and hectares under cultivation with different crops are very small. The Danish Normative System for animal excretions is based on data from the Danish Agricultural Advisory Centre (DAAC), which is the central office for all Danish agricultural advisory services.

DAAC engages in a great deal of research as well as the collection of efficacy reports from Danish farmers for dairy production, meat production, swine production, etc to optimise productivity in Danish agriculture. In total, feeding plans from 15-18% of Danish dairy production, 25-30% of pig production. 80-90% of poultry production and approximately 100% of fur production are collected annually. These basic feeding plans are used to develop the standard values of the "Danish Normative System".

The system of standard values has been updated annually from 2000. For dairy cows, approximately 800 feeding plans are used to develop the normative figures. The normative figures (Poulsen et al. 2001) are comprised of arithmetic means. Based on feeding plans, the standard deviation in N-excretion rates between farms can be estimated to ±20% for all animal types (Hanne D. Poulsen. DIAS. Pers, comm). However, due to the large number of farms included in the norm figures the arithmetic mean, it can be assumed as a very good estimate with a low uncertainty. All cattle, sheep and goats have their own ID-number (ear tags) and,

hence, uncertainty with regard to their numbers is almost absent. Statistics Denmark has estimated the uncertainty in the number of pigs to be less than 1%.

The combined effect of low uncertainty in actual animal numbers, feed consumption and excretion rates gives a very low uncertainty in the activity data as a whole. The major uncertainty, therefore, relates to the emission factors.

Table 6.15 Estimated uncertainty associated with activities and emission factors for NH_3 and PM

Source	Emission Gg NH_3	Activity data %	Emission factor %	Combined uncertainty %	Total uncertainty %	Uncertainty 95% Gg NH3
4 Agriculture – NH_3 total	87.05				11	9.36
4B NH_3 Manure Management	64.58	3.2	12.8	13.2	13	9.52
Stable	33.40	5	20	20.6		
Storage	8.35	5	20	20.6		
Spreading	22.83	5	20	20.6		
4.D Agricultural Soils	22.40	0.9	17.3	17.3	17	3.88
Grazing animal	2.63	5	20	20.6		
Synthetic fertiliser	5.43	1	25	25.0		
Crops	14.35	1	25	25.0		
Ammonia treated straw	0.00	10	25	26.9		
4.G Other – Sewage Sludge	0.07	2	20	20.1	20	0.01

Source	Emission Mg	Activity data %	Emission factor %	Combined uncertainty %	Total uncertainty %	Uncertainty 95% Mg TSP
4 Agriculture – total TSP	14 838	2	500	500	500	74 192
4 Agriculture – total PM_{10}	9 662	2	500	500	500	48 310
4 Agriculture – total $PM_{2.5}$	1 666	2	500	500	500	8 329

6.7 Quality assurance and quality control (QA/QC)

A general QA/QC and verification plan for the agricultural sector is still under development, but some measures have been formulated as general lines for the further work. The objectives for the quality planning, as given in the CLRTAP Emission Inventory Guidebook, which is closely related to the IPCC Good Practice Guidance, are to improve the transparency, consistency, comparability, completeness and confidence.

To ensure consistency in the inventory, certain time-series have been prepared for both the activity data and the emission factors, 1985 - 2006. Considerable variation between years can reveal miscalculations or changes in methods. These variations are checked and errors have been rectified.

Activity data and emission factors are collected and discussed in cooperation with specialists and researchers at different institutes and research sections. As a consequence, both data and methods are evaluated continuously according to latest knowledge and information. A more detailed description of quality assurance and quality control is given in the Denmark´s National Inventory Report 2006 - submitted under the United Nations Framework Convention on Climate Change (http://www2.dmu.dk/Pub/FR632_Final.pdf).

6.8 Recalculations

Compared with the previous NH_3 and PM emissions inventory (submission 2006), some updates have been made. These changes only reflect small changes for the total emission - less than 1% (Table 6.16).

Table 6.16 Changes in NH_3 emission in the agricultural sector compared to NRF reported last year

NH_3 emission (Gg NH3)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Previous	139.24	139.02	135.08	130.78	131.00	132.95	129.06	126.66	125.74	120.48	112.95
Updated	139.24	139.02	135.08	130.78	131.00	132.95	129.03	126.60	125.65	120.37	112.81
Difference (pct)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1
NH_3 emission (Gg NH3)	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
Previous	108.68	107.43	108.24	103.55	102.78	101.31	98.37	93.87	95.44	89.57	
Updated	108.54	107.30	108.11	103.42	102.62	101.15	98.22	93.73	95.30	90.36	
Difference (pct)	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	
PM emission (Mg TSP)					**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
Previous					15 772	15 574	15 531	14 731	14 639	14 621	
Updated					15 765	15 567	15 524	14 724	14 621	14 688	
Difference (pct)					0,0	0,0	0,0	0,0	-0,1	0,5	

There have been no changes in the methodology. The data received from statistics Denmark concerning the livestock production and the cultivated area 2005 is updated and these updated data are implemented in the inventory. Previous inventory had some small errors on grassing days for dairy cattle from 1990 to 1995, which is now corrected.

6.9 Planned improvements

In previous inventory the NH_3 emission from sewage sludge used as fertiliser and applied on agricultural soils is registered under NFR category 4.B 13 Manure Management "Other". This emission source is now included in NFR category 4.G "Other".

Until now the number of bulls is based on the annually census. Instead, it is planned to use information on slaughtering data received from Statistics Denmark, which better reflects the year production. At the same time the exported animals will be included.

It is planned to investigate the NH_3 emission from growing crops based on litterateur study. Properly this emission source is over estimated in the Danish inventory, but more information is needed before the emission factor is revised. The draft for new guidelines mentioned the emission from crops short after application of fertiliser, but no emission from crops later at the growing season is taken into account.

In recent years, there has been focus on reduction of the ammonia emission and especially the possibilities for emission reduction in stables. A number of investigations to estimate the effects from technical measures on the emission have been initiated. However, very few stables have implemented ammonia reduction technologies, although these probably will be an important issue in future. When data is available, it is planned to implement the reduction effect in the emission inventory.

For PM emission, it is planned to include dust emission from stables for the years 1985 to 1999. It is also planned to include the dust emission from arable farming – i.e. harvesting and field preparation by machines. First draft to guidelines is preformed but not yet final confirmed. The inventory from Finland shows that dust emission from arable farming contributes with approximately 25% of the total emission from the agricultural sector (Karvosenoja et al., 2001 and Louhekainen et al., 1987), which indicates the potential of a relevant PM emission source.

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7 Reporting spatially distributed emissions on grid

7.1 Background for reporting

Geographically distributed emissions, has been reported in 2007 to the UNECE LRTAP Convention for the years 1990, 1995, 2000 and 2005. Emission data are disaggregated to the standard EMEP grid with a resolution of 50km x 50km. Mandatory reporting are following 14 air pollutants: SO_x, NO_x, NH_3, NMVOC, CO, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, DIOX, PAH and HCB. The reporting includes gridded data for sector totals as well as totals for all sectors together. Guidelines for reporting air emissions on grid are given in UN (2003). Gridded emission data are used in integrated European air pollution models, e.g. RAINS/GAINS and EMEP's chemical transport models. Table 7.1 lists the categories (sectors) used for reporting emission data on grid based on the Danish inventories.

Table 7.1 Categories used for reporting gridded emission data according to the guidelines from United Nations

Categories for Gridding		UN categories used for DK reporting
01	Combustion in Power Plants and Industry	√
02a	Transport above 1000m	√
02b	Transport below 1000m	√
03	Commercial Residential and Other Stationary Combustion	√
04	Fugitive Emissions from Fuels	√
05	Industrial Processes	√
06	Solvents and other product use	√
07	Agriculture	√
08	Waste	√
09	Other	-
	Natural	-

The gridded emission data for the 2007 reporting are available at the EU eionet homepage that can be linked from either the NERI homepage (www[5]) or the homepage of the European Environment Agency (www[6]).

7.2 Methods and data for disaggregation of emission data

In the present work geographic data was used as proxies positioning the activity, which causes the emission. As an example we used a geographic data set for land cover of forest for distributing emissions from forest machinery.

[5] http://www.dmu.dk/

[6] http://www.eea.europa.eu/

Based on the theme of forest land cover, fractions of forest in each grid cell were calculated, and the total emission from forest machinery was distributed in harmony with the fractions of forest in each grid cell. A similar methodology was used for distributing emissions from other categories.

An explanation of the applied methodology in greater detail is available in Jensen et al., (2008). A wide range of different geographic data sets has been applied in the mapping procedure. The most essential data are listed in Table 7.2.

Table 7.1 List of different geographic data used in the mapping exercise.

Data owner	Data set	Contents
The National Survey and Cadastre	Topographic map	Geo-referenced basic map layers on administrative units, Land cover, territorial borders, coastline and infrastructure.
National Agency for Enterprise and Construction	Central Dwelling and Building Register (Danish abbreviation BBR)	Geo-referenced information on dwellings and buildings
The Directorate for Food, Fisheries and Agri Business	The Central Husbandry Register (CHR)	Geo-referenced information on stock of livestock at farm level
The Directorate for Food, Fisheries and Agri Business	The General Agricultural Register (GLR)	Geo-referenced information on agricultural fields
National Environmental Research Institute	Large Point Sources (LPS)	Geo-referenced information on power plants and large industrial plants
Danish Forest and Nature Agency	Military training terrain	Geo-referenced information on military training terrains

The disaggregation was as far as possible done at the SNAP level within the different reporting categories listed in Table 7.1. The disaggregation at the highly detailed SNAP level was later aggregated to the reporting categories (sector totals), and these were again further aggregated to national totals for all sectors. It is worth to mention that the composition of the predefined reporting categories for gridded emission data are not fully compatible with the categories used in the NFR-schemes for annual reporting of emission data[7] to UNECE.

7.3 Maps with geographical distributed emission data

It is not possible in this section to present all maps for all reporting years and sectors. Therefore, we choose to show national totals for selected air pollutants from the latest reporting year (2005). The selected air pollutants are: Ammonia (NH_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and small particulate matter ($PM_{2.5}$). Figure 7.1 shows the geographical distributed emissions for these air pollutants. Even from the national distributed totals, spatial patterns from the major sectors are recognisable.

[7] The annual reporting of emission data to UNECE includes all air pollutants except greenhouse gases.

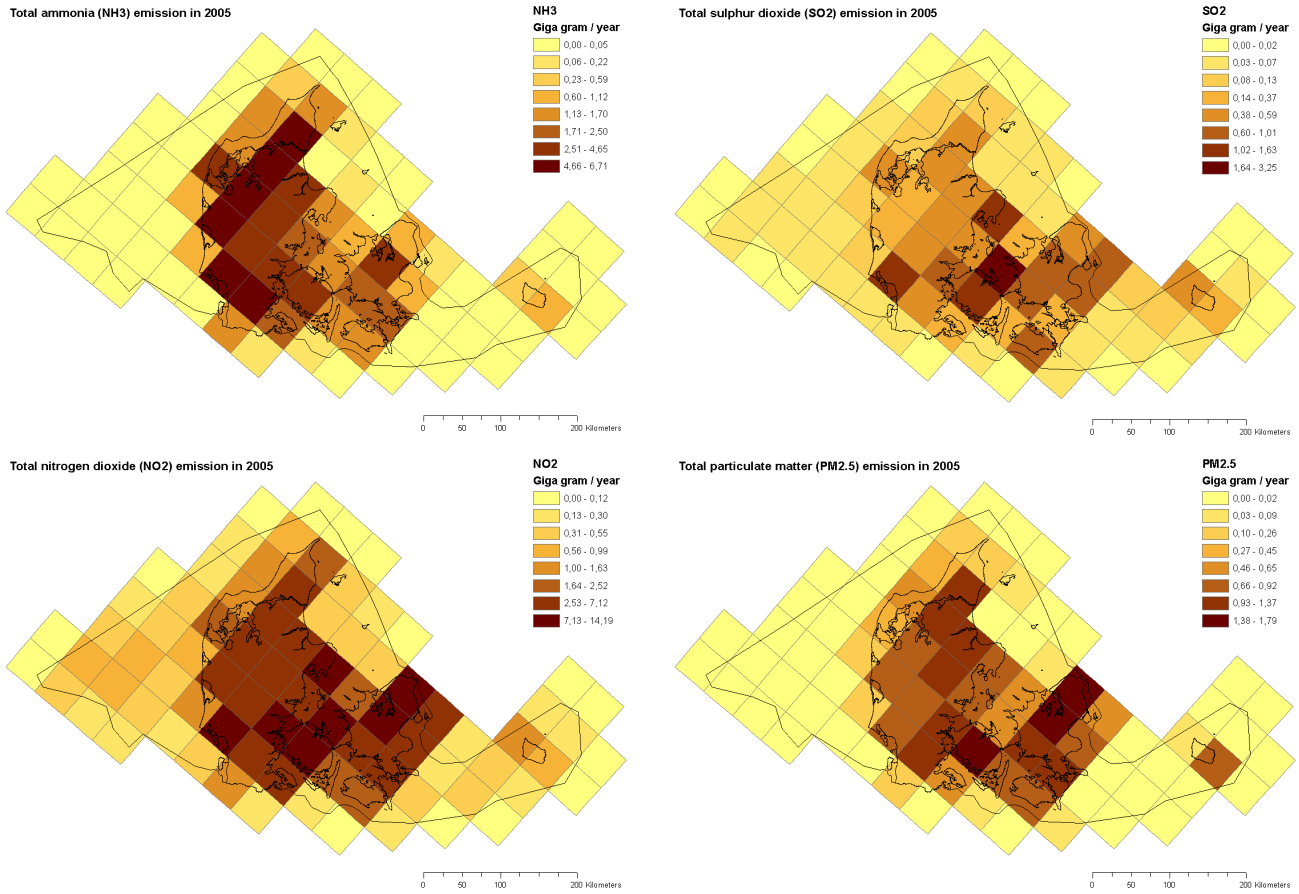

Figure 7.1 Geographical distribution of national emissions of NH_3, SO_2, NO_2 and $PM_{2.5}$ in 2005.

The agricultural sector is the major contributor to the national total NH_3 emission. Emission of NH_3 is mainly related to livestock farming and especially to the handling of manure from the animals. Emissions of NH_3 are therefore related to storage and spreading of manure as well as emissions from stables (Mikkelsen et al., 2006). The geographical pattern of the NH_3 emission is in good agreement with the localisation and concentration of the Danish livestock farming in the northern and western part of Jutland.

The geographical distribution of SO_2 reflects mainly the localisation of large power plants in Denmark, because these are the overall sources of SO_2 emissions. During the 4 reporting years, this pattern has become weaker, due to the implementation of techniques for reduction of sulphur in the outlet smoke from the power plants. Even though the SO_2 emission has decreased dramatically it still produces a distinct pattern reflecting the localisation of large power plants in Denmark.

For NO_2 the pattern is not that distinct as for SO_2, because it reflects a combination of emission contributions from both power plants and industry, commercial and residential plants and as well transport – mainly road transport. This means that the geographic pattern to a certain point reflects the localisation of infrastructure, dwellings and power plants and industry in Denmark.

The distribution of $PM_{2.5}$ is mainly related to road transport and emissions from residential wood use. Therefore the emissions of $PM_{2.5}$ follow

the localisation of the Danish road network and the large residential areas with single family houses.

As already mentioned the total SO_2 emission for Denmark has decreased significantly since 1990. The total emission of SO_2 in 2005 corresponds to approx. 12 percent of the total SO_2 emission in 1990. The spatially distributed pattern of SO_2 in 1990 is illustrated in Figure 7.2. For making comparisons between the two reporting years – see also Figure 7.1.

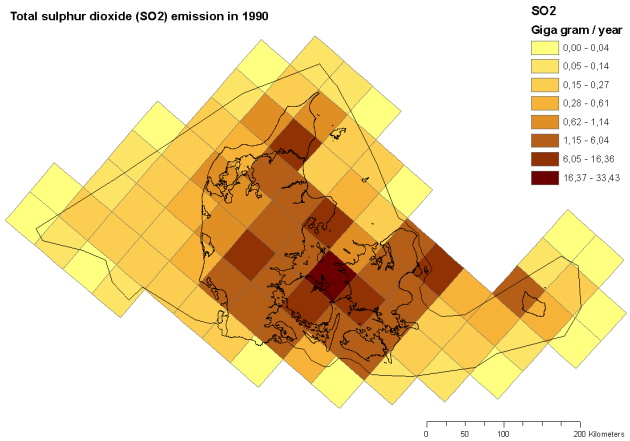

Figure 7.2 Spatial pattern of the total annual SO_2 emission in Denmark in 1990.

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8 Recalculations and Improvements

In general, considerable work is being carried out to improve the inventories. Investigations and research carried out in Denmark and abroad produce new results and findings which are given consideration and, to the extent which is possible, are included as the basis for emission estimates and as data in the inventory databases. Furthermore, the updates of the EMEP/CORINAIR guidebook, and the work of the Task Force on Emission Inventories and its expert groups are followed closely in order to be able to incorporate the best scientific information as the basis for the inventories. The further important references in this regard are the IPCC guidelines and IPCC good practice guidance.

The implementation of new results in inventories is made in a way so that improvements, as far as possible, better reflect Danish conditions and circumstances. This is in accordance with good practice. Furthermore, efforts are made to involve as many experts as possible in the reasoning, justification and feasibility of implementation of improvements.

In improving the inventories, care is taken to consider implementation of improvements for the whole time-series of inventories to make it consistent. Such efforts lead to recalculation of previously submitted inventories. This submission includes recalculated inventories for the whole time-series. The reasoning for the recalculations performed is to be found in the sectoral chapters of this report. The text below focuses on improvements and recalculations, in general, and further serves as an overview and summary of the relevant text in the sectoral chapters.

8.1 Energy

Improvements and updates of the Danish energy statistics are made regularly by the producer of the statistics, the Danish Energy Agency. In close cooperation with the DEA, these improvements and updates are reflected in the emission inventory for the energy sector. The Danish energy statistics have, for the most part, been aggregated to the SNAP categorisation. This, however, does not include energy statistics for fuel consumption data for specific industries.

The inventories are still being improved through work to increase the number of large point sources, e.g. power plants, included in the databases as individual point sources. Such an inclusion makes it possible to use plant-specific data for emissions, etc, available e.g. in annual environmental reports from the plants in question.

8.1.1 Stationary Combustion

The national energy statistics has been updated for the years 1980-2005. This has only resulted in small differences.

For natural gas fired gas engines NO_x, NMVOC and CO emission factors have been updated for the entire time-series based on new research.

8.1.2 Mobile sources

Road transport

An error in the distribution of the total mileage between passenger cars and vans has been corrected from 1985 to 2005, and this change in input data has given slight emission changes. The mileage for passenger cars has been reduced in the new situation, and due to the fuel balance in the calculation model for diesel more fuel has been allocated to vans and heavy duty vehicles which in general have higher fuel related emission factors.

Also changes have been made to the gasoline fuel consumption input data for the NERI model, throughout the 1985-2005 periods. The gasoline fuel consumption generally increases, due to a reduced gasoline consumption calculated for non road working machinery in the same years. This latter fuel amount is being subtracted from the road transport sales of gasoline reported by the DEA, prior to NERI road transport model input.

The emission factors for NMVOC have been updated in the model. NMVOC is derived as the difference between VOC and CH_4, and the latter emission factors have been revised due to updates in the COPERT IV background data, both for cold start and operationally hot engines.

For NH_3, The hot start emission factors for passenger cars and vans have been updated in the NERI model, and in addition a new cold start calculation module has been implemented. The NERI model changes are based on the updated COPERT IV methodology and emission data.

National sea transport

Based on new research findings, the fuel consumption of heavy oil and gas oil for national sea transport is now calculated directly by NERI. Fuel adjustments are made in the fishery sector (gas oil) and stationary industry sources (heavy fuel oil) in order to maintain the grand national energy balance. The fuel consumption changes for national sea transport cause the emissions to change from 1985 to 2005.

Fishery

Fuel adjustments are made for gas oil, which affects the emissions for this sector. The emission changes for fisheries are followed by the opposite emission changes in national sea transport of approximately the same absolute values.

Military

Emission factors derived from the new road transport simulations have caused minor emission changes from 1985-2005.

Residential

The emissions somewhat decrease due to a smaller amount of fuel used by gasoline fuelled working machinery.

Agriculture

Updated stock information for ATV's (All Terrain Vehicles) 2002-2005, has given a small fuel use and emissions increase for these years.

Railways
No changes have been made.

Aviation
No changes have been made.

8.1.3 Industrial processes

SO_2 emissions from a sulphur recovery plant in sector 'Chemical Industry' have been included as process emissions.

The estimated SO_2 and NO_X emissions from cement production have been updated for the years 2002 to 2004.

8.1.4 Solvents

The previous method was based on results from an agreement between the Danish Industry and the Danish Environmental Protection Agency (DEPA). The emissions from various industries were reported to the Danish EPA. The reporting was not annual and linear interpolation was used between the reporting years. It is important to notice that not all use of solvents was included in this agreement and no activity data were available. It is not possible to perform direct comparison of methodologies or to make corrections to the previous method, due to the fundamental differences in structure. But an increase in total emissions was expected due to the more comprehensive list of chemicals.

Improvements and additions are continuously being implemented in the new approach, due to the comprehensiveness and complexity of the use and application of solvents in industries and households. The main improvements in the 2006 reporting include revisions of the following

- Propane and butane is used as aerosol in spraying cans primarily in households. The mean volume of a can is set to 200 ml according to information from e.g. trade associations. This reduces the propane and butane emissions compared to previous inventories.
- Propylalcohol used as windscreen washing agent is reallocated from autopaint and repair to household use.
- Emission factor for propylalcohol used as windscreen washing agent, corresponding to approximately 80% of the annually used amount, is changed to 1.0 for use. Approximately 20% of the annual propylalcohol use is used in closed industrial processes. This amount is assigned a low emission factor of 0.01.

8.1.5 Agriculture

Compared with the previous NH_3 and PM emissions inventory (submission 2007), some updates have been made. These changes only reflect small changes for the total emission - less than 1%.

There have been no changes in the methodology. The data received from statistics Denmark concerning the livestock production and the cultivated area 2005 is updated and these updated data are implemented in the inventory. Previous inventory had some small errors on grassing days for dairy cattle from 1990 to 1995, which is now corrected.

Annex 1

The complete NFR tables for Denmark can be found on Eionets Central Data Repository:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_EMEP_UNECE/envr7vebg

Annex 2A, 2B and 2C

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Annex 2A

Stationary combustion plants

This annex is a sector report for stationary combustion plants that includes more detailed documentation than included in the main report. Further it includes both greenhouse gases and pollutants reported to the LRTAP Convention.

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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 UNECE 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 2006 are included. The report updates a similar report published in 2007.

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 2007 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 2006 er 75 stationære forbrændingsanlæg defineret som punktkilder. Punktkilderne omfatter: kraftværker, decentrale kraftvarmeværker, affaldsforbrændingsanlæg, industrielle forbrændingsanlæg samt raffinaderier. Brændselsforbruget for disse anlæg svarer til 62 % 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 24 %, mens forbruget af fossile brændsler er steget med 13,1 %. 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, CO, tungmetaller (dog ikke Cu), PM_{10}, $PM_{2.5}$, PAH og dioxin. Endvidere udgør emissionen over 10 % for NO_X, NMVOC, TSP, og Cu. Stationær forbrænding bidrager med mindre end 10 % af den samlede danske emission af CH_4 og N_2O.

Indenfor 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, PAH og dioxin. 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 2006 end i basisåret 1990 – CO_2 er 4 % højere og drivhusgasemissionen er 5 % 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 3,8 siden 1990. Denne stigning skyldes, at der i perioden er installeret et betydeligt antal gasmotorer på decentrale kraftvarmeværker. De senere år er der set en tendens til at forbruget af naturgas i gasmotorer er faldende.

SO_2-emissionen fra stationær forbrænding er faldet med 95 % siden 1980 og 82 % 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 51 % siden 1985 og 34 % 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 212 % 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 66 % siden 1985 og 34 % siden 1995. Stigningen skyldes primært idriftsættelsen af gasmotorer på decentrale kraftvarmeværker samt det forøgede træforbrug i husholdninger.

Tungmetalemissionerne er faldet betydeligt siden 1990. Emissionen af de enkelte tungmetaller er reduceret mellem mellem 38 % og 82 %[1]. Faldet skyldes den forbedrede røggasrensing på affaldsforbrændingsanlæg og på kraftværker.

[1] Den beregnede Zn er lidt højere end for 1990, men det forventes at det alene skyldes utilstrækkelige data.

Emissionen af de forskellige PAH'er er steget til ca. det dobbelte siden 1990, hvilket hænger sammen med den øgede mængde træ, der forbrændes i brændeovne eller små villakedler. Dioxinemissionen er faldet med 61% siden 1990, hvilket skyldes dioxinrensning på affaldsforbrændingsanlæg.

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 five 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 2007 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 2006, 75 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 62% 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 24%, fossil fuel consumption, however, increased by 13.1%. 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, CO, heavy metals (except Cu), PM_{10}, $PM_{2.5}$, PAH and dioxin. Furthermore, emissions from stationary combustion plants account for more than 10% of the total Danish emission for the following pollutants: NO_X, NMVOC, TSP, 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, PAH and dioxin. 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 CO_2 and the total GHG emission were higher in 2006 than in 1990: CO_2 by 4% and GHG by 5%. 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 3.8 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 95% from 1980 and 82% 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 51% since 1985 and 34% 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 212% 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 66% from 1985 and 34% from 1995. The increased NMVOC emission results mainly from the increased use of lean-burn gas engines and the increased consumption of wood in the residential sector.

All heavy metal emissions have decreased considerably since 1990 – between 38% and 82%[2]. The decreases result from improvements in flue

[2] The estimated Zn emission is 10% higher in 2006 than in 1990. This is presumably due to insufficient emission factor update for resent years.

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

The PAH emission has doubled since 1990 due to increased combustion of wood in residential plants. Dioxin emission decreased by 61% compared to 1990, this is due to dioxin abatement technology installed on waste incineration 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 2006 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://www.dmu.dk/Luft/Emissioner/Home+of+Inventory/* 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 2006 (Nielsen et al. 2008a).

Pollutant	CO_2	CH_4	N_2O	HFCs, PFCs and SF6
Unit		Gg CO_2 equivalent		
1. Energy	55838	594	470	-
2. Industrial Processes	1611	-	-	887
3. Solvent and Other Product Use	102	-	37	-
4. Agriculture	-	3645	5960	-
5. Land-Use Change and Forestry	-1802	-0.5	0.1	-
6. Waste	-	1276	50	-
Total Danish emission (gross)[1)]	70471			
Total Danish emission (net) [2)]	68669			

1) Not including Land-Use Change and Forestry

2) Including Land-Use Change and Forestry

Table 2 Emissions 2006 reported to the LRTAP Convention (Nielsen et al. 2008b).

Pollutant	NO_X	CO	NMVOC	SO_2	TSP	PM_{10}	$PM_{2.5}$
	Gg	Gg	Gg	Gg	Mg	Mg	Mg
1. Energy	185	590	74	25	32 135	28 798	26 060
2. Industrial Processes	0.0	0.3	1.1	0.3	-	-	-
3. Solvent and Other Product Use	-	-	33	-	-	-	-
4. Agriculture	-	-	2	-	14 838	9662	1666
5. Land-Use Change and Forestry	-	-	-	-	-	-	-
6. Waste	-	-	-	-	-	-	-
Total Danish emission	185	591	110	25	46 973	38 460	27 726

Table 3 Emissions 2006 reported to the LRTAP Convention (Nielsen et al. 2008b).

Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1. Energy	6.08	0.71	1.28	0.65	1.35	9.50	10.72	1.91	26.37
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	6.15	0.71	1.28	0.65	1.35	9.54	10.72	1.91	27.01

Table 4 Emissions 2006 reported to the LRTAP Convention (Nielsen et al. 2008b).

Pollutant	Benzo(a)-pyrene Mg	Benzo(b)fluo-ranthene Mg	Benzo(k)-fluoranthene Mg	Indeno(1,2,3-c,d)pyrene Mg	Dioxin g I-Teq
1. Energy	3.97	4.30	2.37	2.89	18.60
2. Industrial Processes	-	-	-	-	0.02
3. Solvent and Other Product Use	-	-	-	-	-
4. Agriculture	-	-	-	-	-
5. Land-Use Change and Forestry	-	-	-	-	-
6. Waste	-	-	-	-	0.04
7. Other	-	-	-	-	6.10
Total Danish emission	3.97	4.30	2.37	2.89	24.76

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 220% of the 2006 emission
NO_X	127 Gg in 2010	Gothenburg protocol	The ceiling equals 69% of the 2006 emission
NMVOC	85 Gg in 2010	Gothenburg protocol	The ceiling equals 77% of the 2006 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 base year 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, 2007 update, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (EMEP/Corinair 2007). 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.

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 2A-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 sub-categories:

- 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 2006, 75 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 criteria for selection of point sources consist of the following:

- All centralized power plants, including smaller units.
- All units with a capacity of above 25 MW_e.
- All district heating plants with an installed effect of 50 MW or above and a significant fuel consumption
- All waste incineration plants included in the Danish law "Bekendtgørelse om visse listevirksomheders pligt til at udarbejde grønt regnskab".
- Industrial plants
  - With an installed effect of 50 MW or above and significant fuel consumption.
  - With a significant process related emission.

The fuel consumption of stationary combustion plants registered as large point sources is 383 PJ (2006). This corresponds to 62% of the overall fuel consumption for stationary combustion.

A list of the large point sources for 2006 and the fuel consumption rates is provided in Appendix 2A-8. The number of large point sources registered in the databases increased from 1990 to 2006.

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 2A-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. CO_2 emission factors are plant specific for some of the major power plants. Emissions of CO and NMVOC 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
- CO_2 data reported under the EU Emission Tranding Scheme
- Emission data reported from industrial plants

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

If plant-specific emission factors are not available, general area source emission factors are used. Emissions of the greenhouse gases (CH_4 and N_2O) from the large point sources are all based on the area source emission factors.

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 2007a). Some fuel types in the official Danish energy statistics are added to obtain a less detailed fuel aggregation level, see Appendix 2A-10. The calorific values on which the energy statistics are based are also enclosed in Appendix 2A-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 628 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 2007c).

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 about 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 2007) and IPCC Reference Manual (IPCC 1996).

A complete list of emission factors including time-series and references, is provided in Appendix 2A-6. The emission factors for SO_2 and NO_x is thouroughly discussed in Appendix 2A-4.

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 2A-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 2006 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 1990-2006. For the first time in 2006 data from the EU ETS were incorporated into the emission inventory. There are mainly data available from centralised coal fired plants. In the future more data from the ETS will be incorporated when available.

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.

Table 8 CO_2 emission factors 2006.

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		56,78	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

* Some plant specific data available for coal and residual oil

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 1990-2006.

As mentioned above ETS data were utilised for the first time in the emission inventory. The implied emission factors for the power plants using coal ranged from 90.01 to 95.31 kg/GJ. There were detailed data available from 15 coal powered units, which allowed the information to be included in the emission inventory.

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 $25.8 \cdot (12+2 \cdot 16)/12 = 94.6$ kg CO_2/GJ assuming full oxidation. The same emission factor is applied for 1990-2006.

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 $29.5 \cdot (12+2 \cdot 16)/12 = 108$ kg CO_2/GJ assuming full oxidation. The same emission factor is applied for 1990-2006.

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 fac-

tor level was confirmed by a new fuel analysis, which, however, is considered confidential. The same emission factor is applied for 1990-2006.

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 1990-2006.

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 2007b). 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] [GJ/Mg]	Plastic Content [% of energy]	CO_2 emission factor for plastic [3] [g/kg waste]	CO_2 emission factor for plastic [kg/GJ waste]	CO_2 emission factor for municipal waste, total [2] [kg/GJ waste]	CO_2 emission factor for biomass content of 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
2004	10.50	22.3	185	17.6	112.1	94.5
2005	10.50	22.3	185	17.6	112.1	94.5
2006	10.50	22.3	185	17.6	112.1	94.5

1) DEA 2007b

2) Based on data from Jørgensen & Johansen 2003

3) From Table 2A-4

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, 2007) and the actual value is the default value from the Collecter database. The same emission factor is applied for 1990-2006.

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; 2007). 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 1990-2006.

As mentioned above ETS data were utilised for the first time in the emission inventory. The implied emission factors for the power plants using coal ranged from 77.34 to 80.34 kg/GJ. There were detailed data available from 14 units using residual oil, which allowed the information to be included in the emission inventory.

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 1990-2005.

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 1990-2005.

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 1990-2006. Orimulsion is no longer used in Denmark.

Natural gas

The 2006 emission factor for natural gas is estimated by the Danish gas transmission company, Energinet.dk. The calculation is based on gas analysis carried out daily by Energinet.dk. Only natural gas from the Danish gas fields is utilised in Denmark. The emission factors for 2000-2005 have been estimated the same way by the former gas transmission companies DONG and Gastra. For 2000-2002 the Danish Gas Technology Centre have calculated emission factors based on the gas analysis, after that Gastra and now Energinet.dk have publish the CO_2 emission factors on their home page.

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
2004	57.12 kg/GJ
2005	56.96 kg/GJ
2006	56.78 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, 2007). 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 1990-2006.

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, 2007). The same emission factor is applied for 1990-2006.

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). The same emission factor is applied for 1990-2006.

3.5.2 CH_4

The CH_4 emission factors applied for 2006 are presented in Table 12. In general, the same emission factors have been applied for 1990-2006. 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). For natural gas fired gas engines the emission factor refers to an updated study (Nielsen et al., 2008). Other emission factors refer to the EMEP/Corinair Guidebook (EMEP/Corinair, 2007).

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 1990-2006.

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	465[1)]	Nielsen et al. 2008c
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	323[1)]	Nielsen & Illerup 2003
BIOGAS	1A1a, 1A2f, 1A4a, 1A4c	all other	4	EMEP/Corinair 2004

[1)] 2006 emission factor. Time-series is shown below

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 (Nielsen & Illerup 2003).

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.

In addition to the above mentioned project a study conducted in 2006/2007 produced updated emission factors for natural gas powered gas engines including start/stop emissions. (Nielsen et al., 2008c)

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 - 2005. 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 (year 2000). 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 new study (Nielsen et al., 2008c) calculated a start/stop correction factor, this factor have been applied to the time-series estimated on the basis of Nielsen & Illerup, 2003. Nielsen et al, 2008 calculated updated full load emission factors for 2004-2006. The time-series can be seen in table 13.

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 1990-2006. A time-series for the emission factor has been estimated and is presented below (Nielsen et al., 2008). The time-series was based on:

- Emission factors for different engine types
- Nielsen & Illerup, 2003
- Data regarding fuel consumption (DEA, 2007c)
- Correction factors for start/stop emissions

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

Year	Emission factor [g/GJ]
1990	266
1991	309
1992	359
1993	562
1994	623
1995	632
1996	615
1997	551
1998	542
1999	541
2000	537
2001	537
2002	537
2003	537
2004	513
2005	489
2006	465

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 - 2006. 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 (year 2000).

The emission factor is lower than the factor for natural gas, mainly because most engines are lean-burn open-chamber engines - not prechamber 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
2004	323
2005	323
2006	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 0.5 g/GJ and the emission factor 0.5 g/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 0.59 g/GJ and the emission factor 0.59 g/GJ has been applied for all years. The emission factor was based on emission measurements on 16 plants.

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 1990-2006.

3.5.3 N_2O

The N_2O emission factors applied for the 2006 inventory are listed in Table 15. The same emission factors have been applied for 1990-2006.

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). For Coal powered plants in the Public power sector research conducted by Elsam has led to a new emission factor being implemented for the entire time-series. Other emission factors refer to the EMEP/Corinair Guidebook (EMEP/Corinair 2004).

Table 15 N_2O emission factors 1990-2005.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	1A1a	0101**	0.8	Elsam 2005
COAL	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	All except 0101**	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 2A-6. The appendix includes references and time-series. Further the SO_2 and NO_x emission factors are documented in Appendix 2A-4.

The emission factors refer to:

- The EMEP/Corinair Guidebook (EMEP/Corinair 2004) and subsequent updates

- The IPCC Guidelines, Reference Manual (IPCC 1996)
- Danish legislation:
  - Miljøstyrelsen 2001 (Danish Environmental Protection Agency)
  - Miljøstyrelsen 1990 (Danish Environmental Protection Agency)
  - Miljøstyrelsen 1998 (Danish Environmental Protection Agency)
- Danish research reports including:
  - An emission measurement program for decentralised CHP plants (Nielsen & Illerup 2003)
  - Measurement program for natural gas powered gas engines (Nielsen et al., 2008c)
  - 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 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 2A-6.

A detailed documentation for the SO_2 and NO_X emission factors is given in Appendix 2A-4.

3.5.5 Particulate matter (PM)

Emission factors for PM are listed in Appendix 2A-6. The appendix includes references. The emission factors are based on:

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

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

- Danish legislation:
  - Miljøstyrelsen 2001 (Danish Environmental Protection Agency).
  - Miljøstyrelsen 1990 (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 2000-2006.

3.5.6 Heavy metals

Emission factors for 2006 for heavy metals (HM) are presented in Appendix 2A-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 1990-2006.

3.5.7 PAH

Emission factors 2006 for PAHs are shown in Appendix 2A-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).

Emission factor time-series have been estimated for residential wood combustion. All other emission factors are considered constant in 2000-2006. 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, does not include a direct disaggregation to specific industrial subsectors. However, separate national statistics from Statistics Denmark includes 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 Denmark 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.

4 Fuel consumption data

In 2006 total fuel consumption for stationary combustion plants was 618 PJ of which 505 PJ was fossil fuels. The fuel consumption rates are shown in Appendix 2A-5.

Fuel consumption distributed on the stationary combustion subsectors is shown in Figure 1 and Figure 2. The majority - 62% - of all fuels is combusted in the sector, *Public electricity and heat production.* Other sectors with high fuel consumption are *Residential* and *Industry*. The energy consumption in category 1A1c is mainly natural gas used in gas turbines in the off-shore industry.

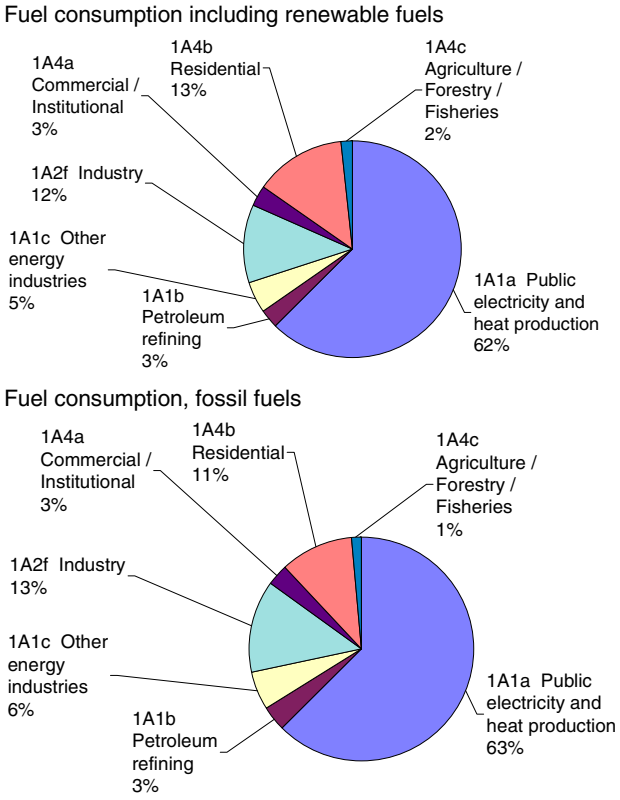


Figure 1 Fuel consumption rate of stationary combustion, 2006 (based on DEA 2007a).

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.

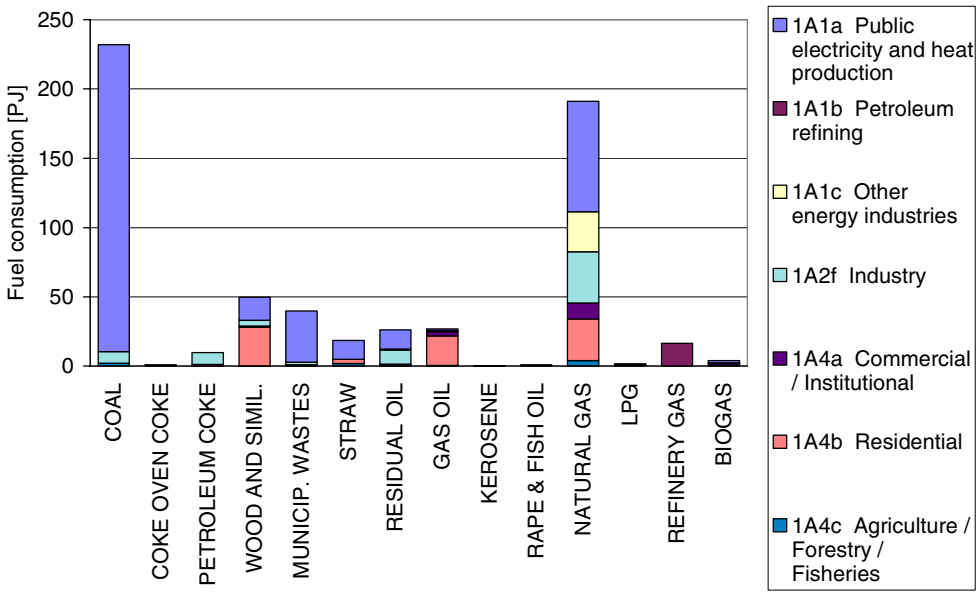


Figure 2 Fuel consumption of stationary combustion plants 2006 (based on DEA 2007a).

Fuel consumption time-series for stationary combustion plants are presented in Figure 3. The total fuel consumption has increased by 24% from 1990 to 2006, while the fossil fuel consumption increased by 13.1%. The consumption of natural gas and renewable fuels has increased since 1990 whereas coal consumption has decreased.

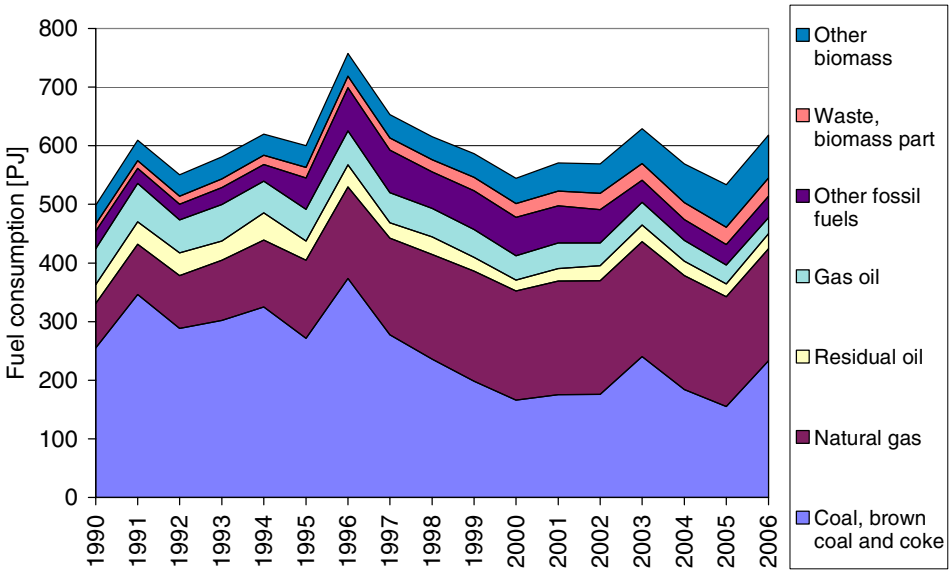


Figure 3 Fuel consumption time-series, stationary combustion (based on DEA 2007a).

The fluctuations in the time-series for fuel consumption are mainly a result of electricity import/export, but also of outdoor temperature variations from year to year. This, in turn, leads to fluctuations in emission levels. The fluctuations in electricity trade, fuel consumption 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 2006 the net electricity export was 24 971 TJ in 2005 there had been a net import. The electricity export in 2006 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.

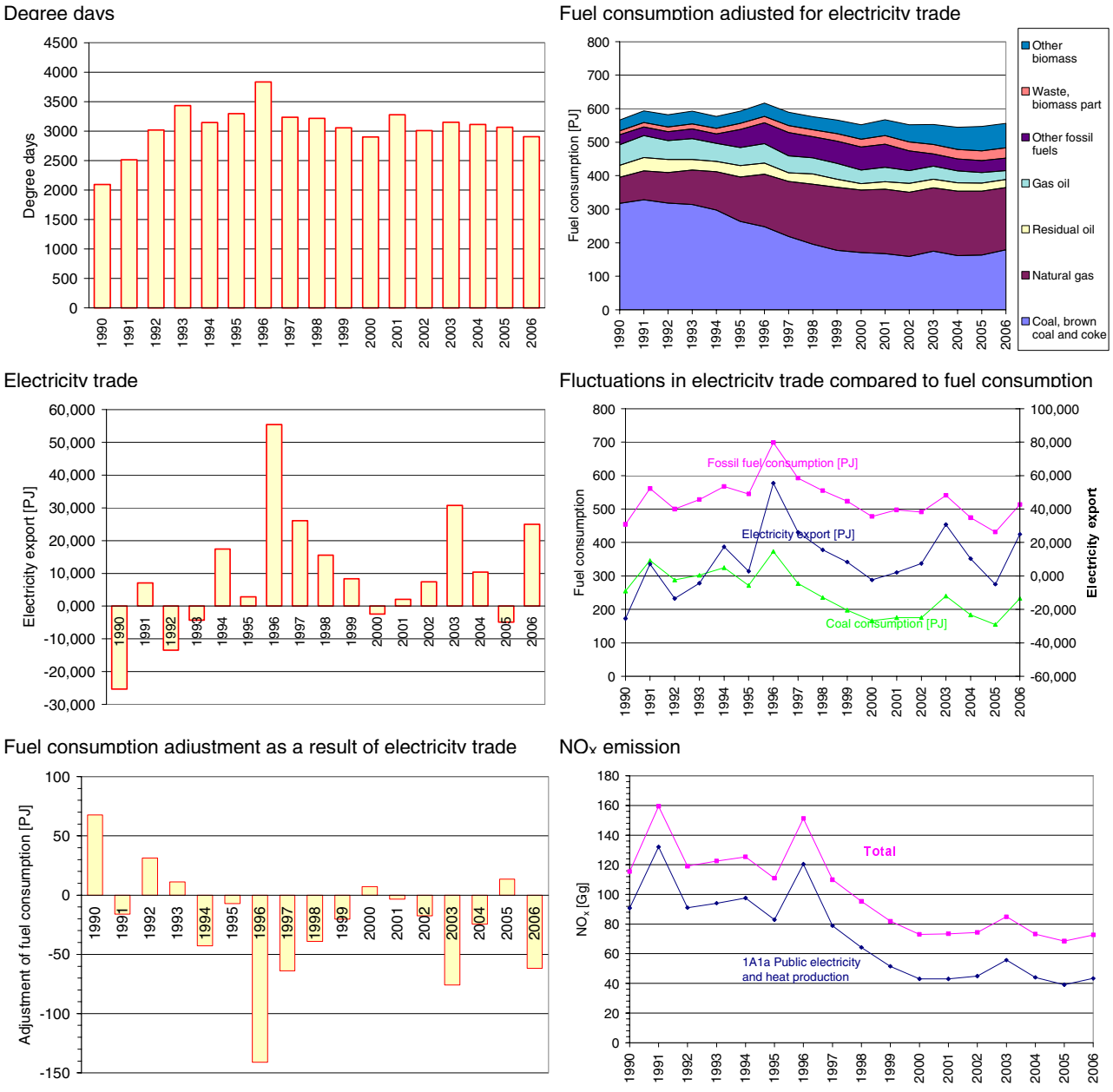


Figure 4 Comparison of time-series fluctuations for electricity trade, fuel consumption and NO_X emission (DEA 2007b).

5 Greenhouse gas emission

The total Danish greenhouse gas (GHG) emission in the year 2006 was 70471 Gg CO_2 equivalent not including land-use change and forestry or 68669 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 58% of the total Danish GHG emission.

The CO_2 emission from stationary combustion plants accounts for 68% of the total Danish CO_2 emission (not including land-use change and forestry). CH_4 accounts for 8% of the total Danish CH_4 emission and N_2O for only 4% of the total Danish N_2O emission.

Table 16 Greenhouse gas emission for the year 2006 [1].

	CO_2	CH_4	N_2O
	Gg CO_2 equivalent		
1A1 Fuel consumption, Energy industries	29470	240	168
1A2 Fuel consumption, Manufacturing Industries and Construction[1]	4609	23	44
1A4 Fuel consumption, Other sectors [1]	4948	198	79
Total emission from stationary combustion plants	39026	461	291
Total Danish emission (gross)	57551	5516	6518
		%	
Emission share for stationary combustion	68	8	4

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.).

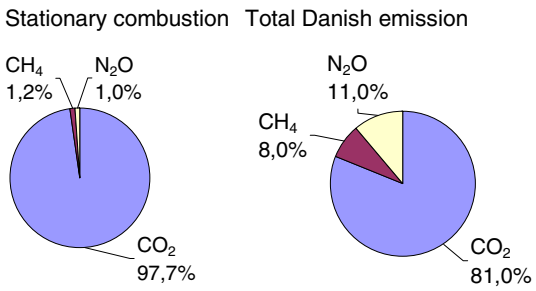


Figure 5 GHG emission (CO_2 equivalent), contribution from each pollutant.

Figure 6 depicts the time-series of GHG emission (CO_2 eq.) 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 2006 than in 1990, CO_2 by 4% and GHG by 5%. However, fluctuations in the GHG emission level are large.

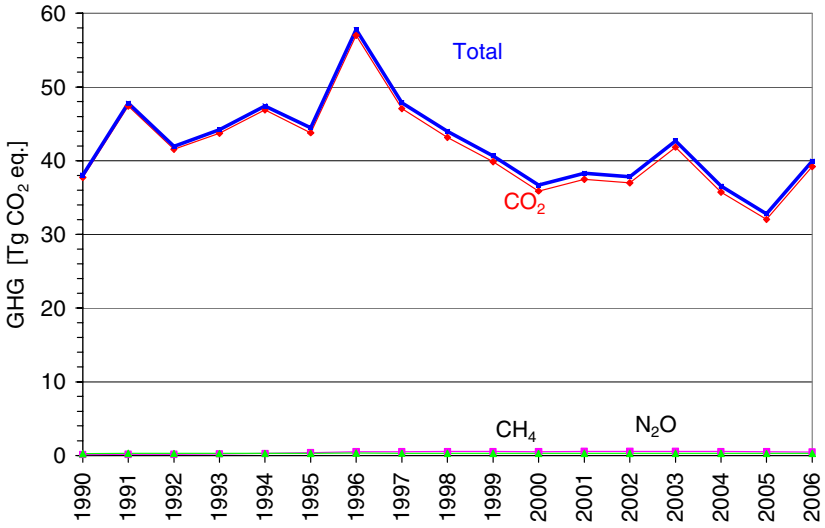


Figure 6 GHG emission time-series for stationary combustion.

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 23% since 1990, and the CO_2 emission by 24%.

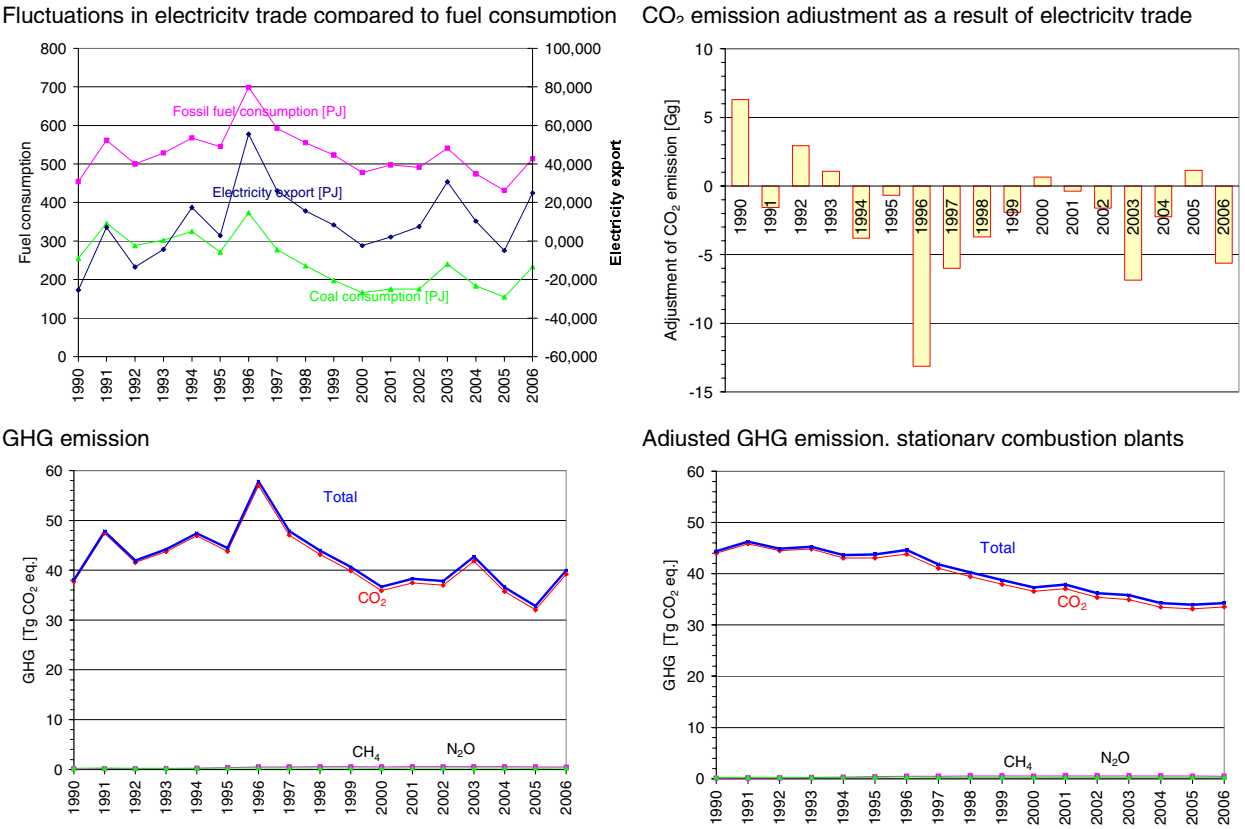


Figure 7 GHG emission time-series for stationary combustion, adjusted for electricity import/export (DEA 2007b).

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 68% of the total Danish CO_2 emission. Table 17 lists the CO_2 emission inventory for stationary combustion plants for 2006. Figure 8 reveals that *Electricity and heat production* accounts for 69% of the CO_2 emission from stationary combustion. This share is somewhat higher than the fossil fuel consumption share for this sector, which is 63% (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 2006 [1)]

CO_2	2006	
1A1a Public electricity and heat production	26 858	Gg
1A1b Petroleum refining	982	Gg
1A1c Other energy industries	1631	Gg
1A2 Industry	4609	Gg
1A4a Commercial / Institutional	957	Gg
1A4b Residential	3462	Gg
1A4c Agriculture / Forestry / Fisheries	529	Gg
Total	39 026	Gg

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

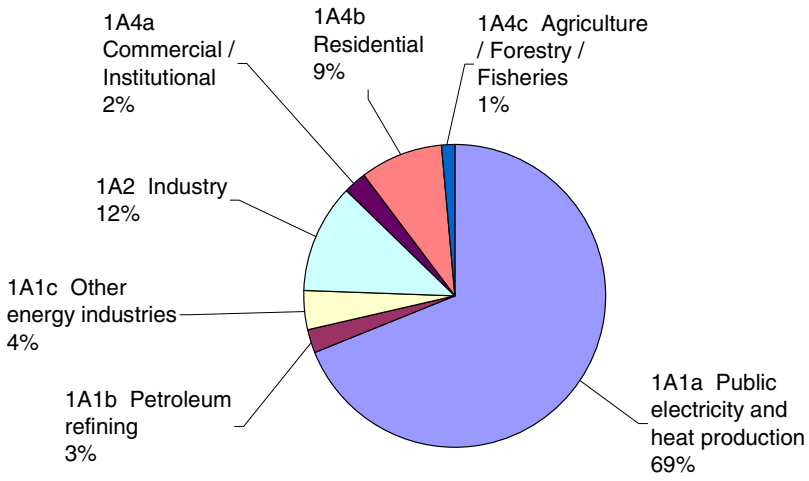


Figure 8 CO_2 emission sources, stationary combustion plants, 2006.

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 >300MW.

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

SNAP source	SNAP name	2006	
0101	Public power	-	Gg
010101	Combustion plants ≥ 300MW (boilers)	21 773	Gg
010102	Combustion plants ≥ 50MW and < 300 MW (boilers)	840	Gg
010103	Combustion plants <50 MW (boilers)	262	Gg
010104	Gas turbines	2557	Gg
010105	Stationary engines	1177	Gg
0102	District heating plants	-	Gg
010201	Combustion plants ≥ 300MW (boilers)	2	Gg
010202	Combustion plants ≥ 50MW and < 300 MW (boilers)	21	Gg
010203	Combustion plants <50 MW (boilers)	178	Gg
010204	Gas turbines	-	Gg
010205	Stationary engines	48	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 2006 the CO_2 emission from biomass combustion was 11 186 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 46% of the fossil fuel consumption and for 57% of the CO_2 emission. Natural gas accounts for 37% of the fossil fuel consumption but only 27% of the CO_2 emission.

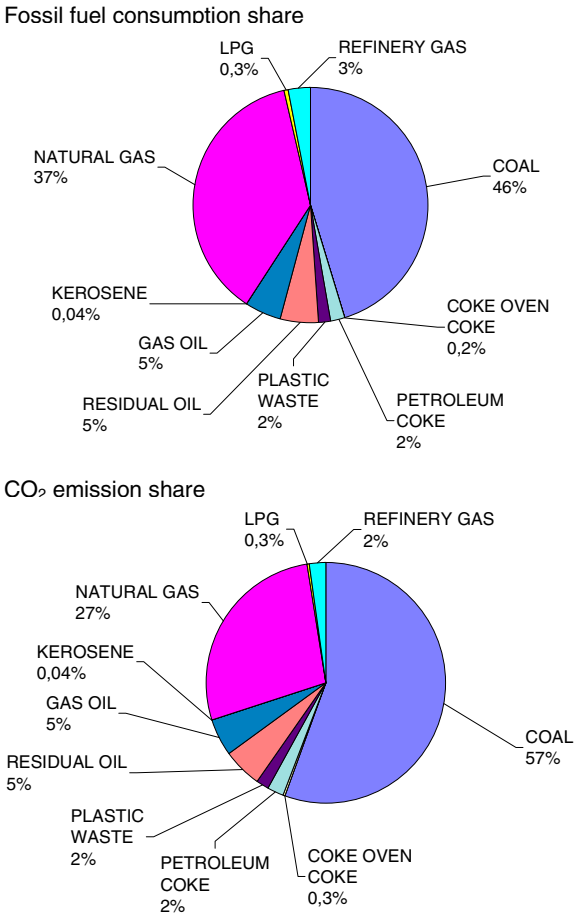


Figure 9 CO_2 emission, fuel origin.

Time-series for CO_2 emission are provided in Figure 10. Despite an increase in fuel consumption of 24% since 1990 CO_2 emission from stationary combustion has increased by only 4% because of the change of fuel type used.

The fluctuations in total CO_2 emission follow the fluctuations in CO_2 emission from *Electricity and heat production* (Figure 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 13.1% between 1990 and 2006.

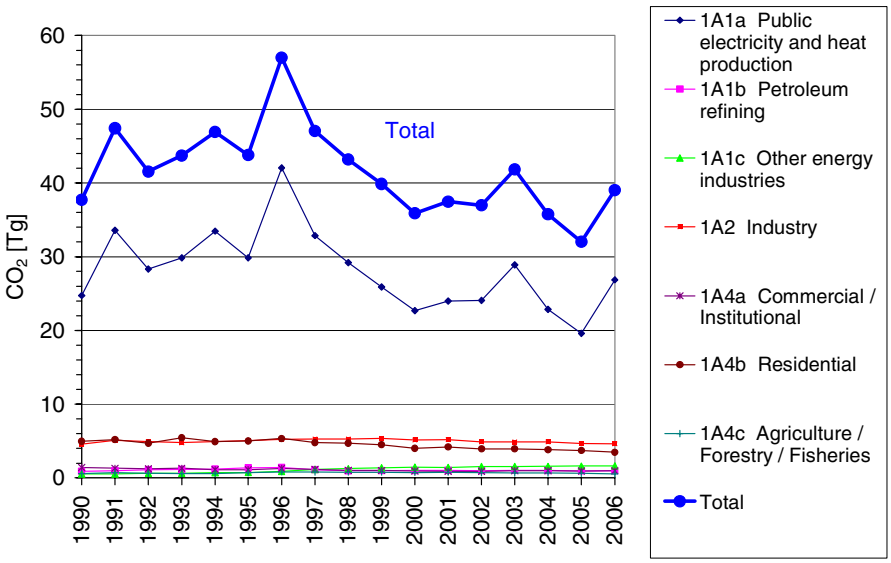


Figure 10 CO_2 emission time-series for stationary combustion plants.

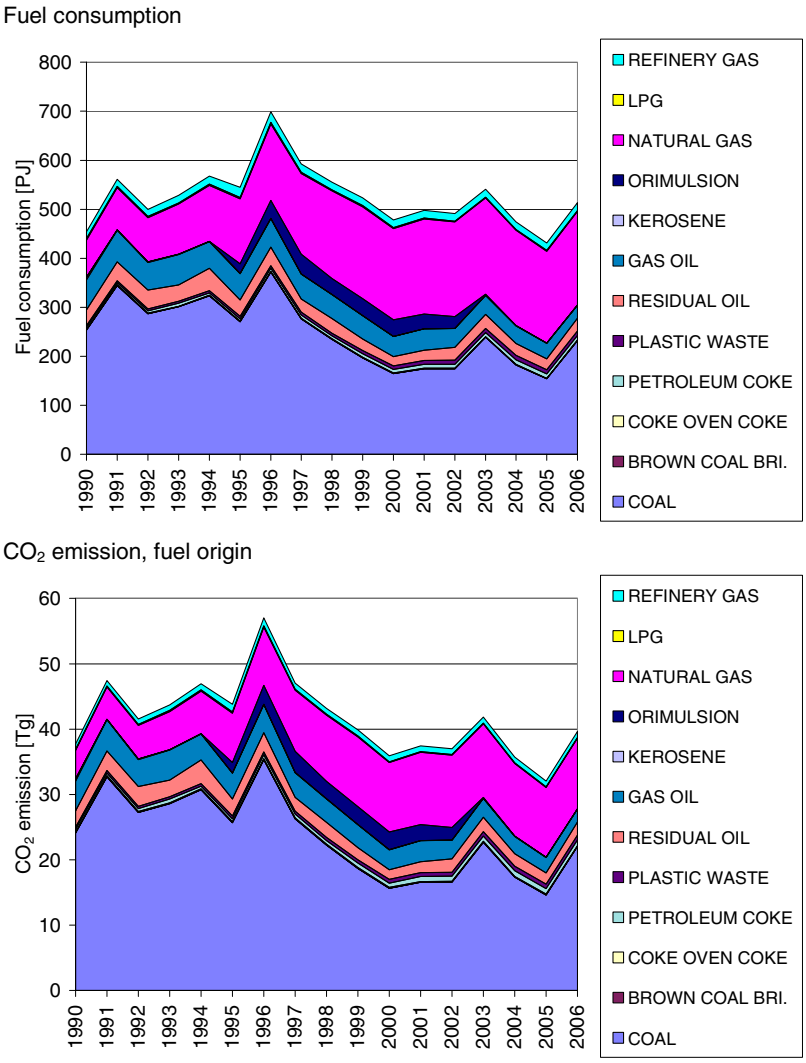


Figure 11 Fossil fuel consumption and CO_2 emission time-series for stationary combustion.

5.2 CH_4

CH_4 emission from stationary combustion plants accounts for 8% of the total Danish CH_4 emission. Table 19 lists the CH_4 emission inventory for stationary combustion plants in 2005. Figure 12 reveals that *Electricity and heat production* accounts for 52% 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 2006 [1].

CH_4	2006	
1A1a Public electricity and heat production	11 337	Mg
1A1b Petroleum refining	0.5	Mg
1A1c Other energy industries	86	Mg
1A2 Industry	1115	Mg
1A4a Commercial / Institutional	872	Mg
1A4b Residential	7088	Mg
1A4c Agriculture / Forestry / Fisheries	1450	Mg
Total	21 947	Mg

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

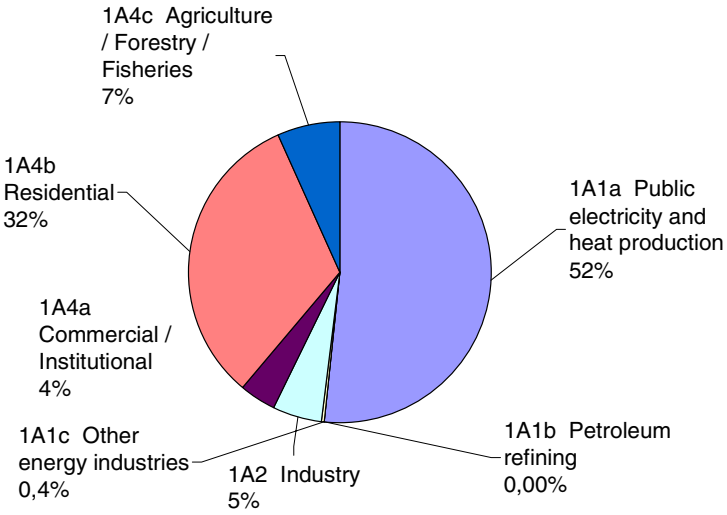


Figure 12 CH_4 emission sources, stationary combustion plants, 2006.

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 3.5.2. A considerable number of lean-burn gas engines are in operation in Denmark and these plants account for 60% 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.

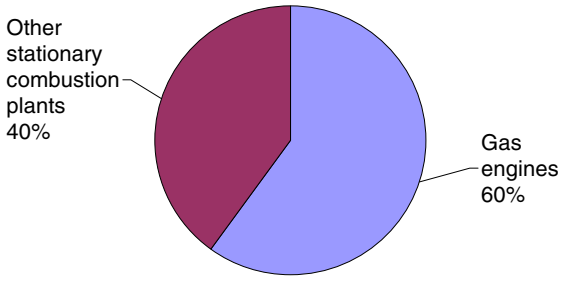


Figure 13 Gas engine CH_4 emission share, 2006.

The CH_4 emission from stationary combustion increased by a factor of 3.8 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. In later years the fuel consumption has declined in gas engines causing CH_4 emission from stationary combustion to decrease.

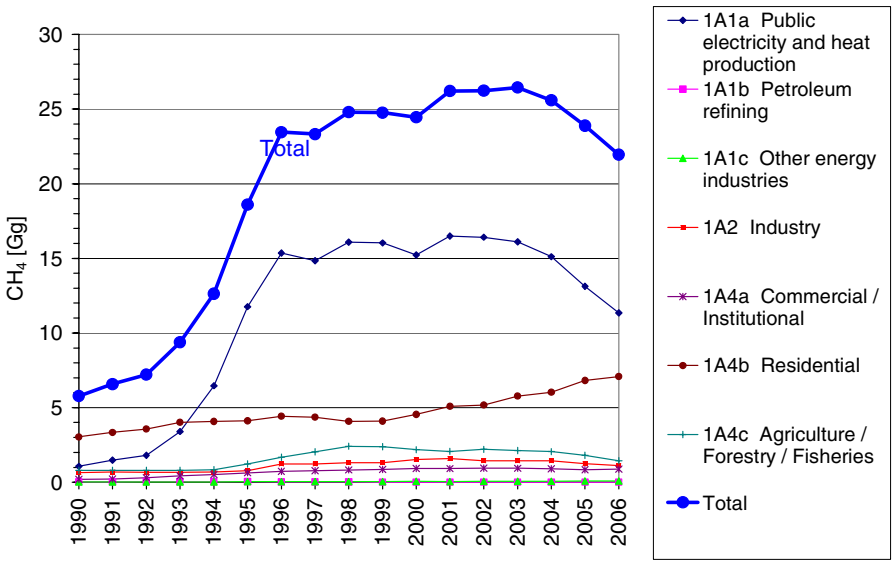


Figure 14 CH_4 emission time-series for stationary combustion plants.

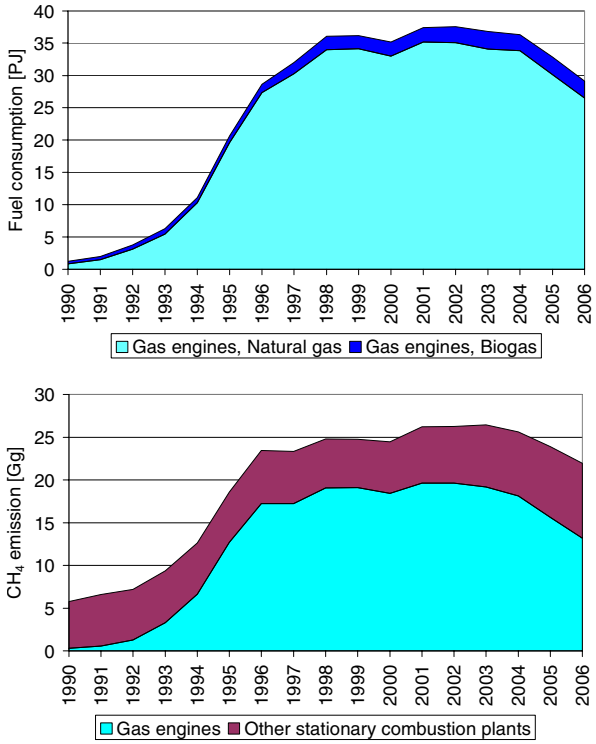


Figure 15 Fuel consumption and CH_4 emission from gas engines, time-series.

5.3 N_2O

The N_2O emission from stationary combustion plants accounts for 4% of the total Danish N_2O emission. Table 20 lists the N_2O emission inventory for stationary combustion plants in the year 2006. Figure 16 reveals that *Electricity and heat production* accounts for 47% of the N_2O emission from stationary combustion.

Table 20 N_2O emission from stationary combustion plants 2006 [1].

N_2O	2006	
1A1a Public electricity and heat production	445	Mg
1A1b Petroleum refining	34	Mg
1A1c Other energy industries	63	Mg
1A2 Industry	143	Mg
1A4a Commercial / Institutional	29	Mg
1A4b Residential	202	Mg
1A4c Agriculture / Forestry / Fisheries	23	Mg
Total	940	Mg

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

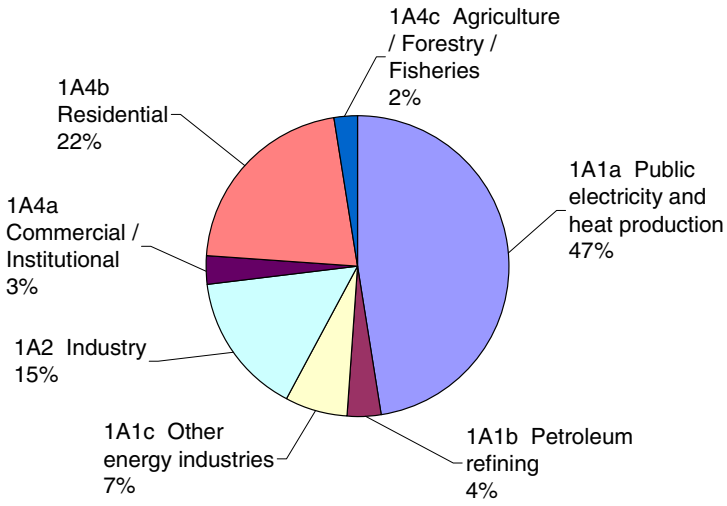


Figure 16 N_2O emission sources, stationary combustion plants, 2006.

Figure 17 shows time-series for N_2O emission. The N_2O emission from stationary combustion increased by 10% from 1990 to 2006, but again fluctuations in emission level due to electricity import/export are considerable.

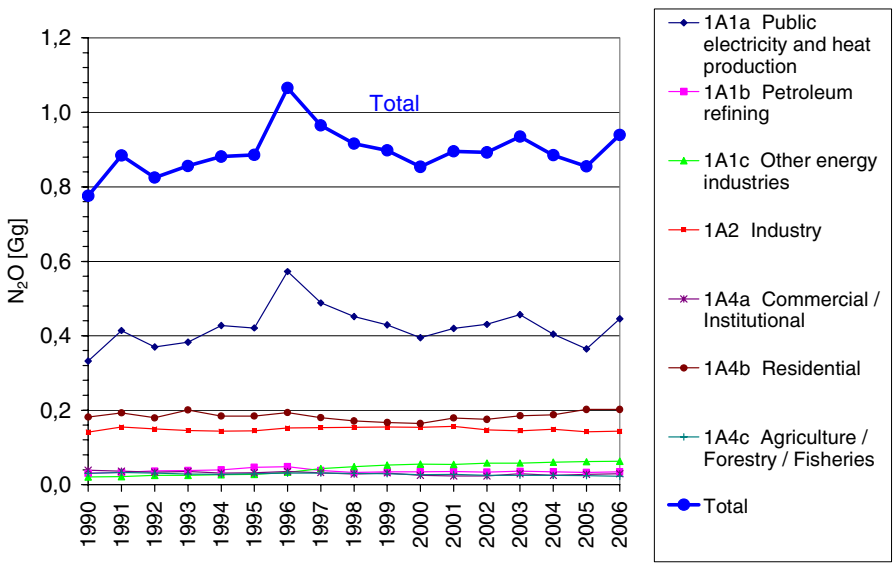


Figure 17 N_2O emission time-series for stationary combustion plants.

6 SO_2, NO_X, NMVOC and CO

The emissions of SO_2, NO_X, NMVOC and CO from Danish stationary combustion plants 2006 are presented in Table 21. The emissions of these pollutants are also included in the report to the Climate Convention.

SO_2 from stationary combustion plants accounts for 90% of the total Danish emission. NO_X, CO and NMVOC account for 39%, 50% and 21% of total Danish emissions, respectively.

Table 21 SO_2, NO_X, NMVOC and CO emission from stationary combustion 2005 [1].

Pollutant	NO_X	CO	NMVOC	SO_2
	Gg	Gg	Gg	Gg
1A1 Fuel consumption, Energy industries	51,9	10,3	3,3	10,2
1A2 Fuel consumption, Manufacturing Industries and Construction (Stationary combustion)	12,5	12,0	0,6	7,9
1A4 Fuel consumption, Other sectors (Stationary combustion)	8,3	275,1	19,3	4,4
Total emission from stationary combustion plants	72,7	297,3	23,2	22,6
Total Danish emission	185,3	590,6	110,0	25,0
		%		
Emission share for stationary combustion	39	50	21	90

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 90% 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 43% of the emission. However, the SO_2 emission share is lower than the fuel consumption share for this sector, which is 62%. 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 78% of the emission.

The fuel origin of the SO_2 emission is shown in Figure 3A-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 (47%). Most remarkably is the emission share from residual oil combustion, which is 28%. 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 35%, a remarkably high emission share compared with fuel consumption. The main emission sources in the in-

dustrial 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 95% from 1980 and 82% 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 39% 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 2006 [1].

SO_2	2006	
1A1a Public electricity and heat production	9832	Mg
1A1b Petroleum refining	407	Mg
1A1c Other energy industries	11	Mg
1A2 Industry	7903	Mg
1A4a Commercial / Institutional	272	Mg
1A4b Residential	2407	Mg
1A4c Agriculture / Forestry / Fisheries	1754	Mg
Total	22 585	Mg

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

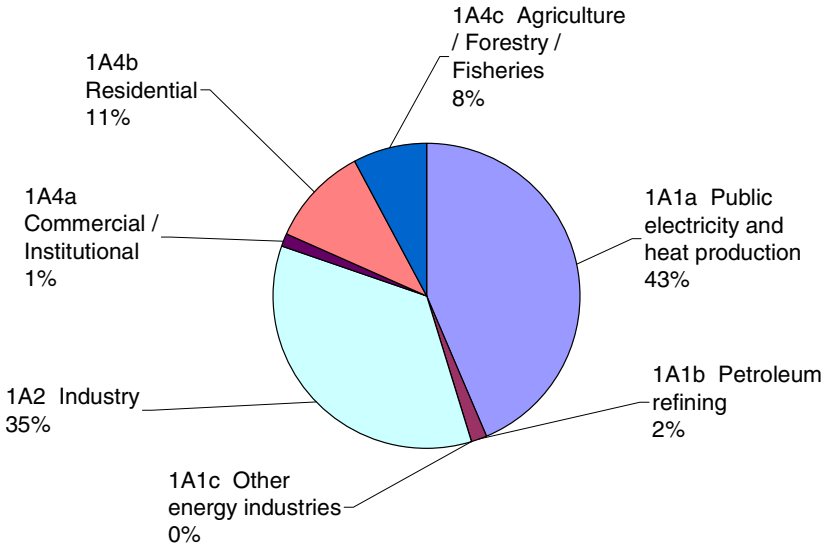


Figure 18 SO_2 emission sources, stationary combustion plants, 2006.

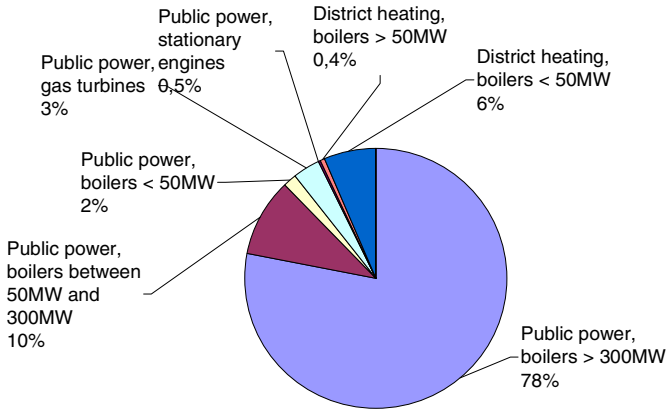


Figure 19 Disaggregated SO_2 emissions from *Energy and heat production.*

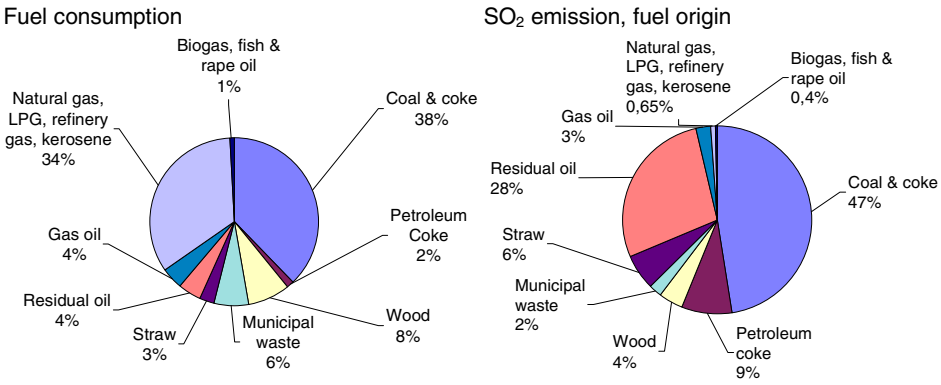


Figure 20 Fuel origin of the SO_2 emission from stationary combustion plants.

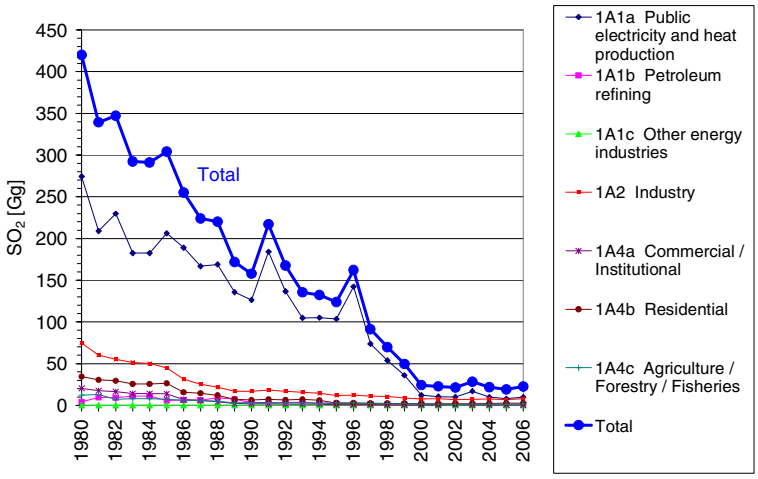


Figure 21 SO_2 emission time-series for stationary combustion.

6.2 NO_X

Stationary combustion accounts for 39% 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 59% of the emission from stationary combustion plants.

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 17% of the emission. The main industrial emission source is cement production, accounting for 65% of the emission.

Residential plants accounts for 8% of the NO_X emission. The fuel origin of this emission is mainly wood, gas oil and natural gas accounting for 57%, 19% and 18% 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 51% from 1985 and 34% 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 2006 [1)].

	2006	
1A1a Public electricity and heat production	43 306	Mg
1A1b Petroleum refining	1366	Mg
1A1c Other energy industries	7192	Mg
1A2 Industry	12 498	Mg
1A4a Commercial / Institutional	1226	Mg
1A4b Residential	5924	Mg
1A4c Agriculture / Forestry / Fisheries	1138	Mg
Total	72 650	Mg

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

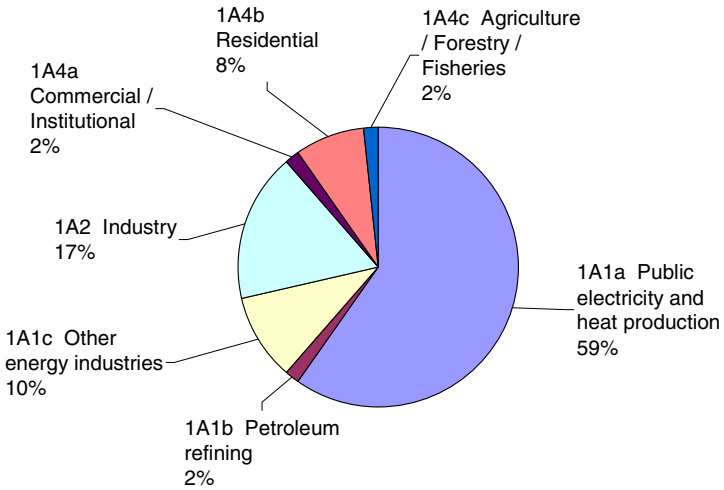


Figure 22 NO_X emission sources, stationary combustion plants, 2006.

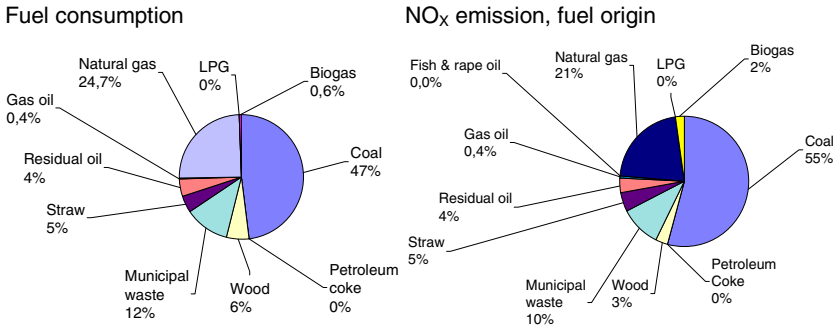


Figure 23 NO_X emissions from 1A1a Electricity and heat production, fuel origin.

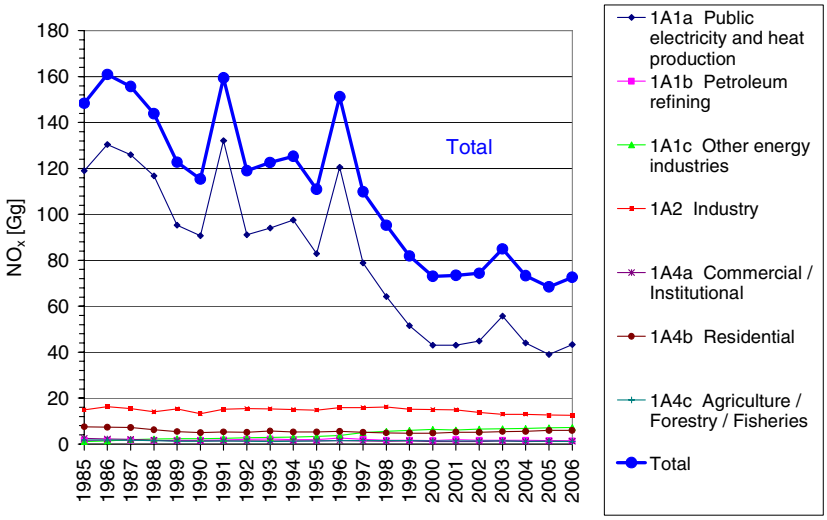


Figure 24 NO_X emission time-series for stationary combustion.

6.3 NMVOC

Stationary combustion plants account for 21% 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 74% 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 16% 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 66% from 1985 and 34% from 1995. The increased emission is mainly a result of increasing wood consumption in residential plants and of the increased use of lean-burn gas engines in CHP plants as discussed in Chapter 7.2.

The emission from residential plants is 78% higher in 2006 than in 1990, but the NMVOC emission from wood combustion increased by 139%

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 2006 [1].

	2006	
1A1a Public electricity and heat production	3282	Mg
1A1b Petroleum refining	0	Mg
1A1c Other energy industries	43	Mg
1A2 Industry	568	Mg
1A4a Commercial / Institutional	722	Mg
1A4b Residential	17 109	Mg
1A4c Agriculture / Forestry / Fisheries	1458	Mg
Total	23 182	Mg

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

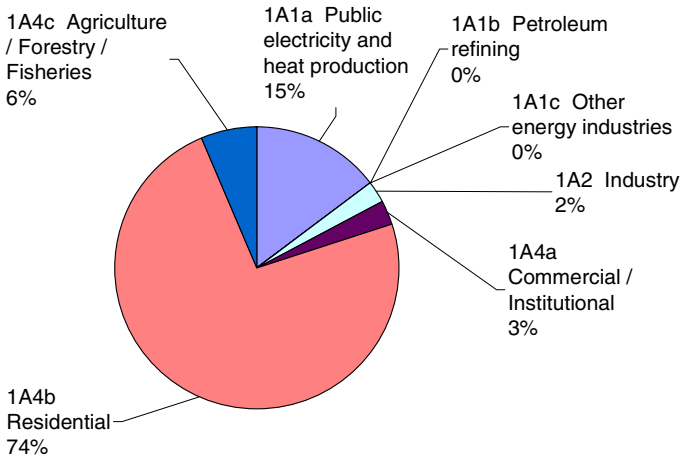


Figure 25 NMVOC emission sources, stationary combustion plants, 2006.

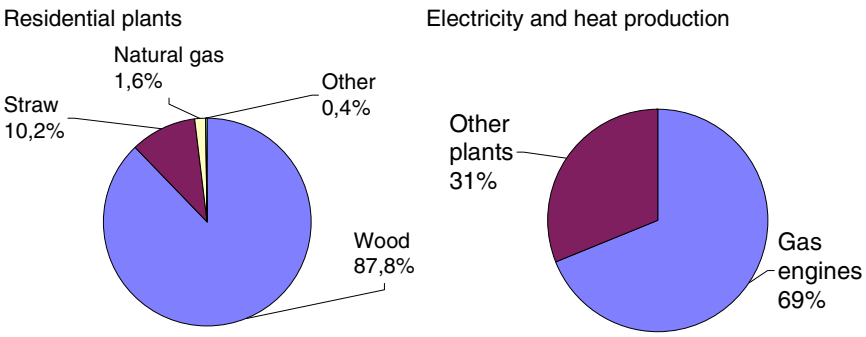


Figure 26 NMVOC emission from residential plants and from electricity and heat production, 2006.

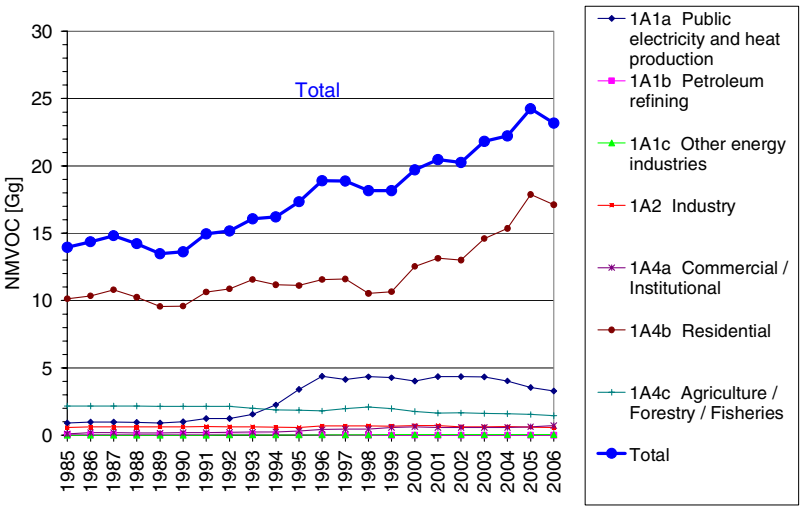


Figure 27 NMVOC emission time-series for stationary combustion.

6.4 CO

Stationary combustion accounts for 50% of the total Danish CO emission. Table 25 and Figure 28 present the CO emission inventory for stationary combustion subsectors.

Residential plants are the largest emission source, accounting for 90% of the emission. Wood combustion accounts for 95% of the emission from residential plants, see Figure 29. This is in spite of the fact that the fuel consumption share is only 33%. 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 65% from 1985 and increased 57% 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 212% 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 2006 [1].

	2006	
1A1a Public electricity and heat production	9787	Mg
1A1b Petroleum refining	244	Mg
1A1c Other energy industries	219	Mg
1A2 Industry	12 028	Mg
1A4a Commercial / Institutional	924	Mg
1A4b Residential	265 888	Mg
1A4c Agriculture / Forestry / Fisheries	8243	Mg
Total	297 333	Mg

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

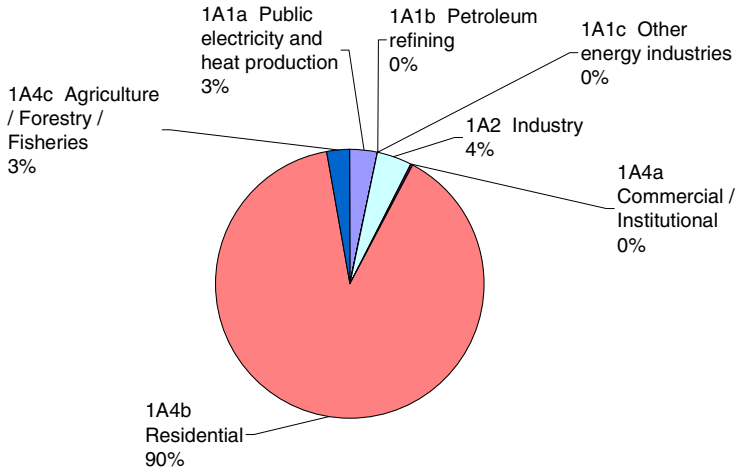


Figure 28 CO emission sources, stationary combustion plants, 2006.

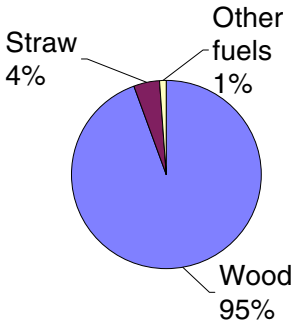


Figure 29 CO emission sources, residential plants, 2006.

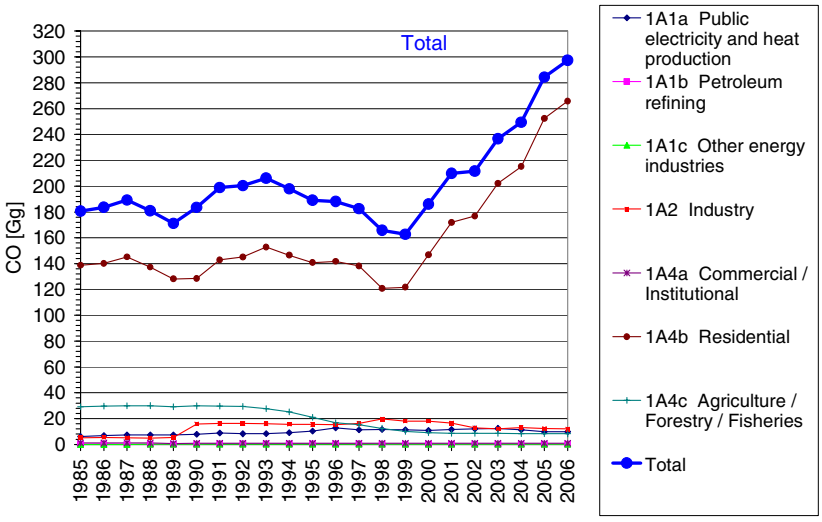


Figure 30 CO emission time-series for stationary combustion.

7 Particulate matter (PM)

The emission of total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ from Danish stationary combustion plants 2006 is presented in Table 26. The PM emission is reported to the LRTAP Convention.

To date, PM emissions from stationary combustion, transport, agriculture and the industrial sector have been included in the Danish inventory. TSP from stationary combustion accounts for 48% of the total Danish emission. The emission shares for PM_{10} and $PM_{2.5}$ are 54% and 70%, respectively.

Table 26 Danish PM emissions 2006.

Pollutant	TSP	PM_{10}	$PM_{2.5}$
	Mg	Mg	Mg
1A1 Fuel combustion, Energy industries	1073	836	701
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion)[1)]	980	672	385
1A4 Fuel combustion, Other sectors (Stationary combustion)[1)]	20423	19353	18296
Total emission from stationary combustion plants	22476	20861	19382
Total Danish emission (gross)	46 973	38 460	27 726
		%	
Emission share for stationary combustion	48	54	70

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 91% 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 87% of the $PM_{2.5}$ emission from stationary combustion is emitted from residential wood combustion. This corresponds to 61% 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 96% 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 2000-2006 and the short time-series for TSP, PM_{10} and $PM_{2.5}$ emission is shown in Figure 33. The decrease in PM emission from 2005 to 2006 is due to a lower emission factor, with the increasing implementation of new technology in stoves and fireplaces.

Table 27 PM emission from stationary combustion plants, 2006 [1)].

	TSP	PM_{10}	$PM_{2.5}$	
1A1a Public electricity and heat production	957	728	596	Mg
1A1b Petroleum refining	113	107	104	Mg
1A1c Other energy industries	3	2	2	Mg
1A2 Industry	980	672	385	Mg
1A4a Commercial / Institutional	166	162	152	Mg
1A4b Residential	19 736	18 708	17 697	Mg
1A4c Agriculture / Forestry / Fisheries	521	482	446	Mg
Total	22 476	20 861	19 382	Mg

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

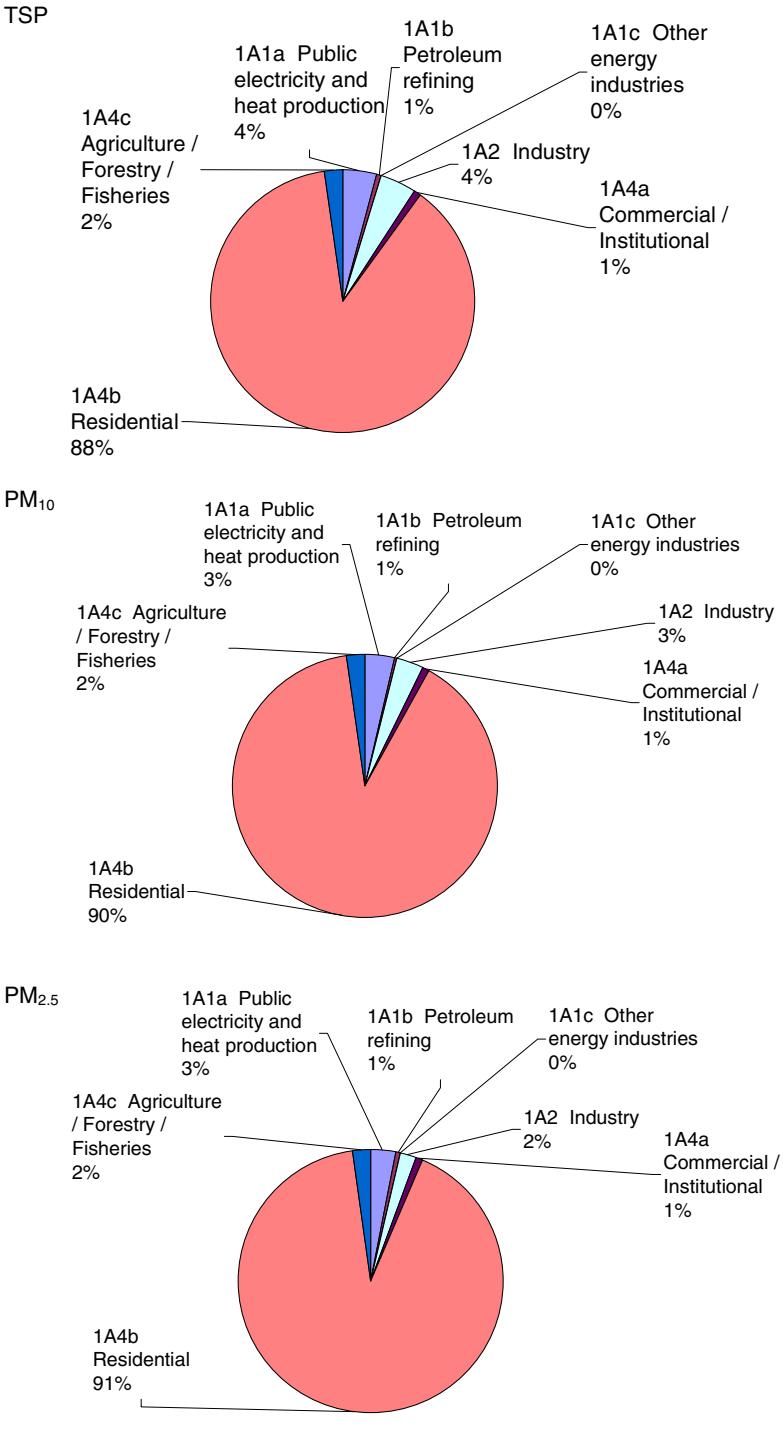


Figure 31 PM emission sources, stationary combustion plants, 2006.

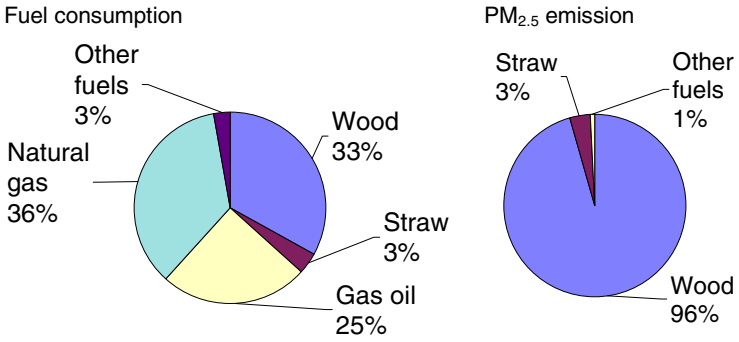


Figure 32 Fuel consumption and $PM_{2.5}$ emission from residential plants.

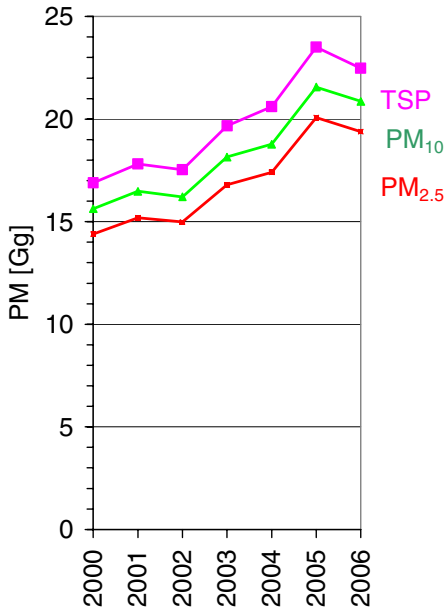


Figure 33 PM emission time-series for stationary combustion.

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 2006 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 12%, but for all other heavy metals the emission share is more than 77%, see Table 28.

Table 28 The emission of heavy metals in 2006, reported to the LRTAP Convention in 2008.

Pollutant	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1A1 Fuel combustion, Energy industries	3.45	0.23	0.68	0.34	0.54	0.67	2.72	1.07	15.36
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion)	0.92	0.19	0.26	0.23	0.45	0.20	6.20	0.59	1.30
1A4 Fuel combustion, Other sectors (Stationary combustion)	0.34	0.23	0.32	0.06	0.11	0.29	0.96	0.13	4.68
Total emission from stationary combustion plants	4.71	0.66	1.27	0.63	1.10	1.16	9.88	1.80	21.34
Total Danish emission	6.15	0.71	1.28	0.65	1.35	9.54	10.72	1.91	27.01
Emission share for stationary combustion	77%	92%	99%	97%	81%	12%	92%	95%	79%

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 73%, 34% and 53% 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, 2006 [1].

	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	
1A1a Public electricity and heat production	332	226	520	664	677	2323	3435	106715	355	kg
1A1b Petroleum refining	9	8	21	8	3	398	15	8	2	kg
1A1c Other energy industries	0	0	0	0	0	0	0	0	0	kg
1A2 Industry	230	188	448	204	264	6205	917	593	1302	kg
1A4a Commercial / Institutional	11	19	40	41	64	212	135	17	541	kg
1A4b Residential	32	199	31	224	237	146	166	102	4084	kg
1A4c Agriculture / Forestry / Fisheries	20	15	37	22	22	601	42	15	60	kg
Total	633	655	1096	1163	1267	9885	4710	1802	21 344	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, 2006.

Pollutant	Emission share of plant category	
	Municipal waste incineration, CHP and district heating	Power plants >25MW$_e$
As	28 %	21 %
Cd	21 %	3 %
Cr	21 %	18 %
Cu	34 %	12 %
Hg	22 %	21 %
Ni	4 %	17 %
Pb	60 %	6 %
Se	0.5 %	57 %
Zn	59 %	4 %

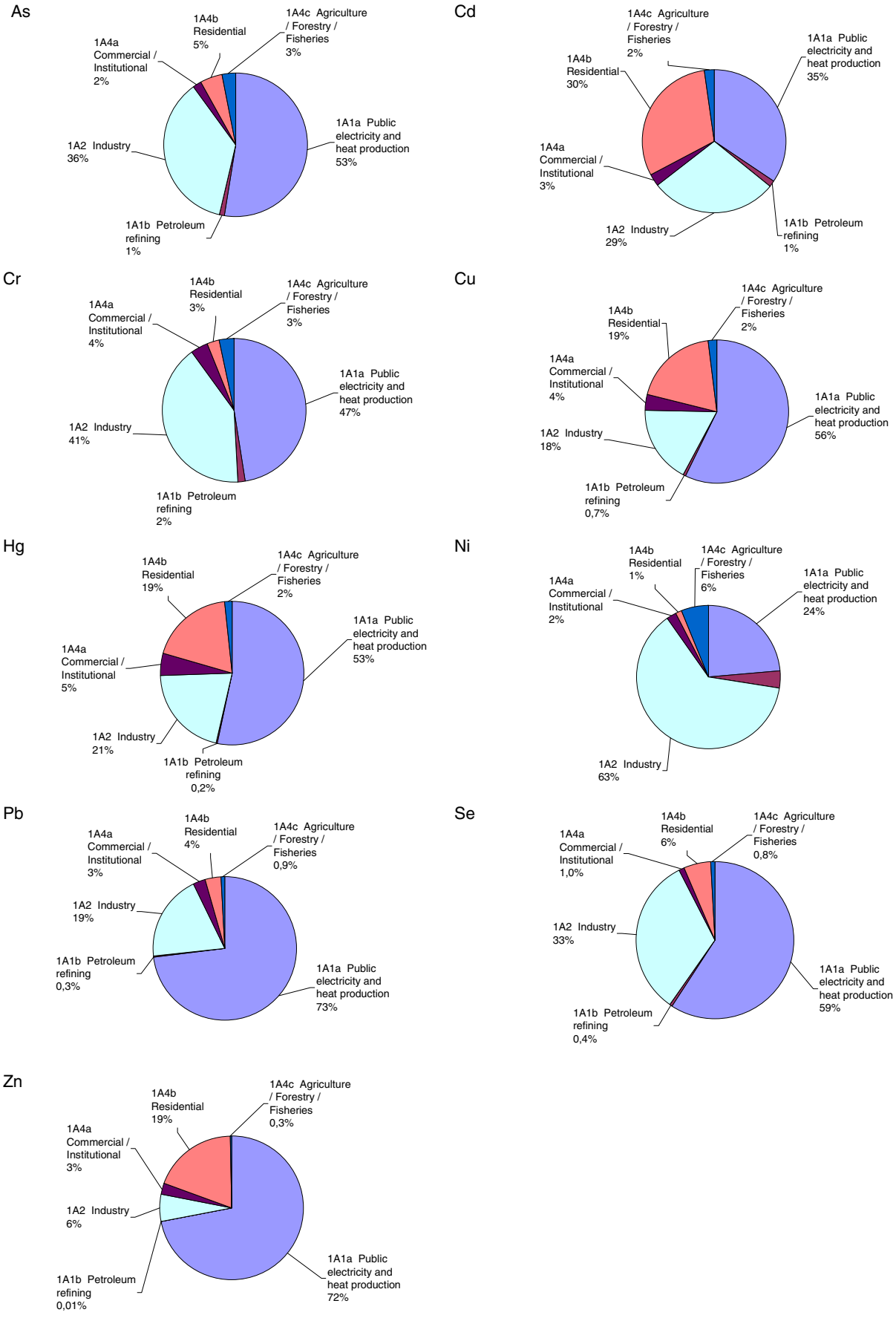


Figure 34 Heavy metal emission sources, stationary combustion plants, 2006.

Time-series for heavy metal emissions are provided in Figure 35. Emissions of all heavy metals, except Zn, 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 increasing Zn emission estimated in resent years might be a result of insufficient data for resent years. Emission from MSW incineration plants is the most important source of emission. For Se and Zn the same emission factor has been applied since 1995 whereas a time-series have been estimated for all other heavy metal emission factors (Nielsen & Illerup 2003). A time-series for Se and Zn will be estimated for future inventories.

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 1990-2006.

Pollutant	Decrease since 1990
As	56 %
Cd	38 %
Cr	82 %
Cu	68 %
Hg	59 %
Ni	54 %
Pb	69 %
Se	58 %
Zn	-10 %

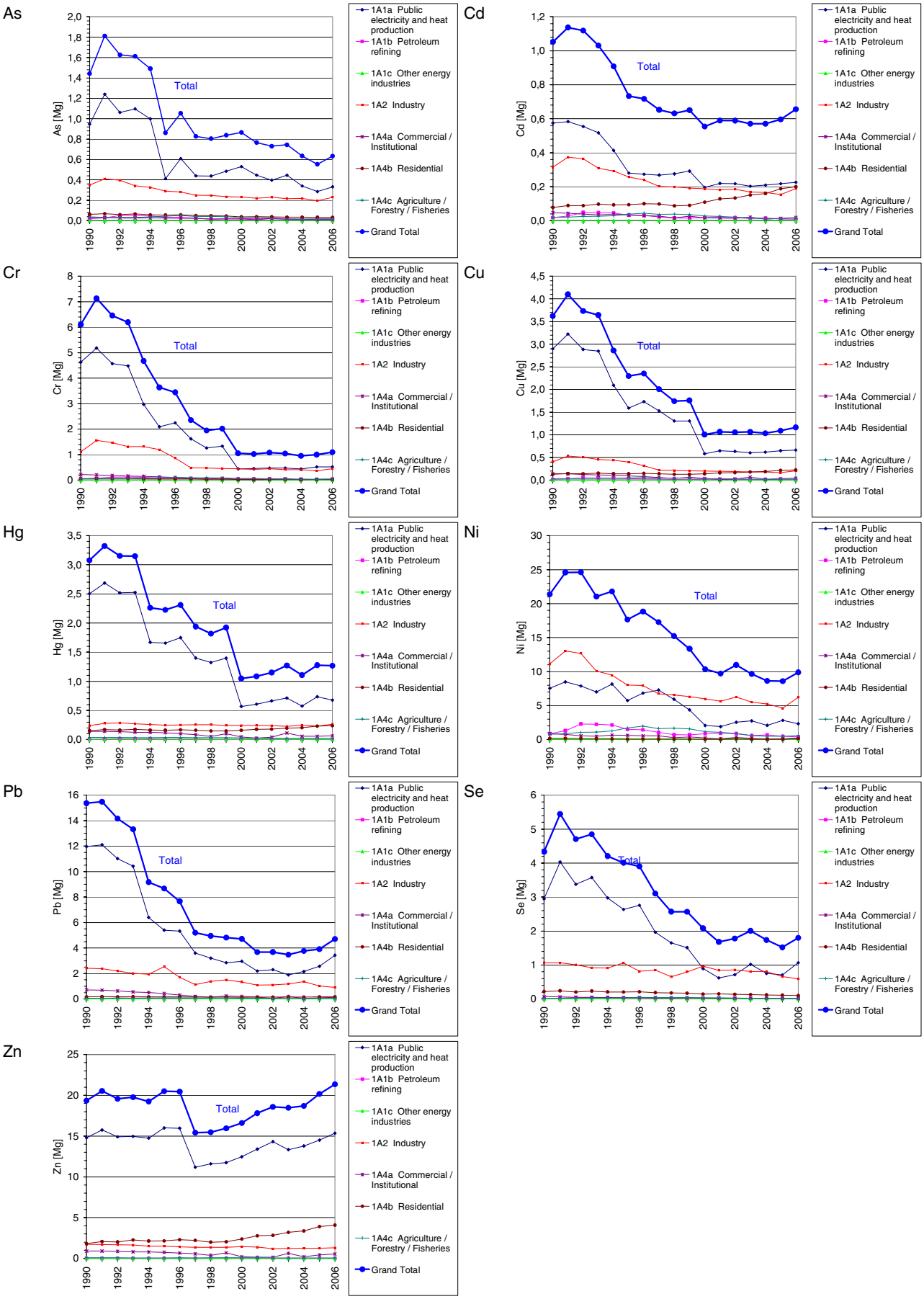


Figure 35 Heavy metal emission time-series, stationary combustion plants.

9 PAH and dioxin

Emission inventories for 4 PAHs and for dioxin are reported to the LRTAP Convention. The emission data for 2006 are presented in Table 32. Stationary combustion plants account for more than 95% of the PAH emissions and for 74% of the dioxin emission in 2006.

Table 32 The emission for the year 2006

Pollutant	Benzo(a)-pyrene Mg	Benzo(b)fluo-ranthene Mg	Benzo(k)fluo-ranthene Mg	Indeno(1,2,3-c,d)pyrene Mg	Dioxin [g I-Tec]
1A1 Fuel combustion, Energy industries	0.01	0.03	0.02	0.01	1.7
1A2 Fuel combustion, Manufacturing Industries and Construction (Stationary combustion)	0.03	0.10	0.01	0.01	0.2
1A4 Fuel combustion, Other sectors (Stationary combustion)	3.87	4.09	2.25	2.79	16.4
Total emission from stationary combustion plants	3.91	4.21	2.28	2.81	18.2
Total Danish emission (gross)	3.97	4.30	2.37	2.89	24.8
Emission share for stationary combustion	98 %	98 %	96 %	97 %	74 %

Table 33 and Figure 37 present the PAH and dioxin emission inventory for the stationary combustion subsectors. Residential combustion is the largest emission source for both PAH and dioxin. Combustion of wood is the predominant source, accounting for more than 98% of the PAH emission in residential plants. See Figure 36. The residential sector accounts for 79% of the dioxin emission from stationary combustion plants.

Time-series for PAH and dioxin emission are presented in Figure 38.

The increasing emission trend for PAH 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.

Dioxin emission decreased 61% since 1990 mainly due to installation of dioxin filters in MSW incineration plants. The emission from residential plants is increasing due to increased wood consumption in this sector.

Table 33 PAH emission from stationary combustion plants, 2006.

	Benzo(a)-pyrene kg	Benzo(b)-fluoranthene kg	Benzo(k)-fluoranthene kg	Indeno(1,2,3-c,d)pyrene kg	Dioxin [g I-Tec]
1A1a Public electricity and heat production	7	30	15	7	1,7
1A1b Petroleum refining	0	0	0	0	0,0
1A1c Other energy industries	0	0	0	0	0,0
1A2 Industry	28	96	15	8	0,2
1A4a Commercial / Institutional	161	212	70	115	0,5
1A4b Residential	3551	3699	2153	2419	14,4
1A4c Agriculture / Forestry / Fisheries	161	174	25	259	1,4
Total	3908	4211	2278	2808	18,2

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

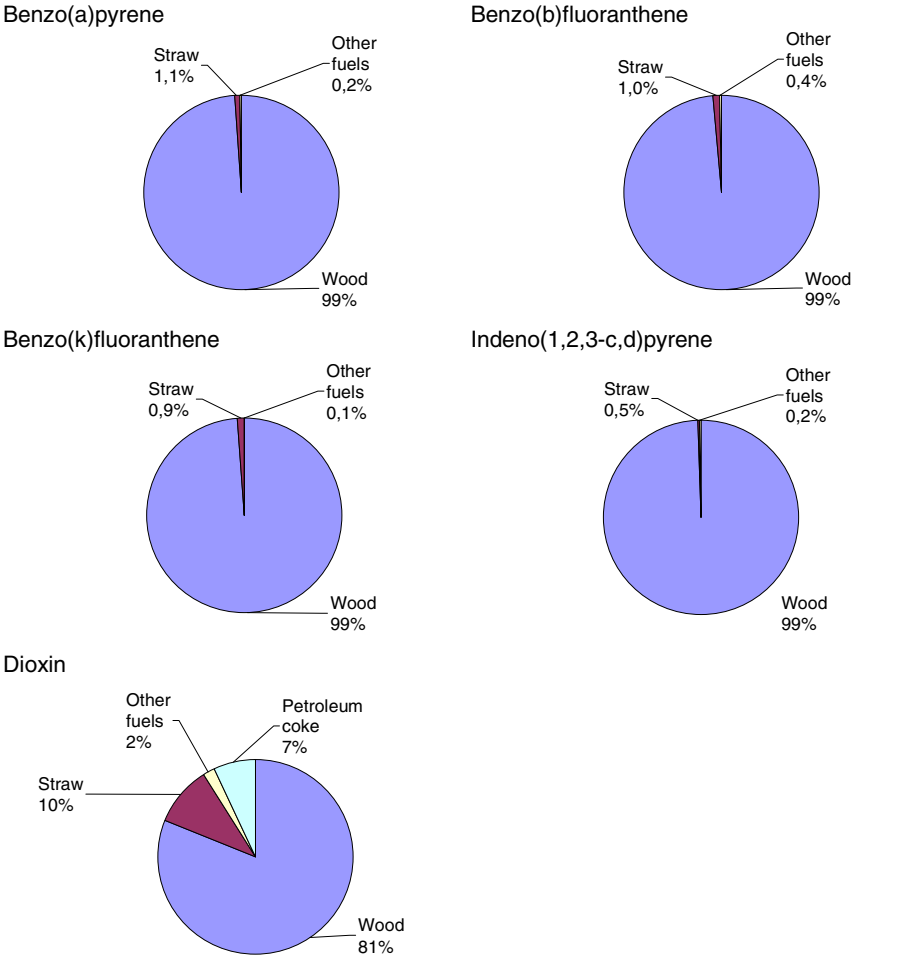
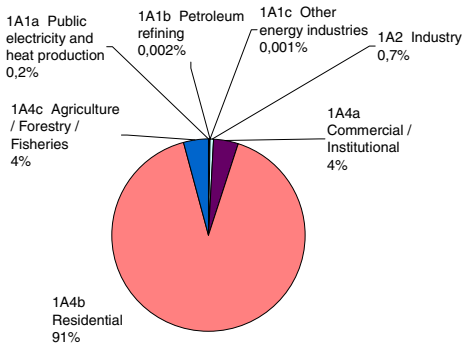
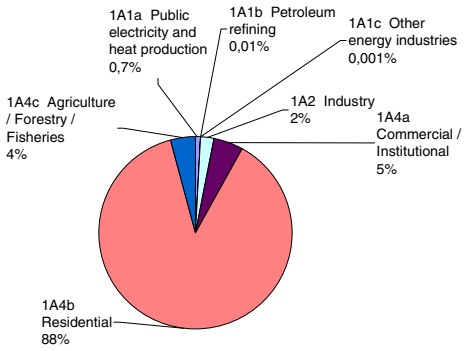


Figure 36 PAH and dioxin emission from residential combustion plants (stationary), fuel origin.

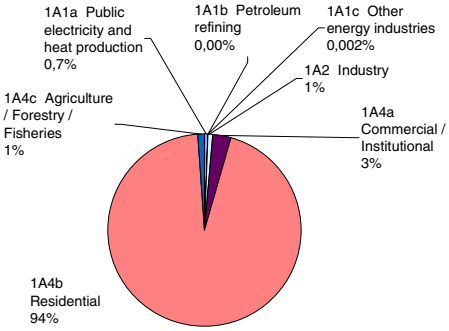
Benzo(a)pyrene



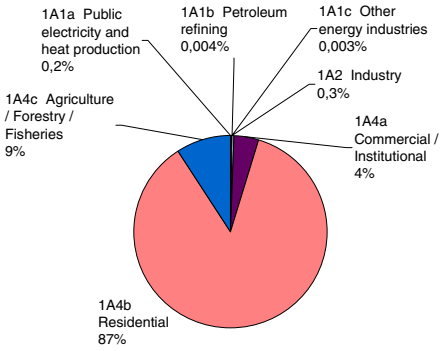
Benzo(b)fluoranthene



Benzo(k)fluoranthene



Indeno(1,2,3-c,d)pyrene



Dioxin

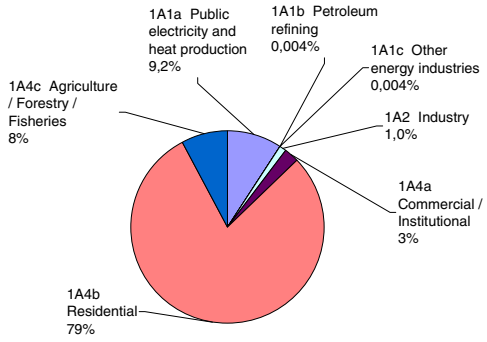


Figure 37 PAH and dioxin emission sources, stationary combustion plants, 2006.

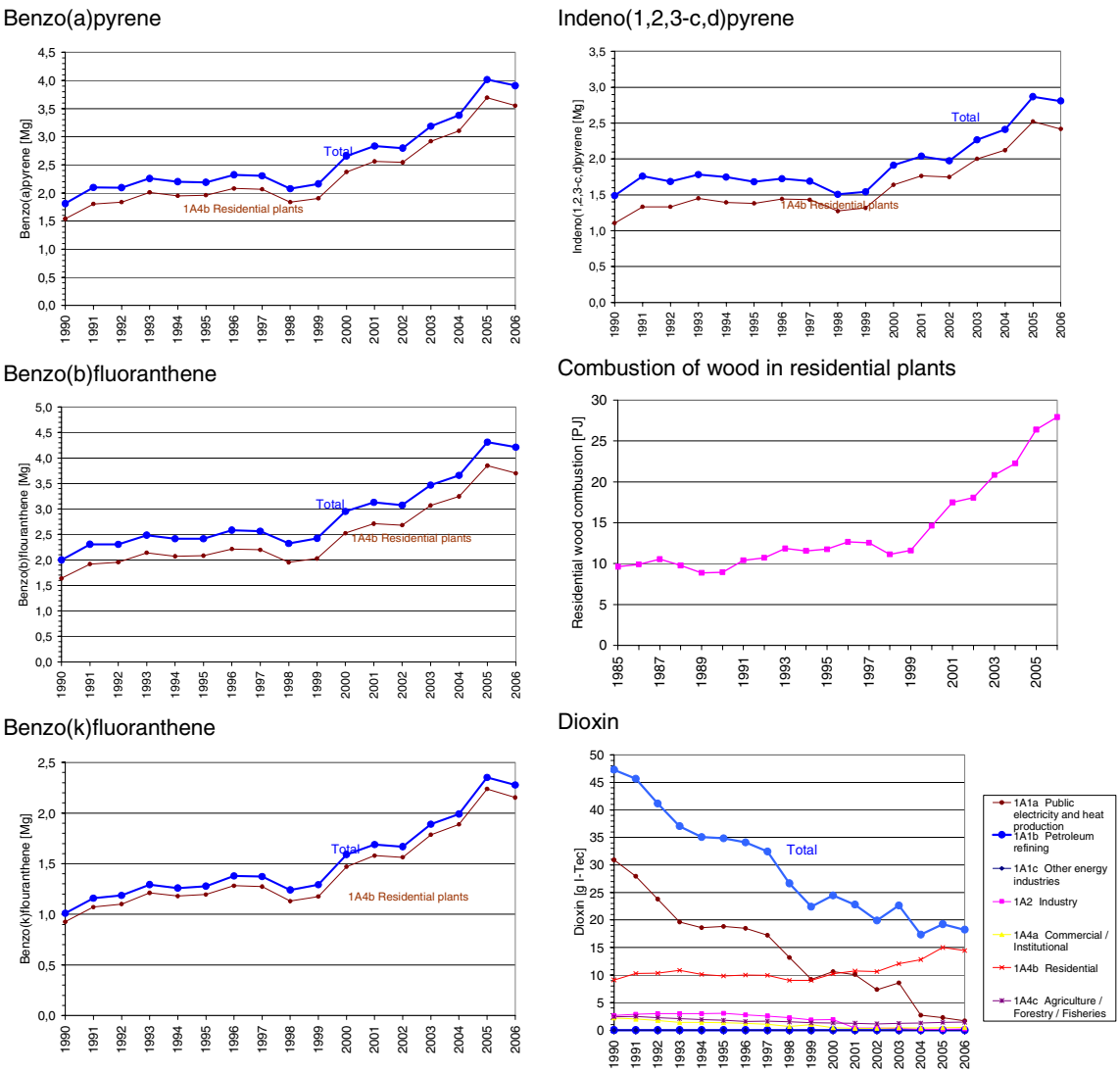


Figure 38 PAH emission time-series, stationary combustion plants. Comparison with wood consumption in residential plants.

10 QA/QC and validation

A QA/QC plan is implemented. A thorough description can be found in Denmark's National Inventory Report (Nielsen et al. 2008a)

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 1.6% (1990-2006). 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[3] both run accredited laboratories for emission measurements.
- The sectoral report for stationary combustion has twice been in external review.

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

[3] Now FORCE

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 2007b). 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 purpose 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 – 12.3 PJ in 2006.

In 2006 the fuel consumption rates in the two approaches differ by -1.44% and the CO_2 emission differs by -0.30%. In the period 1990-2006 fuel consumption and the CO_2 emission differs by less than 1.6. The differences are below 1% for all years except 1998 and 2006. According to IPCC Good Practice Guidance (IPCC 2000) the difference should be within 2%. The reference approach for 2006 and the comparison with the Danish national approach are provided in Appendix 2A-12. The appendix also includes a correspondence list for the fuel categories (Danish Energy Authority/IPCC reference approach).

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

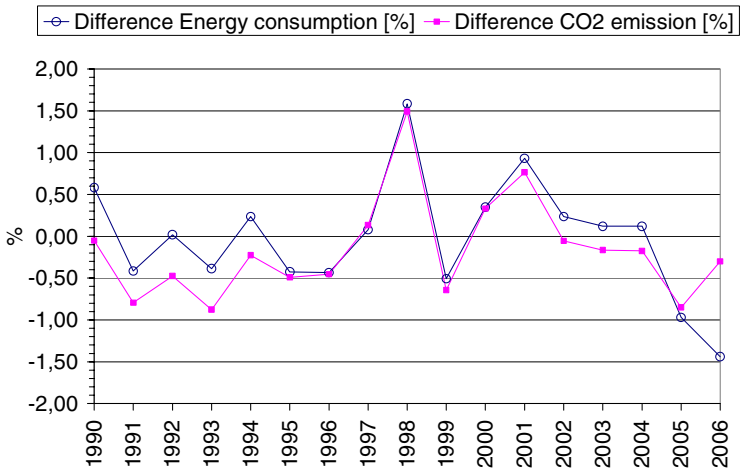


Figure 39 Comparison of the reference approach and the national approach.

10.2 Key source analysis

As part of the reporting 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 emission from eight different fuels is the key source 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	Level, Trend

11 Uncertainty

According to the IPCC Good Practice Guidance (IPCC 2000) uncertainty estimates should be included in the annual National Inventory Report.

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 ±7.9% and the increase in the GHG emission since 1990 has been estimated to be 4.9% ± 2.0 %-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 (2001)
3) Jensen & Lindroth (2002)
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 2006 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 2A-9.

The uncertainty interval for GHG is estimated to be ±7.9% and the uncertainty for the trend in GHG emission is ±2.0%-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 7.1% for SO_2, 16% for NO_X, 42% for NMVOC and 46% for CO. For PM, heavy metals, and PAH the uncertainty estimate is greater than 100%.

Table 36 Danish uncertainty estimates, 2006.

Pollutant	Uncertainty Total emission [%]	Trend 1990-2005 [%]	Uncertainty Trend [%-age points]
GHG	7.9	+4.9	± 2.0
CO_2	3.0	+3.5	± 1.6
CH_4	47	+280	± 222
N_2O	1000	+21	± 3.8
SO_2	7.1	-89	±0.8
NO_X	16	-37	±2.5
NMVOC	42	+70	±7.9
CO	46	+62	±6.4
TSP [1)]	454	+33	±30
PM_{10} [1)]	464	+34	±28
$PM_{2.5}$ [1)]	472	+35	±24
As	118	-56	±9
Cd	358	-38	±136
Cr	118	-82	±10
Cu	254	-68	±53
Hg	262	-59	±62
Ni	119	-54	±9
Pb	105	-69	±4
Se	101	-58	±5
Zn	231	+10	±82
Benzo(b)fluoranthene	970	+70	±6
Benzo(k)fluoranthene	987	+191	±86
Benzo(a)pyrene	991	+106	±6
Indeno(1,2,3-c,d)	995	+79	±14

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, 2000 and 2005 (Jensen et al., 2008). 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, dioxin and PAH. The assumptions and methodology will not be discussed here, but gridded emission data for SO_2 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.

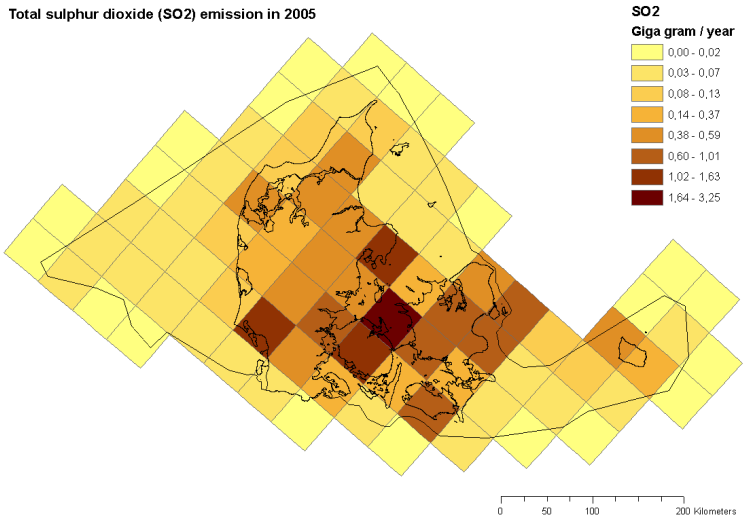


Figure 40 Gridded SO_2 emission from stationary combustion, 2005 (Jensen et al., 2008).

13 Improvements/recalculations since reporting in 2007

Improvements and recalculations since the 2007 emission inventory include:

- Update of fuel rates according to the latest energy statistics. The update included the years 1980-2005.
- For natural gas fired gas engines emission factors for CH_4, NMVOC, CO and NO_x were updated in connection with a research project including the higher emission factor during start-up/shut-down in the total emission factor.
- CO_2 data from the ETS has been utilised for the first time in the inventory for 2006. It was mainly coal and residual oil fuelled power plants where detailed information was available.

14 Future improvements

Some planned improvements of the emission inventories are discussed below.

1) Improved documentation for 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.

2) QA/QC and validation

The QA/QC and validation of the inventories for stationary combustion will be further expanded as part of the ongoing work that for the Danish inventory as a whole. The work is documented in Denmark's National Inventory Report (Nielsen et al. 2008a)

3) 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.

4) Further use of EU ETS data

The use of data from the EU ETS will continue and hopefully be expanded as more companies will provide detailed information, which can be utilised in the emission inventory.

5) Other improvements

- HM emission factors should be compared to new Danish legislation and updated if relevant.
- A time-series for Zn will be estimated

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 24 % - fossil fuel consumption, however only increased by 13.1%. 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, CO, heavy metals (except Cu), PM_{10}, $PM_{2.5}$, PAH and dioxin. Furthermore, the emission from stationary combustion plants accounts for more than 10% of the total Danish emission for the following pollutants: NO_X, NMVOC, TSP, 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, PAH and dioxin. 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 2006 than in 1990: CO_2 by 4% and GHG by 5%. 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 3.8 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 95% from 1980 and by 82% 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 51% since 1985 and 34% since 1995. The reduced emission is mainly a result of the reduced emission from electricity and heat production. The

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

Wood consumption in residential plants has increased by 212% from 1990 to 2006 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 66% from 1985 and 34% from 1995. The increased NMVOC emission is mainly a result of the increased use of lean-burn gas engines and the increasing wood combustion in the residential sector.

All the heavy metal emissions decreased considerably since 1990 – between 38% and 82%[4]. 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 doubled since 1990 due to the increased consumption of wood in residential plants. Dioxin emission decreased 61% compared to 1990, this is due to dioxin abatement technology installed in municipal waste incineration plants.

The uncertainty level of the Danish greenhouse gas emission from stationary combustion is estimated to be within a range of ±7.9% and the trend uncertainty within a range of ±2.0%-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.

[4] The estimated Zn emission is 10% higher in 2006 than in 1990. This is presumably due to insufficient emission factor update for resent years.

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Appendix

Appendix 2A-1: The Danish emission inventory for the year 2006 reported to the Climate Convention in 2008

Appendix 2A-2: Emission inventory for the year 2006 reported to the LRTAP Convention in 2008

Appendix 2A-3: IPCC/SNAP source correspondence list

Appendix 2A-4: Emission factors, references

Appendix 2A-5: Fuel rate

Appendix 2A-6: Emission factors

Appendix 2A-7: Implied emission factors for power plants and municipal waste incineration plants

Appendix 2A-8: Large point sources

Appendix 2A-9: Uncertainty estimates

Appendix 2A-10: Lower Calorific Value (LCV) of fuels

Appendix 2A-11: Adjustment of CO_2 emission

Appendix 2A-12: Reference approach

Appendix 2A-13: Emission inventory 2006 based on SNAP sectors

Appendix 2A-1 The Danish emission inventory for the year 2006 reported to the Climate Convention

Table 37 The Danish emission inventory for the year 2006 reported to the Climate Convention in 2008 (Nielsen et al. 2008a).

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**55.749,21**	**5.515,08**	**6.518,03**	**834,89**	**15,68**	**35,99**	**68.668,89**
1. Energy	**55.837,72**	**594,46**	**470,34**				**56.902,52**
A. Fuel Combustion (Sectoral Approach)	55.422,99	496,89	468,07				56.387,95
1. Energy Industries	29.470,34	239,88	168,26				29.878,49
2. Manufacturing Industries and Construction	5.629,55	24,34	57,83				5.711,72
3. Transport	13.417,24	28,08	137,18				13.582,50
4. Other Sectors	6.779,39	204,46	103,56				7.087,42
5. Other	126,46	0,13	1,24				127,83
B. Fugitive Emissions from Fuels	414,74	97,57	2,26				514,57
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	414,74	97,57	2,26				514,57
2. Industrial Processes	**1.611,40**	**IE,NA,NO**	**IE,NA,NO**	**834,89**	**15,68**	**35,99**	**2.497,97**
A. Mineral Products	1.609,22	IE,NA	IE,NA				1.609,22
B. Chemical Industry	2,18	NA,NO	NA,NO	NA	NA	NA	2,18
C. Metal Production	NA,NO	NA,NO	NO	NA,NO	NO	NA,NO	NA,NO
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				834,89	15,68	35,99	886,57
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**102,00**		**37,29**				**139,29**
4. Agriculture		**3.644,78**	**5.960,36**				**9.605,14**
A. Enteric Fermentation		2.602,45					2.602,45
B. Manure Management		1.042,33	518,75				1.561,08
C. Rice Cultivation		NO					NO
D. Agricultural Soils[3]		NE,NO	5.441,61				5.441,61
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry[1]	**-1.801,90**	**-0,49**	**0,07**				**-1.802,32**
A. Forest Land	-2.757,66	NO	NO				-2.757,66
B. Cropland	888,16	NA	NA				888,16
C. Grassland	80,99	NA	NA				80,99
D. Wetlands	-13,39	-0,49	0,07				-13,81
E. Settlements	NA,NE	NA,NE	NA,NE				NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE				NA,NE
G. Other	NO	NO	NO				NO
6. Waste	**IE,NA,NE,NO**	**1.276,33**	**49,96**				**1.326,29**
A. Solid Waste Disposal on Land	NA,NE,NO	1.028,01					1.028,01
B. Waste-water Handling		248,31	49,96				298,28
C. Waste Incineration	IE	IE	IE				IE
D. Other	NO	NO	NO				NO
Memo Items: [4]							
International Bunkers	6.015,95	2,81	94,40				6.113,16
Aviation	2.583,30	1,09	27,51				2.611,90
Marine	3.432,65	1,72	66,89				3.501,26
CO_2 Emissions from Biomass	**11.186,23**						**11.186,23**

Appendix 2A-2 Emission inventory for the year 2006 reported to the LRTAP Convention in 2008

Table 38a Emission inventory for the year 2006 reported to the LRTAP in 2008 (a) (Nielsen et al. 2008b).

	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	43.31	9.79	3.28	9.83	957.00	727.62	595.94
1 A 1 b Petroleum refining	1.37	0.24	0.00	0.41	112.96	106.76	103.67
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	7.19	0.22	0.04	0.01	3.18	1.82	1.51
1 A 2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 A 2 a Iron and Steel	IE	IE	IE	IE	157.13	47.14	7.07
1 A 2 b Non-ferrous Metals	IE	IE	IE	IE	35.13	31.57	14.61
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)	23.30	19.54	2.15	7.93	1778.24	1583.91	1354.55
1 A 3 a ii Civil Aviation (Domestic, LTO)	0.18	0.71	0.13	0.01	1.35	1.35	1.35
1 A 3 a ii Civil Aviation (Domestic, Cruise)	0.41	0.13	0.03	0.03	1.74	1.74	1.74
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	19.51	130.1	11.92	0.04	654.99	654.99	654.99
1 A 3 b ii R.T., Light duty vehicles	11.69	14.43	1.92	0.02	1398.46	1398.46	1398.46
1 A 3 b iii R.T., Heavy duty vehicles	35.59	8.23	1.68	0.02	983.17	983.17	983.17
1 A 3 b iv R.T., Mopeds & Motorcycles	0.21	18.74	3.63	0.00	64.68	64.68	64.68
1 A 3 b v R.T., Gasoline evaporation	NA	NA	4.02	NA	NA	NA	NA
1 A 3 b vi R.T., Automobile tyre and brake wear	NA	NA	NA	NA	1579.96	1184.76	644.89
1 A 3 b vii R.T., Automobile road abrasion	NA	NA	NA	NA	1083.23	541.61	292.47
1 A 3 c Railways	3.54	0.63	0.23	0.00	119.56	119.56	119.56
1 A 3 d ii National Navigation	7.44	7.19	1.19	1.09	290.53	289.01	288.25
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	1.23	0.92	0.72	0.27	166.01	162.16	152.26
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	5.92	265.9	17.11	2.41	19736.2	18708.5	17697.0
1 A 4 b ii Household and gardening (mobile)	0.27	87.74	8.04	0.00	79.33	79.33	79.33
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	1.14	8.24	1.46	1.75	520.51	481.95	446.45
1 A 4 c ii Off-road Vehicles and Other Machinery	11.54	15.78	2.17	0.03	937.95	937.95	937.95
1A 4 c iii National Fishing	8.66	1.19	0.37	0.60	147.91	146.43	145.69
1 A 5 a Other, Stationary (including Military)	NO	NO	NO	NO	NO	NO	NO
1 A 5 b Other, Mobile (Including military)	0.62	0.39	0.06	0.03	20.59	20.59	20.59
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	NA	NA	NA	1303.23	521.29	52.13
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	9.53	IE	NA	NA	NA
1 B 2 a iv Refining / Storage	NA	NA	3.55	0.26	NA	NA	NA
1 B 2 a v Distribution of oil products	NA	NA	0.98	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	0.09	NA	NA	NA	NA

1 B 2 c Venting and flaring	2.15	0.19	0.04	0.05	1.50	1.50	1.50
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	0.00	0.01	NE	NE	NE	NE
2 A 6 Road Paving with Asphalt	NE	0.27	0.55	NE	NE	NE	NE
2 A 7 Other including Non Fuel Mining & Construction (Please specify in a covering note)	NE	NE	0.02	NE	NE	NE	NE
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	NO	NO	NO	NO	NO	NO	NO
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)	0.04	NE	0.03	0.26	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	0.51	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	12.70	NA	NA	NA	NA
3 B DEGREASING AND DRY CLEANING	NA	NA	5.29	NA	NA	NA	NA
3 C CHEMICAL PRODUCTS, MANUFACTURE AND PROCESSING	NA	NA	3.49	NA	NA	NA	NA
3 D OTHER including products containing HMs and POPs (Please specify in a covering note)	NA	NA	11.25	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 B 1 a Dairy	NA	NA	NA	NA	634.64	291.93	187.52
4 B 1 b Non-Dairy	NA	NA	NA	NA	333.98	153.63	98.79
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	30.62	14.09	9.39
4 B 7 Mules and Asses	NO	NO	NO	NO	NO	NO	NO
4 B 8 Swine	NA	NA	NA	NA	8430.43	3793.70	618.89
4 B 9 Poultry	NA	NA	NA	NA	5408.67	5408.67	751.29
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	1.79	NA	NE	NE	NE
4 F FIELD BURNING OF AGRICULTURAL WASTES	NO	NO	NO	NO	NO	NO	NO
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	0.00	0.00	0.00
7 OTHER	NA	NA	NA	NA	NA	NA	NA
National Total	**185.30**	**590.6**	**109.97**	**25.05**	**46972.9**	**38459.8**	**27725.7**
Memo Items							
International Aviation (LTO)	1.00	0.67	0.13	0.07	3.45	3.45	3.45

International Aviation (Cruise)	10.17	1.20	0.36	0.76	38.18	38.18	38.18
International Navigation	84.72	8.72	2.64	52.94	8299.62	8216.62	8175.13
5 E Other	NO	NO	NO	NO	NO	NO	NO
X (11 08 Volcanoes)	NO	NO	NO	NO	NO	NO	NO

Table 38b Emission inventory for the year 2006 reported to the LRTAP in 2008 (b) (Nielsen et al. 2008b).

	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	3.44	0.23	0.68	0.33	0.52	0.66	2.32	1.07	15.36
1 A 1 b Petroleum refining	0.01	0.01	0.00	0.01	0.02	0.01	0.40	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	-	-	-	-	-	-	-	-	-
1 A 2 a Iron and Steel	0.57	0.01	IE	0.02	0.09	IE	0.10	0.39	0.39
1 A 2 b Non-ferrous Metals	0.01	0.00	IE	IE	IE	0.00	IE	IE	-
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)	0.34	0.18	0.26	0.21	0.38	0.72	6.12	0.20	1.21
1 A 3 a ii Civil Aviation (Domestic, LTO)	1.25	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	3.40	0.14	0.02	2.00
1 A 3 b ii R.T., Light duty vehicles	0.00	0.01	NE	NE	0.04	1.50	0.06	0.01	0.88
1 A 3 b iii R.T., Heavy duty vehicles	0.00	0.01	NE	NE	0.05	1.79	0.07	0.01	1.05
1 A 3 b iv R.T., Mopeds & Motorcycles	0.00	0.00	NE	NE	0.00	0.05	0.00	0.00	0.03
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	NA	0.00	NA	NA	0.00	0.12	0.01	0.00	0.07
1 A 3 d ii National Navigation	0.01	0.00	0.01	0.01	0.01	0.07	0.48	0.03	0.09
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	0.14	0.02	0.06	0.01	0.04	0.04	0.21	0.02	0.54
1 A 4 b Residential	-	-	-	-	-	-	-	-	-
1 A 4 b i Residential plants	0.17	0.20	0.24	0.03	0.03	0.22	0.15	0.10	4.08
1 A 4 b ii Household and gardening (mobile)	0.00	0.00	NE	NE	0.00	0.12	0.01	0.00	0.07
1 A 4 c Agriculture / Forestry / Fishing	-	-	-	-	-	-	-	-	-
1 A 4 c i Stationary	0.04	0.01	0.02	0.02	0.04	0.02	0.60	0.02	0.06
1 A 4 c ii Off-road Vehicles and Other Machinery	0.00	0.00	NA	NA	0.02	0.61	0.02	0.00	0.36
1A 4 c iii National Fishing	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.03	0.07
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)	0.05	0.00	-	-	0.00	0.07	0.00	0.00	0.04
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	NA
1 B 2 a iv Refining / Storage	NA	NA	NA	NA	NA	NA	NA	NA	NA
1 B 2 a v Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NA
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	NA	NA	NA	NA	NA	NA	NA	NA	NA
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	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	-	-	-	-	-	-	-	-	-
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	NO	NO	NO	NO	NO	NO	NO	NO	NO
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)	NO	NO	NO	NO	NO	NO	NO	NO	NO
7 OTHER	NA	NA	NA	NA	NA	NA	NA	NA	NA
National Total	**6.15**	**0.71**	**1.28**	**0.65**	**1.35**	**9.54**	**10.72**	**1.91**	**27.01**
Memo Items									
International Aviation (LTO)	0.02	0.00	-	-	0.00	0.11	0.00	0.00	0.07
International Aviation (Cruise)	-	0.01	-	-	0.04	1.28	0.05	0.01	0.75
International Navigation	0.19	0.03	0.03	0.40	0.17	0.40	23.17	0.37	0.85
5 E Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
X (11 08 Volcanoes)	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 38c Emission inventory for the year 2006 reported to the LRTAP in 2008 (c) (Nielsen et al. 2008b).

	Dioxin g I-Teq	Benzo(a)-pyrene Mg	Benzo(b)-fluoranthene Mg	Benzo(k)-fluoranthene Mg	Inde-no(1,3,3-c,d)pyrene Mg
1 A 1 a Public Electricity and Heat Production	1.669	0.007	0.030	0.015	0.007
1 A 1 b Petroleum refining	0.001	0.000	0.000	0.000	0.000
1 A 1 c Manufacture of Solid fuels and Other ENRrgy Industries	0.001	0.000	0.000	0.000	0.000
1 A 2 Manufacturing Industries and Construction	-	-	-	-	-
1 A 2 a Iron and Steel	NA	NA	NA	NA	NA
1 A 2 b NAn-ferrous Metals	0.032	NA	NA	NA	NA
1 A 2 c Chemicals	NA	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)	0.165	0.031	0.103	0.021	0.012
1 A 3 a ii Civil Aviation (Domestic, LTO)	0.000	0.000	0.000	0.000	0.000
1 A 3 a ii Civil Aviation (Domestic, Cruise)	-	-	-	-	-
1 A 3 b Road Transportation	-	-	-	-	-
1 A 3 b i R.T., Passenger cars	0.095	0.028	0.027	0.028	0.032
1 A 3 b ii R.T., Light duty vehicles	0.022	0.020	0.019	0.017	0.019
1 A 3 b iii R.T., Heavy duty vehicles	0.044	0.004	0.022	0.033	0.006
1 A 3 b iv R.T., Mopeds & Motorcycles	0.027	0.001	0.001	0.001	0.001
1 A 3 b v R.T., GasoliNR evaporation	NA	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	0.002	0.000	0.001	0.001	0.000
1 A 3 d ii National Navigation	0.060	0.001	0.003	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	NO
1 A 4 a Commercial / Institutional	0.496	0.161	0.212	0.070	0.115
1 A 4 b Residential	-	-	-	-	-
1 A 4 b i Residential plants	14.438	3.551	3.699	2.153	2.419
1 A 4 b ii Household and gardening (mobile)	0.016	0.000	0.001	0.000	0.001
1 A 4 c Agriculture / Forestry / Fishing	-	-	-	-	-
1 A 4 c i Stationary	1.440	0.161	0.174	0.025	0.259
1 A 4 c ii Off-road Vehicles and Other MachiNRry	0.013	0.004	0.008	0.007	0.004
1A 4 c iii National Fishing	0.077	0.001	0.004	0.002	0.008
1 A 5 a Other, Stationary (including Military)	NO	NO	NO	NO	NO
1 A 5 b Other, Mobile (Including military)	0.001	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	0.000	-	-	-	-

2 A MINRRAL PRODUCTS (a)	-	-	-	-	-
2 A 1 Cement Production	NA	NA	NA	NA	NA
2 A 2 Lime Production	0.017	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	NA	NA	NA	NA	NA
2 A 7 Other including NAn Fuel Mining & Construction (Please specify in a covering NAte)	NA	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
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	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 PROCESS-ING	NA	NA	NA	NA	NA
3 D OTHER including products containing HMs and POPs (Please specify in a covering NAte)	NA	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	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	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	NA	NA	NA	NA	NA
6 B WASTEWATER HANDLING	NA	NA	NA	NA	NA
6 C WASTE INCINRRATION (d)	0.039	NO	NO	NO	NO
6 D OTHER WASTE (e)	-	NA	NA	NA	NA
7 OTHER	6.100	NA	NA	NA	NA
National Total	**24.757**	**3.971**	**4.304**	**2.375**	**2.887**
International Aviation (LTO)	0.000	0.000	0.000	0.000	0.000
International Aviation (Cruise)	-	-	-	-	-
International MariNR (b)	0.581	0.004	0.015	0.007	0.022

5 E Other	NO	NO	NO	NO	NO
X (11 08 VolcaNAes)	NO	NO	NO	NO	NO

Appendix 2A-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.

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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[5]. 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. From 2003 onwards 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 [1000 ton]1)	Total fuel consumption [PJ]1)	Coal Consumption [Kton]1)	H_u of coal [GJ/ton] 2)	Oil consumption [Kton]1)	H_u of Residual oil [GJ/ton]2)	Fuel consumption coal and residual oil[TJ]	SO_2 emission factor [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	25.15	287	40.65	173048	45
2003	14.9	301	226	24.73	17	40.65	243222	61
2004	7.8	257	171	24.6	13	40.65	184420	42
2005	6.3	229	144	24.4	12	40.65	156264	41
2006	8.7	311	222	24.8	13	40.65	234787	37

1) Eltra and Elkraft System, annual reporting of total SO_2 and NO_x emissions from Danish power plants > 25MW_e. From 2003 consumption data in TJ.

2) Danish Energy Authority, 2007

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

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

Year	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))

1990-2006

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 2005 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 1991-2006 (DEA, 2007b). In spite of the fact that the lower calorific value was 26.1 GJ/ton in 1990 (DEA, 2007b) 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).

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

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

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, 2007b). 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
1990-2006	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, 2007b).

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.

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

1980-2000: $EMF_{SO2} = 10^6 \cdot ((2 \cdot 1.3 \cdot 0.01 \cdot (1-0.05)) / 31.4) = 787$ g/GJ

2001-2006: $EMF_{SO2} = 10^6 \cdot ((2 \cdot 1.0 \cdot 0.01 \cdot (1-0.05)) / 31.4) = 605$ 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 measure-

ments 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 2000-2006 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.

Table 4 Emission factors for CHP plants combusting municipal waste

Year	Applied emission factor [g/GJ]
1988	138
1989	138
1990	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
2004	24
2005	24
2006	24

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[6]. 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).

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

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

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
2004	67
2005	67
2006	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 (2007b). 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 onwards 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.

Table 6 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)]
2004				349 [3)]
2005				283 [3)]
2006				308 [3)]

1. Eltra & Elkraft System annual reportings

2. DEA 2007b

3. Estimated based on plant specific data from Energinet.dk (Previously 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 too 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 1997-2006 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, 2007b).

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, 2007b).

For the years 1980-1987 the emission factors refer to Risø (2005). These emission factors were based 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 2007b).

For the years 1995-2006 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 (2007b). 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, 2007b). 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 fac-

tor 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 (2007a) and the similar DEA data reported in former years. The use of orimulsion in Denmark ceased in 2005, the power plant that previously used orimulsion changed the fuel to coal.

1.18 Natural gas

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

This sulphur content refers to the Danish gas transmission company Gastra[7] (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 7 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 = $3.16 \cdot 0.94 + 15 \cdot 0.36 = 8.4$ mg S /m_n^3 mg/m_n^3

Emission factor = $2 \cdot (8.4/39.77) = 0.42$ 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.

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 (Au-

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

gustesen, 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 (2007b) 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 2008 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 8 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[8]. 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 9 NO_x emission factors for coal and residual oil, power plants

Year	NO_x emission [kton]	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
2004	34	257	131
2005	29	229	127
2006	34	311	109

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

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, 2007a).

2.2 Coal, other plants

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

The 2000-2005 emission factors for other plants refer 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[9]. 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))

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

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 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)

Table 10 NO_x emission factor [g/GJ

Year	NO_x emission factor [g/GJ]
1985-1998	130
1999-2006	90

The applied emission factor 130 g/GJ is in the right level, but might be somewhat too high. From 1999 onwards an emission factor of 90 g/GJ will be applied

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 1985-2006. 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[10]. 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 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.

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

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. This emission factor has also been utilized in 2004 and 2005.

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 2004 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 (1997-2005) 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).

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 Luftvjledningen (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 (2007a) and the similar DEA data reported in former years. The use of orimulsion in Denmark ceased in 2005, the power plant that previously used orimulsion changed the fuel to coal.

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 of 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 is 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. The lower emission factor will be implemented in the 2009 submission.

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 to 2003 (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. For the years 2004 to 2006 the emission factors refer to a Danish study (Nielsen et al., 2008).

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. The current emission factor is already below the emission limit.

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[11].

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

[11] All boiler capacities

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).

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. 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 2A-5 Fuel rate

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

fuel	fuel	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
102	COAL	245685	195560	238415	232978	232978	301615	305999	300366	280932	231283
106	BROWN COAL BRI.	384	497	817	705	705	813	459	347	197	129
107	COKE OVEN COKE	3540	2815	2948	2540	2540	1960	1587	1522	1255	1030
110	PETROLEUM COKE	1143	2626	6101	7230	7230	8627	9747	8198	5901	4550
111	WOOD AND SIMIL.	11331	13997	14976	14999	14999	15008	17025	17968	17629	17595
114	MUNICIP. WASTES	10639	11259	11883	12573	12573	13834	14366	14349	14465	15125
117	STRAW	4840	6647	7420	8319	8319	9892	10274	10831	11258	11659
118	SEWAGE SLUDGE	0	0	0	0	0	0	0	0	0	0
203	RESIDUAL OIL	177766	138192	117466	96629	95487	84784	74195	55385	44543	38303
204	GAS OIL	147199	121179	107795	99565	99565	109918	102702	101129	83420	71248
206	KEROSENE	3925	3571	3610	3554	3554	4611	3886	3005	1947	1765
210	NAPHTA	0	0	0	0	0	0	102	0	0	0
215	RAPE & FISH OIL	0	0	0	0	0	0	0	1972	1860	1302
225	ORIMULSION	0	0	0	0	0	0	0	0	0	0
301	NATURAL GAS	5041	5501	5664	6280	6280	30403	48497	62192	67423	71715
303	LPG	6381	5591	5602	5639	5639	5026	4869	4382	3570	2938
308	REFINERY GAS	11029	11672	10581	11858	11858	11520	13168	13253	13619	14632
309	BIOGAS	184	194	204	206	206	294	345	342	354	636
Total		629087	519300	533480	503075	501934	598306	607221	595240	548371	483911
Continued		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
102	COAL	253444	344300	286838	300799	323397	270346	371908	276277	234285	196472
106	BROWN COAL BRI.	116	167	95	128	92	75	56	54	48	38
107	COKE OVEN COKE	1276	1450	1181	1155	1226	1273	1226	1253	1346	1423
110	PETROLEUM COKE	4460	4404	4814	6179	4309	4850	6381	6523	5798	7284
111	WOOD AND SIMIL.	18247	20042	21031	22220	21940	21845	23389	23459	22938	24403
114	MUNICIP. WASTES	15499	16744	17797	19410	20312	22906	24952	26770	26591	29138
117	STRAW	12481	13306	13880	13366	12662	13053	13546	13912	13904	13668
118	SEWAGE SLUDGE	0	0	0	0	0	0	0	0	0	0
203	RESIDUAL OIL	32118	38252	38505	32823	46229	33009	37766	26580	29985	23696
204	GAS OIL	61449	64998	56102	62025	53930	53698	58019	51071	48425	47555
206	KEROSENE	5086	943	784	771	650	581	540	437	417	256
210	NAPHTA	0	0	0	0	0	0	0	0	0	0
215	RAPE & FISH OIL	744	744	744	800	245	251	60	14	14	27
225	ORIMULSION	0	0	0	0	0	19913	36767	40488	32580	34191
301	NATURAL GAS	76092	86107	90467	102475	114586	132699	156277	164489	178707	187877
303	LPG	2596	2549	2315	2371	2398	2638	2870	2363	2413	2177
308	REFINERY GAS	14169	14537	14865	15405	16360	20838	21476	16945	15225	15724
309	BIOGAS	752	910	899	1077	1279	1754	1985	2390	2635	2613
Total		498529	609453	550318	581004	619616	599728	757218	653026	615310	586540
Continued		2000	2001	2002	2003	2004	2005	2006			
102	COAL	164708	174309	174654	238978	182497	154008	231966			
106	BROWN COAL BRI.	26	33	19	3	0	0	0			
107	COKE OVEN COKE	1187	1110	1068	995	1143	980	1011			
110	PETROLEUM COKE	7292	8313	8282	8717	9373	9339	9720			
111	WOOD AND SIMIL.	27522	30867	31630	39002	43649	49653	49789			
114	MUNICIP. WASTES	30352	32325	35057	36494	37229	37765	39894			
117	STRAW	12220	13698	15651	16719	17939	18483	18625			
118	SEWAGE SLUDGE	40	375	65	55	58	58	0			
203	RESIDUAL OIL	18836	21091	26161	28431	24500	21940	26083			
204	GAS OIL	41260	43668	38674	38955	35919	31852	26795			

206	KEROSENE	170	287	256	338	215	280	221
210	NAPHTA	0	0	0	0	0	0	0
215	RAPE & FISH OIL	49	191	127	259	650	732	970
225	ORIMULSION	34148	30244	23846	1921	19	0	0
301	NATURAL GAS	186122	193827	193609	196322	194678	187456	191015
303	LPG	1885	1610	1477	1554	1669	1671	1720
308	REFINERY GAS	15556	15755	15197	16555	15891	15347	16388
309	BIOGAS	2871	3020	3332	3545	3452	3947	3919
Total		544243	570722	569105	628843	568879	533510	618114

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

ipcc_id	fuel	fuel_gr_abbr	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1a	102	COAL	010100	8523	12892	10176	8221						
1A1a	102	COAL	010101	219781	303105	252745	269459	295430	244510	347252	252648	211429	176641
1A1a	102	COAL	010102	2119	2654	2250	2269	8605	8381	9033	8671	9023	8238
1A1a	102	COAL	010103					837	526	149	39	24	34
1A1a	102	COAL	010104					272	270	301	74		
1A1a	102	COAL	010105					20					
1A1a	102	COAL	010200	6017	6635	5173	3581	0	0	0	0		
1A1a	102	COAL	010201					153	20				
1A1a	102	COAL	010202					1112	790	200	65	18	0
1A1a	102	COAL	010203					378	317	228	49	48	7
1A1a	110	PETROLEUM COKE	010100				1239						
1A1a	110	PETROLEUM COKE	010102										
1A1a	111	WOOD AND SIMIL.	010100			172	515						
1A1a	111	WOOD AND SIMIL.	010101					43				264	0
1A1a	111	WOOD AND SIMIL.	010102			0	0	1053	865	862	1001	1372	2377
1A1a	111	WOOD AND SIMIL.	010103					624	672	578	645	575	732
1A1a	111	WOOD AND SIMIL.	010104					79	4				
1A1a	111	WOOD AND SIMIL.	010105										2
1A1a	111	WOOD AND SIMIL.	010200	3217	3648	4096	3751	0	0	0	0		
1A1a	111	WOOD AND SIMIL.	010201					9					
1A1a	111	WOOD AND SIMIL.	010202					0	44	165	191	207	194
1A1a	111	WOOD AND SIMIL.	010203					3338	3491	3857	3795	3972	3928
1A1a	114	MUNICIP. WASTES	010100	990	3563	5578	8433						
1A1a	114	MUNICIP. WASTES	010101									1288	1278
1A1a	114	MUNICIP. WASTES	010102		0	0	0	5110	6527	7153	10832	11715	16938
1A1a	114	MUNICIP. WASTES	010103					2910	3755	5003	3074	1957	4039
1A1a	114	MUNICIP. WASTES	010104					1665	2028	3192	3025	2806	2453
1A1a	114	MUNICIP. WASTES	010105										
1A1a	114	MUNICIP. WASTES	010200	13567	12142	11111	9839	0	0	0	0		
1A1a	114	MUNICIP. WASTES	010201					7					
1A1a	114	MUNICIP. WASTES	010202					3472	3703	4646	4649	4618	
1A1a	114	MUNICIP. WASTES	010203					5909	5559	3699	3978	3458	2915
1A1a	117	STRAW	010100	479	985	1487	1643						

1A1a	117	STRAW	010101					100	82	610	740	1014	1340
1A1a	117	STRAW	010102	0	0	0	0	622	1287	1704	1845	1752	1819
1A1a	117	STRAW	010103					1127	1297	1362	1174	1181	1058
1A1a	117	STRAW	010104										
1A1a	117	STRAW	010200	3524	3843	3915	3806	0	0	0	0		
1A1a	117	STRAW	010201					22					
1A1a	117	STRAW	010202					57	180	114	96	136	142
1A1a	117	STRAW	010203					3378	3409	3700	3564	3526	3565
1A1a	203	RESIDUAL OIL	010100	775	364	1742	741						
1A1a	203	RESIDUAL OIL	010101	7172	10053	8691	8420	22142	11174	16072	7736	11557	7214
1A1a	203	RESIDUAL OIL	010102	42	17	27	24	180	254	443	421	510	763
1A1a	203	RESIDUAL OIL	010103					252	173	201	159	116	102
1A1a	203	RESIDUAL OIL	010104					320	347	237	302	355	118
1A1a	203	RESIDUAL OIL	010105	9	9	9	9	12	4	5	2	6	4
1A1a	203	RESIDUAL OIL	010200	2006	2236	1141	879	0	0	0	0		
1A1a	203	RESIDUAL OIL	010202					134	173	171	141	102	136
1A1a	203	RESIDUAL OIL	010203					859	939	1201	875	779	962
1A1a	204	GAS OIL	010100	239	416	641	245						
1A1a	204	GAS OIL	010101					12	51	42	195	109	258
1A1a	204	GAS OIL	010102	0	0	0	0	43	30	153	114	82	159
1A1a	204	GAS OIL	010103					59	40	78	42	44	61
1A1a	204	GAS OIL	010104	44	44	44	44	44	76	81	54	147	60
1A1a	204	GAS OIL	010105	17	33	35	35	116	137	99	100	134	108
1A1a	204	GAS OIL	010200	1941	813	744	947	0	0	0	0		
1A1a	204	GAS OIL	010201					27	7				
1A1a	204	GAS OIL	010202					174	361	800	515	418	258
1A1a	204	GAS OIL	010203					844	444	555	510	652	296
1A1a	204	GAS OIL	010204										
1A1a	204	GAS OIL	010205					1					1
1A1a	215	FISH & RAPE OIL	010102										
1A1a	215	FISH & RAPE OIL	010103					34	24	22	0	5	7
1A1a	215	FISH & RAPE OIL	010105										
1A1a	215	FISH & RAPE OIL	010200	744	744	744	800						
1A1a	215	FISH & RAPE OIL	010202										
1A1a	215	FISH & RAPE OIL	010203					212	227	39	14	8	20
1A1a	225	ORIMULSION	010101						19913	36767	40488	32580	34191

1A1a	301	NATURAL GAS	010100								6	21	17
1A1a	301	NATURAL GAS	010101	4005	4395	3279	4422	8438	10454	12217	14600	20809	21308
1A1a	301	NATURAL GAS	010102	0	0	0	0	295	300	1346	5620	5987	2416
1A1a	301	NATURAL GAS	010103					2487	1775	1558	1138	959	717
1A1a	301	NATURAL GAS	010104	1859	2397	4806	7327	7777	8548	14500	12220	13003	21614
1A1a	301	NATURAL GAS	010105	678	1291	2199	4169	8358	16420	22162	24109	26701	26834
1A1a	301	NATURAL GAS	010200	11033	13655	12350	11420	0	0	0	0	0	
1A1a	301	NATURAL GAS	010202					1072	1017	844	661	539	282
1A1a	301	NATURAL GAS	010203					6160	5525	3803	2420	1989	1874
1A1a	301	NATURAL GAS	010205					132	339	377	230	236	226
1A1a	303	LPG	010100		1	1	3						
1A1a	303	LPG	010101										
1A1a	303	LPG	010102										
1A1a	303	LPG	010103						1	0			
1A1a	303	LPG	010200	9	13	10	0	0	0		0		
1A1a	303	LPG	010203					3					0
1A1a	308	REFINERY GAS	010101							35	40		
1A1a	309	BIOGAS	010100	141	219	29	42						
1A1a	309	BIOGAS	010101					17	0	24	20		
1A1a	309	BIOGAS	010102	0	0	0	0	10	0	94	41	50	30
1A1a	309	BIOGAS	010103					54	118	79	111	87	104
1A1a	309	BIOGAS	010104			79	89	200	169	7			
1A1a	309	BIOGAS	010105	95	175	251	406	415	599	826	1230	1549	1500
1A1a	309	BIOGAS	010200	30	30	53	53	0	0	0	0		
1A1a	309	BIOGAS	010203					46	44	54	34	31	25
1A1a	309	BIOGAS	010205					41					
1A1b	203	RESIDUAL OIL	010306	1309	2038	3569	3490	3337	2334	2244	1622	1106	1090
1A1b	204	GAS OIL	010306		40	44	29	49	33	22	87		
1A1b	303	LPG	010306		0	5		8	15	21	18		
1A1b	308	REFINERY GAS	010300	458	926	1526	16						
1A1b	308	REFINERY GAS	010304				2067	2355	2290	5070	4082	2996	4173
1A1b	308	REFINERY GAS	010306	13520	13486	13237	13214	14005	18548	16337	12771	12203	11551
1A1c	204	GAS OIL	010505										
1A1c	301	NATURAL GAS	010502	0	0	0	0	0	399	391	417	413	409
1A1c	301	NATURAL GAS	010504	9482	9703	11119	11235	12268	12506	14850	19455	21637	23562
1A1c	301	NATURAL GAS	010505	2	4	4	4	3	4	8	5	15	14

1A1c	309	BIOGAS	010505	7	7	7	7	6	52	60	57	31	29
1A2f	102	COAL	030100	8850	8977	6751	7699	5867	4833	4461	4494	4676	3715
1A2f	102	COAL	030102	0	0	0	0	615	1051	1450	1467	1406	1412
1A2f	102	COAL	030103					190	183	193	192	0	
1A2f	102	COAL	030106										
1A2f	102	COAL	030311	5019	6049	6577	6602	6914	7225	7068	7209	6628	5638
1A2f	106	BROWN COAL BRI.	030100	4	7	4	18	3	2	1	1		
1A2f	107	COKE OV.COKE/HC	030100	1169	1351	1078	1073	1163	287	304	295	319	381
1A2f	107	COKE OV.COKE/HC	030318						937	886	931	1007	1030
1A2f	110	PETROLEUM COKE	030100	300	0	56	123	0	98	110	34	26	39
1A2f	110	PETROLEUM COKE	030311	2499	2991	3234	3231	3469	3707	4966	5230	4775	6399
1A2f	111	WOOD AND SIMIL.	030100	5784	5690	5751	5822	4465	4254	4098	4166	4274	4250
1A2f	111	WOOD AND SIMIL.	030102									2	1
1A2f	111	WOOD AND SIMIL.	030103					481	413	624	524	412	414
1A2f	114	MUNICIP. WASTES	030100	28	28	37	39	26	29	28	24	29	35
1A2f	114	MUNICIP. WASTES	030102									0	
1A2f	114	MUNICIP. WASTES	030311										
1A2f	117	STRAW	030100									0	0
1A2f	117	STRAW	030103						3				
1A2f	117	STRAW	030105										
1A2f	118	SEWAGE SLUDGE	030311										
1A2f	203	RESIDUAL OIL	030100	16531	19002	18557	14527	12588	10217	10610	9223	9121	8683
1A2f	203	RESIDUAL OIL	030102					742	911	789	790	663	696
1A2f	203	RESIDUAL OIL	030103					200	207	166	123	122	136
1A2f	203	RESIDUAL OIL	030104								54		0
1A2f	203	RESIDUAL OIL	030105										
1A2f	203	RESIDUAL OIL	030311	1763	2153	2367	2397	2619	2840	1771	1864	2539	886
1A2f	204	GAS OIL	030100	538	1370	1431	952	813	1460	2252	1895	1799	2478
1A2f	204	GAS OIL	030102						3			0	1
1A2f	204	GAS OIL	030103					2	1	11	1	2	0
1A2f	204	GAS OIL	030104								0	0	7
1A2f	204	GAS OIL	030105			1	2	2					
1A2f	204	GAS OIL	030106	6	7	9	3	9	7	7	8	16	70
1A2f	204	GAS OIL	030315								1	1	5
1A2f	206	KEROSENE	030100	70	46	38	35	30	24	31	28	16	9
1A2f	215	FISH & RAPE OIL	030100										

1A2f	215	FISH & RAPE OIL	030105											
1A2f	301	NATURAL GAS	030100	22280	23781	23888	25535	29248	30318	29252	29423	29114	31167
1A2f	301	NATURAL GAS	030102					863	2662	2465	2972	2962	3100
1A2f	301	NATURAL GAS	030103					300	64	147	170	132	127
1A2f	301	NATURAL GAS	030104	506	609	664	730	761	910	2563	3366	5106	6501
1A2f	301	NATURAL GAS	030105	0	0	0	0	11	173	873	960	1157	1160
1A2f	301	NATURAL GAS	030106	136	24	38	70	53	24	15	5	32	39
1A2f	301	NATURAL GAS	030315								924	903	1005
1A2f	301	NATURAL GAS	030318						625	590	621	671	687
1A2f	303	LPG	030100	1576	1689	1589	1451	1558	1738	1920	1597	1624	1355
1A2f	308	REFINERY GAS	030100	191	125	102	108	0	0	35	53	27	
1A2f	309	BIOGAS	030100	0	0	0	0	13	126	96	117	74	33
1A2f	309	BIOGAS	030102					7	16	16	19	16	16
1A2f	309	BIOGAS	030104						1	1	1		
1A2f	309	BIOGAS	030105									0	0
1A4a	102	COAL	020100	88	9	96	76	90	66	41	43	2	
1A4a	106	BROWN COAL BRI.	020100	1	2		8	1	1	0	0		
1A4a	110	PETROLEUM COKE	020100	62	104	90	96	92	70	91	98	71	50
1A4a	111	WOOD AND SIMIL.	020100	204	204	204	204	216	273	449	471	493	642
1A4a	111	WOOD AND SIMIL.	020105									2	2
1A4a	114	MUNICIP. WASTES	020100	914	1011	1071	1099	1182	1275	1222	1180	710	1473
1A4a	114	MUNICIP. WASTES	020103					31	31	10	8	10	7
1A4a	203	RESIDUAL OIL	020100	1070	865	601	517	719	677	718	729	384	450
1A4a	203	RESIDUAL OIL	020103					88	78				
1A4a	204	GAS OIL	020100	11795	10623	9062	9007	7157	6556	6620	6093	5442	5781
1A4a	204	GAS OIL	020102					191		0		0	
1A4a	204	GAS OIL	020103					0		58	58	54	39
1A4a	204	GAS OIL	020105				1	1	1	20	2	0	0	0
1A4a	206	KEROSENE	020100	569	210	207	189	155	124	103	96	128	117
1A4a	301	NATURAL GAS	020100	6376	6934	7382	8909	7343	8437	11247	9107	8662	7525
1A4a	301	NATURAL GAS	020103					2			2	49	11
1A4a	301	NATURAL GAS	020104		0			12	26	31	26	23	31
1A4a	301	NATURAL GAS	020105	46	89	278	350	474	609	681	866	959	986
1A4a	303	LPG	020100	83	77	77	122	125	131	138	128	116	110
1A4a	303	LPG	020103									0	
1A4a	303	LPG	020105									1	1

1A4a	309	BIOGAS	020100	199	179	84	64	113	170	173	272	225	293
1A4a	309	BIOGAS	020103							14	39	71	74
1A4a	309	BIOGAS	020104						27				
1A4a	309	BIOGAS	020105	270	290	387	406	349	411	390	405	439	437
1A4b	102	COAL	020200	589	1125	866	786	619	377	86	86	127	79
1A4b	106	BROWN COAL BRI.	020200	51	67	39	80	76	62	47	49	44	38
1A4b	107	COKE OV.COKE/HC	020200	107	99	103	81	63	49	37	27	20	11
1A4b	110	PETROLEUM COKE	020200	761	697	961	990	748	734	929	839	726	706
1A4b	111	WOOD AND SIMIL.	020200	8954	10412	10720	11860	11564	11761	12669	12569	11134	11615
1A4b	117	STRAW	020200	5087	5087	5087	4750	4414	4077	3633	3892	3773	3443
1A4b	203	RESIDUAL OIL	020200	217	219	168	130	95	63	66	46	43	50
1A4b	204	GAS OIL	020200	46463	50638	42914	49967	43679	43288	45296	39595	37850	35675
1A4b	206	KEROSENE	020200	4405	660	512	521	438	411	383	287	252	119
1A4b	301	NATURAL GAS	020200	17362	20433	21440	24904	24737	26947	30412	28362	29138	28982
1A4b	301	NATURAL GAS	020202							26	25	18	31
1A4b	301	NATURAL GAS	020204	0	8	499	776	1023	1095	1448	1488	1576	1554
1A4b	303	LPG	020200	670	522	442	673	589	628	653	510	546	624
1A4c	102	COAL	020300	2458	2854	2204	2106	2295	1798	1446	1239	904	708
1A4c	102	COAL	020304										
1A4c	106	BROWN COAL BRI.	020300	60	92	52	22	12	10	7	4	4	
1A4c	110	PETROLEUM COKE	020300	837	611	473	500	0	240	286	323	201	89
1A4c	111	WOOD AND SIMIL.	020300	87	87	87	68	68	68	87	97	230	231
1A4c	111	WOOD AND SIMIL.	020304									1	14
1A4c	117	STRAW	020300	3391	3391	3391	3167	2942	2718	2422	2595	2515	2295
1A4c	117	STRAW	020302								6	6	6
1A4c	203	RESIDUAL OIL	020300	1224	1296	1634	1687	1942	2617	3071	2492	2563	2396
1A4c	203	RESIDUAL OIL	020302									9	1
1A4c	203	RESIDUAL OIL	020304									9	11
1A4c	204	GAS OIL	020300	406	1014	1176	794	708	1182	1940	1799	1675	2297
1A4c	204	GAS OIL	020302								0		
1A4c	204	GAS OIL	020304							4	2		
1A4c	206	KEROSENE	020300	43	28	26	26	27	21	23	25	21	11
1A4c	215	FISH & RAPE OIL	020304										
1A4c	301	NATURAL GAS	020300	2222	2680	2385	2463	2485	2560	2666	2645	2476	2242
1A4c	301	NATURAL GAS	020303						0	6	26	66	77
1A4c	301	NATURAL GAS	020304	104	104	136	161	282	961	1796	2620	3354	3379

1A4c	303	LPG	020300	259	247	192	122	116	125	137	109	126	87
1A4c	309	BIOGAS	020300					3	4	132	26	35	30
1A4c	309	BIOGAS	020304	10	10	10	10	7	16	17	18	26	41
Total				498529	609453	550318	581004	619616	599728	757218	653026	615310	586540

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

ipcc_id	fuel	fuel_gr_abbr	snap_id	2000	2001	2002	2003	2004	2005	2006
1A1a	102	COAL	010100							
1A1a	102	COAL	010101	146911	158990	161608	225397	167931	140019	218319
1A1a	102	COAL	010102	6225	4971	4685	4578	4512	4048	3289
1A1a	102	COAL	010103	35	24	15	34	24	0	0
1A1a	102	COAL	010104							
1A1a	102	COAL	010105							
1A1a	102	COAL	010200							
1A1a	102	COAL	010201							
1A1a	102	COAL	010202	0	1	0	0	1	4	0
1A1a	102	COAL	010203	4	0	0	0	0	0	0
1A1a	110	PETROLEUM COKE	010100							
1A1a	110	PETROLEUM COKE	010102					7	2	0
1A1a	111	WOOD AND SIMIL.	010100							
1A1a	111	WOOD AND SIMIL.	010101		1	66	305	231	1247	695
1A1a	111	WOOD AND SIMIL.	010102	2275	2187	3176	5855	5627	5966	6355
1A1a	111	WOOD AND SIMIL.	010103	670	747	780	446	1062	1079	1129
1A1a	111	WOOD AND SIMIL.	010104			120	1657	4488	4479	2609
1A1a	111	WOOD AND SIMIL.	010105	53	60	62	0	0	0	0
1A1a	111	WOOD AND SIMIL.	010200							
1A1a	111	WOOD AND SIMIL.	010201							
1A1a	111	WOOD AND SIMIL.	010202	180	250	164	196	620	417	600
1A1a	111	WOOD AND SIMIL.	010203	3882	4298	4651	5066	4798	5018	5312
1A1a	114	MUNICIP. WASTES	010100							
1A1a	114	MUNICIP. WASTES	010101	1231	2809	3502	143	0	0	0
1A1a	114	MUNICIP. WASTES	010102	18306	17902	19003	22524	24720	24848	25935
1A1a	114	MUNICIP. WASTES	010103	8361	8343	8321	7848	7885	8133	8310
1A1a	114	MUNICIP. WASTES	010104	417	0	0	625	0	0	67
1A1a	114	MUNICIP. WASTES	010105	0	0	0	0	0	0	740
1A1a	114	MUNICIP. WASTES	010200							
1A1a	114	MUNICIP. WASTES	010201							
1A1a	114	MUNICIP. WASTES	010202							
1A1a	114	MUNICIP. WASTES	010203	1396	2195	2430	2570	2507	2093	2133
1A1a	117	STRAW	010100							
1A1a	117	STRAW	010101	1120	1588	2643	3192	4366	4088	4422
1A1a	117	STRAW	010102	1827	1746	1641	1712	1815	1765	1489
1A1a	117	STRAW	010103	640	1905	1754	1928	1336	1394	1358
1A1a	117	STRAW	010104		102	1216	1707	2477	3118	3175
1A1a	117	STRAW	010200							
1A1a	117	STRAW	010201							
1A1a	117	STRAW	010202	151	98	0	0	95	96	82
1A1a	117	STRAW	010203	3291	3418	3556	3339	3007	3180	3258
1A1a	203	RESIDUAL OIL	010100	0	0	0	0	0	0	0
1A1a	203	RESIDUAL OIL	010101	4046	5951	5018	7329	5578	5461	4346
1A1a	203	RESIDUAL OIL	010102	513	254	279	334	596	591	884
1A1a	203	RESIDUAL OIL	010103	109	117	120	106	17	0	0
1A1a	203	RESIDUAL OIL	010104	117	1768	6695	9359	7484	6336	8397
1A1a	203	RESIDUAL OIL	010105	17	1	1	6	2	0	0
1A1a	203	RESIDUAL OIL	010200							
1A1a	203	RESIDUAL OIL	010202	59	87	123	84	34	27	30
1A1a	203	RESIDUAL OIL	010203	617	611	548	323	187	260	102
1A1a	204	GAS OIL	010100	0	0	0	0	0	0	0
1A1a	204	GAS OIL	010101	136	123	92	957	220	186	476
1A1a	204	GAS OIL	010102	279	367	279	115	139	116	94

1A1a	204	GAS OIL	010103	0	34	37	17	15	22	51
1A1a	204	GAS OIL	010104	103	40	75	79	81	126	81
1A1a	204	GAS OIL	010105	69	85	66	64	107	73	60
1A1a	204	GAS OIL	010200							
1A1a	204	GAS OIL	010201					93	53	21
1A1a	204	GAS OIL	010202	694	830	167	256	419	178	164
1A1a	204	GAS OIL	010203	233	355	307	1126	493	367	301
1A1a	204	GAS OIL	010204						8	6
1A1a	204	GAS OIL	010205	0	0	0	0	5	1	1
1A1a	215	FISH & RAPE OIL	010102					1	2	0
1A1a	215	FISH & RAPE OIL	010103				2	55	152	254
1A1a	215	FISH & RAPE OIL	010105					2	0	0
1A1a	215	FISH & RAPE OIL	010200							
1A1a	215	FISH & RAPE OIL	010202				19	5	21	24
1A1a	215	FISH & RAPE OIL	010203	49	191	126	238	589	557	692
1A1a	225	ORIMULSION	010101	34148	30244	23846	1921	19	0	0
1A1a	301	NATURAL GAS	010100	15	11	0	1	2	0	6
1A1a	301	NATURAL GAS	010101	23542	20515	19247	20165	19287	18925	20813
1A1a	301	NATURAL GAS	010102	1590	4250	2893	1877	1582	2007	1080
1A1a	301	NATURAL GAS	010103	684	734	657	1058	837	1651	2238
1A1a	301	NATURAL GAS	010104	22974	25003	30031	29928	30713	25116	31959
1A1a	301	NATURAL GAS	010105	25640	27865	27702	27012	26392	23502	20419
1A1a	301	NATURAL GAS	010200							
1A1a	301	NATURAL GAS	010202	218	287	291	278	428	320	123
1A1a	301	NATURAL GAS	010203	1427	1768	1482	1850	1612	2256	2136
1A1a	301	NATURAL GAS	010205	203	228	207	172	474	552	853
1A1a	303	LPG	010100							
1A1a	303	LPG	010101							0
1A1a	303	LPG	010102						0	0
1A1a	303	LPG	010103							
1A1a	303	LPG	010200							
1A1a	303	LPG	010203	0	0	0	0	0	0	0
1A1a	308	REFINERY GAS	010101							
1A1a	309	BIOGAS	010100							
1A1a	309	BIOGAS	010101							
1A1a	309	BIOGAS	010102	26	23	20	22	17	17	17
1A1a	309	BIOGAS	010103	135	124	90	97	78	70	105
1A1a	309	BIOGAS	010104							
1A1a	309	BIOGAS	010105	1549	1589	1686	1705	1435	1536	1287
1A1a	309	BIOGAS	010200							
1A1a	309	BIOGAS	010203	22	11	13	17	23	41	17
1A1a	309	BIOGAS	010205					36	110	155
1A1b	203	RESIDUAL OIL	010306	1323	1443	1363	907	1072	746	619
1A1b	204	GAS OIL	010306				3	9	2	10
1A1b	303	LPG	010306							
1A1b	308	REFINERY GAS	010300							
1A1b	308	REFINERY GAS	010304	3908	3979	3855	3804	3797	3346	2323
1A1b	308	REFINERY GAS	010306	11649	11777	11342	12750	12094	12001	14065
1A1c	204	GAS OIL	010505			0	0	0	0	0
1A1c	301	NATURAL GAS	010502	341	353	379	323	361	325	379
1A1c	301	NATURAL GAS	010504	25016	24413	26180	26247	27067	27791	28342
1A1c	301	NATURAL GAS	010505	14	12	11	12	12	9	8
1A1c	309	BIOGAS	010505	33	29	31	32	61	100	116
1A2f	102	COAL	030100	3667	3554	2127	2826	3338	2724	2754
1A2f	102	COAL	030102	1063	997	998	1570	1499	1499	1232
1A2f	102	COAL	030103							

1A2f	102	COAL	030106						0	0
1A2f	102	COAL	030311	5708	4523	4349	3369	3754	3917	4365
1A2f	106	BROWN COAL BRI.	030100							
1A2f	107	COKE OV.COKE/HC	030100	238	223	279	276	302	241	246
1A2f	107	COKE OV.COKE/HC	030318	944	883	786	693	814	739	765
1A2f	110	PETROLEUM COKE	030100	285	128	224	230	174	161	163
1A2f	110	PETROLEUM COKE	030311	6475	7657	7543	7714	8188	7796	8284
1A2f	111	WOOD AND SIMIL.	030100	4450	4596	3313	3534	3426	3607	3586
1A2f	111	WOOD AND SIMIL.	030102	1	1	0	0	0	0	9
1A2f	111	WOOD AND SIMIL.	030103	440	431	411	295	342	527	521
1A2f	114	MUNICIP. WASTES	030100						0	259
1A2f	114	MUNICIP. WASTES	030102			0	5	4	4	4
1A2f	114	MUNICIP. WASTES	030311	505	1062	1788	1406	1927	1932	1403
1A2f	117	STRAW	030100							
1A2f	117	STRAW	030103							
1A2f	117	STRAW	030105	0	0	0	0	0	0	0
1A2f	118	SEWAGE SLUDGE	030311	40	375	65	55	58	58	
1A2f	203	RESIDUAL OIL	030100	8157	7629	8617	6610	6144	4985	7752
1A2f	203	RESIDUAL OIL	030102	714	792	809	1645	1690	1898	1606
1A2f	203	RESIDUAL OIL	030103	140	90	0	0	0	0	0
1A2f	203	RESIDUAL OIL	030104	0	0	0	0	0	0	0
1A2f	203	RESIDUAL OIL	030105		0	0	1	0	5	0
1A2f	203	RESIDUAL OIL	030311	859	502	592	587	817	694	979
1A2f	204	GAS OIL	030100	2184	3011	2369	2666	2551	1694	663
1A2f	204	GAS OIL	030102	3	5	0	4	3	3	13
1A2f	204	GAS OIL	030103	82	0	0	0	0	0	0
1A2f	204	GAS OIL	030104	0	0	1	0	0	2	0
1A2f	204	GAS OIL	030105	0	1	0	0	0	0	0
1A2f	204	GAS OIL	030106	8	10	7	7	9	9	7
1A2f	204	GAS OIL	030315	2	2	1	1	4	7	1
1A2f	206	KEROSENE	030100	8	26	65	48	20	13	19
1A2f	215	FISH & RAPE OIL	030100						0	0
1A2f	215	FISH & RAPE OIL	030105			0	0	0	0	0
1A2f	301	NATURAL GAS	030100	28608	30958	29348	28370	26869	27736	27593
1A2f	301	NATURAL GAS	030102	2690	2869	1190	2274	2296	2200	2293
1A2f	301	NATURAL GAS	030103	116	118	15	119	124	190	131
1A2f	301	NATURAL GAS	030104	6756	6139	6724	6526	6633	5965	4711
1A2f	301	NATURAL GAS	030105	1556	1642	1545	1544	1570	1256	952
1A2f	301	NATURAL GAS	030106	51	54	26	17	22	2	3
1A2f	301	NATURAL GAS	030315	1101	1089	1016	946	911	874	827
1A2f	301	NATURAL GAS	030318	629	589	524	552	607	557	557
1A2f	303	LPG	030100	1019	761	678	730	749	740	775
1A2f	308	REFINERY GAS	030100							
1A2f	309	BIOGAS	030100	33	28	38	34	46	53	45
1A2f	309	BIOGAS	030102	16	59	72	96	113	48	52
1A2f	309	BIOGAS	030104							
1A2f	309	BIOGAS	030105	1	24	18	14	17		104
1A4a	102	COAL	020100					1	0	0
1A4a	106	BROWN COAL BRI.	020100							
1A4a	110	PETROLEUM COKE	020100	12	12	5	9	0	65	9
1A4a	111	WOOD AND SIMIL.	020100	776	665	672	681	681	816	952
1A4a	111	WOOD AND SIMIL.	020105		0	1	0	0	0	0
1A4a	114	MUNICIP. WASTES	020100	122	0	0	1296	110	581	860
1A4a	114	MUNICIP. WASTES	020103	14	13	13	75	76	173	183
1A4a	203	RESIDUAL OIL	020100	343	173	478	171	108	121	252
1A4a	203	RESIDUAL OIL	020103							

1A4a	204	GAS OIL	020100	4958	4685	4031	4289	4411	3755	3029
1A4a	204	GAS OIL	020102							
1A4a	204	GAS OIL	020103	71	44	44	30	19	48	32
1A4a	204	GAS OIL	020105	1	1	1	1	1	2	1
1A4a	206	KEROSENE	020100	63	80	70	74	77	101	59
1A4a	301	NATURAL GAS	020100	7234	7323	7624	9215	9200	9500	10651
1A4a	301	NATURAL GAS	020103	43	67	165	11	50	36	25
1A4a	301	NATURAL GAS	020104	23	31	43	34	22	13	40
1A4a	301	NATURAL GAS	020105	1033	1045	1080	1023	1033	862	946
1A4a	303	LPG	020100	122	119	137	170	215	218	211
1A4a	303	LPG	020103							
1A4a	303	LPG	020105					0	0	0
1A4a	309	BIOGAS	020100	311	355	425	322	426	562	575
1A4a	309	BIOGAS	020103	87	85	74	85	101	355	138
1A4a	309	BIOGAS	020104							
1A4a	309	BIOGAS	020105	507	504	528	531	517	544	501
1A4b	102	COAL	020200	14	13	15	0	0	8	4
1A4b	106	BROWN COAL BRI.	020200	26	33	19	3	0	0	0
1A4b	107	COKE OV.COKE/HC	020200	5	3	3	26	27	0	0
1A4b	110	PETROLEUM COKE	020200	513	513	509	762	1005	1315	1264
1A4b	111	WOOD AND SIMIL.	020200	14625	17484	18067	20855	22274	26400	27924
1A4b	117	STRAW	020200	3112	2901	2901	2901	2901	2901	2905
1A4b	203	RESIDUAL OIL	020200	36	27	149	47	44	49	195
1A4b	204	GAS OIL	020200	30276	31506	28998	27027	25291	23863	21197
1A4b	206	KEROSENE	020200	91	159	110	205	111	158	136
1A4b	301	NATURAL GAS	020200	27569	29262	28082	30023	29858	29524	28542
1A4b	301	NATURAL GAS	020202	55	69	30	63	64	18	26
1A4b	301	NATURAL GAS	020204	1439	1450	1392	1451	1476	1467	1499
1A4b	303	LPG	020200	651	649	608	596	651	667	689
1A4c	102	COAL	020300	1079	1234	856	1203	1437	1787	2004
1A4c	102	COAL	020304						3	0
1A4c	106	BROWN COAL BRI.	020300							
1A4c	110	PETROLEUM COKE	020300	6	3	0	1	0	0	0
1A4c	111	WOOD AND SIMIL.	020300	170	147	147	112	98	98	98
1A4c	111	WOOD AND SIMIL.	020304	0	0					
1A4c	117	STRAW	020300	2074	1934	1934	1934	1934	1934	1937
1A4c	117	STRAW	020302	6	6	6	6	6	6	0
1A4c	203	RESIDUAL OIL	020300	1779	1640	1365	911	720	759	904
1A4c	203	RESIDUAL OIL	020302	3	2	2	6	5	7	17
1A4c	203	RESIDUAL OIL	020304	4	5	3	3	0	0	0
1A4c	204	GAS OIL	020300	2156	2567	2193	2309	2050	1335	589
1A4c	204	GAS OIL	020302							
1A4c	204	GAS OIL	020304	5	3	5	6	0	2	0
1A4c	206	KEROSENE	020300	8	23	11	11	7	8	7
1A4c	215	FISH & RAPE OIL	020304	0	1	0	0	0	0	0
1A4c	301	NATURAL GAS	020300	2384	2687	2543	2320	2258	2248	2009
1A4c	301	NATURAL GAS	020303	62	60	64	54	54	58	42
1A4c	301	NATURAL GAS	020304	3109	2935	3116	2856	2864	2494	1811
1A4c	303	LPG	020300	93	80	55	58	53	46	46
1A4c	309	BIOGAS	020300	76	80	96	135	169	103	333
1A4c	309	BIOGAS	020304	77	109	239	456	411	409	475
Total				544243	570722	569105	628843	568879	533510	618114

Appendix 2A-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		56,78	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

* Data from EU ETS incorporated for individual plants

Time-series for natural gas and municipal waste are shown below.

ETS data were utilised for the first time in the emission inventory for the year 2006. The implied emission factors for the power plants using coal ranged from 90.01 to 95.31 kg/GJ. There were detailed data available from 15 coal powered units, which allowed the information to be included in the emission inventory. The implied emission factors for the power plants using residual oil ranged from 77.34 to 80.34 kg/GJ. There were detailed data available from 14 units using residual oil, which allowed the information to be included in the emission inventory.

All other emission factors are the same for 1990-2006.

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
2004	57.12	17.6	+94.5
2005	56.96	17.6	+94.5
2006	56.78	17.6	+94.5

Table 44 CH_4 emission factors and references 2006.

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) 465	Nielsen et al., 2008c
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) 2006 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 1990-2006.

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	266	239
1991	309	251
1992	359	264
1993	562	276
1994	623	289
1995	632	301
1996	615	305
1997	551	310
1998	542	314
1999	541	318
2000	537	323
2001	537	323
2002	537	323
2003	537	323
2004	513	323
2005	489	323
2006	465	323

Table 46 N_2O emission factors and references 2006.

Fuel	ipcc_id	SNAP_id	Emission factor [g/GJ]	Reference
COAL	1A1a	0101**	0,8	Elsam 2005
COAL	1A1a, 1A1c, 1A2f, 1A4a, 1A4b, 1A4c	All except 0101**	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 1990-2006

Table 47 SO_2, NO_X, NMVOC and CO emission factors and references 2006.

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	37	18	109	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	90	22, 21, 4	48	1	50	3
WOOD AND SIMIL.	1A1a, 1A2f	010202, 010203, 0301, 030102, 030103	25	22, 21	90	22, 21, 4	48	1	240	4
WOOD AND SIMIL.	1A4a, 1A4c	0201, 020105, 0203	25	22, 21	90	22, 21, 4	600	1	240	4
WOOD AND SIMIL.	1A4b	0202	25	22, 21	120	22	538	39	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	90	4, 28	50	1	325	4, 5
STRAW	1A4b, 1A4c	0201, 0203	130	5	90	4, 28	600	1	4000	1,6,7
RESIDUAL OIL	1A1a	0101, 010101, 010102, 010103, 010104, 010105	308	18	109	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	97	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	148	40	105	40	115	40
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	59	4	4	1	36	4

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30. Product sheet from Shell. Available on the internet at: http://www.shell.com/home/dk-da/html/iwgen/app_profile/app_products_0310_1510.html (13-05-2004)
31. 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://www2.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/FR442.pdf
32. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, 1996. Available on the Internet at http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.htm (11-04-2005)
33. NERI calculation based on plant specific data 2003
34. NERI calculation based on plant specific data 2002
35. Same emission factor as for natural gas fuelled gas turbines is assumed
36. Wit, J. d & Andersen, S. D. 2003. Emissioner fra større gasfyrede kedler, Dansk Gasteknisk Center 2003. The emission factor have been assumed to be the average value of the stated interval (NERI assumption).
37. Folkecenter for Vedvarende Energi, 2000. http://www.folkecenter.dk/plant-oil/emission/emission_rapsolie.pdf
38. Assumed same emission factor as for gas oil (NERI assumption). However the value is not correct – the emission factor 65 g/GJ will be applied in future inventories.
39. Aggregated emission factor based on the technology distribution in the sector and guidebook emission factors.
40. Nielsen et al., 2008c: Revised emission factors for gas engines including start/stop emissions. NERI technical report (In press)

Time-series for emission factors for SO_2, NO_X, NMVOC and CO that are not the same in 1990-2006 are shown below. All other factors are constant in 1990-2006.

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
SO_2	COAL	0101	1A1a	506	571	454	386						
SO_2	COAL	010101	1A1a	506	571	454	386	343	312	420	215	263	193
SO_2	COAL	010102	1A1a	506	571	454	386	343	312	420	215	263	193
SO_2	COAL	010103	1A1a					343	312	420	215	263	193
SO_2	COAL	010104	1A1a					343	312	420	215		
SO_2	PETROLEUM COKE	0201	1A4a	787	787	787	787	787	787	787	787	787	787
SO_2	PETROLEUM COKE	0202	1A4b	787	787	787	787	787	787	787	787	787	787
SO_2	PETROLEUM COKE	0203	1A4c	787	787	787	787	787	787	787	787	787	787
SO_2	PETROLEUM COKE	0301	1A2f	787	787	787	787	787	787	787	787	787	787
SO_2	MUNICIP. WASTES	0101	1A1a	138	116	95	73						
SO_2	MUNICIP. WASTES	010102	1A1a		116	95	73	52	30			26	25
SO_2	MUNICIP. WASTES	010103	1A1a					52	30	29	28	26	25
SO_2	MUNICIP. WASTES	010104	1A1a					52	30	29	28	26	25
SO_2	MUNICIP. WASTES	010105	1A1a										
SO_2	MUNICIP. WASTES	0102	1A1a	138	131	124	117	110	103	95	88		
SO_2	MUNICIP. WASTES	010202	1A1a					110	103				
SO_2	MUNICIP. WASTES	010203	1A1a					110	103	95	88	81	74
SO_2	MUNICIP. WASTES	0201	1A4a	138	131	124	117	110	103	95	88	81	74
SO_2	MUNICIP. WASTES	020103	1A4a					110	103	95	88	81	74
SO_2	MUNICIP. WASTES	0301	1A2f	138	131	124	117	110	103	95	88	81	74
SO_2	RESIDUAL OIL	0101	1A1a	446	470	490	475						
SO_2	RESIDUAL OIL	010101	1A1a						351	408	344	369	369
SO_2	RESIDUAL OIL	010102	1A1a	446	470	490	475	1564	351	408	344	369	369
SO_2	RESIDUAL OIL	010103	1A1a					1564	351	408	344	369	369
SO_2	RESIDUAL OIL	010104	1A1a					1564	351	408	344	369	369
SO_2	RESIDUAL OIL	010105	1A1a	446	470	490	475	1564	351	408	344	369	369
SO_2	RESIDUAL OIL	0102	1A1a	495	495	495	495	495	495	495	344		
SO_2	RESIDUAL OIL	010202	1A1a					495	495	495	344	344	344
SO_2	RESIDUAL OIL	010203	1A1a					495	495	495	344	344	344
SO_2	RESIDUAL OIL	010306	1A1b	643	38	222	389				537	537	537
SO_2	RESIDUAL OIL	0201	1A4a	495	495	495	495	495	495	495	344	344	344
SO_2	RESIDUAL OIL	020103	1A4a					495	495				
SO_2	RESIDUAL OIL	0202	1A4b	495	495	495	495	495	495	495	344	344	344
SO_2	RESIDUAL OIL	0203	1A4c	495	495	495	495	495	495	495	344	344	344
SO_2	RESIDUAL OIL	020302	1A4c									344	344
SO_2	RESIDUAL OIL	020304	1A4c									344	344
SO_2	RESIDUAL OIL	0301	1A2f	495	495	495	495	495	495	495	344	344	344
SO_2	RESIDUAL OIL	030102	1A2f					495	495	495	344	344	344
SO_2	RESIDUAL OIL	030103	1A2f					495	495	495	344	344	344
SO_2	GAS OIL	0101	1A1a	94	94	94	94						
SO_2	GAS OIL	010101	1A1a					94	23	23	23	23	23
SO_2	GAS OIL	010102	1A1a	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	010103	1A1a					94	23	23	23	23	23
SO_2	GAS OIL	010104	1A1a	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	010105	1A1a	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	0102	1A1a	94	94	94	94	94	23	23	23		
SO_2	GAS OIL	010201	1A1a					94	23				
SO_2	GAS OIL	010202	1A1a					94	23	23	23	23	23
SO_2	GAS OIL	010203	1A1a					94	23	23	23	23	23
SO_2	GAS OIL	010205	1A1a					94					23
SO_2	GAS OIL	010306	1A1b		94	94	94	94	23	23	23		
SO_2	GAS OIL	010505	1A1c										
SO_2	GAS OIL	0201	1A4a	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	020102	1A4a					94		23		23	

SO_2	GAS OIL	020103	1A4a					94		23	23	23	23
SO_2	GAS OIL	020105	1A4a			94	94	94	23	23	23	23	23
SO_2	GAS OIL	0202	1A4b	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	0203	1A4c	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	0301	1A2f	94	94	94	94	94	23	23	23	23	23
SO_2	GAS OIL	030103	1A2f					94	23	23	23	23	23
SO_2	GAS OIL	030105	1A2f			94	94	94					
SO_2	GAS OIL	030106	1A2f	94	94	94	94	94	23	23	23	23	23
SO_2	ORIMULSION	010101	1A1a							147	149		
NO_X	COAL	0101	1A1a	342	384	294	289						
NO_X	COAL	010101	1A1a	342	384	294	289	267	239	250	200	177	152
NO_X	COAL	010102	1A1a	342	384	294	289	267	239	250	200	177	152
NO_X	COAL	010103	1A1a					267	239	250	200	177	152
NO_X	COAL	010104	1A1a					267	239	250	200		
NO_X	COAL	010202	1A1a					200	200	200	200	200	200
NO_X	COAL	010203	1A1a					200	200	200	200	200	200
NO_X	COAL	0201	1A4a	200	200	200	200	200	200	200	200	200	
NO_X	COAL	0202	1A4b	200	200	200	200	200	200	200	200	200	200
NO_X	COAL	0203	1A4c	200	200	200	200	200	200	200	200	200	200
NO_X	COAL	0301	1A2f	200	200	200	200	200	200	200	200	200	200
NO_X	BROWN COAL BRI.	0202	1A4b	200	200	200	200	200	200	200	200	200	200
NO_X	COKE OVEN COKE	0202	1A4b	200	200	200	200	200	200	200	200	200	200
NO_X	COKE OVEN COKE	0301	1A2f	200	200	200	200	200	200	200	200	200	200
NO_X	PETROLEUM COKE	0301	1A2f	200	200	200	200	200	200	200	200	200	200
NO_X	WOOD AND SIMIL.	010202	1A1a					130	130	130	130	130	90
NO_X	WOOD AND SIMIL.	010203	1A1a					130	130	130	130	130	90
NO_X	WOOD AND SIMIL.	0201	1A4a	130	130	130	130	130	130	130	130	130	90
NO_X	WOOD AND SIMIL.	020105	1A4a									130	90
NO_X	WOOD AND SIMIL.	0203	1A4c	130	130	130	130	130	130	130	130	130	90
NO_X	WOOD AND SIMIL.	020304	1A4c									130	90
NO_X	WOOD AND SIMIL.	0301	1A2f	130	130	130	130	130	130	130	130	130	90
NO_X	WOOD AND SIMIL.	030102	1A2f									130	90
NO_X	WOOD AND SIMIL.	030103	1A2f					130	130	130	130	130	90
NO_X	RESIDUAL OIL	0101	1A1a	342	384	294	289						
NO_X	RESIDUAL OIL	010101	1A1a						239	250	200	177	152
NO_X	RESIDUAL OIL	010102	1A1a	342	384	294	289	267	239	250	200	177	152
NO_X	RESIDUAL OIL	010103	1A1a					267	239	250	200	177	152
NO_X	RESIDUAL OIL	010104	1A1a					267	239	250	200	177	152
NO_X	RESIDUAL OIL	010105	1A1a	342	384	294	289	267	239	250	200	177	152
NO_X	GAS OIL	010103	1A1a					80	75	65	65	65	65
NO_X	GAS OIL	0102	1A1a	100	95	90	85	80	75	70	65		
NO_X	GAS OIL	010201	1A1a					80	75				
NO_X	GAS OIL	010202	1A1a					80	75	70	65	65	65
NO_X	GAS OIL	010203	1A1a					80	75	70	65	65	65
NO_X	GAS OIL	010306	1A1b		95	90	85	80	75	70	65		
NO_X	GAS OIL	0301	1A2f	100	95	90	85	80	75	70	65	65	65
NO_X	GAS OIL	030102	1A2f						75			65	65
NO_X	GAS OIL	030103	1A2f					80	75	70	65	65	65
NO_X	GAS OIL	030106	1A2f	100	95	90	85	80	75	70	65	65	65
NO_X	FISH & RAPE OIL	0102	1A1a	100	95	90	85						
NO_X	FISH & RAPE OIL	010203	1A1a					80	75	70	65	65	65
NO_X	ORIMULSION	010101	1A1a							139	138		
NO_X	NATURAL GAS	0101	1A1a								115	115	115
NO_X	NATURAL GAS	010101	1A1a					115			115		
NO_X	NATURAL GAS	010102	1A1a	115	115	115	115	115	115			115	115
NO_X	NATURAL GAS	010104	1A1a	161	157	153	149	145	141	138	134	131	127

NO_X	NATURAL GAS	010105	1A1a	276	241	235	214	199	194	193	170	167	167
NO_X	NATURAL GAS	010205	1A1a					199	194	193	170	167	167
NO_X	NATURAL GAS	010505	1A1c	276	241	235	214	199	194	193	170	167	167
NO_X	NATURAL GAS	020104	1A4a		157			145	141	138	134	131	127
NO_X	NATURAL GAS	020105	1A4a	276	241	235	214	199	194	193	170	167	167
NO_X	NATURAL GAS	020204	1A4b	276	241	235	214	199	194	193	170	167	167
NO_X	NATURAL GAS	020303	1A4c						141	138	134	131	127
NO_X	NATURAL GAS	020304	1A4c	276	241	235	214	199	194	193	170	167	167
NO_X	NATURAL GAS	030104	1A2f	161				145	141	138	134	131	127
NO_X	NATURAL GAS	030105	1A2f	276	241	235	214	199	194	193	170	167	167
NO_X	BIOGAS	010105	1A1a	711	696	681	665	650	635	616	597	578	559
NO_X	BIOGAS	010505	1A1c	711	696	681	665	650	635	616	597	578	559
NO_X	BIOGAS	020105	1A4a	711	696	681	665	650	635	616	597	578	559
NO_X	BIOGAS	020304	1A4c	711	696	681	665	650	635	616	597	578	559
NO_X	BIOGAS	030105	1A2f									578	559
NMVOC	WOOD AND SIMIL.	0202	1A4b	704	704	704	704	704	704	704	704	704	704
NMVOC	NATURAL GAS	010105	1A1a	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	010205	1A1a	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	010505	1A1c	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	020105	1A4a	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	020204	1A4b	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	020304	1A4c	60	69	81	127	140	142	138	124	122	122
NMVOC	NATURAL GAS	030105	1A2f	60	69	81	127	140	142	138	124	122	122
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
CO	WOOD AND SIMIL.	010203	1A1a					293	267	240	240	240	240
CO	WOOD AND SIMIL.	0201	1A4a	400	373	347	320	293	267	240	240	240	240
CO	WOOD AND SIMIL.	0203	1A4c	400	373	347	320	293	267	240	240	240	240
CO	WOOD AND SIMIL.	0301	1A2f	400	373	347	320	293	267	240	240	240	240
CO	WOOD AND SIMIL.	030103	1A2f					293	267	240	240	240	240
CO	MUNICIP. WASTES	0102	1A1a	100	85	70	55	40	25	10	10		
CO	MUNICIP. WASTES	010201	1A1a					40					
CO	MUNICIP. WASTES	010202	1A1a					40	25				
CO	MUNICIP. WASTES	010203	1A1a					40	25	10	10	10	10
CO	MUNICIP. WASTES	0201	1A4a	100	85	70	55	40	25	10	10	10	10
CO	MUNICIP. WASTES	020103	1A4a					40	25	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
CO	STRAW	010203	1A1a					417	371	325	325	325	325
CO	STRAW	0202	1A4b	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
CO	STRAW	0203	1A4c	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
CO	NATURAL GAS	010105	1A1a	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	010205	1A1a	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	010505	1A1c	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	020105	1A4a	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	020204	1A4b	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	020304	1A4c	189	211	212	227	226	222	221	182	182	182
CO	NATURAL GAS	030105	1A2f	189	211	212	227	226	222	221	182	182	182
CO	BIOGAS	010105	1A1a	230	234	239	243	248	252	256	260	265	269
CO	BIOGAS	010505	1A1c	230	234	239	243	248	252	256	260	265	269
CO	BIOGAS	020105	1A4a	230	234	239	243	248	252	256	260	265	269
CO	BIOGAS	020304	1A4c	230	234	239	243	248	252	256	260	265	269
CO	BIOGAS	030105	1A2f									265	269

Continued

pol.	fuel	snap_id	ipcc_id	2000	2001	2002	2003	2004	2005	2006
SO_2	COAL	0101	1A1a							
SO_2	COAL	010101	1A1a	64	47	45	61	42	41	37
SO_2	COAL	010102	1A1a	64	47	45	61	42	41	37
SO_2	COAL	010103	1A1a	64	47	45	61	42	41	37
SO_2	COAL	010104	1A1a							
SO_2	PETROLEUM COKE	0201	1A4a	787	605	605	605	605	605	605
SO_2	PETROLEUM COKE	0202	1A4b	787	605	605	605	605	605	605
SO_2	PETROLEUM COKE	0203	1A4c	787	605	605	605	605	605	605
SO_2	PETROLEUM COKE	0301	1A2f	787	605	605	605	605	605	605
SO_2	MUNICIP. WASTES	0101	1A1a							
SO_2	MUNICIP. WASTES	010102	1A1a	23,9	23,9	23,9	23,9	23,9	23,9	23,9
SO_2	MUNICIP. WASTES	010103	1A1a	23,9	23,9	23,9	23,9	23,9	23,9	23,9
SO_2	MUNICIP. WASTES	010104	1A1a	23,9	23,9	23,9	23,9	23,9	23,9	23,9
SO_2	MUNICIP. WASTES	010105	1A1a	23,9	23,9	23,9	23,9	23,9	23,9	23,9
SO_2	MUNICIP. WASTES	0102	1A1a							
SO_2	MUNICIP. WASTES	010202	1A1a							
SO_2	MUNICIP. WASTES	010203	1A1a	67	67	67	67	67	67	67
SO_2	MUNICIP. WASTES	0201	1A4a	67	67	67	67	67	67	67
SO_2	MUNICIP. WASTES	020103	1A4a	67	67	67	67	67	67	67
SO_2	MUNICIP. WASTES	0301	1A2f							
SO_2	RESIDUAL OIL	0101	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	010101	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	010102	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	010103	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	010104	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	010105	1A1a	403	315	290	334	349	283	309
SO_2	RESIDUAL OIL	0102	1A1a							
SO_2	RESIDUAL OIL	010202	1A1a	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	010203	1A1a	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	010306	1A1b	537	537	537	537	537	537	537
SO_2	RESIDUAL OIL	0201	1A4a	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	020103	1A4a							
SO_2	RESIDUAL OIL	0202	1A4b	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	0203	1A4c	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	020302	1A4c	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	020304	1A4c	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	0301	1A2f	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	030102	1A2f	344	344	344	344	344	344	344
SO_2	RESIDUAL OIL	030103	1A2f	344	344	344	344	344	344	344
SO_2	GAS OIL	0101	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010101	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010102	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010103	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010104	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010105	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	0102	1A1a							
SO_2	GAS OIL	010201	1A1a					23	23	23
SO_2	GAS OIL	010202	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010203	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010205	1A1a	23	23	23	23	23	23	23
SO_2	GAS OIL	010306	1A1b				23	23	23	23
SO_2	GAS OIL	010505	1A1c			23	23	23	23	23
SO_2	GAS OIL	0201	1A4a	23	23	23	23	23	23	23

SO_2	GAS OIL	020102	1A4a							
SO_2	GAS OIL	020103	1A4a	23	23	23	23	23	23	23
SO_2	GAS OIL	020105	1A4a	23	23	23	23	23	23	23
SO_2	GAS OIL	0202	1A4b	23	23	23	23	23	23	23
SO_2	GAS OIL	0203	1A4c	23	23	23	23	23	23	23
SO_2	GAS OIL	0301	1A2f	23	23	23	23	23	23	23
SO_2	GAS OIL	030103	1A2f	23	23	23	23	23	23	23
SO_2	GAS OIL	030105	1A2f	23	23	23	23	23	23	23
SO_2	GAS OIL	030106	1A2f	23	23	23	23	23	23	23
SO_2	ORIMULSION	010101	1A1a		10	12	12	12	12	12
NO_X	COAL	0101	1A1a							
NO_X	COAL	010101	1A1a	129	122	130	144	131	127	109
NO_X	COAL	010102	1A1a	129	122	130	144	131	127	109
NO_X	COAL	010103	1A1a	129	122	130	144	131	127	109
NO_X	COAL	010104	1A1a							
NO_X	COAL	010202	1A1a	95	95	95	95	95	95	95
NO_X	COAL	010203	1A1a	95	95	95	95	95	95	95
NO_X	COAL	0201	1A4a					95	95	95
NO_X	COAL	0202	1A4b	95	95	95	95	95	95	95
NO_X	COAL	0203	1A4c	95	95	95	95	95	95	95
NO_X	COAL	0301	1A2f	95	95	95	95	95	95	95
NO_X	BROWN COAL BRI.	0202	1A4b	95	95	95	95	95	95	95
NO_X	COKE OVEN COKE	0202	1A4b	95	95	95	95	95	95	95
NO_X	COKE OVEN COKE	0301	1A2f	95	95	95	95	95	95	95
NO_X	PETROLEUM COKE	0301	1A2f	95	95	95	95	95	95	95
NO_X	WOOD AND SIMIL.	010202	1A1a	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	010203	1A1a	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	0201	1A4a	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	020105	1A4a		90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	0203	1A4c	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	020304	1A4c	90	90					
NO_X	WOOD AND SIMIL.	0301	1A2f	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	030102	1A2f	90	90	90	90	90	90	90
NO_X	WOOD AND SIMIL.	030103	1A2f	90	90	90	90	90	90	90
NO_X	RESIDUAL OIL	0101	1A1a	129	122	130	144	131	127	109
NO_X	RESIDUAL OIL	010101	1A1a	129	122	130	144	131	127	109
NO_X	RESIDUAL OIL	010102	1A1a	129	122	130	144	131	127	109
NO_X	RESIDUAL OIL	010103	1A1a	129	122	130	144	131	127	109
NO_X	RESIDUAL OIL	010104	1A1a	129	122	130	144	131	127	109
NO_X	RESIDUAL OIL	010105	1A1a	129	122	130	144	131	127	109
NO_X	GAS OIL	010103	1A1a	65	65	65	65	65	65	65
NO_X	GAS OIL	0102	1A1a							
NO_X	GAS OIL	010201	1A1a					65	65	65
NO_X	GAS OIL	010202	1A1a	65	65	65	65	65	65	65
NO_X	GAS OIL	010203	1A1a	65	65	65	65	65	65	65
NO_X	GAS OIL	010306	1A1b				65	65	65	65
NO_X	GAS OIL	0301	1A2f	65	65	65	65	65	65	65
NO_X	GAS OIL	030102	1A2f	65	65	65	65	65	65	65
NO_X	GAS OIL	030103	1A2f	65	65	65	65	65	65	65
NO_X	GAS OIL	030106	1A2f	65	65	65	65	65	65	65
NO_X	FISH & RAPE OIL	0102	1A1a							
NO_X	FISH & RAPE OIL	010203	1A1a	65	65	65	65	65	65	65
NO_X	ORIMULSION	010101	1A1a		88	86	86	86	86	86
NO_X	NATURAL GAS	0101	1A1a	115	115	115	115	97	97	97
NO_X	NATURAL GAS	010101	1A1a		115	115	115	97	97	97
NO_X	NATURAL GAS	010102	1A1a	115	115	115	115	97	97	97

NO_X	NATURAL GAS	010104	1A1a	124	124	124	124	124	124	124
NO_X	NATURAL GAS	010105	1A1a	168	168	168	168	161	154	148
NO_X	NATURAL GAS	010205	1A1a	168	168	168	168	161	154	148
NO_X	NATURAL GAS	010505	1A1c	168	168	168	168	161	154	148
NO_X	NATURAL GAS	020104	1A4a	124	124	124	124	124	124	124
NO_X	NATURAL GAS	020105	1A4a	168	168	168	168	161	154	148
NO_X	NATURAL GAS	020204	1A4b	168	168	168	168	161	154	148
NO_X	NATURAL GAS	020303	1A4c	124	124	124	124	124	124	124
NO_X	NATURAL GAS	020304	1A4c	168	168	168	168	161	154	148
NO_X	NATURAL GAS	030104	1A2f	124	124	124	124	124	124	124
NO_X	NATURAL GAS	030105	1A2f	168	168	168	168	161	154	148
NO_X	BIOGAS	010105	1A1a	540	540	540	540	540	540	540
NO_X	BIOGAS	010505	1A1c	540	540	540	540	540	540	540
NO_X	BIOGAS	020105	1A4a	540	540	540	540	540	540	540
NO_X	BIOGAS	020304	1A4c	540	540	540	540	540	540	540
NO_X	BIOGAS	030105	1A2f	540	540	540	540	540	540	540
NMVOC	WOOD AND SIMIL.	0202	1A4b	704	630	602	599	594	598	538
NMVOC	NATURAL GAS	010105	1A1a	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	010205	1A1a	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	010505	1A1c	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	020105	1A4a	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	020204	1A4b	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	020304	1A4c	121	121	121	121	115	110	105
NMVOC	NATURAL GAS	030105	1A2f	121	121	121	121	115	110	105
CO	WOOD AND SIMIL.	0102	1A1a							
CO	WOOD AND SIMIL.	010202	1A1a	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	010203	1A1a	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0201	1A4a	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0203	1A4c	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	0301	1A2f	240	240	240	240	240	240	240
CO	WOOD AND SIMIL.	030103	1A2f	240	240	240	240	240	240	240
CO	MUNICIP. WASTES	0102	1A1a							
CO	MUNICIP. WASTES	010201	1A1a							
CO	MUNICIP. WASTES	010202	1A1a							
CO	MUNICIP. WASTES	010203	1A1a	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	0201	1A4a	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	020103	1A4a	10	10	10	10	10	10	10
CO	MUNICIP. WASTES	0301	1A2f							
CO	STRAW	0102	1A1a							
CO	STRAW	010202	1A1a	325	325	325	325	325	325	325
CO	STRAW	010203	1A1a	325	325	325	325	325	325	325
CO	STRAW	0202	1A4b	4000	4000	4000	4000	4000	4000	4000
CO	STRAW	0203	1A4c	4000	4000	4000	4000	4000	4000	4000
CO	NATURAL GAS	010105	1A1a	183	183	183	183	160	137	115
CO	NATURAL GAS	010205	1A1a	183	183	183	183	160	137	115
CO	NATURAL GAS	010505	1A1c	183	183	183	183	160	137	115
CO	NATURAL GAS	020105	1A4a	183	183	183	183	160	137	115
CO	NATURAL GAS	020204	1A4b	183	183	183	183	160	137	115
CO	NATURAL GAS	020304	1A4c	183	183	183	183	160	137	115
CO	NATURAL GAS	030105	1A2f	183	183	183	183	160	137	115
CO	BIOGAS	010105	1A1a	273	273	273	273	273	273	273
CO	BIOGAS	010505	1A1c	273	273	273	273	273	273	273
CO	BIOGAS	020105	1A4a	273	273	273	273	273	273	273
CO	BIOGAS	020304	1A4c	273	273	273	273	273	273	273
CO	BIOGAS	030105	1A2f	273	273	273	273	273	273	273

Table 49a PM emission factors and references 2006.

Fuel	IPCC sector	SNAP	TSP		PM_{10}		$PM_{2.5}$	
			[g/GJ]	Ref.	[g/GJ]	Ref.	[g/GJ]	Ref.
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	674	17	640	17	604	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. Danish legislation, Miljøstyrelsen 2001. Luftvejledningen, Begrænsning af luftforurening fra virksomheder, Vejledning fra Miljøstyrelsen nr 2 2001
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. Danish legislation. Miljøstyrelsen 1990, Bekendtgørelse 689, 15/10/1990, Bekendtgørelse om begrænsning af emissioner af svovldioxid, kvælstofoxider og støv fra store fyringsanlæg. (and Bekendtgørelse 518/1995)
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., Henriksen, T. C., Lundhede, T., Breugel C. v., Jensen, N. Z. (2007) "Brændeovne og små kedler - partikelemissioner og reduktionstiltag". Miljøprojekt nr. 1164 2007. Miljøstyrelsen. http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publikationer/2007/978-87-7052-451-3/html/default.htm

Time-series have been estimated for the PM emission factors for residential wood combustion. All other emission factors are constant in 2000-2006. The time-series for residential wood combustion are shown below.

Table 49b PM emission factors, time-series

	2000	2001	2002	2003	2004	2005	2006
TSP	883	791	756	750	744	747	674
PM_{10}	839	751	718	713	707	710	640
$PM_{2.5}$	795	712	681	675	670	672	606

Table 50 HM emission factors and references 2006.

Fuel	IPCC sector	SNAP	As [mg/GJ]	Ref.	Cd [mg/GJ]	Ref.	Cr [mg/GJ]	Reference	Cu [mg/GJ]	Reference	Hg [mg/GJ]	Reference	Ni [mg/GJ]	Reference	Pb [mg/GJ]	Reference	Se [mg/GJ]	Reference	Zn [mg/GJ]	Reference
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] 2006 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 1990-2006.

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	2004	2005	2006
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	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	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	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	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	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	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	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	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	10	10	10
Cu	010103					71,1	58	44,9	31,8	31,8	31,8	10	10	10	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	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	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	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	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	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	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	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	123	123	123
Pb	010103					388	305	221	138	138	138	123	123	123	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	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	360	360	360
Zn	010103					550	487	423	360	360	360	360	360	360	360	360	360	360
Zn	010104					550	487	423	360	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	360	360	360
Zn	0201	805	741	678	614	550	487	423	360	360	360	360	360	360	360	360	360	360
Zn	020103					550	487	423	360	360	360	360	360	360	360	360	360	360
Zn	0301	805	741	678	614	550	487	423	360	360	360							

Table 53 PAH emission factors 2006.

Fuel	IPCC id	SNAP	Benzo(a)-pyrene [µg/GJ]	Ref.	Benzo(b)-fluoranthene [µg/GJ]	Ref.	Benzo(k)-fluoranthene [µg/GJ]	Ref.	Indeno(1,2,3-c,d)-pyrene [µg/GJ]	Ref.
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, 1A4c	0201, 020105, 0203	168707	4	221769	4	73469	4	119728	4
WOOD AND SIMIL.	1A4b	0202	125594	10	130661	10	76327	10	86045	10
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)
10. Aggregated emission factor based on the technology distribution and guidebook emission factors

Time-series have been estimated for the PAH emission factors for residential wood combustion. All other emission factors are constant in 1990-2006. The time-series for residential wood combustion are shown below.

pol_abbr	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Benzo(a)	159007	159007	159007	159007	159007	159007	159007	159007	159007	159007
Benzo(b)	169323	169323	169323	169323	169323	169323	169323	169323	169323	169323
Benzo(k)	98938	98938	98938	98938	98938	98938	98938	98938	98938	98938
Indeno	110485	110485	110485	110485	110485	110485	110485	110485	110485	110485

Continued	2000	2001	2002	2003	2004	2005	2006
Benzo(a)	159007	143838	138379	137894	137250	138232	125594
Benzo(b)	169323	152440	145973	144794	143470	143857	130661
Benzo(k)	98938	89090	85295	84572	83770	83962	76327
Indeno	110485	99585	95554	95029	94401	94917	86045

Appendix 2A-7 Implied emission factors for municipal waste incineration plants and power plants combustion coal

Table 54 Implied emission factors for municipal waste incineration plants 2006.

Pollutant	Implied Emission factor	Unit
SO_2	9	g/GJ
NO_x	115	g/GJ
TSP	1.2	g/GJ
PM_{10}	0.9	g/GJ
$PM_{2.5}$	0.8	g/GJ
As	5.3	mg/GJ
Cd	3.9	mg/GJ
Cr	6.5	mg/GJ
Cu	11	mg/GJ
Hg	5.2	mg/GJ
Ni	12	mg/GJ
Pb	78	mg/GJ
Se	0.14	mg/GJ
Zn	350	mg/GJ

Table 55 Implied emission factors for power plants combusting coal, 2006.

Pollutant	Implied Emission factor	Unit
SO_2	33	g/GJ
NO_x	125	g/GJ
TSP	2.8	g/GJ
PM_{10}	2.2	g/GJ
$PM_{2.5}$	1.8	g/GJ
As	0.55	mg/GJ
Cd	0.05	mg/GJ
Cr	0.82	mg/GJ
Cu	0.52	mg/GJ
Hg	1.00	mg/GJ
Ni	1.08	mg/GJ
Pb	0.87	mg/GJ
Se	4.31	mg/GJ
Zn	2.73	mg/GJ

Appendix 2A-8 Large point sources

Table 56 Large point sources, fuel consumption in 2006 (1A1, 1A2 and 1A4).

lps_id	lps_name	fuel_id	fuel	Fuel consumption GJ	ipcc_id
001	Amagervaerket	102A	COAL	15969680	1A1a
001	Amagervaerket	111A	WOOD AND SIMIL.	406011	1A1a
001	Amagervaerket	117A	STRAW	730023	1A1a
001	Amagervaerket	203A	RESIDUAL OIL	108580	1A1a
002	Svanemoellevaerket	204A	GAS OIL	80282,04	1A1a
002	Svanemoellevaerket	301A	NATURAL GAS	6484369,77	1A1a
003	H.C.Oerstedsvaerket	203A	RESIDUAL OIL	1686494,76	1A1a
003	H.C.Oerstedsvaerket	301A	NATURAL GAS	3517302,91	1A1a
004	Kyndbyvaerket	203A	RESIDUAL OIL	594130	1A1a
004	Kyndbyvaerket	204A	GAS OIL	36233,98	1A1a
005	Masnedoevaerket	111A	WOOD AND SIMIL.	34006,61	1A1a
005	Masnedoevaerket	117A	STRAW	515954,78	1A1a
005	Masnedoevaerket	204A	GAS OIL	18882,67	1A1a
007	Stigsnaesvaerket	102A	COAL	17142232,53	1A1a
007	Stigsnaesvaerket	203A	RESIDUAL OIL	292046,62	1A1a
007	Stigsnaesvaerket	204A	GAS OIL	3300	1A1a
008	Asnaesvaerket	102A	COAL	43572774	1A1a
008	Asnaesvaerket	203A	RESIDUAL OIL	422592	1A1a
009	Statoil Raffinaderi	203A	RESIDUAL OIL	780	1A1b
009	Statoil Raffinaderi	204A	GAS OIL	6973	1A1b
009	Statoil Raffinaderi	308A	REFINERY GAS	9083090	1A1b
010	Avedoerevaerket	102A	COAL	15016901,4	1A1a
010	Avedoerevaerket	111A	WOOD AND SIMIL.	2608712,53	1A1a
010	Avedoerevaerket	117A	STRAW	2539974,55	1A1a
010	Avedoerevaerket	203A	RESIDUAL OIL	8500062,84	1A1a
010	Avedoerevaerket	204A	GAS OIL	5438	1A1a
010	Avedoerevaerket	301A	NATURAL GAS	12521178,29	1A1a
011	Fynsvaerket+Odense kraftvarmevaerk	102A	COAL	22106430	1A1a
011	Fynsvaerket+Odense kraftvarmevaerk	114A	MUNICIP. WASTES	2842000	1A1a
011	Fynsvaerket+Odense kraftvarmevaerk	203A	RESIDUAL OIL	270970	1A1a
011	Fynsvaerket+Odense kraftvarmevaerk	204A	GAS OIL	27000	1A1a
011	Fynsvaerket+Odense kraftvarmevaerk	301A	NATURAL GAS	13220	1A1a
012	Studstrupvaerket	102A	COAL	32646380	1A1a
012	Studstrupvaerket	117A	STRAW	1982080	1A1a
012	Studstrupvaerket	203A	RESIDUAL OIL	384980	1A1a
014	Nordjyllandsvaerket	102A	COAL	27602510	1A1a
014	Nordjyllandsvaerket	203A	RESIDUAL OIL	240960	1A1a
014	Nordjyllandsvaerket	204A	GAS OIL	3566	1A1a
017	Shell Raffinaderi	203A	RESIDUAL OIL	465077	1A1b
017	Shell Raffinaderi	308A	REFINERY GAS	7305106	1A1b
018	Skaerbaekvaerket	204A	GAS OIL	382000	1A1a
018	Skaerbaekvaerket	301A	NATURAL GAS	15482000	1A1a
019	Enstedvaerket	102A	COAL	22710000	1A1a
019	Enstedvaerket	111A	WOOD AND SIMIL.	288790	1A1a
019	Enstedvaerket	117A	STRAW	1709590	1A1a
019	Enstedvaerket	203A	RESIDUAL OIL	114160	1A1a
020	Esbjergvaerket	102A	COAL	21552000	1A1a
020	Esbjergvaerket	203A	RESIDUAL OIL	128000	1A1a
020	Esbjergvaerket	303A	LPG	108	1A1a
022	Oestkraft	102A	COAL	637323	1A1a

022	Oestkraft	111A	WOOD AND SIMIL.	22640	1A1a
022	Oestkraft	203A	RESIDUAL OIL	247025	1A1a
023	Danisco Grindsted	102A	COAL	518172	1A2f
023	Danisco Grindsted	301A	NATURAL GAS	22177	1A2f
024	Nybro Gasbehandlingsanlaeg	301A	NATURAL GAS	379490,91	1A1c
025	Horsens Kraftvarmevaerk	114A	MUNICIP. WASTES	817964	1A1a
025	Horsens Kraftvarmevaerk	301A	NATURAL GAS	843038	1A1a
026	Herningvaerket	111A	WOOD AND SIMIL.	2573000	1A1a
026	Herningvaerket	203A	RESIDUAL OIL	487000	1A1a
026	Herningvaerket	301A	NATURAL GAS	607000	1A1a
027	I/S Vestforbraending	114A	MUNICIP. WASTES	5256279	1A1a
027	I/S Vestforbraending	204A	GAS OIL	8751,79	1A1a
027	I/S Vestforbraending	301A	NATURAL GAS	15984,82	1A1a
028	Amagerforbraending	114A	MUNICIP. WASTES	4510659,9	1A1a
029	Energi Randers Produktion	102A	COAL	1989984	1A1a
029	Energi Randers Produktion	111A	WOOD AND SIMIL.	1221491	1A1a
029	Energi Randers Produktion	204A	GAS OIL	38769	1A1a
029	Energi Randers Produktion	309A	BIOGAS	16560	1A1a
030	Grenaa Kraftvarmevaerk	102A	COAL	661624	1A1a
030	Grenaa Kraftvarmevaerk	111A	WOOD AND SIMIL.	38142	1A1a
030	Grenaa Kraftvarmevaerk	117A	STRAW	543028	1A1a
030	Grenaa Kraftvarmevaerk	203A	RESIDUAL OIL	34100	1A1a
030	Grenaa Kraftvarmevaerk	204A	GAS OIL	4340	1A1a
031	Hilleroed Kraftvarmevaerk	301A	NATURAL GAS	2880454	1A1a
032	Helsingoer Kraftvarmevaerk	301A	NATURAL GAS	1599088	1A1a
033	DanSteel	301A	NATURAL GAS	1305612,48	1A2f
034	Dalum Papir	111A	WOOD AND SIMIL.	8586	1A2f
034	Dalum Papir	204A	GAS OIL	10294,12	1A2f
034	Dalum Papir	301A	NATURAL GAS	965155,28	1A2f
035	Danisco Sugar Assens	102A	COAL	166306	1A2f
035	Danisco Sugar Assens	203A	RESIDUAL OIL	265770	1A2f
036	Kolding Forbraendingsanlaeg	114A	MUNICIP. WASTES	776695	1A1a
037	Maabjergvaerket	111A	WOOD AND SIMIL.	392000	1A1a
037	Maabjergvaerket	114A	MUNICIP. WASTES	1838000	1A1a
037	Maabjergvaerket	117A	STRAW	430000	1A1a
037	Maabjergvaerket	301A	NATURAL GAS	119740	1A1a
038	Soenderborg Kraftvarmevaerk	114A	MUNICIP. WASTES	717612	1A1a
038	Soenderborg Kraftvarmevaerk	301A	NATURAL GAS	1174462,78	1A1a
039	I/S Kara Affaldsforbraendingsanlaeg	114A	MUNICIP. WASTES	2052656	1A1a
039	I/S Kara Affaldsforbraendingsanlaeg	301A	NATURAL GAS	6821,54	1A1a
040	Viborg Kraftvarme	301A	NATURAL GAS	2203850,64	1A1a
042	I/S Nordforbraending	114A	MUNICIP. WASTES	1287930	1A1a
045	Aalborg Portland	102A	COAL	4364609	1A2f
045	Aalborg Portland	110A	PETROLEUM COKE	8283791	1A2f
045	Aalborg Portland	114A	MUNICIP. WASTES	1403179	1A2f
045	Aalborg Portland	203A	RESIDUAL OIL	978754	1A2f
046	Affaldscenter aarhus - Forbraendsan-laegget	114A	MUNICIP. WASTES	2409172,5	1A1a
047	I/S Reno Nord	114A	MUNICIP. WASTES	1780267,2	1A1a
048	Silkeborg Kraftvarmevaerk	301A	NATURAL GAS	3325918,58	1A1a
049	Rensningsanlaegget Lynetten	114A	MUNICIP. WASTES	182700	1A4a
049	Rensningsanlaegget Lynetten	204A	GAS OIL	31510,04	1A4a
049	Rensningsanlaegget Lynetten	309A	BIOGAS	137540	1A4a
050	Fasan+Naestved Kraftvarmevaerk	114A	MUNICIP. WASTES	1199720	1A1a

051	AVV Forbraendingsanlaeg	114A	MUNICIP. WASTES	848515,5	1A1a
052	Affaldsforbraendingsanlaeg I/S REFA	114A	MUNICIP. WASTES	1188337,5	1A1a
053	Svendborg Kraftvarmevaerk	114A	MUNICIP. WASTES	529431	1A1a
053	Svendborg Kraftvarmevaerk	301A	NATURAL GAS	3802,15	1A1a
054	Kommunekemi	114A	MUNICIP. WASTES	1545564	1A1a
054	Kommunekemi	203A	RESIDUAL OIL	105047	1A1a
054	Kommunekemi	204A	GAS OIL	13558,1	1A1a
055	I/S Faelles Forbraending	114A	MUNICIP. WASTES	309487,5	1A1a
056	Vestfyns Forbraendingsanlaeg	114A	MUNICIP. WASTES	79729	1A1a
058	I/S Reno Syd	114A	MUNICIP. WASTES	648722	1A1a
059	I/S Kraftvarmevaerk Thisted	114A	MUNICIP. WASTES	545821,5	1A1a
059	I/S Kraftvarmevaerk Thisted	117A	STRAW	3683	1A1a
060	Knudmosevaerket	114A	MUNICIP. WASTES	494025	1A1a
060	Knudmosevaerket	301A	NATURAL GAS	43669,61	1A1a
061	Kavo I/S Energien+Slagelse Kraftvar-mevaerk	114A	MUNICIP. WASTES	690319,1	1A1a
065	Haderslev Kraftvarmevaerk	114A	MUNICIP. WASTES	639184	1A1a
065	Haderslev Kraftvarmevaerk	301A	NATURAL GAS	68	1A1a
066	Frederiskhavn Affaldskraftvarmevaerk	114A	MUNICIP. WASTES	338500	1A1a
066	Frederiskhavn Affaldskraftvarmevaerk	204A	GAS OIL	1400	1A1a
067	Vejen Kraftvarmevaerk	114A	MUNICIP. WASTES	360000	1A1a
068	Bofa I/S	114A	MUNICIP. WASTES	208535	1A1a
069	DTU	301A	NATURAL GAS	1343549,63	1A1a
070	Naestved Kraftvarmevaerk	301A	NATURAL GAS	138221,98	1A1a
071	Maricogen	301A	NATURAL GAS	1232251,26	1A2f
072	Hjoerring Varmeforsyning	301A	NATURAL GAS	324788,55	1A1a
075	Rockwool A/S Hedehusene	301A	NATURAL GAS	46800	1A2f
076	Rockwool A/S Vamdrup	107A	COKE OV.COKE/HC	403920	1A2f
076	Rockwool A/S Vamdrup	301A	NATURAL GAS	269280	1A2f
077	Rockwool A/S Doense	107A	COKE OV.COKE/HC	360720	1A2f
077	Rockwool A/S Doense	301A	NATURAL GAS	240480	1A2f
078	Rexam Glass Holmegaard A/S	204A	GAS OIL	554	1A2f
078	Rexam Glass Holmegaard A/S	301A	NATURAL GAS	827157	1A2f
081	Haldor Topsoee	204A	GAS OIL	1300	1A2f
081	Haldor Topsoee	301A	NATURAL GAS	520100	1A2f
081	Haldor Topsoee	303A	LPG	200	1A2f
082	Danisco Sugar Nakskov	102A	COAL	547172	1A2f
082	Danisco Sugar Nakskov	203A	RESIDUAL OIL	550644,9	1A2f
082	Danisco Sugar Nakskov	204A	GAS OIL	2727,04	1A2f
082	Danisco Sugar Nakskov	309A	BIOGAS	43405,74	1A2f
083	Danisco Sugar Nykoebing	203A	RESIDUAL OIL	789620,3	1A2f
085	L90 Affaldsforbraending	114A	MUNICIP. WASTES	2127310,5	1A1a
085	L90 Affaldsforbraending	203A	RESIDUAL OIL	10870,22	1A1a
086	Hammel Fjernvarme	114A	MUNICIP. WASTES	335811	1A1a

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	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						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			
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			
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			
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
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
085	L90 Affaldsforbræn-ding	01	1a1a	010102	x	x		x	x	x	x										
086	Hammel Fjernvarme	01	1a1a	010203	x	x		x	x	x	x										
	Total				11634	44772	16	10890	1191	957	698	117	17	176	121	270	1588	274	1064	422	

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 2A-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	21465	1	5	5,099	2,752	-0,097	0,564	-0,483	0,798	0,932
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	109	3	5	5,831	0,016	-0,001	0,003	-0,005	0,012	0,013
Stationary Combustion, Petroleum coke	CO_2	410	847	3	5	5,831	0,124	0,011	0,022	0,055	0,094	0,109
Stationary Combustion, Plastic waste	CO_2	349	702	5	5	7,071	0,125	0,009	0,018	0,044	0,130	0,138
Stationary Combustion, Residual oil	CO_2	2505	2014	2	2	2,828	0,143	-0,016	0,053	-0,032	0,150	0,153
Stationary Combustion, Gas oil	CO_2	4547	1983	4	5	6,403	0,319	-0,073	0,052	-0,363	0,295	0,468
Stationary Combustion, Kerosene	CO_2	366	16	4	5	6,403	0,003	-0,010	0,000	-0,048	0,002	0,048
Stationary Combustion, Natural gas	CO_2	4320	10846	3	1	3,162	0,862	0,166	0,285	0,166	1,209	1,220
Stationary Combustion, LPG	CO_2	169	112	4	5	6,403	0,018	-0,002	0,003	-0,008	0,017	0,019
Stationary Combustion, Refinery gas	CO_2	806	932	3	5	5,831	0,137	0,002	0,025	0,012	0,104	0,105
Stationary combustion plants, gas engines	CH_4	7	277	2,2	40	40,060	0,279	0,007	0,007	0,283	0,023	0,284
Stationary combustion plants, other	CH_4	115	184	2,2	100	100,024	0,463	0,002	0,005	0,169	0,015	0,170
Stationary combustion plants	N_2O	240	291	2,2	1000	1000,002	7,323	0,001	0,008	1,052	0,024	1,053
Total		38060	39779				62,410					3,863
Total uncertainties		Overall uncertainty in the year (%):					**7,900**		Trend uncertainty (%):			**1,966**

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	21465	1	5	5,099	2,805	-0,091	0,569	-0,456	0,805	0,925
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	109	3	5	5,831	0,016	-0,001	0,003	-0,004	0,012	0,013
Stationary Combustion, Petroleum coke	CO_2	410	847	3	5	5,831	0,127	0,011	0,022	0,056	0,095	0,111
Stationary Combustion, Plastic waste	CO_2	349	702	5	5	7,071	0,127	0,009	0,019	0,045	0,132	0,139
Stationary Combustion, Residual oil	CO_2	2505	2014	2	2	2,828	0,146	-0,015	0,053	-0,031	0,151	0,154
Stationary Combustion, Gas oil	CO_2	4547	1983	4	5	6,403	0,325	-0,072	0,053	-0,361	0,298	0,468
Stationary Combustion, Kerosene	CO_2	366	16	4	5	6,403	0,003	-0,010	0,000	-0,048	0,002	0,048
Stationary Combustion, Natural gas	CO_2	4320	10846	3	1	3,162	0,879	0,169	0,288	0,169	1,221	1,232
Stationary Combustion, LPG	CO_2	169	112	4	5	6,403	0,018	-0,002	0,003	-0,008	0,017	0,019
Stationary Combustion, Refinery gas	CO_2	806	932	3	5	5,831	0,139	0,003	0,025	0,013	0,105	0,106
Total	CO_2	37698	39026				8,817					2,663
Total uncertainties			Overall uncertainty in the year (%):				**2,969**			Trend uncertainty (%):		**1,632**

Table 60 Uncertainty estimation, CH_4.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	tainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity introduced by emission factor uncertainty	in national emissions introduced by activity data uncertainty	duced 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	312	13170	2,2	40	40,060	24,039	2,072	2,278	82,890	7,089	83,193
Stationary combustion plants, other	CH_4	5468	8777	2,2	100	100,024	40,004	-2,054	1,519	-205,395	4,725	205,449
Total	CH_4	5780	21947				2178,14					49130,4
Total uncertainties		Overall uncertainty in the year (%):					**46,671**		Trend uncertainty (%):			**221,654**

Table 61 Uncertainty estimation, N_2O.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	tainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity emissions introduced by emission factor uncertainty	emissions introduced by activity data uncertainty	duced 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	0,775	0,940	2,200	1000	1000,002	1000,002	0,000	1,212	0,000	3,770	3,770
Total	N_2O	0,775	0,940				1000005					14,214
Total uncertainties		Overall uncertainty in the year (%):				1000,002			Trend uncertainty (%):		**3,770**	

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 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 SO_2	Mg SO_2	%	%	%	%	%	%	%	%	%
01	SO_2	129601	10250	2	10	10,198	4,628	-0,052	0,065	-0,522	0,184	0,553
02	SO_2	11491	4433	2	20	20,100	3,945	0,018	0,028	0,353	0,079	0,362
03	SO_2	16708	7903	2	10	10,198	3,568	0,035	0,050	0,349	0,142	0,377
Total SO_2		157800	22585				49,715					0,579
Total uncertainties			Overall uncertainty in the year (%):			7,051				Trend uncertainty (%):		0,761

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 uncertainty	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	94738	51864	2	20	20,100	14,349	-0,067	0,4493	-1,335	1,271	1,843
02	NO_x	7518	8288	2	50	50,040	5,709	0,031	0,0718	1,540	0,203	1,553
03	NO_x	13167	12498	2	20	20,100	3,458	0,036	0,1083	0,729	0,306	0,790
Total NO_x		115423	72650				250,438					6,434
Total uncertainties			Overall uncertainty in the year (%):			15,825				Trend uncertainty (%):		2,536

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	1075	3326	2	50	50,040	7,178	0,110	0,2441	5,489	0,690	5,532
02	NMVOC	11923	19289	2	50	50,040	41,636	-0,073	1,4157	-3,631	4,004	5,406
03	NMVOC	627	568	2	50	50,040	1,225	-0,037	0,0417	-1,829	0,118	1,833
Total NMVOC		13625	23182				1786,609					63,180
Total uncertainties			Overall uncertainty in the year (%):			42,268				Trend uncertainty (%):		7,949

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	8262	10251	2	20	20,100	0,693	-0,017	0,056	-0,342	0,158	0,377
02	CO	159294	275055	2	50	50,040	46,291	0,091	1,499	4,553	4,241	6,222
03	CO	15877	12028	2	20	20,100	0,813	-0,075	0,066	-1,493	0,185	1,505
Total	CO	183432	297333				2143,967					41,125
Total uncertainties				Overall uncertainty in the year (%):			46,303		Trend uncertainty (%):			6,416

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	1073	2	50	50,040	2,389	-0,028	0,064	-1,382	0,180	1,394
02	TSP	14581	20423	2	500	500,004	454,336	0,060	1,209	30,118	3,419	30,311
03	TSP	1157	980	2	50	50,040	2,181	-0,033	0,058	-1,653	0,164	1,661
Total	TSP	16896	22476				206431,988					923,457
Total uncertainties				Overall uncertainty in the year (%):			454,348			Trend uncertainty (%):		30,388

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	836	2	50	50,040	2,006	-0,027	0,054	-1,344	0,151	1,353
02	PM_{10}	13832	19353	2	500	500,004	463,859	0,056	1,239	28,064	3,503	28,282
03	PM_{10}	851	672	2	50	50,040	1,611	-0,030	0,043	-1,485	0,122	1,490
Total	PM_{10}	15625	20861				215172,092					803,934
Total uncertainties				Overall uncertainty in the year (%):			463,866			Trend uncertainty (%):		28,354

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	701	2	50	50,040	1,810	-0,026	0,049	-1,323	0,138	1,330
02	$PM_{2.5}$	13090	18296	2	500	500,004	471,975	0,047	1,271	23,280	3,594	23,556
03	$PM_{2.5}$	506	385	2	50	50,040	0,995	-0,021	0,027	-1,025	0,076	1,028
Total	$PM_{2.5}$	14400	19382				222764,962					557,710
Total uncertainties				Overall uncertainty in the year (%):			471,980			Trend uncertainty (%):		23,616

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	340	2	100	100,020	53,759	-0,058	0,236	-5,758	0,668	5,797
02	As	127	63	2	1000	1000,002	98,730	0,005	0,043	4,628	0,123	4,630
03	As	349	230	2	100	100,020	36,386	0,053	0,160	5,321	0,452	5,340
Total	As	1442	633				13961,541					83,558
Total uncertainties				Overall uncertainty in the year (%):			118,159			Trend uncertainty (%):		9,141

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	234	2	100	100,020	35,744	-0,127	0,223	-12,738	0,630	12,754
02	Cd	145	233	2	1000	1000,002	355,194	0,135	0,221	135,430	0,626	135,432
03	Cd	315	188	2	100	100,020	28,750	-0,007	0,179	-0,749	0,507	0,905
Total	Cd	1052	655				128266,883					18505,180
Total uncertainties				Overall uncertainty in the year (%):			358,144			Trend uncertainty (%):		136,034

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	540	2	100	100,020	49,286	-0,049	0,089	-4,869	0,250	4,875
02	Cr	326	108	2	1000	1000,002	98,688	0,008	0,018	8,138	0,050	8,138
03	Cr	1103	448	2	100	100,020	40,863	0,041	0,073	4,084	0,208	4,090
Total	Cr	6103	1096				13838,254					106,714
Total uncertainties				Overall uncertainty in the year (%):			117,636			Trend uncertainty (%):		10,330

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	672	2	100	100,020	57,806	-0,072	0,186	-7,228	0,525	7,247
02	Cu	301	287	2	1000	1000,002	246,709	0,052	0,079	52,452	0,224	52,452
03	Cu	405	204	2	100	100,020	17,538	0,020	0,056	2,034	0,159	2,041
Total	Cu	3622	1163				64514,393					2807,907
Total uncertainties				Overall uncertainty in the year (%):			253,997			Trend uncertainty (%):		**52,990**

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	679	2	100	100,020	53,647	-0,114	0,221	-11,407	0,625	11,424
02	Hg	330	324	2	1000	1000,002	255,446	0,061	0,105	61,020	0,298	61,021
03	Hg	238	264	2	100	100,020	20,824	0,054	0,086	5,388	0,243	5,393
Total	Hg	3076	1267				68564,295					3883,144
Total uncertainties				Overall uncertainty in the year (%):			261,848			Trend uncertainty (%):		62,315

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	2721	2	100	100,020	27,531	-0,054	0,127	-5,387	0,360	5,399
02	Ni	1852	959	2	1000	1000,002	97,053	0,005	0,045	4,818	0,127	4,819
03	Ni	11140	6205	2	100	100,020	62,782	0,049	0,290	4,901	0,821	4,969
Total	Ni	21376	9885				14118,867					77,066
Total uncertainties				Overall uncertainty in the year (%):			118,823			Trend uncertainty (%):		8,779

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	3450	2	100	100,020	73,262	-0,015	0,225	-1,470	0,635	1,602
02	Pb	945	343	2	1000	1000,002	72,773	0,003	0,022	3,439	0,063	3,439
03	Pb	2421	917	2	100	100,020	19,479	0,011	0,060	1,136	0,169	1,149
Total	Pb	15361	4710				11042,642					15,713
Total uncertainties				Overall uncertainty in the year (%):			105,084			Trend uncertainty (%):		3,964

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	1074	2	100	100,020	59,642	-0,036	0,248	-3,585	0,701	3,653
02	Se	308	135	2	1000	1000,002	74,787	0,002	0,031	1,551	0,088	1,553
03	Se	1065	593	2	100	100,020	32,897	0,034	0,137	3,446	0,387	3,467
Total	Se	4334	1802				10232,599					27,780
Total uncertainties				Overall uncertainty in the year (%):			101,156			Trend uncertainty (%):		5,271

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	15357	2	100	100,020	71,965	-0,050	0,794	-5,016	2,246	5,496
02	Zn	2810	4685	2	1000	1000,002	219,492	0,082	0,242	81,759	0,685	81,762
03	Zn	1729	1302	2	100	100,020	6,101	-0,031	0,067	-3,131	0,190	3,136
Total	Zn	19340	21344				53393,099					6725,056
Total uncertainties				Overall uncertainty in the year (%):			231,069			Trend uncertainty (%):		82,006

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	30	2	100	100,020	0,715	-0,009	0,012	-0,918	0,034	0,919
02		2391	4085	2	1000	1000,002	970,018	0,004	1,653	4,024	4,676	6,169
03		49	96	2	100	100,020	2,284	0,005	0,039	0,512	0,110	0,523
Total		2471	4211				940941,308					39,176
Total uncertainties				Overall uncertainty in the year (%):			970,021			Trend uncertainty (%):		6,259

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	0,660	-0,020	0,019	-2,007	0,054	2,008
02		749	2248	2	1000	1000,002	986,921	0,085	2,875	84,936	8,132	85,324
03		23	15	2	100	100,020	0,648	-0,066	0,019	-6,565	0,053	6,566
Total		782	2278				974013,497					7327,324
Total uncertainties				Overall uncertainty in the year (%):			986,921			Trend uncertainty (%):		85,600

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 uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		kg	kg	%	%	%	%	%	%	%	%	%
01		8	7	2	100	100,020	0,190	-0,005	0,004	-0,469	0,011	0,469
02		1880	3873	2	1000	1000,002	990,901	0,002	2,040	1,572	5,770	5,981
03		11	28	2	100	100,020	0,720	0,003	0,015	0,310	0,042	0,313
Total		1898	3908				981885,937					36,088
Total uncertainties				Overall uncertainty in the year (%):			990,902			Trend uncertainty (%):		6,007

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 uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		kg	kg	%	%	%	%	%	%	%	%	%
01		6	7	2	100	100,020	0,249	-0,003	0,004	-0,273	0,013	0,274
02		1552	2792	2	1000	1000,002	994,532	0,013	1,777	12,721	5,025	13,678
03		14	8	2	100	100,020	0,298	-0,010	0,005	-1,011	0,015	1,011
Total		1572	2808				989094,026					188,176
Total uncertainties				Overall uncertainty in the year (%):			994,532			Trend uncertainty (%):		13,718

Appendix 2A-10 Lower Calorific Value (LCV) of fuels

Table 82 Time-series for calorific values of fuels (Danish Energy Authority, DEA 2007b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
Refinery Feedstocks	GJ / ton	41.60	41.60	41.60	41.60	41.60	41.60	41.60	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
LPG	GJ / ton	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
Motor Gasoline	GJ / ton	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
JP4	GJ / ton	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Other Kerosene	GJ / ton	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
JP1	GJ / ton	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
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
Fuel Oil	GJ / ton	40.40	40.40	40.40	40.40	40.40	40.40	40.70	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
Petroleum Coke	GJ / ton	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
White Spirit	GJ / ton	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
Lubricants	GJ / ton	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
Town Gas	GJ / 1000 m3							17.00	17.00	17.00	17.00
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
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
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
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
Straw	GJ / ton	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
Firewood, Hardwood	GJ / m3	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
Wood Pellets	GJ / ton	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
Wood Waste	GJ/Rummeter	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
Waste Combustion	GJ / ton	8.20	8.20	9.00	9.40	9.40	10.00	10.50	10.50	10.50	10.50
Bio ethanol	GJ / ton	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7
Bio diesel	GJ / ton	37.60	37.60	37.60	37.60	37.60	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

Continued		2000	2001	2002	2003	2004	2005	2006
Crude Oil, Average	GJ / ton	43.00	43.00	43.00	43.00	43.00	43.00	43
Crude Oil, Golf	GJ / ton	41.80	41.80	41.80	41.80	41.80	41.80	41.8
Crude Oil, North Sea	GJ / ton	43.00	43.00	43.00	43.00	43.00	43.00	43
Refinery Feedstocks	GJ / ton	42.70	42.70	42.70	42.70	42.70	42.70	42.7
Refinery Gas	GJ / ton	52.00	52.00	52.00	52.00	52.00	52.00	52
LPG	GJ / ton	46.00	46.00	46.00	46.00	46.00	46.00	46
Naphtha (LVN)	GJ / ton	44.50	44.50	44.50	44.50	44.50	44.50	44.5
Motor Gasoline	GJ / ton	43.80	43.80	43.80	43.80	43.80	43.80	43.8
Aviation Gasoline	GJ / ton	43.80	43.80	43.80	43.80	43.80	43.80	43.8
JP4	GJ / ton	43.80	43.80	43.80	43.80	43.80	43.80	43.8
Other Kerosene	GJ / ton	43.50	43.50	43.50	43.50	43.50	43.50	43.5
JP1	GJ / ton	43.50	43.50	43.50	43.50	43.50	43.50	43.5
Gas/Diesel Oil	GJ / ton	42.70	42.70	42.70	42.70	42.70	42.70	42.7
Fuel Oil	GJ / ton	40.65	40.65	40.65	40.65	40.65	40.65	40.65
Orimulsion	GJ / ton	27.62	27.64	27.71	27.65	27.65	27.65	27.65
Petroleum Coke	GJ / ton	31.40	31.40	31.40	31.40	31.40	31.40	31.4
Waste Oil	GJ / ton	41.90	41.90	41.90	41.90	41.90	41.90	41.9
White Spirit	GJ / ton	43.50	43.50	43.50	43.50	43.50	43.50	43.5
Bitumen	GJ / ton	39.80	39.80	39.80	39.80	39.80	39.80	39.8
Lubricants	GJ / ton	41.90	41.90	41.90	41.90	41.90	41.90	41.9
Natural Gas	GJ / 1000 Nm3	40.15	39.99	40.06	39.94	39.77	39.67	39.54
Town Gas	GJ / 1000 m3	17.01	16.88	17.39	16.88	17.58	17.51	17202
Electricity Plant Coal	GJ / ton	24.80	24.90	25.15	24.73	24.60	24.40	24.8
Other Hard Coal	GJ / ton	26.50	26.50	26.50	26.50	26.50	26.50	26.5
Gas Plant Coal	GJ / ton							
Coke	GJ / ton	29.30	29.30	29.30	29.30	29.30	29.30	29.3
Brown Coal Briquettes	GJ / ton	18.30	18.30	18.30	18.30	18.30	18.30	18.3
Straw	GJ / ton	14.50	14.50	14.50	14.50	14.50	14.50	14.5
Wood Chips	GJ/Rummeter	2.80	2.80	2.80	2.80	2.80	2.80	2.8
Firewood, Hardwood	GJ / m3	10.40	10.40	10.40	10.40	10.40	10.40	10.4
Firewood, Conifer	GJ / m3	7.60	7.60	7.60	7.60	7.60	7.60	7.6
Wood Pellets	GJ / ton	17.50	17.50	17.50	17.50	17.50	17.50	17.5
Wood Waste	GJ / ton	14.70	14.70	14.70	14.70	14.70	14.70	14.7
Wood Waste	GJ/Rummeter	3.20	3.20	3.20	3.20	3.20	3.20	3.2
Biogas	GJ / 1000 m3	23.00	23.00	23.00	23.00	23.00	23.00	23
Waste Combustion	GJ / ton	10.50	10.50	10.50	10.50	10.50	10.50	10.5
Bio ethanol	GJ / ton	26.7	26.7	26.7	26.7	26.7	26.7	26.7
Bio diesel	GJ / ton	37.60	37.60	37.60	37.60	37.60	37.60	37.6
Fish Oil	GJ / ton	37.20	37.20	37.20	37.20	37.20	37.20	37.2

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 2A-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
Actual Degree Days	Degree days	2 926	2 857	3 284	3 022	3 434	3 148	3 297	3 837	3 236	3 217
Normal Degree Days	Degree days	3 419	3 379	3 380	3 359	3 365	3 366	3 378	3 395	3 389	3 375
Net electricity import	TJ	25 373	-7 099	3 486	4 266	-17 424	-2 858	-55 444	-26 107	-15 552	-8 327
Actual CO_2 emission	1 000 000 tonnes	37.7	47.4	41.5	43.7	46.9	43.8	57.0	47.0	43.2	39.9
Adjusted CO_2 emission	1 000 000 tonnes	60.8	61.5	60.8	59.7	59.6	59.1	58.5	57.7	56.2	55.4

Continued

Degree Days		2000	2001	2002	2003	2004	2005	2006
Actual Degree Days	Degree days	3 056	2 902	3 279	3 011	3 150	3 113	3 068
Normal Degree Days	Degree days	3 339	3 304	3 289	3 273	3 271	3 261	3 224
Net electricity import	TJ	2 394	-2 071	-7 453	-30 760	-10 340	4 932	-24 971
Actual CO_2 emission	1 000 000 tonnes	35.9	37.5	37.0	41.8	35.7	32.0	39.2
Adjusted CO_2 emission	1 000 000 tonnes	54.2	53.6	52.2	51.7	50.9	51.0	52.5

Appendix 2A-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 (TJ/Unit)	NCV/ GCV [1]	Apparent consumption (TJ)
Liquid Fossil	Primary Fuels	Crude Oil	TJ	724.416,36	116.460,86	497.478,95		-395,34	343.793,61	1,00	NCV	343.793,61
		Orimulsion	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
		Natural Gas Liquids	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
	Secondary Fuels	Gasoline	TJ		40.246,54	47.531,98	1,62	43,17	-7.330,22	1,00	NCV	-7.330,22
		Jet Kerosene	TJ		25.039,78	19.306,10	35.877,55	-5.996,98	-24.146,88	1,00	NCV	-24.146,88
		Other Kerosene	TJ		NA	NA	NA	NA	NA	1,00	NCV	NA
		Shale Oil	TJ		NA	NA		NA	NA	1,00	NCV	NA
		Gas / Diesel Oil	TJ		102.093,10	71.431,95	13.116,25	-4.804,59	22.349,49	1,00	NCV	22.349,49
		Residual Fuel Oil	TJ		42.413,03	46.859,21	31.564,68	1.253,65	-37.264,51	1,00	NCV	-37.264,51
		Liquefied Petroleum Gas (LPG)	TJ		193,29	4.683,86		28,15	-4.518,72	1,00	NCV	-4.518,72
		Ethane	TJ		NA	NA		NA	NA	1,00	NCV	NA
		Naphtha	TJ		NA	298,19		48,64	-346,83	1,00	NCV	-346,83
		Bitumen	TJ		8.924,12	123,18		-245,88	9.046,82	1,00	NCV	9.046,82
		Lubricants	TJ		2.659,02	99,55	134,96	NA	2.424,50	1,00	NCV	2.424,50
		Petroleum Coke	TJ		8.179,42	488,80		-1.403,58	9.094,19	1,00	NCV	9.094,19
		Refinery Feedstocks	TJ		391,09	4.035,32		-329,94	-3.314,29	1,00	NCV	-3.314,29
		Other Oil	TJ		NA	NA		NA	NA	1,00	NCV	NA
Other Liquid Fossil												623,57
White Spirit				NA	697,13	73,56	NA	NA	623,57	1,00	NCV	623,57
Liquid Fossil Totals												310.410,74
Solid Fossil	Primary Fuels	Anthracite [2]	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
		Coking Coal	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
		Other Bituminous Coal	TJ	NA	216.242,74	2.740,99	NA	-14.750,83	228.252,57	1,00	NCV	228.252,57
		Sub-bituminous Coal	TJ	NA	NA	NA	NA	NA	NA	1,00	NCV	NA
		Lignite	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
		Oil Shale	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
		Peat	TJ	NA	NA	NA		NA	NA	1,00	NCV	NA
	Secondary Fuels	BKB [3] and Patent Fuel	TJ		6,57	6,70		NA	-0,13	1,00	NCV	-0,13
		Coke Oven/Gas Coke	TJ		1.124,53	NA		112,72	1.011,82	1,00	NCV	1.011,82
Other Solid Fossil												8.896,41
Plastic part of municipal waste				8.896,41	NA	NA	NA	NA	8.896,41	1,00	NCV	8.896,41
Solid Fossil Totals												238.160,67
Gaseous Fossil		Natural Gas (Dry)	TJ	390.346,52	NA	196.275,20		4.134,18	189.937,15	1,00	NCV	189.937,15
Other Gaseous Fossil												NA
Gaseous Fossil Totals												189.937,15
Total												738.508,56
Biomass total												104.300,45
		Solid Biomass	TJ	84.318,63	16.062,78	NA		NA	100.381,42	1,00	NCV	100.381,42
		Liquid Biomass	TJ	3.684,80	NA	3.684,80		NA	NA	1,00	NCV	NA
		Gas Biomass	TJ	3.919,04	NA	NA		NA	3.919,04	1,00	NCV	3.919,04

[1] To convert quantities in previous columns to energy units, use net calorific values (NCV) and write NCV in this column. If gross calorific values (GCV) are used, write GCV in this column.
[2] If data for Anthracite are not available separately, include with Other Bituminous Coal.
[3] BKB: Brown coal/peat briquettes.

TABLE 1.A(c) COMPARISON OF CO2 EMISSIONS FROM FUEL COMBUSTION
(Sheet 1 of 1)

Inventory 2006
Submission 2008 v1.1
DENMARK

FUEL TYPES	REFERENCE APPROACH			SECTORAL APPROACH [1]		DIFFERENCE [2]	
	Apparent energy consumption [3] (PJ)	Apparent energy consumption (excluding non-energy use and feedstocks) [4] (PJ)	CO_2 emissions (Gg)	Energy consumption (PJ)	CO_2 emissions (Gg)	Energy consumption (%)	CO_2 emissions (%)
Liquid Fuels (excluding international bunkers)	310,41	298,32	22.198,00	304,01	22.124,98	-1,87	0,33
Solid Fuels (excluding international bunkers) [5]	238,16	229,26	22.402,27	232,98	21.602,94	-1,59	3,70
Gaseous Fuels	189,94	189,94	10.655,47	191,01	10.952,35	-0,56	-2,71
Other [5]	NA,NO	NO	NA,NO	IE,NA,NO	742,72		-100,00
Total [5]	***738,51***	***717,52***	***55.255,75***	***728,00***	***55.422,99***	***-1,44***	***-0,30***

[1] "Sectoral approach" is used to indicate the approach (if different from the Reference approach) used by the Party to estimate CO_2 emissions from fuel combustion as reported in table 1.A(a), sheets 1-4.

[2] Difference in CO_2 emissions estimated by the Reference approach (RA) and the Sectoral approach (SA) (difference = 100% x ((RA-SA)/SA)). For calculating the difference in energy consumption between the two approaches, data as reported in the column "Apparent energy consumption (excluding non-energy use and feedstocks)" are used for the Reference approach.

[3] Apparent energy consumption data shown in this column are as in table 1.A(b).

[4] For the purposes of comparing apparent energy consumption from the Reference approach with energy consumption from the Sectoral approach, Parties should, in this column, subtract from the apparent energy consumption (Reference approach) the energy content corresponding to the fuel quantities used as feedstocks and/or for non-energy purposes, in accordance with the accounting of energy use in the Sectoral approach

[5] Emissions from biomass are not included.

Note: The Reporting Instructions of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories require that estimates of CO_2 emissions from fuel combustion, derived using a detailed Sectoral approach, be compared to those from the Reference approach (Worksheet 1-1 of the IPCC Guidelines, Volume 2, Workbook). This comparison is to assist in verifying the Sectoral data.

Documentation Box:

Parties should provide detailed explanations on the fuel combustion sub-sector, including information related to the comparison of CO_2 emissions calculated using the Sectoral approach with those calculated using the Reference approach, in the corresponding part of Chapter 3: Energy (CRF sub-sector 1.A) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.

If the CO_2 emission estimates from the two approaches differ by more than 2 per cent, Parties should briefly explain the cause of this difference in this documentation box and provide a reference to relevant section of the NIR where this difference is explained in more detail.

1.AC Difference - Reference and Sectoral Approach:Non-energy use of fuels is not included in the Danish National Approach. Fuel consumption for non-energy is subtracted in Reference Approach to ma
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	Other Oil	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 2A-13 Emission inventory 2006 based on SNAP sectors

Table 86 Emission inventory 2006 based on SNAP sectors.

SNAP[2)]	SO_2 [Mg]	NO_X [Mg]	NMVOC [Mg]	CH_4 [Mg]	CO [Mg]	CO_2 [1)] [Gg]	N_2O [Mg]	TSP [Mg]	PM_{10} [Mg]	$PM_{2,5}$ [Mg]	As [kg]	Cd [kg]	Cr [kg]	Cu [kg]	Hg [kg]	Ni [kg]	Pb [kg]	Se [kg]	Zn [kg]	Flouranthe [kg]	Benzo(b) [kg]	Benzo(k) [kg]	Benzo(a) [kg]	Benzo(g) [kg]	Indeno [kg]
Total 01	10250	51864	3326	11423	10251	29470	543	1073	836	701	340	234	540	672	679	2721	3450	1074	15357	227	30	15	7	18	7
010100	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010101	7672	27989	389	470	2585	21773	212	580	467	385	107	10	160	100	219	1568	169	980	375	14	2	1	1	2	1
010102	969	5134	57	43	770	840	44	78	53	43	141	107	250	352	278	482	1997	53	9902	3	1	0	0	0	0
010103	148	1406	18	42	292	262	16	27	11	9	60	40	24	86	48	40	875	1	3156	3	0	0	0	0	0
010104	321	3457	81	80	670	2557	94	60	56	47	4	1	5	5	5	24	16	25	42	20	5	1	1	2	2
010105	50	3848	2169	9911	2711	1177	28	21	6	5	5	4	2	7	6	4	91	0	267	3	1	0	0	0	0
010201	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010202	40	83	34	23	180	21	3	14	10	8	1	5	1	5	5	19	3	1	85	5	1	1	0	0	0
010203	628	1174	443	321	2437	178	47	177	125	98	14	59	77	110	117	186	284	6	1529	176	20	12	5	12	4
010204	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010205	3	211	92	447	141	48	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010304	0	299	0	0	14	132	5	12	12	12															
010306	407	1067	0	0	230	849	29	101	95	92	9	8	21	8	3	398	15	8	2	1	0	0	0	0	0
010502	0	43	1	2	11	22	0	0	0	0															
010504	9	7086	40	43	176	1609	62	3	2	1										0	0	0	0	0	0
010505	2	64	2	41	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total 02	4433	8288	19289	9409	275055	4948	254	20423	19353	18296	63	233	108	287	324	959	343	135	4685	24135	4085	2248	3873	6845	2792
020100	261	774	613	268	670	895	26	163	161	151	10	18	40	41	62	211	135	17	475	771	212	70	161	218	114
020103	1	36	2	2	8	6	1	1	1	1	1	0	0	1	3	1	1	0	66	3	0	0	0	0	0
020104	0	5	0	0	0	2	0	0	0	0										0	0	0	0	0	0
020105	10	411	107	602	246	54	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
020200	2407	5701	16952	6390	265715	3376	200	19735	18708	17697	32	199	31	224	237	146	166	102	4084	22751	3699	2153	3551	6436	2419
020202	0	1	0	0	1	1	0	0	0	0										0	0	0	0	0	0
020204	0	222	157	697	172	85	2	1	0	0										0	0	0	0	0	0
020300	1738	606	1261	454	7904	422	20	518	481	446	20	14	36	21	22	590	41	15	60	608	174	25	161	190	259
020302	6	2	0	0	1	1	0	0	0	0	0	0	1	0	0	11	0	0	0	0	0	0	0	0	0
020303	0	5	0	0	0	2	0	0	0	0										0	0	0	0	0	0
020304	10	525	197	996	338	103	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total 03																									
030100	4619	2952	301	355	1950	2605	71	249	183	126	121	132	275	144	79	5006	250	100	643	152	9	8	1	4	3
030102	1058	433	28	37	128	374	9	100	29	8	27	22	57	25	9	1037	46	20	20	23	1	1	0	1	1
030103	13	52	25	19	129	7	2	10	7	5	0	4	0	4	4	0	2	0	71	2	1	1	0	0	0
030104	1	484	7	7	29	267	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
030105	2	197	101	476	138	54	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
030106	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
030303								157	47	7	24	11	86			102	566	393	393						
030307								2	1	1		0		1			9								
030308								1	1	1									0						
030310								32	29	13															
030311	1741	8170	93	201	1475	1300	46	191	172	76	57	20	28	28	171	57	28	20	142	3514	84	4	27	3	3
030312								28	14	3															
030315	0	112	2	5	1	47	1	1	1	1	0	0	0	0	0	0	12	59	25	0	0	0	0	0	0
030316								82	74	57															
030318	468	96	10	15	8178	114	3	125	113	88	2	0	2	2	1	3	5	0	8	11	1	1	0	1	1

1) Excluding CO_2 emission from biomass
2) SNAP sector codes are shown in Appendix 2A-3

Annex 2B

Transport

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Annex 16: Fuel use and emissions in NFR format

Annex 17: Uncertainty estimates

Annex 2B Transport

Annex 2B-1: Fleet data 1985-2006 for road transport (No. vehicles)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	80570	46208	44014	42804	36466	39959	37597	37130	3434	2761	2103
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	333715	187911	161642	139010	119424	80741	67991	53302	44338	31104	22511
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	104223	86056	79240	72588	65797	49614	42976	34748	25889	17458	10806
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	345946	301692	295677	288944	280769	262502	250449	233656	215509	183239	147178
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		282011	280181	278685	278152	275859	272989	269953	275188	264791	254032
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			39608	73527	101489	139813	169133	205235	210861	208281	206803
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									38465	74495	108508
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	61592	35940	34233	33292	28362	31079	29242	28879	2671	2148	1635
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	218180	127631	109640	94188	80844	54600	45991	36078	30465	21520	15647
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	60836	55062	50674	46402	42040	31712	27445	22173	16509	11141	6870
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	210574	174545	170749	166595	161591	150612	143385	133412	122642	103931	83270
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		190297	188949	187872	187524	186044	184194	182297	186155	179510	172582
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			35647	75763	119562	201007	288096	375253	383870	378063	375137
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									95358	196046	274022
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	5923	3423	3260	3171	2701	2960	2785	2750	254	205	156
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	18532	10781	9234	7914	6781	4567	3849	3022	2619	1881	1366
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	8730	4392	4043	3702	3354	2531	2191	1770	1318	888	549
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	31066	24667	24157	23595	22912	21429	20432	19053	17571	14934	12016
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		25679	25524	25389	25338	25120	24844	24546	24977	23975	22975
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			3961	8129	12434	20068	27915	35770	36617	36081	35808
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									12432	27315	44923
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			4042	8018	11872	18305	24557	31177	31314	31730	35118

Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									7046	14640	23084
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	75828	79714	75794	72294	68535	62144	58848	55004	48251	43893	43004
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			213	437	668	1078	1499	1921	1928	1952	2161
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									655	1478	2711
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	3451	3703	3556	3425	3281	3040	2906	2747	2461	2266	2237
Passenger Cars	LPG	Conventional	0	1990	287	286	286	288	289	289	301	311	172	97	44
Passenger Cars	2-Stroke	Conventional	0	9999	4823	5417	4804	4308	3747	3029	2443	1824	1248	761	400
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	33049	42333	43215	44179	45486	47261	44601	41519	37209	34454	31489
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							4259	8524	12645	17212	16632
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											4705
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	121431	155543	158781	162324	167129	173650	163877	152553	142109	131572	122992
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998							15648	31318	48292	65727	64964
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001											18376
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	251	250	255	260	268	279	288	295	261	274	253
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	5140	5108	5214	5330	5488	5205	4891	4532	3999	3692	3079
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996						497	1004	1506	1440	1435	1269
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001									529	1087	1487
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	10350	10286	10500	10734	11052	10482	9850	9126	7800	6603	5613
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996						1001	2022	3033	2808	2566	2314
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001									1032	1945	2710
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	13115	13034	13306	13602	14005	13283	12481	11564	10720	9832	8982
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996						1268	2562	3844	3859	3821	3702
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001									1419	2896	4336
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	11517	11446	11684	11944	12298	11664	10960	10154	9337	8720	8180
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996						1114	2250	3376	3362	3389	3371
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001									1236	2568	3949
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006											
Buses	Urban Buses	Conventional	0	1993	4712	4753	4561	4522	4490	4083	3635	3261	2946	2792	2542
Buses	Urban Buses	Euro I	1994	1996						390	746	1084	1060	972	913

Buses	Urban Buses	Euro II	1997	2001									390	729	1053
Buses	Urban Buses	Euro III	2002	2006											
Buses	Coaches	Conventional	0	1993	3298	3327	2868	3007	3086	2927	4507	4156	3662	3369	3007
Buses	Coaches	Euro I	1994	1996						280	925	1381	1318	1173	1080
Buses	Coaches	Euro II	1997	2001									485	879	1246
Buses	Coaches	Euro III	2002	2006											
Mopeds	<50 cm³	Conventional	0	1999	151000	120000	118000	113000	109000	105000	114167	123333	132500	141667	150833
Mopeds	<50 cm³	Euro I	2000	2003											
Mopeds	<50 cm³	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	6209	6617	6804	6904	7111	7406	7672	8214	8980	9598	10385
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	7037	7499	7712	7824	8059	8394	8695	9310	10177	10878	11769
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	19352	20622	21207	21516	22162	23083	23911	25602	27986	29914	32365
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	8796	9374	9639	9780	10074	10492	10869	11637	12721	13597	14712
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006											

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	1744	1614	1475	1392	1313	1313	1313
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	17980	15837	14155	13149	12404	12335	12279
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	7298	5510	4178	3128	2433	2882	2869
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	118979	97964	79041	60723	45824	25489	14555
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	235890	219216	194543	171430	142490	133653	117770
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	204184	201708	197423	192152	185488	183896	185747
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	135030	132812	130153	128898	126400	133689	129230
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		21858	47428	70311	99658	126777	128423
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							31558
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	1356	1255	1147	1083	1021	1021	1021
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	12537	11077	9923	9230	8707	8852	8964
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	4642	3500	2659	1987	1545	1858	1892
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	67222	55300	44572	34238	25810	14529	8564
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	160800	149915	133745	118448	99092	86463	72814

Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	370803	367136	359959	351645	340424	286124	227403
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	326268	320971	314678	311808	305621	334798	342059
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		49700	105323	147067	195430	250309	274132
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							52995
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	129	120	109	103	97	97	97
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	1110	986	885	825	778	807	836
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	371	280	212	159	123	147	148
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	9722	8009	6459	4964	3744	2045	1103
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	21251	19699	17377	15265	12607	12107	10565
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	35388	35024	34329	33516	32431	27636	23084
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	61899	60799	59506	58896	57815	48867	39683
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		15179	30712	45080	65819	82828	77816
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							22245
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	39314	43578	48670	53462	59968	62042	63663
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	31541	34764	38842	43327	49262	61839	72606
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		5482	13338	21371	33648	49775	62020
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							13028
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	42604	42641	42100	40525	38619	38012	37146
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	2420	2683	2998	3295	3698	3647	3556
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	4232	4658	5196	5790	6592	6450	6112
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		1163	2682	4432	7505	10932	11986
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							3426
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	2228	2229	2187	2096	1978	2005	1958
Passenger Cars	LPG	Conventional	0	1990	32	63	21	15	15	15	15
Passenger Cars	2-Stroke	Conventional	0	9999	300	200	150	100	50		
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	28488	25423	21615	18838	14576	12300	9827
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	15979	15527	15049	13949	14793	14462	13766
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	9299	14017	13917	13805	14126	14061	13667
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			5140	10719	16724	23033	29145
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	115695	105397	92990	82927	66760	59477	51497
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	64894	64370	64743	61406	67753	69932	72140
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	37766	58112	59870	60771	64697	67990	71620
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006			22112	47186	76596	111375	152728
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	257	249	249	247	233	252	266
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	2406	1979	1739	1407	1069	835	628
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	1057	951	956	813	903	837	777
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	1703	1990	2064	1872	2036	1936	1852
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006			484	941	1541	2036	2547

Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	5085	4210	3136	2571	1639	1281	963
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	2235	2024	1724	1486	1384	1284	1192
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	3600	4234	3724	3421	3123	2970	2840
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006			872	1720	2364	3123	3907
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	7933	6814	5525	4571	3110	2431	1826
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	3486	3276	3037	2642	2627	2436	2262
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	5616	6853	6560	6082	5926	5634	5388
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006			1537	3058	4484	5925	7412
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	7361	6527	5486	4716	3282	2565	1927
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	3234	3138	3016	2726	2772	2570	2387
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	5211	6564	6514	6275	6253	5946	5686
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006			1526	3156	4732	6252	7822
Buses	Urban Buses	Conventional	0	1993	2319	2159	1977	1859	1711	1551	1381
Buses	Urban Buses	Euro I	1994	1996	852	792	752	713	663	643	614
Buses	Urban Buses	Euro II	1997	2001	1345	1596	1525	1447	1345	1317	1273
Buses	Urban Buses	Euro III	2002	2006			346	670	951	1275	1585
Buses	Coaches	Conventional	0	1993	2724	2444	2165	1962	1773	1542	1328
Buses	Coaches	Euro I	1994	1996	1001	896	823	752	687	639	591
Buses	Coaches	Euro II	1997	2001	1579	1807	1670	1527	1394	1309	1224
Buses	Coaches	Euro III	2002	2006			379	706	986	1267	1524
Mopeds	<50 cm³	Conventional	0	1999	143607	136249	128209	120305	112262	98369	82388
Mopeds	<50 cm³	Euro I	2000	2003	16393	28751	42791	48695	46069	45882	50386
Mopeds	<50 cm³	Euro II	2004	9999					10669	24749	36226
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	11054	11367	11582	11850	12326	13158	14241
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	11670	12487	12882	13380	14078	14943	16241
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	858	918	1348	1806	1816	2292	2766
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006					604	1187	1879
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	32093	34338	35424	36794	38714	41092	44663
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	2360	2525	3707	4967	4993	6302	7606
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006					1661	3263	5169
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	14588	15608	16102	16725	17597	18678	20301
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	1073	1148	1685	2258	2270	2865	3457
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006					755	1483	2349

Annex 2B-2: Mileage data 19852006 for road transport (km)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	12115	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	16052	13358	12280	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	18800	16553	17094	17157	16720	16142	14571	12958	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		20257	20778	21152	20734	20113	18818	17553	16474	14970	13688
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			24567	25667	25746	26068	24555	23306	22300	20949	19624
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									26232	25674	24561
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	12033	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	16045	13352	12269	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	18883	16515	17059	17121	16659	16068	14525	12940	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		20402	20935	21291	20886	20231	18942	17667	16584	15142	13875
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			24567	25726	25975	26475	25307	24084	23002	21643	20226
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									26232	25700	24547
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	12053	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	16050	13361	12285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	18834	16582	17121	17200	16793	16180	14593	12966	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		20101	20643	21047	20575	20005	18715	17452	16353	14779	13551
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			24567	25712	25924	26398	25184	23952	22880	21524	20119
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									26232	25727	24744
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			42600	42505	41806	41473	40106	38625	36268	33906	32434
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									41813	40714	39790
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	25365	28694	28549	27996	27386	26630	25416	24032	22779	21643	21021
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			42600	42529	41894	41615	40354	38857	36471	34109	32607
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									41813	40769	40104
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											

Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	26523	29795	29621	28991	28185	27216	25845	24311	22873	21537	20880
Passenger Cars	LPG	Conventional	0	1990	18832	16538	17080	17144	16698	16113	14553	12950	12050	11999	11794
Passenger Cars	2-Stroke	Conventional	0	9999	18832	16538	17080	17144	16698	16113	14553	12950	12050	11999	11794
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	20184	17544	18019	18706	18893	18937	18138	17727	17852	17884	17453
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							18138	17727	17852	17884	17453
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											17453
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	30638	33157	33484	32340	32266	34169	32777	32789	32519	31998	31226
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998							32777	32789	32519	31998	31226
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001											31226
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	38145	37941	38562	39503	37262	36784	36279	35575	32740	33082	33668
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	35978	48034	48003	45749	42629	44460	43917	44077	36397	37104	39868
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996						44460	43917	44077	36397	37104	39868
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001									36397	37104	39868
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	50129	58064	58026	55301	51529	53743	53086	53280	51043	49398	46486
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996						53743	53086	53280	51043	49398	46486
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001									51043	49398	46486
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	69684	80715	80662	76875	71632	74709	73796	74065	76469	76582	79347
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996						74709	73796	74065	76469	76582	79347
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001									76469	76582	79347
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	69684	80715	80662	76875	71632	74709	73796	74065	76469	76582	79347
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996						74709	73796	74065	76469	76582	79347
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001									76469	76582	79347
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006											
Buses	Urban Buses	Conventional	0	1993	92802	112240	117692	113847	116584	127459	126072	125955	123611	120313	118107

Buses	Urban Buses	Euro I	1994	1996						127459	126072	125955	123611	120313	118107
Buses	Urban Buses	Euro II	1997	2001									123611	120313	118107
Buses	Urban Buses	Euro III	2002	2006											
Buses	Coaches	Conventional	0	1993	58168	72330	84745	77381	79571	85908	62394	73915	74429	73035	72648
Buses	Coaches	Euro I	1994	1996						85908	62394	73915	74429	73035	72648
Buses	Coaches	Euro II	1997	2001									74429	73035	72648
Buses	Coaches	Euro III	2002	2006											
Mopeds	<50 cm³	Conventional	0	1999	2334	2182	2282	2393	2449	2510	2470	2439	2481	2498	2125
Mopeds	<50 cm³	Euro I	2000	2003											
Mopeds	<50 cm³	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	6702	6470	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	6702	6470	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	6702	6470	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	6702	6470	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006											

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	12800	11946	11628	11611	11646	11093	10706
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	18422	17417	16703	15385	14480	12894	11777
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	23828	22155	21228	20262	19167	17555	16242
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		25033	24933	25811	23998	22096	20028
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							23306
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	11677	11499	11628	11611	11646	11093	10706

Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	12961	12030	11628	11611	11646	11093	10706
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	18954	17934	17241	16099	15270	13761	12393
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	23722	22066	21099	20154	19119	17565	16249
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		25033	24924	25554	23855	21973	19956
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							23306
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	12691	11875	11628	11611	11646	11093	10706
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	18864	17845	17147	15980	15139	13657	12287
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	24087	22498	21546	20526	19375	17855	16451
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		25033	24906	25737	24025	22152	20130
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							23306
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	30423	28953	27593	25909	25090	23523	21059
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	38511	36035	34206	33003	32021	30779	28240
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		40832	40341	39594	40005	38582	34726
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							40509
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	20153	19275	18818	18984	19491	19442	18609
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	30584	29108	27750	26127	25336	23934	21357
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	39052	36697	34869	33560	32425	31292	28595
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		40832	40307	39605	40208	38823	34990
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							40509
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	20004	19172	18818	18984	19491	19442	18609
Passenger Cars	LPG	Conventional	0	1990	11677	11499	11628	11611	11646	11093	10706
Passenger Cars	2-Stroke	Conventional	0	9999	11677	11499	11628	11611	11646		
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	17611	17712	17891	17762	17528	16747	16885
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	17611	17712	17891	17762	17528	16747	16885
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	17611	17712	17891	17762	17528	16747	16885
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			17891	17762	17528	16747	16885
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	30415	29837	29971	31946	32471	32844	33098
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	30415	29837	29971	31946	32471	32844	33098
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	30415	29837	29971	31946	32471	32844	33098
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006			29971	31946	32471	32844	33098
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	34671	40373	41105	41246	41114	38707	39027
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	40778	53031	53758	59444	58769	56318	56753
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	40778	53031	53758	59444	58769	56318	56753
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	40778	53031	53758	59444	58769	56318	56753

Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006			53758	59444	58769	56318	56753
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	44710	25187	21988	24031	24839	23803	23987
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	44710	25187	21988	24031	24839	23803	23987
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	44710	25187	21988	24031	24839	23803	23987
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006			21988	24031	24839	23803	23987
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006			82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	76314	82078	82204	87358	91024	87227	87902
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006			82204	87358	91024	87227	87902
Buses	Urban Buses	Conventional	0	1993	115754	111490	111156	118551	120341	116974	117879
Buses	Urban Buses	Euro I	1994	1996	115754	111490	111156	118551	120341	116974	117879
Buses	Urban Buses	Euro II	1997	2001	115754	111490	111156	118551	120341	116974	117879
Buses	Urban Buses	Euro III	2002	2006			111156	118551	120341	116974	117879
Buses	Coaches	Conventional	0	1993	70600	70379	72342	77550	83860	81513	82144
Buses	Coaches	Euro I	1994	1996	70600	70379	72342	77550	83860	81513	82144
Buses	Coaches	Euro II	1997	2001	70600	70379	72342	77550	83860	81513	82144
Buses	Coaches	Euro III	2002	2006			72342	77550	83860	81513	82144
Mopeds	<50 cm³	Conventional	0	1999	1919	1526	1550	1547	1529	1460	1472
Mopeds	<50 cm³	Euro I	2000	2003	1919	1526	1550	1547	1529	1460	1472
Mopeds	<50 cm³	Euro II	2004	9999					1529	1460	1472
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006					7387	7089	7148
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006					7387	7089	7148
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	7170	7229	7387	7428	7387	7089	7148
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006					7387	7089	7148

Annex 2B-3: EU directive emission limits for road transportation vehicles

Private cars and light duty vehicles I (<1305 kg)

g/km		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	2.72	2.2	2.3	1.0	1.0	1.0
	Diesel	2.72	1.0	0.64	0.5	0.5	0.5
HC	Gasoline	-	-	0.20	0.10	0.1	0.1
NMHC	Gasoline	-	-	-	-	0.068	0.068
NO_x	Gasoline	-	-	0.15	0.08	0.06	0.06
	Diesel	-	-	0.5	0.25	0.18	0.08
$HC+NO_x$	Gasoline	0.97	0.5	-	-		-
	Diesel	0.97	0.7/0.9[2)]	0.56	0.30	0.23	0.17
Particulates	Diesel	0.14	0.08/0.10[2)]	0.05	0.025	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	15	15	15
HC	Gasoline	-	-	-	1.8	1.8	1.8
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2)] Less stringent emission limits for direct injection diesel engines

[3)] Unit: g/test

Light duty vehicles II (1305-1760 kg)

g/km		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	5.17	4.0	4.17	1.81	1.81	1.81
	Diesel	5.17	1.25	0.80	0.63	0.63	0.63
HC	Gasoline	-	-	0.25	0.13	0.13	0.13
NMHC	Gasoline	-	-	-	-	0.9	0.9
NO_x	Gasoline	-	-	0.18	0.10	0.75	0.75
	Diesel	-	-	0.65	0.33	0.235	0.105
$HC+NO_x$	Gasoline	1.4	0.6	-	-	-	-
	Diesel	1.4	1.0/1.3[2)]	0.72	0.39	0.295	0.195
Particulates	Gasoline					0.005	0.005
	Diesel	0.19	0.12/0.14[2)]	0.07	0.04	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	24	24	24
HC	Gasoline	-	-		2.7	2.7	2.7
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2)] Less stringent emission limits for direct injection diesel engines

[3)] Unit: g/test

Light duty vehicles III (>1760 kg)

g/km		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	6.9	5.0	5.22	2.27	2.27	2.27
	Diesel	6.9	1.5	0.95	0.74	0.74	0.74
HC	Gasoline	-	-	0.29	0.16	0.16	0.16
NMHC	Gasoline					0.108	0.108
NO_x	Gasoline	-	-	0.21	0.11	0.082	0.082
	Diesel	-	-	0.78	0.39	0.28	0.125
$HC+NO_x$	Gasoline	1.7	0.7	-	-	-	-
	Diesel	1.7	1.2/1.6[2)]	0.86	0.46	0.35	0.215
Particulates	Gasoline					0.005	0.005
	Diesel	0.25	0.17/0.20[2)]	0.10	0.06	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	30	30	30
HC	Gasoline	-	-	-	3.2	3.2	3.2
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2)] Less stringent emission limits for direct injection diesel engines

[3)] Unit: g/test

Heavy duty diesel vehicles

(g/kWh)		EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EEV[2)]
	Test[1)]	1993	1996	2001	2006	2009	2000
CO	ECE/ESC	4.5	4.0	2.1	1.5	1.5	1.5
	ETC	-	-	(5.45)	4.0	4.0	3.0
HC	ECE/ESC	1.1	1.1	0.66	0.46	0.46	0.25
	ETC	-	-	(0.78)	0.55	0.55	0.40
NO_x	ECE/ESC	8.0	7.0	5.0	3.5	2.0	2.0
	ETC	-	-	(5.0)	3.5	2.0	2.0
Particulates[3)]	ECE/ESC	0.36/0.61	0.15/0.25	0.10/0.13	0.02	0.02	0.02
	ETC	-	-	(0.16/0.21)	0.03	0.03	0.02
	ELR	-	-	0.8	0.5	0.5	0.15

[1)] Test procedure: Euro 1 og Euro 2: ECE (stationary)

Euro 3: ESC (stationary) + ELR (load response)

Euro 4, Euro 5 og EEV: ESC (stationary) + ETC (transient) + ELR (load response)

[2)] EEV: Emission limits for extra environmental friendly vehicles, used as a basis for economical incitaments (gas fueled vehicles).

[3)] For Euro 1, Euro 2 og Euro 3 less stringent emission limits apply for small engines:

Euro 1: <85 kW

Euro 2: <0,7 l

Euro 3: <0,75 l

Annex 2B-4: Basis emission factors (g/km)

Sector	Subsector	Tech 2	FCu	FCr	FCh	COu	COr	COh	PMu	PMr	PMh	NO_xu	NO_xr	NO_xh
Passenger Cars	Gasoline <1,4 l	PRE ECE	67,499	55,000	62,743	27,505	19,333	15,520	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	58,240	44,460	48,600	18,966	14,480	18,620	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/02	53,248	45,170	51,200	15,859	8,200	8,260	0,063	0,044	0,041	1,619	2,102	2,909
Passenger Cars	Gasoline <1,4 l	ECE 15/03	53,248	45,170	51,200	16,752	8,793	7,620	0,042	0,029	0,029	1,680	2,253	3,276
Passenger Cars	Gasoline <1,4 l	ECE 15/04	51,420	43,440	47,700	9,087	4,956	4,292	0,030	0,020	0,020	1,691	2,089	2,662
Passenger Cars	Gasoline <1,4 l	Euro I	47,399	41,954	46,055	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline <1,4 l	Euro II	46,486	39,509	44,016	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline <1,4 l	Euro III	48,687	42,255	45,323	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline <1,4 l	Euro IV	50,038	44,193	48,285	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	79,277	67,000	76,386	27,505	19,333	15,520	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	67,779	51,090	60,300	18,966	14,480	18,620	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	61,731	50,686	59,680	15,859	8,200	8,260	0,063	0,044	0,041	1,831	2,377	3,283
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	61,731	50,686	59,680	16,752	8,793	7,620	0,042	0,029	0,029	1,917	2,580	3,472
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	61,652	49,112	52,052	9,087	4,956	4,292	0,030	0,020	0,020	2,122	2,757	3,524
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	57,521	48,522	51,518	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	56,324	47,687	48,786	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	58,259	49,897	53,092	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	60,486	52,793	55,293	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline >2,0 l	PRE ECE	96,536	80,000	88,267	27,505	19,333	15,520	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	73,798	57,090	66,300	18,966	14,480	18,620	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/02	75,270	63,260	70,700	15,859	8,200	8,260	0,063	0,044	0,041	2,066	2,675	3,680
Passenger Cars	Gasoline >2,0 l	ECE 15/03	75,270	63,260	70,700	16,752	8,793	7,620	0,042	0,029	0,029	2,806	3,441	4,604
Passenger Cars	Gasoline >2,0 l	ECE 15/04	71,055	58,080	69,900	9,087	4,956	4,292	0,030	0,020	0,020	2,293	2,750	3,687
Passenger Cars	Gasoline >2,0 l	Euro I	74,616	61,902	65,020	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline >2,0 l	Euro II	76,837	65,226	66,732	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline >2,0 l	Euro III	70,798	57,424	56,826	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline >2,0 l	Euro IV	86,099	67,877	65,859	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Diesel <2,0 l	Euro I	47,836	42,807	48,388	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663
Passenger Cars	Diesel <2,0 l	Euro II	50,442	44,117	48,779	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel <2,0 l	Euro III	48,920	43,427	45,585	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel <2,0 l	Euro IV	48,920	43,427	45,585	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	Diesel <2,0 l	Conventional	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,520	0,433	0,528
Passenger Cars	Diesel >2,0 l	Euro I	65,267	58,299	64,360	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663

Passenger Cars	Diesel >2,0 l	Euro II	65,267	58,299	64,360	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel >2,0 l	Euro III	65,267	58,299	64,360	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel >2,0 l	Euro IV	65,267	58,299	64,360	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	Diesel >2,0 l	Conventional	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,824	0,723	0,861
Passenger Cars	LPG	Conventional	59,000	45,000	54,000	2,043	2,373	9,723	0,040	0,030	0,025	2,203	2,584	2,861
Light Duty Vehicles	Gasoline <3,5t	Conventional	82,270	59,883	56,470	14,925	6,075	7,389	0,040	0,040	0,040	2,671	3,118	3,387
Light Duty Vehicles	Gasoline <3,5t	Euro I	96,450	70,388	66,450	4,187	0,862	1,087	0,003	0,002	0,002	0,427	0,400	0,429
Light Duty Vehicles	Gasoline <3,5t	Euro II	96,450	70,388	66,450	2,554	0,526	0,663	0,003	0,002	0,002	0,145	0,136	0,146
Light Duty Vehicles	Gasoline <3,5t	Euro III	96,450	70,388	66,450	2,177	0,448	0,565	0,001	0,001	0,001	0,090	0,084	0,090
Light Duty Vehicles	Diesel <3,5 t	Conventional	76,718	65,934	72,142	1,124	1,009	1,060	0,285	0,303	0,322	1,673	0,843	0,834
Light Duty Vehicles	Diesel <3,5 t	Euro I	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5 t	Euro II	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5 t	Euro III	68,860	58,185	63,660	0,322	0,269	0,347	0,047	0,044	0,061	0,740	0,634	0,664
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	225,000	150,000	165,000	70,000	55,000	55,000	0,400	0,400	0,400	4,500	7,500	7,500
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	95,822	87,060	109,160	1,612	1,216	1,267	0,288	0,220	0,231	3,363	3,435	4,412
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	77,226	74,990	96,471	0,533	0,417	0,496	0,111	0,085	0,090	2,343	2,497	3,204
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	72,861	72,179	93,536	0,441	0,364	0,416	0,047	0,043	0,053	2,498	2,575	3,216
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	77,798	76,111	97,038	0,528	0,372	0,375	0,051	0,037	0,037	1,955	1,896	2,330
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	186,796	147,006	169,108	2,513	1,722	1,825	0,396	0,272	0,287	8,575	7,259	8,446
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	157,382	126,707	149,418	1,190	0,822	0,874	0,235	0,160	0,170	5,118	4,333	5,002
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	151,150	122,421	145,510	0,969	0,726	0,808	0,099	0,078	0,100	5,465	4,544	5,171
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	158,817	127,460	150,203	1,163	0,780	0,821	0,104	0,071	0,076	4,431	3,535	3,915
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	295,313	227,040	230,740	2,803	1,927	1,895	0,549	0,384	0,376	12,512	10,087	10,251
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	255,466	198,864	203,490	1,975	1,387	1,365	0,389	0,264	0,255	8,507	6,835	6,905
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	245,791	192,865	197,773	1,588	1,198	1,230	0,168	0,124	0,155	8,916	7,118	7,115
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	255,628	198,692	202,461	1,886	1,298	1,279	0,168	0,114	0,111	7,153	5,549	5,512
Heavy Duty Vehicles	Diesel >32t	Conventional	392,838	311,460	297,380	3,143	2,293	2,190	0,683	0,506	0,478	16,482	13,628	12,693
Heavy Duty Vehicles	Diesel >32t	Euro I	346,235	276,687	264,125	2,662	2,009	1,913	0,524	0,373	0,347	11,621	9,581	8,935
Heavy Duty Vehicles	Diesel >32t	Euro II	336,196	270,809	257,607	2,161	1,731	1,720	0,237	0,175	0,223	12,060	9,895	9,161
Heavy Duty Vehicles	Diesel >32t	Euro III	346,156	276,262	262,095	2,497	1,841	1,759	0,219	0,155	0,143	9,625	7,809	7,238
Buses	Urban Buses	Conventional	315,796	253,287	219,035	4,741	3,178	2,375	0,751	0,498	0,374	14,511	12,324	10,937
Buses	Urban Buses	Euro I	268,961	219,461	190,892	2,274	1,532	1,059	0,407	0,290	0,211	8,836	7,474	6,391
Buses	Urban Buses	Euro II	259,715	216,150	190,405	2,004	1,359	0,914	0,187	0,141	0,118	9,441	7,809	6,730
Buses	Urban Buses	Euro III	273,102	224,893	195,747	2,218	1,456	0,988	0,176	0,127	0,101	7,997	6,112	4,916
Buses	Coaches	Conventional	281,771	214,600	198,320	2,640	1,684	1,409	0,538	0,364	0,312	10,938	8,865	8,559
Buses	Coaches	Euro I	259,336	198,133	182,616	2,140	1,405	1,179	0,425	0,277	0,227	8,372	6,741	6,409
Buses	Coaches	Euro II	258,542	198,791	182,581	1,787	1,213	1,071	0,183	0,134	0,119	9,357	7,401	6,978

Buses	Coaches	Euro III	276,957	213,400	197,945	2,202	1,453	1,231	0,202	0,140	0,117	8,039	6,015	5,526
Mopeds	<50 cm³	Conventional	25,000	25,000	0,000	13,800	13,800	0,000	0,188	0,188	0,000	0,020	0,020	0,000
Mopeds	<50 cm³	Euro I	15,000	15,000	0,000	5,600	5,600	0,000	0,076	0,076	0,000	0,020	0,020	0,000
Mopeds	<50 cm³	Euro II	12,080	12,080	0,000	1,300	1,300	0,000	0,038	0,038	0,000	0,260	0,260	0,000
Motorcycles	2-stroke >50 cm³	Conventional	30,368	32,375	36,950	23,380	25,490	27,500	0,200	0,200	0,200	0,032	0,088	0,133
Motorcycles	4-stroke <250 cm³	Conventional	23,340	26,690	35,600	22,380	26,300	38,600	0,020	0,020	0,020	0,130	0,242	0,362
Motorcycles	4-stroke <250 cm³	Euro I	22,060	29,470	52,000	12,901	14,597	15,450	0,020	0,020	0,020	0,245	0,416	0,725
Motorcycles	4-stroke <250 cm³	Euro II	22,060	29,470	52,000	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531
Motorcycles	4-stroke 250 - 750 cm³	Conventional	28,580	28,640	34,700	20,440	21,517	25,810	0,020	0,020	0,020	0,136	0,251	0,374
Motorcycles	4-stroke 250 - 750 cm³	Euro I	28,964	29,336	41,300	9,538	13,315	19,810	0,020	0,020	0,020	0,292	0,477	0,757
Motorcycles	4-stroke 250 - 750 cm³	Euro II	28,964	29,336	41,300	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531
Motorcycles	4-stroke >750 cm³	Conventional	37,520	34,340	38,600	14,880	18,030	24,300	0,020	0,020	0,020	0,148	0,266	0,392
Motorcycles	4-stroke >750 cm³	Euro I	44,952	36,378	40,800	7,884	6,831	10,800	0,020	0,020	0,020	0,210	0,522	1,092
Motorcycles	4-stroke >750 cm³	Euro II	44,952	36,378	40,800	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531

Sector	Subsector	Tech 2	CH_4u	CH_4r	CH_4h	N_2Ou	N_2Or	N_2Oh	NH_3u	NH_3r	NH_3h	VOCu	VOCr	VOCh
Passenger Cars	Gasoline <1,4 l	PRE ECE	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline <1,4 l	ECE 15/02	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/03	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/04	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline <1,4 l	Euro I	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline <1,4 l	Euro II	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline <1,4 l	Euro III	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,029	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline <1,4 l	Euro IV	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,029	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline >2,0 l	PRE ECE	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121

Passenger Cars	Gasoline >2,0 l	ECE 15/02	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/03	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/04	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline >2,0 l	Euro I	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline >2,0 l	Euro II	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline >2,0 l	Euro III	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,029	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline >2,0 l	Euro IV	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Diesel <2,0 l	Euro I	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,053	0,031	0,026
Passenger Cars	Diesel <2,0 l	Euro II	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,034	0,021	0,015
Passenger Cars	Diesel <2,0 l	Euro III	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,018	0,011	0,009
Passenger Cars	Diesel <2,0 l	Euro IV	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel <2,0 l	Conventional	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	Diesel >2,0 l	Euro I	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,080	0,046	0,034
Passenger Cars	Diesel >2,0 l	Euro II	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,098	0,058	0,038
Passenger Cars	Diesel >2,0 l	Euro III	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel >2,0 l	Euro IV	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,011	0,006	0,006
Passenger Cars	Diesel >2,0 l	Conventional	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	LPG	Conventional	0,080	0,035	0,025	0,000	0,000	0,000	0,000	0,000	0,000	1,082	0,667	0,490
Light Duty Vehicles	Gasoline <3,5t	Conventional	0,150	0,040	0,025	0,010	0,007	0,007	0,002	0,002	0,002	1,877	0,729	0,446
Light Duty Vehicles	Gasoline <3,5t	Euro I	0,026	0,016	0,014	0,034	0,020	0,010	0,070	0,132	0,074	0,220	0,109	0,078
Light Duty Vehicles	Gasoline <3,5t	Euro II	0,017	0,013	0,011	0,023	0,013	0,008	0,163	0,149	0,084	0,053	0,026	0,019
Light Duty Vehicles	Gasoline <3,5t	Euro III	0,003	0,002	0,004	0,007	0,001	0,001	0,002	0,030	0,065	0,031	0,015	0,011
Light Duty Vehicles	Diesel <3,5 t	Conventional	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5 t	Euro I	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5 t	Euro II	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5 t	Euro III	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,081	0,065	0,063
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0,140	0,110	0,070	0,006	0,006	0,006	0,002	0,002	0,002	7,000	5,500	3,500
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,432	0,865	0,648
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,285	0,185	0,154
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,184	0,118	0,096
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,166	0,105	0,082
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,317	0,833	0,680
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,551	0,364	0,308
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,355	0,231	0,193
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,315	0,204	0,173
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,094	0,690	0,561
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,768	0,503	0,419

Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,492	0,319	0,261
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,436	0,281	0,234
Heavy Duty Vehicles	Diesel >32t	Conventional	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,958	0,593	0,482
Heavy Duty Vehicles	Diesel >32t	Euro I	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,889	0,574	0,473
Heavy Duty Vehicles	Diesel >32t	Euro II	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,564	0,363	0,290
Heavy Duty Vehicles	Diesel >32t	Euro III	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,493	0,315	0,260
Buses	Urban Buses	Conventional	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,830	1,116	0,865
Buses	Urban Buses	Euro I	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,754	0,488	0,395
Buses	Urban Buses	Euro II	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,491	0,318	0,262
Buses	Urban Buses	Euro III	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,437	0,283	0,231
Buses	Coaches	Conventional	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,008	0,577	0,422
Buses	Coaches	Euro I	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,936	0,563	0,441
Buses	Coaches	Euro II	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,623	0,380	0,290
Buses	Coaches	Euro III	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,575	0,354	0,289
Mopeds	<50 cm³	Conventional	0,219	0,219	0,000	0,001	0,001	0,001	0,001	0,001	0,001	13,910	13,910	0,000
Mopeds	<50 cm³	Euro I	0,044	0,044	0,000	0,001	0,001	0,001	0,001	0,001	0,001	2,730	2,730	0,000
Mopeds	<50 cm³	Euro II	0,024	0,024	0,000	0,001	0,001	0,001	0,001	0,001	0,001	1,560	1,560	0,000
Motorcycles	2-stroke >50 cm³	Conventional	0,150	0,150	0,150	0,002	0,002	0,002	0,002	0,002	0,002	9,340	8,402	8,360
Motorcycles	4-stroke <250 cm³	Conventional	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	1,550	0,960	1,320
Motorcycles	4-stroke <250 cm³	Euro I	0,142	0,144	0,132	0,002	0,002	0,002	0,002	0,002	0,002	1,103	0,870	0,870
Motorcycles	4-stroke <250 cm³	Euro II	0,136	0,092	0,092	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	1,350	0,944	1,010
Motorcycles	4-stroke 250 - 750 cm³	Euro I	0,148	0,174	0,156	0,002	0,002	0,002	0,002	0,002	0,002	1,002	0,753	0,790
Motorcycles	4-stroke 250 - 750 cm³	Euro II	0,156	0,120	0,122	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612
Motorcycles	4-stroke >750 cm³	Conventional	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	2,520	1,610	1,190
Motorcycles	4-stroke >750 cm³	Euro I	0,092	0,092	0,154	0,002	0,002	0,002	0,002	0,002	0,002	1,170	0,742	0,920
Motorcycles	4-stroke >750 cm³	Euro II	0,084	0,062	0,102	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612

Annex 2B-5: Reduction factors for road transport emission factors

Sector	Subsector	Tech 2	FCuR	FCrR	FChR	COuR	COrR	COhR	PMuR	PMrR	PMhR	NOxuR	NOxrR	NOxhR	VOCuR	VOCrR	VOChR
Passenger Cars	Gasoline <1,4 l	PRE ECE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	ECE 15/02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	ECE 15/03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	ECE 15/04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline <1,4 l	Euro II	1.9	5.8	4.4	62.6	58.1	57.5	0.0	0.0	0.0	43.6	45.2	60.4	60.2	61.3	62.1
Passenger Cars	Gasoline <1,4 l	Euro III	-2.7	-0.7	1.6	70.6	49.6	34.9	60.2	54.6	37.4	72.2	78.5	88.7	91.7	87.5	77.0
Passenger Cars	Gasoline <1,4 l	Euro IV	-5.6	-5.3	-4.8	89.0	79.1	70.1	60.2	54.6	37.4	80.1	89.2	95.9	93.3	88.7	84.5
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	2.1	1.7	5.3	62.6	58.1	57.5	0.0	0.0	0.0	43.6	45.2	60.4	60.2	61.3	62.1
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	-1.3	-2.8	-3.1	70.6	49.6	34.9	60.2	54.6	37.4	72.2	78.5	88.7	91.7	87.5	77.0
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	-5.2	-8.8	-7.3	89.0	79.1	70.1	60.2	54.6	37.4	80.1	89.2	95.9	93.3	88.7	84.5
Passenger Cars	Gasoline >2,0 l	PRE ECE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	ECE 15/02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	ECE 15/03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	ECE 15/04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Gasoline >2,0 l	Euro II	-3.0	-5.4	-2.6	62.6	58.1	57.5	0.0	0.0	0.0	43.6	45.2	60.4	60.2	61.3	62.1
Passenger Cars	Gasoline >2,0 l	Euro III	5.1	7.2	12.6	70.6	49.6	34.9	60.2	54.6	37.4	72.2	78.5	88.7	91.7	87.5	77.0
Passenger Cars	Gasoline >2,0 l	Euro IV	-15.4	-9.7	-1.3	89.0	79.1	70.1	60.2	54.6	37.4	80.1	89.2	95.9	93.3	88.7	84.5
Passenger Cars	Diesel <2,0 l	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Diesel <2,0 l	Euro II	-5.4	-3.1	-0.8	18.1	48.8	83.0	17.9	36.9	53.2	-7.9	1.2	-0.2	34.8	33.4	41.6
Passenger Cars	Diesel <2,0 l	Euro III	-2.3	-1.4	5.8	76.4	81.1	94.3	48.5	51.9	58.3	-18.7	-18.5	-13.0	65.9	63.3	66.2
Passenger Cars	Diesel <2,0 l	Euro IV	-2.3	-1.4	5.8	80.1	84.2	89.7	49.0	60.6	75.8	10.6	24.5	13.2	27.6	44.3	51.9
Passenger Cars	Diesel <2,0 l	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	Diesel >2,0 l	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Passenger Cars	Diesel >2,0 l	Euro II	0.0	0.0	0.0	18.1	48.8	83.0	17.9	36.9	53.2	-7.9	1.2	-0.2	-22.1	-25.4	-11.5
Passenger Cars	Diesel >2,0 l	Euro III	0.0	0.0	0.0	76.4	81.1	94.3	48.5	51.9	58.3	-18.7	-18.5	-13.0	52.2	62.7	63.9
Passenger Cars	Diesel >2,0 l	Euro IV	0.0	0.0	0.0	80.1	84.2	89.7	49.0	60.6	75.8	10.6	24.5	13.2	86.4	86.1	83.2
Passenger Cars	Diesel >2,0 l	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Cars	LPG	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Gasoline <3,5t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Gasoline <3,5t	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Gasoline <3,5t	Euro II	0.0	0.0	0.0	39.0	39.0	39.0	0.0	0.0	0.0	66.0	66.0	66.0	76.0	76.0	76.0
Light Duty Vehicles	Gasoline <3,5t	Euro III	0.0	0.0	0.0	48.0	48.0	48.0	60.2	54.6	37.4	79.0	79.0	79.0	86.0	86.0	86.0
Light Duty Vehicles	Diesel <3,5 t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Diesel <3,5 t	Euro I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Diesel <3,5 t	Euro II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Light Duty Vehicles	Diesel <3,5 t	Euro III	0.0	0.0	0.0	18.0	18.0	18.0	33.0	33.0	33.0	35.0	35.0	35.0	38.0	38.0	38.0
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	19.4	13.9	11.6	67.0	65.7	60.8	61.5	61.4	61.1	30.3	27.3	27.4	80.1	78.6	76.2
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	24.0	17.1	14.3	72.6	70.1	67.1	83.6	80.5	77.2	25.7	25.0	27.1	87.2	86.4	85.1
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	18.8	12.6	11.1	67.3	69.4	70.4	82.2	83.1	84.0	41.9	44.8	47.2	88.4	87.8	87.3
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	15.7	13.8	11.6	52.6	52.2	52.1	40.7	40.9	40.8	40.3	40.3	40.8	58.2	56.3	54.7
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	19.1	16.7	14.0	61.4	57.8	55.7	75.0	71.3	65.3	36.3	37.4	38.8	73.1	72.3	71.6
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	15.0	13.3	11.2	53.7	54.7	55.0	73.7	73.7	73.6	48.3	51.3	53.6	76.1	75.5	74.6
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	13.5	12.4	11.8	29.5	28.0	28.0	29.2	31.4	32.1	32.0	32.2	32.6	29.8	27.2	25.4
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	16.8	15.1	14.3	43.4	37.9	35.1	69.4	67.6	58.9	28.7	29.4	30.6	55.0	53.7	53.6
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	13.4	12.5	12.3	32.7	32.7	32.5	69.4	70.2	70.5	42.8	45.0	46.2	60.2	59.2	58.3
Heavy Duty Vehicles	Diesel >32t	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Duty Vehicles	Diesel >32t	Euro I	11.9	11.2	11.2	15.3	12.4	12.6	23.2	26.4	27.5	29.5	29.7	29.6	7.3	3.2	2.0
Heavy Duty Vehicles	Diesel >32t	Euro II	14.4	13.1	13.4	31.3	24.5	21.4	65.2	65.4	53.4	26.8	27.4	27.8	41.2	38.8	40.0
Heavy Duty Vehicles	Diesel >32t	Euro III	11.9	11.3	11.9	20.6	19.7	19.7	68.0	69.4	70.0	41.6	42.7	43.0	48.6	46.9	46.2
Buses	Urban Buses	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	Urban Buses	Euro I	14.8	13.4	12.8	52.0	51.8	55.4	45.7	41.8	43.7	39.1	39.4	41.6	58.8	56.3	54.4
Buses	Urban Buses	Euro II	17.8	14.7	13.1	57.7	57.2	61.5	75.0	71.7	68.5	34.9	36.6	38.5	73.2	71.5	69.7
Buses	Urban Buses	Euro III	13.5	11.2	10.6	53.2	54.2	58.4	76.6	74.5	72.9	44.9	50.4	55.1	76.1	74.6	73.3
Buses	Coaches	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	Coaches	Euro I	8.0	7.7	7.9	18.9	16.5	16.3	20.9	23.8	27.1	23.5	24.0	25.1	7.2	2.5	-4.4
Buses	Coaches	Euro II	8.2	7.4	7.9	32.3	28.0	24.0	66.0	63.1	61.7	14.5	16.5	18.5	38.2	34.1	31.3

Buses	Coaches	Euro III	1.7	0.6	0.2	16.6	13.7	12.6	62.3	61.6	62.4	26.5	32.1	35.4	43.0	38.7	31.7
Mopeds	<50 cm³	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mopeds	<50 cm³	Euro I	40.0	40.0	0.0	59.4	59.4	0.0	59.8	59.8	0.0	0.0	0.0	0.0	80.4	80.4	0.0
Mopeds	<50 cm³	Euro II	51.7	51.7	0.0	90.6	90.6	0.0	80.0	80.0	0.0	-1200.0	-1200.0	0.0	88.8	88.8	0.0
Motorcycles	2-stroke >50 cm³	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motorcycles	4-stroke <250 cm³	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motorcycles	4-stroke <250 cm³	Euro I	5.5	-10.4	-46.1	42.4	44.5	60.0	0.0	0.0	0.0	-88.7	-72.0	-100.3	28.9	9.4	34.1
Motorcycles	4-stroke <250 cm³	Euro II	5.5	-10.4	-46.1	71.1	77.4	75.9	75.0	75.0	75.0	-50.0	-9.5	-46.7	32.1	42.0	53.6
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motorcycles	4-stroke 250 - 750 cm³	Euro I	-1.3	-2.4	-19.0	53.3	38.1	23.2	0.0	0.0	0.0	-114.6	-90.2	-102.4	25.7	20.2	21.8
Motorcycles	4-stroke 250 - 750 cm³	Euro II	-1.3	-2.4	-19.0	68.3	72.4	63.9	75.0	75.0	75.0	-43.4	-5.6	-42.0	22.0	41.0	39.4
Motorcycles	4-stroke >750 cm³	Conventional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motorcycles	4-stroke >750 cm³	Euro I	-19.8	-5.9	-5.7	47.0	62.1	55.6	0.0	0.0	0.0	-41.9	-96.4	-178.6	53.6	53.9	22.7
Motorcycles	4-stroke >750 cm³	Euro II	-19.8	-5.9	-5.7	56.5	67.0	61.7	75.0	75.0	75.0	-31.8	0.4	-35.5	58.2	65.4	48.6

Annex 2B-6: Fuel use factors (MJ/km) and emission factors (g/km)

Sector	Year	FCu (MJ)	FCr (MJ)	FCh (MJ)	CO_2u	CO_2r	CO_2h	CH_4u	CH_4r	CH_4h	N_2Ou	N_2Or	N_2Oh	SO_2u	SO_2r	SO_2h	NO_Xu	NO_Xr	NO_Xh
Passenger Cars	1985	3.883	2.059	1.651	284	150	121	0.172	0.027	0.017	0.011	0.006	0.004	0.075	0.038	0.032	2.245	2.170	1.942
Passenger Cars	1986	3.844	2.049	1.638	281	150	120	0.171	0.027	0.017	0.011	0.006	0.004	0.049	0.025	0.021	2.236	2.169	1.949
Passenger Cars	1987	3.829	2.038	1.623	280	149	119	0.171	0.027	0.017	0.011	0.006	0.004	0.051	0.026	0.022	2.234	2.162	1.943
Passenger Cars	1988	3.742	2.026	1.606	273	148	117	0.169	0.027	0.017	0.011	0.006	0.004	0.051	0.026	0.022	2.206	2.152	1.937
Passenger Cars	1989	3.707	2.020	1.598	271	148	117	0.168	0.027	0.017	0.011	0.006	0.004	0.037	0.019	0.016	2.194	2.148	1.940
Passenger Cars	1990	3.691	2.018	1.593	270	147	116	0.168	0.027	0.017	0.011	0.006	0.004	0.036	0.019	0.015	2.200	2.159	1.954
Passenger Cars	1991	3.624	2.059	1.584	265	150	116	0.158	0.027	0.016	0.011	0.006	0.004	0.034	0.018	0.015	2.050	2.070	1.838
Passenger Cars	1992	3.440	2.057	1.819	251	150	133	0.145	0.026	0.018	0.012	0.006	0.005	0.023	0.013	0.012	1.856	1.942	1.996
Passenger Cars	1993	3.452	2.054	1.811	252	150	132	0.138	0.025	0.018	0.012	0.006	0.004	0.013	0.008	0.007	1.781	1.825	1.884
Passenger Cars	1994	3.339	2.101	1.802	244	154	132	0.122	0.024	0.017	0.013	0.007	0.004	0.012	0.008	0.007	1.595	1.667	1.697
Passenger Cars	1995	3.198	2.103	2.035	234	154	149	0.109	0.023	0.018	0.013	0.007	0.005	0.012	0.008	0.008	1.427	1.514	1.757
Passenger Cars	1996	3.151	2.059	2.265	230	150	166	0.099	0.022	0.019	0.013	0.007	0.005	0.012	0.008	0.009	1.315	1.341	1.790
Passenger Cars	1997	3.079	2.045	2.232	225	149	163	0.088	0.020	0.018	0.013	0.007	0.005	0.011	0.008	0.009	1.189	1.174	1.584
Passenger Cars	1998	3.076	2.048	2.220	225	150	162	0.080	0.019	0.017	0.013	0.007	0.005	0.011	0.008	0.009	1.089	1.031	1.398
Passenger Cars	1999	3.057	2.049	2.212	223	150	162	0.073	0.018	0.016	0.013	0.006	0.004	0.009	0.006	0.007	1.006	0.915	1.241
Passenger Cars	2000	3.043	2.052	2.208	222	150	161	0.067	0.017	0.015	0.013	0.006	0.004	0.007	0.005	0.005	0.947	0.831	1.127
Passenger Cars	2001	3.072	2.056	2.209	225	150	161	0.062	0.016	0.014	0.012	0.006	0.004	0.007	0.005	0.005	0.900	0.768	1.037
Passenger Cars	2002	3.044	2.060	2.209	223	151	162	0.056	0.014	0.012	0.012	0.006	0.004	0.007	0.005	0.005	0.836	0.697	0.936
Passenger Cars	2003	3.056	2.064	2.209	223	151	162	0.051	0.013	0.011	0.011	0.005	0.003	0.007	0.005	0.005	0.783	0.635	0.846
Passenger Cars	2004	3.009	2.066	2.208	220	151	162	0.045	0.012	0.010	0.010	0.005	0.003	0.007	0.005	0.005	0.725	0.576	0.759
Passenger Cars	2005	3.026	2.059	2.198	221	151	161	0.041	0.010	0.009	0.009	0.004	0.003	0.001	0.001	0.001	0.677	0.520	0.674
Passenger Cars	2006	3.011	2.066	2.200	220	151	161	0.036	0.009	0.008	0.009	0.004	0.003	0.001	0.001	0.001	0.616	0.463	0.592
Light Duty Vehicles	1985	4.614	2.619	2.391	341	193	177	0.056	0.015	0.008	0.002	0.001	0.001	0.895	0.526	0.490	2.387	1.117	0.978
Light Duty Vehicles	1986	4.590	2.621	2.396	339	194	177	0.054	0.015	0.008	0.002	0.001	0.001	0.543	0.320	0.298	2.364	1.093	0.954
Light Duty Vehicles	1987	4.599	2.621	2.397	340	194	177	0.054	0.015	0.008	0.002	0.001	0.001	0.545	0.321	0.299	2.370	1.091	0.952
Light Duty Vehicles	1988	4.540	2.621	2.397	335	194	177	0.054	0.015	0.008	0.002	0.001	0.001	0.539	0.321	0.299	2.332	1.087	0.949
Light Duty Vehicles	1989	4.514	2.623	2.401	333	194	177	0.052	0.015	0.008	0.002	0.001	0.001	0.361	0.216	0.201	2.311	1.072	0.934
Light Duty Vehicles	1990	4.505	2.624	2.403	333	194	178	0.052	0.015	0.008	0.001	0.001	0.001	0.363	0.217	0.202	2.302	1.061	0.924
Light Duty Vehicles	1991	4.541	2.623	2.402	335	194	178	0.052	0.015	0.008	0.001	0.001	0.001	0.365	0.217	0.202	2.326	1.065	0.928
Light Duty Vehicles	1992	4.431	2.622	2.598	327	194	192	0.052	0.015	0.009	0.002	0.001	0.001	0.230	0.140	0.141	2.271	1.083	1.024
Light Duty Vehicles	1993	4.468	2.622	2.597	330	194	192	0.052	0.015	0.009	0.002	0.001	0.001	0.090	0.054	0.055	2.293	1.086	1.027
Light Duty Vehicles	1994	4.059	2.790	2.801	300	206	207	0.046	0.016	0.010	0.001	0.001	0.001	0.082	0.058	0.059	2.066	1.141	1.091
Light Duty Vehicles	1995	4.051	2.770	2.780	299	205	205	0.044	0.015	0.009	0.002	0.001	0.001	0.082	0.058	0.059	2.009	1.123	1.076

Light Duty Vehicles	1996	3.974	2.752	2.958	293	203	219	0.040	0.015	0.009	0.002	0.002	0.002	0.080	0.057	0.062	1.919	1.102	1.133
Light Duty Vehicles	1997	3.904	2.732	2.938	288	202	217	0.038	0.014	0.009	0.003	0.002	0.002	0.079	0.057	0.062	1.829	1.083	1.114
Light Duty Vehicles	1998	3.888	2.714	2.916	287	200	215	0.036	0.014	0.008	0.003	0.003	0.002	0.078	0.056	0.061	1.773	1.071	1.105
Light Duty Vehicles	1999	3.853	2.698	2.899	284	199	214	0.033	0.013	0.008	0.004	0.003	0.003	0.043	0.031	0.034	1.704	1.049	1.084
Light Duty Vehicles	2000	3.822	2.682	2.881	282	198	213	0.031	0.012	0.007	0.004	0.003	0.003	0.009	0.006	0.007	1.642	1.032	1.067
Light Duty Vehicles	2001	3.840	2.667	2.864	284	197	212	0.028	0.011	0.007	0.005	0.004	0.003	0.009	0.006	0.007	1.604	1.015	1.052
Light Duty Vehicles	2002	3.787	2.648	2.844	280	196	210	0.025	0.010	0.006	0.006	0.004	0.003	0.009	0.006	0.007	1.487	0.965	1.001
Light Duty Vehicles	2003	3.773	2.631	2.829	279	194	209	0.022	0.008	0.005	0.006	0.004	0.004	0.009	0.006	0.007	1.403	0.915	0.950
Light Duty Vehicles	2004	3.694	2.608	2.806	273	193	207	0.018	0.007	0.004	0.007	0.004	0.004	0.009	0.006	0.007	1.276	0.867	0.902
Light Duty Vehicles	2005	3.704	2.591	2.792	274	191	206	0.015	0.006	0.004	0.008	0.004	0.004	0.002	0.001	0.001	1.219	0.830	0.864
Light Duty Vehicles	2006	3.670	2.576	2.778	271	190	205	0.013	0.005	0.003	0.008	0.004	0.004	0.002	0.001	0.001	1.148	0.797	0.831
Heavy Duty Vehicles	1985	13.245	9.672	9.165	980	716	678	0.160	0.063	0.055	0.035	0.030	0.026	3.087	2.259	2.143	13.200	10.127	9.435
Heavy Duty Vehicles	1986	13.246	9.673	9.166	980	716	678	0.160	0.063	0.055	0.035	0.030	0.026	1.853	1.356	1.286	13.204	10.128	9.436
Heavy Duty Vehicles	1987	13.246	9.673	9.166	980	716	678	0.160	0.063	0.055	0.035	0.030	0.026	1.853	1.356	1.286	13.204	10.128	9.436
Heavy Duty Vehicles	1988	13.246	9.673	9.166	980	716	678	0.160	0.063	0.055	0.035	0.030	0.026	1.854	1.356	1.286	13.204	10.128	9.437
Heavy Duty Vehicles	1989	13.247	9.674	9.167	980	716	678	0.160	0.063	0.055	0.035	0.030	0.026	1.236	0.904	0.858	13.207	10.128	9.437
Heavy Duty Vehicles	1990	13.110	9.604	9.122	970	711	675	0.159	0.063	0.054	0.035	0.030	0.026	1.223	0.898	0.853	13.056	10.050	9.389
Heavy Duty Vehicles	1991	13.463	9.815	8.625	996	726	638	0.163	0.064	0.051	0.035	0.031	0.025	1.256	0.917	0.807	13.401	10.270	8.883
Heavy Duty Vehicles	1992	13.462	9.814	8.624	996	726	638	0.163	0.064	0.051	0.035	0.031	0.025	0.816	0.596	0.524	13.398	10.270	8.882
Heavy Duty Vehicles	1993	13.200	9.319	9.493	977	690	702	0.160	0.061	0.056	0.035	0.029	0.027	0.308	0.218	0.222	13.145	9.747	9.780
Heavy Duty Vehicles	1994	10.754	9.711	10.013	796	719	741	0.132	0.064	0.060	0.029	0.031	0.029	0.251	0.227	0.234	10.530	9.982	10.135
Heavy Duty Vehicles	1995	10.631	9.541	10.038	787	706	743	0.132	0.064	0.060	0.029	0.030	0.030	0.248	0.223	0.235	10.234	9.631	9.989
Heavy Duty Vehicles	1996	10.945	9.279	9.945	810	687	736	0.137	0.063	0.060	0.030	0.030	0.030	0.255	0.217	0.233	10.358	9.206	9.721
Heavy Duty Vehicles	1997	11.147	9.392	9.962	825	695	737	0.137	0.064	0.061	0.030	0.030	0.030	0.260	0.220	0.233	10.430	9.182	9.585
Heavy Duty Vehicles	1998	11.114	9.367	9.901	822	693	733	0.134	0.064	0.061	0.030	0.030	0.030	0.259	0.219	0.232	10.268	9.026	9.381
Heavy Duty Vehicles	1999	11.210	9.423	9.892	829	697	732	0.133	0.065	0.062	0.030	0.030	0.030	0.144	0.121	0.127	10.246	8.963	9.244
Heavy Duty Vehicles	2000	11.134	9.363	9.821	824	693	727	0.129	0.064	0.062	0.030	0.030	0.030	0.026	0.022	0.023	10.084	8.809	9.068
Heavy Duty Vehicles	2001	11.399	9.535	9.869	844	706	730	0.131	0.067	0.063	0.030	0.030	0.030	0.027	0.022	0.023	10.181	8.837	8.973
Heavy Duty Vehicles	2002	11.355	9.506	9.815	840	703	726	0.126	0.067	0.063	0.030	0.030	0.030	0.027	0.022	0.023	9.822	8.513	8.617
Heavy Duty Vehicles	2003	11.310	9.475	9.774	837	701	723	0.121	0.067	0.062	0.030	0.030	0.030	0.026	0.022	0.023	9.507	8.225	8.313
Heavy Duty Vehicles	2004	11.173	9.380	9.673	827	694	716	0.115	0.066	0.062	0.030	0.030	0.030	0.026	0.022	0.023	9.043	7.814	7.886
Heavy Duty Vehicles	2005	11.109	9.330	9.619	822	690	712	0.111	0.066	0.062	0.030	0.030	0.030	0.005	0.004	0.005	8.744	7.542	7.605
Heavy Duty Vehicles	2006	11.053	9.286	9.572	818	687	708	0.107	0.066	0.061	0.030	0.030	0.030	0.005	0.004	0.004	8.471	7.293	7.348
Buses	1985	13.991	10.503	5.954	1035	777	441	0.186	0.082	0.047	0.032	0.031	0.020	3.277	2.460	1.394	14.555	11.430	6.449
Buses	1986	13.991	10.501	5.955	1035	777	441	0.186	0.082	0.047	0.032	0.031	0.020	1.966	1.476	0.837	14.552	11.425	6.448
Buses	1987	13.992	10.509	5.954	1035	778	441	0.186	0.082	0.047	0.032	0.031	0.020	1.966	1.477	0.837	14.561	11.442	6.452
Buses	1988	13.992	10.522	5.952	1035	779	440	0.186	0.082	0.047	0.032	0.031	0.020	1.966	1.479	0.836	14.575	11.469	6.458

Buses	1989	13.992	10.516	5.953	1035	778	440	0.186	0.082	0.047	0.032	0.031	0.020	1.311	0.985	0.558	14.569	11.457	6.455
Buses	1990	13.991	10.493	5.956	1035	776	441	0.186	0.082	0.047	0.032	0.031	0.020	1.311	0.983	0.558	14.544	11.408	6.444
Buses	1991	13.496	10.905	5.956	999	807	441	0.180	0.085	0.047	0.031	0.032	0.020	1.264	1.022	0.558	14.023	11.865	6.443
Buses	1992	13.908	10.558	5.956	1029	781	441	0.185	0.082	0.047	0.032	0.031	0.020	0.847	0.643	0.363	14.467	11.471	6.444
Buses	1993	13.871	10.273	6.927	1026	760	513	0.185	0.080	0.055	0.032	0.030	0.023	0.325	0.241	0.162	14.385	11.178	7.500
Buses	1994	13.194	10.262	7.822	976	759	579	0.178	0.081	0.062	0.030	0.030	0.027	0.309	0.240	0.183	13.459	10.885	8.301
Buses	1995	12.975	9.788	8.658	960	724	641	0.177	0.079	0.070	0.030	0.030	0.030	0.304	0.229	0.203	12.890	10.097	8.947
Buses	1996	12.605	9.778	8.555	933	724	633	0.175	0.080	0.070	0.030	0.030	0.030	0.295	0.229	0.200	12.202	9.832	8.623
Buses	1997	12.445	9.683	8.486	921	717	628	0.170	0.078	0.068	0.030	0.030	0.030	0.291	0.227	0.199	11.889	9.585	8.429
Buses	1998	12.349	9.632	8.447	914	713	625	0.165	0.075	0.066	0.030	0.030	0.030	0.289	0.226	0.198	11.726	9.459	8.328
Buses	1999	12.234	9.566	8.398	905	708	621	0.161	0.073	0.064	0.030	0.030	0.030	0.158	0.123	0.108	11.511	9.289	8.194
Buses	2000	12.134	9.511	8.357	898	704	618	0.157	0.072	0.063	0.030	0.030	0.030	0.028	0.022	0.020	11.327	9.147	8.080
Buses	2001	12.054	9.465	8.324	892	700	616	0.153	0.070	0.061	0.030	0.030	0.030	0.028	0.022	0.019	11.184	9.033	7.991
Buses	2002	12.011	9.449	8.323	889	699	616	0.149	0.068	0.060	0.030	0.030	0.030	0.028	0.022	0.019	10.907	8.781	7.766
Buses	2003	11.991	9.451	8.332	887	699	617	0.146	0.067	0.058	0.030	0.030	0.030	0.028	0.022	0.020	10.698	8.589	7.587
Buses	2004	11.961	9.432	8.332	885	698	617	0.143	0.065	0.057	0.030	0.030	0.030	0.028	0.022	0.020	10.485	8.387	7.413
Buses	2005	11.921	9.423	8.331	882	697	617	0.139	0.064	0.056	0.030	0.030	0.030	0.006	0.004	0.004	10.245	8.175	7.218
Buses	2006	11.882	9.412	8.330	879	697	616	0.136	0.062	0.054	0.030	0.030	0.030	0.006	0.004	0.004	10.015	7.969	7.030
Mopeds	1985	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1986	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1987	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1988	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1989	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1990	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1991	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1992	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1993	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1994	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1995	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1996	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1997	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1998	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	1999	1.095	1.095		80	80		0.219	0.219		0.001	0.001		0.003	0.003		0.020	0.020	
Mopeds	2000	1.050	1.050		77	77		0.201	0.201		0.001	0.001		0.002	0.002		0.020	0.020	
Mopeds	2001	1.019	1.019		74	74		0.188	0.188		0.001	0.001		0.002	0.002		0.020	0.020	
Mopeds	2002	0.985	0.985		72	72		0.175	0.175		0.001	0.001		0.002	0.002		0.020	0.020	
Mopeds	2003	0.969	0.969		71	71		0.169	0.169		0.001	0.001		0.002	0.002		0.020	0.020	

Mopeds	2004	0.940	0.940		69	69		0.159	0.159		0.001	0.001		0.002	0.002		0.035	0.035	
Mopeds	2005	0.893	0.893		65	65		0.143	0.143		0.001	0.001		0.000	0.000		0.055	0.055	
Mopeds	2006	0.842	0.842		61	61		0.125	0.125		0.001	0.001		0.000	0.000		0.071	0.071	
Motorcycles	1985	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1986	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1987	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1988	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1989	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1990	1.252	1.284	1.916	91	94	140	0.184	0.188	0.234	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.222	0.412
Motorcycles	1991	1.447	1.149	1.578	106	84	115	0.213	0.168	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.135	0.199	0.340
Motorcycles	1992	1.252	1.351	1.690	91	99	123	0.184	0.197	0.206	0.002	0.002	0.002	0.003	0.003	0.004	0.117	0.234	0.364
Motorcycles	1993	1.475	1.149	1.465	108	84	107	0.217	0.168	0.179	0.002	0.002	0.002	0.003	0.003	0.003	0.137	0.199	0.315
Motorcycles	1994	1.308	1.318	1.578	95	96	115	0.193	0.193	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.122	0.228	0.340
Motorcycles	1995	1.224	1.250	2.141	89	91	156	0.180	0.183	0.261	0.002	0.002	0.003	0.003	0.003	0.005	0.114	0.217	0.461
Motorcycles	1996	1.308	1.318	1.578	95	96	115	0.193	0.193	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.122	0.228	0.340
Motorcycles	1997	1.308	1.318	1.578	95	96	115	0.193	0.193	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.122	0.228	0.340
Motorcycles	1998	1.308	1.318	1.578	95	96	115	0.193	0.193	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.122	0.228	0.340
Motorcycles	1999	1.308	1.318	1.578	95	96	115	0.193	0.193	0.193	0.002	0.002	0.002	0.003	0.003	0.004	0.122	0.228	0.340
Motorcycles	2000	1.312	1.321	1.597	96	96	117	0.189	0.189	0.190	0.002	0.002	0.002	0.003	0.003	0.004	0.129	0.241	0.366
Motorcycles	2001	1.312	1.321	1.597	96	96	117	0.189	0.190	0.190	0.002	0.002	0.002	0.003	0.003	0.004	0.130	0.242	0.368
Motorcycles	2002	1.314	1.321	1.604	96	96	117	0.188	0.189	0.189	0.002	0.002	0.002	0.003	0.003	0.004	0.133	0.248	0.379
Motorcycles	2003	1.316	1.322	1.611	96	97	118	0.186	0.188	0.188	0.002	0.002	0.002	0.003	0.003	0.004	0.136	0.254	0.390
Motorcycles	2004	1.317	1.323	1.618	96	97	118	0.185	0.185	0.186	0.002	0.002	0.002	0.003	0.003	0.004	0.138	0.253	0.393
Motorcycles	2005	1.320	1.325	1.630	96	97	119	0.183	0.182	0.183	0.002	0.002	0.002	0.001	0.001	0.001	0.141	0.257	0.404
Motorcycles	2006	1.321	1.325	1.638	96	96	119	0.181	0.180	0.181	0.002	0.002	0.002	0.001	0.001	0.001	0.144	0.260	0.413

Sector	Year	NMVOCu (exh)	NMVOCr (exh)	NMVOCh (exh)	NMVOCu (tot)	NMVOCr (tot)	NMVOCh (tot)	COu	COr	COh	NH3u	NH3r	NH3h	TSPu	TSPr	TSPh
Passenger Cars	1985	3.771	1.039	0.641	6.054	1.425	0.692	44.742	10.034	7.308	0.002	0.002	0.001	0.095	0.044	0.032
Passenger Cars	1986	3.647	1.016	0.623	5.938	1.404	0.675	42.147	9.531	6.866	0.002	0.002	0.001	0.093	0.042	0.031
Passenger Cars	1987	3.594	0.991	0.601	5.854	1.373	0.653	40.275	8.943	6.387	0.002	0.002	0.001	0.092	0.041	0.030
Passenger Cars	1988	3.299	0.958	0.573	5.638	1.353	0.627	35.045	8.169	5.738	0.002	0.002	0.001	0.087	0.040	0.030
Passenger Cars	1989	3.175	0.938	0.558	5.539	1.338	0.612	32.921	7.766	5.367	0.002	0.002	0.001	0.085	0.039	0.029
Passenger Cars	1990	3.125	0.927	0.548	5.491	1.327	0.602	31.831	7.477	5.087	0.002	0.002	0.001	0.082	0.038	0.028
Passenger Cars	1991	3.047	0.884	0.510	5.209	1.249	0.560	31.150	7.128	4.726	0.006	0.011	0.005	0.075	0.036	0.026
Passenger Cars	1992	2.775	0.824	0.549	4.812	1.169	0.595	28.220	6.664	5.092	0.010	0.019	0.009	0.065	0.033	0.028
Passenger Cars	1993	2.761	0.767	0.510	4.580	1.074	0.552	28.020	6.214	4.764	0.013	0.027	0.012	0.062	0.030	0.026

Passenger Cars	1994	2.466	0.692	0.449	4.108	0.969	0.487	24.599	5.641	4.206	0.018	0.040	0.018	0.052	0.027	0.023
Passenger Cars	1995	2.299	0.620	0.457	3.748	0.865	0.490	22.737	5.137	4.389	0.021	0.050	0.025	0.046	0.025	0.024
Passenger Cars	1996	2.248	0.542	0.455	3.478	0.750	0.483	22.063	4.570	4.511	0.024	0.059	0.033	0.041	0.022	0.025
Passenger Cars	1997	1.889	0.453	0.382	2.966	0.635	0.406	17.933	3.774	3.853	0.034	0.072	0.040	0.034	0.018	0.021
Passenger Cars	1998	1.732	0.388	0.328	2.608	0.536	0.348	16.485	3.314	3.426	0.042	0.082	0.046	0.030	0.016	0.018
Passenger Cars	1999	1.517	0.333	0.282	2.276	0.462	0.299	14.324	2.921	3.070	0.049	0.090	0.051	0.028	0.015	0.017
Passenger Cars	2000	1.388	0.294	0.249	1.898	0.381	0.260	13.097	2.649	2.831	0.054	0.095	0.053	0.026	0.014	0.017
Passenger Cars	2001	1.339	0.264	0.224	1.779	0.339	0.234	12.853	2.465	2.693	0.051	0.091	0.054	0.027	0.013	0.017
Passenger Cars	2002	1.167	0.232	0.198	1.551	0.297	0.207	11.308	2.251	2.517	0.049	0.086	0.055	0.025	0.013	0.016
Passenger Cars	2003	1.084	0.204	0.174	1.411	0.259	0.182	10.696	2.046	2.336	0.046	0.081	0.055	0.025	0.013	0.016
Passenger Cars	2004	0.908	0.175	0.151	1.186	0.222	0.157	9.023	1.837	2.147	0.043	0.076	0.054	0.024	0.013	0.017
Passenger Cars	2005	0.860	0.147	0.127	1.109	0.189	0.133	8.885	1.606	1.921	0.039	0.071	0.053	0.026	0.013	0.017
Passenger Cars	2006	0.727	0.122	0.106	0.945	0.159	0.111	7.579	1.385	1.690	0.035	0.064	0.052	0.026	0.013	0.017
Light Duty Veh.	1985	0.814	0.173	0.114	1.130	0.222	0.123	7.660	1.673	1.618	0.001	0.001	0.001	0.544	0.247	0.223
Light Duty Veh.	1986	0.760	0.167	0.111	1.055	0.212	0.120	7.110	1.618	1.560	0.001	0.001	0.001	0.539	0.250	0.226
Light Duty Veh.	1987	0.765	0.166	0.111	1.056	0.211	0.119	7.148	1.614	1.555	0.001	0.001	0.001	0.547	0.251	0.226
Light Duty Veh.	1988	0.712	0.165	0.111	1.012	0.212	0.119	6.685	1.606	1.547	0.001	0.001	0.001	0.507	0.251	0.226
Light Duty Veh.	1989	0.672	0.161	0.109	0.961	0.206	0.117	6.296	1.572	1.511	0.001	0.001	0.001	0.496	0.253	0.228
Light Duty Veh.	1990	0.652	0.158	0.107	0.929	0.202	0.115	6.093	1.548	1.485	0.001	0.001	0.001	0.495	0.254	0.229
Light Duty Veh.	1991	0.684	0.159	0.108	0.961	0.202	0.116	6.381	1.557	1.495	0.001	0.001	0.001	0.519	0.253	0.229
Light Duty Veh.	1992	0.687	0.164	0.119	0.985	0.210	0.128	6.448	1.596	1.665	0.001	0.001	0.001	0.492	0.251	0.246
Light Duty Veh.	1993	0.719	0.165	0.120	1.008	0.210	0.128	6.736	1.603	1.673	0.001	0.001	0.001	0.516	0.251	0.245
Light Duty Veh.	1994	0.643	0.172	0.127	0.929	0.216	0.135	6.014	1.673	1.764	0.001	0.001	0.001	0.474	0.269	0.266
Light Duty Veh.	1995	0.631	0.166	0.124	0.893	0.206	0.131	5.904	1.576	1.668	0.002	0.003	0.002	0.452	0.250	0.249
Light Duty Veh.	1996	0.625	0.159	0.129	0.851	0.194	0.136	5.804	1.473	1.676	0.002	0.004	0.003	0.441	0.233	0.250
Light Duty Veh.	1997	0.563	0.152	0.125	0.773	0.185	0.131	5.250	1.371	1.567	0.003	0.005	0.003	0.383	0.216	0.234
Light Duty Veh.	1998	0.552	0.148	0.123	0.736	0.177	0.128	5.173	1.293	1.486	0.003	0.007	0.004	0.354	0.199	0.217
Light Duty Veh.	1999	0.510	0.141	0.119	0.678	0.168	0.124	4.740	1.197	1.381	0.004	0.008	0.005	0.323	0.184	0.203
Light Duty Veh.	2000	0.478	0.136	0.116	0.595	0.154	0.119	4.448	1.115	1.293	0.005	0.009	0.006	0.293	0.170	0.189
Light Duty Veh.	2001	0.478	0.131	0.113	0.580	0.147	0.116	4.404	1.034	1.207	0.006	0.010	0.006	0.284	0.156	0.175
Light Duty Veh.	2002	0.418	0.121	0.106	0.504	0.135	0.108	3.855	0.920	1.080	0.006	0.010	0.007	0.244	0.139	0.158
Light Duty Veh.	2003	0.381	0.112	0.099	0.448	0.122	0.101	3.426	0.809	0.954	0.006	0.009	0.007	0.227	0.126	0.144
Light Duty Veh.	2004	0.316	0.102	0.092	0.365	0.110	0.094	2.801	0.684	0.816	0.005	0.009	0.007	0.180	0.106	0.125
Light Duty Veh.	2005	0.301	0.095	0.087	0.340	0.101	0.088	2.571	0.599	0.719	0.005	0.008	0.007	0.173	0.095	0.113
Light Duty Veh.	2006	0.271	0.089	0.083	0.300	0.094	0.084	2.232	0.529	0.641	0.004	0.007	0.006	0.152	0.084	0.102
Heavy Duty Veh.	1985	1.220	0.666	0.431	1.220	0.666	0.431	3.534	2.176	1.834	0.003	0.003	0.003	0.592	0.388	0.351
Heavy Duty Veh.	1986	1.217	0.664	0.431	1.217	0.664	0.431	3.496	2.157	1.825	0.003	0.003	0.003	0.592	0.388	0.351

Heavy Duty Veh.	1987	1.216	0.664	0.431	1.216	0.664	0.431	3.494	2.155	1.824	0.003	0.003	0.003	0.592	0.388	0.351
Heavy Duty Veh.	1988	1.216	0.664	0.431	1.216	0.664	0.431	3.488	2.152	1.823	0.003	0.003	0.003	0.592	0.388	0.351
Heavy Duty Veh.	1989	1.214	0.663	0.430	1.214	0.663	0.430	3.465	2.141	1.818	0.003	0.003	0.003	0.592	0.388	0.351
Heavy Duty Veh.	1990	1.220	0.665	0.431	1.220	0.665	0.431	3.448	2.134	1.813	0.003	0.003	0.003	0.588	0.386	0.350
Heavy Duty Veh.	1991	1.229	0.680	0.410	1.229	0.680	0.410	3.505	2.184	1.724	0.004	0.003	0.002	0.601	0.395	0.331
Heavy Duty Veh.	1992	1.232	0.681	0.411	1.232	0.681	0.411	3.531	2.198	1.730	0.004	0.003	0.002	0.601	0.395	0.331
Heavy Duty Veh.	1993	1.241	0.641	0.454	1.241	0.641	0.454	3.527	2.078	1.911	0.004	0.003	0.003	0.592	0.374	0.364
Heavy Duty Veh.	1994	0.988	0.659	0.475	0.988	0.659	0.475	2.827	2.140	1.997	0.003	0.003	0.003	0.475	0.383	0.377
Heavy Duty Veh.	1995	0.948	0.628	0.475	0.948	0.628	0.475	2.753	2.064	1.997	0.003	0.003	0.003	0.462	0.370	0.372
Heavy Duty Veh.	1996	0.934	0.601	0.464	0.934	0.601	0.464	2.760	1.985	1.954	0.003	0.003	0.003	0.467	0.354	0.362
Heavy Duty Veh.	1997	0.864	0.559	0.435	0.864	0.559	0.435	2.645	1.914	1.890	0.003	0.003	0.003	0.449	0.338	0.347
Heavy Duty Veh.	1998	0.811	0.527	0.410	0.811	0.527	0.410	2.572	1.872	1.848	0.003	0.003	0.003	0.423	0.319	0.331
Heavy Duty Veh.	1999	0.759	0.496	0.387	0.759	0.496	0.387	2.489	1.824	1.805	0.003	0.003	0.003	0.403	0.304	0.317
Heavy Duty Veh.	2000	0.719	0.471	0.368	0.719	0.471	0.368	2.438	1.793	1.775	0.003	0.003	0.003	0.379	0.286	0.302
Heavy Duty Veh.	2001	0.674	0.444	0.346	0.674	0.444	0.346	2.441	1.795	1.760	0.003	0.003	0.003	0.364	0.275	0.291
Heavy Duty Veh.	2002	0.626	0.412	0.323	0.626	0.412	0.323	2.397	1.764	1.726	0.003	0.003	0.003	0.336	0.254	0.269
Heavy Duty Veh.	2003	0.585	0.385	0.303	0.585	0.385	0.303	2.338	1.726	1.693	0.003	0.003	0.003	0.312	0.236	0.250
Heavy Duty Veh.	2004	0.527	0.349	0.277	0.527	0.349	0.277	2.234	1.661	1.636	0.003	0.003	0.003	0.279	0.211	0.225
Heavy Duty Veh.	2005	0.496	0.328	0.261	0.496	0.328	0.261	2.213	1.642	1.615	0.003	0.003	0.003	0.259	0.195	0.208
Heavy Duty Veh.	2006	0.467	0.309	0.246	0.467	0.309	0.246	2.191	1.623	1.594	0.003	0.003	0.003	0.240	0.181	0.193
Buses	1985	1.557	0.876	0.366	1.557	0.876	0.366	4.522	2.742	1.229	0.003	0.003	0.002	0.746	0.464	0.228
Buses	1986	1.556	0.875	0.365	1.556	0.875	0.365	4.520	2.739	1.228	0.003	0.003	0.002	0.746	0.463	0.228
Buses	1987	1.559	0.878	0.367	1.559	0.878	0.367	4.527	2.747	1.231	0.003	0.003	0.002	0.746	0.464	0.228
Buses	1988	1.563	0.882	0.369	1.563	0.882	0.369	4.537	2.758	1.235	0.003	0.003	0.002	0.747	0.465	0.228
Buses	1989	1.561	0.880	0.368	1.561	0.880	0.368	4.533	2.753	1.233	0.003	0.003	0.002	0.747	0.465	0.228
Buses	1990	1.553	0.873	0.364	1.553	0.873	0.364	4.513	2.732	1.226	0.003	0.003	0.002	0.745	0.463	0.228
Buses	1991	1.496	0.909	0.364	1.496	0.909	0.364	4.349	2.845	1.225	0.003	0.003	0.002	0.718	0.481	0.228
Buses	1992	1.547	0.876	0.364	1.547	0.876	0.364	4.494	2.744	1.225	0.003	0.003	0.002	0.741	0.465	0.228
Buses	1993	1.529	0.857	0.425	1.529	0.857	0.425	4.447	2.681	1.428	0.003	0.003	0.002	0.736	0.453	0.265
Buses	1994	1.414	0.816	0.470	1.414	0.816	0.470	4.145	2.570	1.575	0.003	0.003	0.003	0.687	0.441	0.293
Buses	1995	1.312	0.736	0.493	1.312	0.736	0.493	3.891	2.335	1.669	0.003	0.003	0.003	0.654	0.409	0.316
Buses	1996	1.204	0.701	0.465	1.204	0.701	0.465	3.611	2.235	1.587	0.003	0.003	0.003	0.615	0.398	0.305
Buses	1997	1.124	0.660	0.443	1.124	0.660	0.443	3.436	2.137	1.528	0.003	0.003	0.003	0.573	0.373	0.287
Buses	1998	1.073	0.634	0.428	1.073	0.634	0.428	3.332	2.080	1.492	0.003	0.003	0.003	0.544	0.355	0.274
Buses	1999	1.015	0.604	0.411	1.015	0.604	0.411	3.206	2.009	1.450	0.003	0.003	0.003	0.513	0.336	0.260
Buses	2000	0.963	0.578	0.397	0.963	0.578	0.397	3.098	1.949	1.413	0.003	0.003	0.003	0.485	0.319	0.248
Buses	2001	0.922	0.557	0.385	0.922	0.557	0.385	3.011	1.900	1.384	0.003	0.003	0.003	0.462	0.306	0.239

Buses	2002	0.873	0.531	0.371	0.873	0.531	0.371	2.932	1.856	1.359	0.003	0.003	0.003	0.437	0.290	0.227
Buses	2003	0.837	0.512	0.361	0.837	0.512	0.361	2.882	1.830	1.345	0.003	0.003	0.003	0.419	0.279	0.219
Buses	2004	0.800	0.492	0.349	0.800	0.492	0.349	2.822	1.794	1.327	0.003	0.003	0.003	0.400	0.267	0.210
Buses	2005	0.756	0.470	0.338	0.756	0.470	0.338	2.753	1.758	1.305	0.003	0.003	0.003	0.378	0.254	0.200
Buses	2006	0.713	0.448	0.326	0.713	0.448	0.326	2.686	1.721	1.284	0.003	0.003	0.003	0.357	0.241	0.191
Mopeds	1985	13.691	13.691		14.001	14.001		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1986	13.691	13.691		14.008	14.008		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1987	13.691	13.691		14.006	14.006		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1988	13.691	13.691		14.027	14.027		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1989	13.691	13.691		14.041	14.041		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1990	13.691	13.691		14.034	14.034		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1991	13.691	13.691		14.019	14.019		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1992	13.691	13.691		14.022	14.022		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1993	13.691	13.691		14.001	14.001		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1994	13.691	13.691		14.013	14.013		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1995	13.691	13.691		14.014	14.014		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1996	13.691	13.691		14.001	14.001		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1997	13.691	13.691		14.017	14.017		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1998	13.691	13.691		14.002	14.002		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	1999	13.691	13.691		14.037	14.037		13.800	13.800		0.001	0.001		0.188	0.188	
Mopeds	2000	12.563	12.563		12.849	12.849		12.960	12.960		0.001	0.001		0.176	0.176	
Mopeds	2001	11.773	11.773		12.084	12.084		12.371	12.371		0.001	0.001		0.168	0.168	
Mopeds	2002	10.937	10.937		11.256	11.256		11.748	11.748		0.001	0.001		0.160	0.160	
Mopeds	2003	10.520	10.520		10.837	10.837		11.437	11.437		0.001	0.001		0.156	0.156	
Mopeds	2004	9.924	9.924		10.241	10.241		10.776	10.776		0.001	0.001		0.148	0.148	
Mopeds	2005	8.923	8.923		9.274	9.274		9.743	9.743		0.001	0.001		0.135	0.135	
Mopeds	2006	7.805	7.805		8.166	8.166		8.676	8.676		0.001	0.001		0.122	0.122	
Motorcycles	1985	2.526	1.963	2.442	3.345	2.182	2.476	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1986	2.526	1.963	2.442	3.353	2.184	2.476	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1987	2.526	1.963	2.442	3.348	2.183	2.476	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1988	2.526	1.963	2.442	3.383	2.192	2.477	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1989	2.526	1.963	2.442	3.403	2.198	2.478	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1990	2.526	1.963	2.442	3.396	2.196	2.478	19.177	21.616	33.899	0.002	0.002	0.002	0.045	0.046	0.057
Motorcycles	1991	2.919	1.756	2.011	3.772	1.984	2.046	22.160	19.341	27.917	0.002	0.002	0.002	0.052	0.041	0.047
Motorcycles	1992	2.526	2.066	2.155	3.388	2.297	2.190	19.177	22.754	29.911	0.002	0.002	0.002	0.045	0.048	0.050
Motorcycles	1993	2.975	1.756	1.867	3.797	1.976	1.901	22.586	19.341	25.923	0.002	0.002	0.002	0.053	0.041	0.044
Motorcycles	1994	2.639	2.014	2.011	3.490	2.242	2.046	20.029	22.185	27.917	0.002	0.002	0.002	0.047	0.047	0.047

Motorcycles	1995	2.470	1.911	2.729	3.318	2.138	2.764	18.751	21.047	37.887	0.002	0.002	0.003	0.044	0.045	0.064
Motorcycles	1996	2.639	2.014	2.011	3.459	2.234	2.045	20.029	22.185	27.917	0.002	0.002	0.002	0.047	0.047	0.047
Motorcycles	1997	2.639	2.014	2.011	3.496	2.244	2.047	20.029	22.185	27.917	0.002	0.002	0.002	0.047	0.047	0.047
Motorcycles	1998	2.639	2.014	2.011	3.467	2.236	2.045	20.029	22.185	27.917	0.002	0.002	0.002	0.047	0.047	0.047
Motorcycles	1999	2.639	2.014	2.011	3.496	2.244	2.046	20.029	22.185	27.917	0.002	0.002	0.002	0.047	0.047	0.047
Motorcycles	2000	2.607	1.998	1.998	3.283	2.179	2.026	19.468	21.623	27.259	0.002	0.002	0.002	0.047	0.047	0.047
Motorcycles	2001	2.568	1.961	1.961	3.233	2.139	1.989	19.445	21.600	27.257	0.002	0.002	0.002	0.046	0.046	0.046
Motorcycles	2002	2.517	1.918	1.919	3.195	2.099	1.947	19.204	21.360	27.001	0.002	0.002	0.002	0.045	0.045	0.045
Motorcycles	2003	2.466	1.875	1.878	3.139	2.055	1.906	18.978	21.134	26.761	0.002	0.002	0.002	0.044	0.044	0.044
Motorcycles	2004	2.414	1.826	1.830	3.097	2.009	1.858	18.614	20.684	26.249	0.002	0.002	0.002	0.043	0.043	0.043
Motorcycles	2005	2.354	1.774	1.780	3.084	1.969	1.810	18.150	20.155	25.645	0.002	0.002	0.002	0.042	0.042	0.042
Motorcycles	2006	2.299	1.725	1.733	3.047	1.925	1.764	17.761	19.704	25.135	0.002	0.002	0.002	0.040	0.040	0.040

Annex 2B-7: Fuel use (GJ) and emissions (tons) per vehicle category and as totals

Year	Sector	FC (PJ)	SO2	NO_X	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
1985	Passenger Cars	64	1208	52255	70537	1843	525859	4647	177	47	1445
1986	Passenger Cars	64	809	53053	70377	1865	504301	4686	180	47	1428
1987	Passenger Cars	65	843	53628	70105	1888	485508	4723	182	48	1423
1988	Passenger Cars	66	871	54803	69859	1923	440334	4788	187	49	1398
1989	Passenger Cars	65	635	54414	68390	1903	412681	4736	185	49	1363
1990	Passenger Cars	68	650	57926	71825	2021	421933	5004	197	52	1392
1991	Passenger Cars	73	669	58348	72370	2045	435763	5315	218	230	1374
1992	Passenger Cars	76	498	58769	71376	2017	425232	5576	238	422	1320
1993	Passenger Cars	78	296	57113	69068	1983	425670	5724	253	604	1270
1994	Passenger Cars	81	303	53865	64627	1871	392516	5920	277	926	1148
1995	Passenger Cars	82	308	50703	59763	1732	369784	5991	287	1170	1057
1996	Passenger Cars	83	313	47345	55267	1611	356898	6055	296	1393	973
1997	Passenger Cars	85	318	43689	48921	1513	303940	6204	304	1820	836
1998	Passenger Cars	87	327	39819	43527	1419	282165	6333	302	2175	751
1999	Passenger Cars	87	273	36142	38192	1313	248692	6370	298	2432	705
2000	Passenger Cars	87	198	33102	31709	1219	226197	6332	291	2587	670
2001	Passenger Cars	86	196	30435	28938	1109	216041	6274	273	2457	655
2002	Passenger Cars	87	199	28247	25657	1014	195346	6350	260	2390	636
2003	Passenger Cars	88	201	26162	23300	934	184534	6417	244	2293	635
2004	Passenger Cars	88	202	24122	19912	842	160535	6451	232	2192	633
2005	Passenger Cars	87	40	21795	18036	756	151966	6396	212	2035	662
2006	Passenger Cars	87	40	19506	15319	658	130112	6372	193	1860	655
1985	Light Duty Vehicles	14	2852	6760	2304	126	16496	1064	5	5	1526
1986	Light Duty Vehicles	16	1942	7457	2425	136	17360	1190	5	6	1710
1987	Light Duty Vehicles	17	1996	7654	2488	140	17864	1222	6	6	1768
1988	Light Duty Vehicles	17	2059	7846	2497	144	17627	1257	6	6	1759
1989	Light Duty Vehicles	18	1436	8056	2479	146	17447	1303	6	6	1813
1990	Light Duty Vehicles	19	1570	8703	2615	157	18462	1416	6	7	1974
1991	Light Duty Vehicles	20	1624	9057	2773	163	19725	1468	6	7	2088
1992	Light Duty Vehicles	20	1042	9052	2852	164	20080	1459	7	7	2035
1993	Light Duty Vehicles	20	417	9376	2983	170	21319	1507	7	7	2144
1994	Light Duty Vehicles	22	455	9949	3098	174	21892	1632	7	8	2323
1995	Light Duty Vehicles	22	448	9656	2949	164	21020	1610	10	15	2172

1996	Light Duty Vehicles	22	456	9633	2872	157	20882	1640	13	22	2135
1997	Light Duty Vehicles	22	462	9550	2709	152	19531	1660	16	29	1964
1998	Light Duty Vehicles	23	467	9566	2644	149	19393	1687	20	37	1853
1999	Light Duty Vehicles	23	263	9454	2502	141	18150	1704	23	46	1735
2000	Light Duty Vehicles	24	55	9489	2303	135	17514	1744	27	55	1639
2001	Light Duty Vehicles	24	56	9533	2283	128	17410	1784	32	65	1585
2002	Light Duty Vehicles	25	59	9432	2128	119	16129	1859	37	68	1459
2003	Light Duty Vehicles	28	65	9902	2116	114	15856	2052	43	68	1489
2004	Light Duty Vehicles	30	71	10165	1967	105	14463	2232	51	73	1348
2005	Light Duty Vehicles	34	16	10886	2048	100	14653	2494	60	73	1399
2006	Light Duty Vehicles	38	18	11690	2080	96	14432	2790	71	76	1398
1985	Heavy Duty Vehicles	32	7559	33484	2451	279	7894	2394	92	9	1381
1986	Heavy Duty Vehicles	36	5110	37712	2749	314	8820	2697	103	10	1554
1987	Heavy Duty Vehicles	36	5006	36951	2695	308	8644	2642	101	10	1523
1988	Heavy Duty Vehicles	35	4926	36371	2660	303	8517	2599	99	10	1501
1989	Heavy Duty Vehicles	37	3415	37815	2760	315	8816	2703	103	10	1560
1990	Heavy Duty Vehicles	38	3546	39243	2898	329	9197	2806	108	11	1625
1991	Heavy Duty Vehicles	39	3609	39943	2944	335	9351	2856	110	11	1652
1992	Heavy Duty Vehicles	37	2279	38795	2866	326	9130	2775	107	11	1606
1993	Heavy Duty Vehicles	37	854	37783	2792	317	8914	2702	104	10	1565
1994	Heavy Duty Vehicles	39	909	39595	2858	332	9249	2878	113	11	1628
1995	Heavy Duty Vehicles	40	924	39449	2803	341	9180	2925	116	12	1618
1996	Heavy Duty Vehicles	41	950	39768	2791	356	9222	3007	120	12	1631
1997	Heavy Duty Vehicles	41	963	39714	2616	357	8918	3046	122	12	1562
1998	Heavy Duty Vehicles	42	971	39572	2501	356	8800	3073	123	12	1499
1999	Heavy Duty Vehicles	43	550	40244	2411	362	8762	3164	127	13	1463
2000	Heavy Duty Vehicles	41	97	38402	2227	345	8325	3051	123	12	1344
2001	Heavy Duty Vehicles	42	98	38394	2098	349	8262	3091	124	12	1291
2002	Heavy Duty Vehicles	41	97	36864	1954	341	8058	3063	123	12	1195
2003	Heavy Duty Vehicles	44	103	38064	1965	357	8414	3254	131	13	1193
2004	Heavy Duty Vehicles	45	106	37752	1878	363	8430	3345	136	14	1127
2005	Heavy Duty Vehicles	44	21	35659	1731	348	8112	3249	133	13	1025
2006	Heavy Duty Vehicles	45	21	35587	1679	352	8234	3332	137	14	983
1985	2-wheelers	1	2	62	5704	131	11021	56	1	1	79
1986	2-wheelers	1	2	61	5168	122	10456	52	1	1	72
1987	2-wheelers	1	2	59	4796	115	9928	50	1	1	67
1988	2-wheelers	1	2	59	4577	112	9772	49	1	1	64

1989	2-wheelers	1	1	58	4368	108	9472	47	1	1	61
1990	2-wheelers	1	2	62	4473	112	9946	49	1	1	63
1991	2-wheelers	1	2	61	4610	116	10157	51	1	1	64
1992	2-wheelers	1	2	67	4669	120	10664	53	1	1	66
1993	2-wheelers	1	2	67	4672	122	10901	54	1	1	66
1994	2-wheelers	1	2	74	4683	126	11393	56	1	1	66
1995	2-wheelers	1	2	80	4966	132	12034	59	1	1	70
1996	2-wheelers	1	2	81	5284	140	12615	62	1	1	75
1997	2-wheelers	1	2	89	5796	154	13844	68	1	1	82
1998	2-wheelers	1	2	96	6234	166	14962	73	1	1	88
1999	2-wheelers	1	2	101	5872	164	15182	74	1	1	83
2000	2-wheelers	1	2	115	5360	162	15287	76	1	1	79
2001	2-wheelers	1	2	122	4534	155	15229	75	1	1	69
2002	2-wheelers	1	2	135	4568	161	16032	80	1	1	70
2003	2-wheelers	1	3	147	4491	166	16622	83	2	2	70
2004	2-wheelers	1	3	162	4396	171	17135	87	2	2	68
2005	2-wheelers	1	1	180	4132	172	17315	90	2	2	64
2006	2-wheelers	1	1	210	4092	184	18743	100	2	2	65
1985	Total	111	11621	92561	80996	2378	561271	8160	275	62	4431
1986	Total	117	7862	98284	80718	2437	540938	8625	289	64	4764
1987	Total	118	7847	98292	80084	2450	521944	8636	289	64	4781
1988	Total	118	7857	99080	79593	2481	476251	8694	293	66	4722
1989	Total	120	5488	100344	77996	2472	448416	8789	295	66	4796
1990	Total	126	5767	105933	81811	2619	459539	9275	312	70	5053
1991	Total	132	5903	107409	82697	2658	474997	9690	335	248	5179
1992	Total	134	3820	106683	81762	2627	465106	9863	352	441	5026
1993	Total	136	1569	104339	79515	2592	466804	9987	365	623	5044
1994	Total	143	1669	103482	75265	2502	435050	10487	398	946	5164
1995	Total	144	1682	99888	70480	2370	412018	10585	414	1198	4917
1996	Total	147	1721	96827	66214	2265	399617	10764	430	1428	4814
1997	Total	149	1744	93041	60042	2176	346233	10978	442	1862	4444
1998	Total	152	1768	89052	54906	2090	325320	11166	447	2226	4191
1999	Total	154	1088	85941	48977	1980	290786	11312	450	2492	3986
2000	Total	153	352	81108	41599	1861	267325	11202	443	2657	3732
2001	Total	153	353	78485	37854	1740	256942	11223	429	2536	3599
2002	Total	155	357	74679	34307	1636	235566	11352	421	2472	3360
2003	Total	161	371	74275	31872	1572	225428	11806	420	2376	3386

2004	Total	165	381	72201	28154	1480	200562	12115	421	2281	3177
2005	Total	166	77	68519	25947	1376	192046	12229	406	2123	3150
2006	Total	171	79	66993	23171	1290	171521	12594	402	1951	3101

Annex 2B-8: COPERT IV:DEA statistics fuel use ratios and mileage adjustment factors

Sales			1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel ratio	Gasoline	DEA:COPERT IV	1.04	1.00	0.97	0.95	0.92	0.97	1.01	1.06	1.09	1.11	1.10	1.08	1.10	1.11	1.09
	Diesel (fuel ratio)	DEA:COPERT IV	1.22	1.29	1.25	1.25	1.28	1.39	1.43	1.40	1.41	1.51	1.49	1.51	1.51	1.49	1.46
Mileage factor	Gasoline	DEA:COPERT IV	1.04	1.00	0.97	0.95	0.92	0.97	1.01	1.06	1.09	1.11	1.10	1.08	1.10	1.11	1.09
	Diesel (mileage factor)	DEA:COPERT IV	1.25	1.32	1.28	1.28	1.32	1.45	1.49	1.45	1.47	1.59	1.57	1.59	1.59	1.57	1.54
Consumption																	
Fuel ratio	Gasoline	DEA:COPERT IV	1.08	1.08	1.07	1.08	1.07	1.06	1.06	1.07	1.07	1.08	1.09	1.09	1.11	1.11	1.13
	Diesel (fuel ratio)	DEA:COPERT IV	1.13	1.16	1.13	1.13	1.17	1.27	1.36	1.34	1.34	1.40	1.37	1.38	1.38	1.36	1.34
Mileage factor	Gasoline	DEA:COPERT IV	1.08	1.08	1.07	1.08	1.07	1.06	1.06	1.07	1.07	1.08	1.09	1.09	1.11	1.11	1.13
	Diesel (mileage factor)	DEA:COPERT IV	1.15	1.19	1.15	1.15	1.19	1.31	1.41	1.39	1.40	1.46	1.42	1.43	1.44	1.41	1.40

Continued			2000	2001	2002	2003	2004	2005	2006
Fuel ratio	Gasoline	DEA:COPERT IV	1.09	1.09	1.11	1.11	1.10	1.05	1.06
	Diesel (fuel ratio)	DEA:COPERT IV	1.42	1.38	1.38	1.45	1.47	1.43	1.43
Mileage factor	Gasoline	DEA:COPERT IV	1.09	1.09	1.11	1.11	1.10	1.05	1.06
	Diesel (mileage factor)	DEA:COPERT IV	1.50	1.46	1.47	1.57	1.61	1.57	1.58
Consumption									
Fuel ratio	Gasoline	DEA:COPERT IV	1.15	1.13	1.14	1.13	1.12	1.07	1.08
	Diesel (fuel ratio)	DEA:COPERT IV	1.32	1.29	1.27	1.31	1.32	1.29	1.30
Mileage factor	Gasoline	DEA:COPERT IV	1.15	1.13	1.14	1.13	1.12	1.07	1.08
	Diesel (mileage factor)	DEA:COPERT IV	1.38	1.35	1.34	1.38	1.41	1.38	1.40

Annex 2B-9: Basis fuel use and emission factors, deterioration factors, transient factors and specific operational data for non road working machinery and equipment, and recreational craft

Basis factors for diesel fuelled non road machinery

Engine size [P=kW]	Emission Level	NO_x	VOC	CO	N_2O [g/kWh]	NH_3	TSP	Fuel
P<19	<1981	12.0	5.0	7	0.035	0.002	2.8	300
P<19	1981-1990	11.5	3.8	6	0.035	0.002	2.3	285
P<19	1991-Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage II	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIA	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIB	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IV	11.2	2.5	5	0.035	0.002	1.6	270
19<=P<37	<1981	18.0	2.5	6.5	0.035	0.002	2	300
19<=P<37	1981-1990	18.0	2.2	5.5	0.035	0.002	1.4	281
19<=P<37	1991-Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage II	6.5	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIA	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIB	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IV	6.2	0.6	2.2	0.035	0.002	0.4	262
37<=P<56	<1981	7.7	2.4	6	0.035	0.002	1.8	290
37<=P<56	1981-1990	8.6	2.0	5.3	0.035	0.002	1.2	275
37<=P<56	1991-Stage I	11.5	1.5	4.5	0.035	0.002	0.8	260
37<=P<56	Stage I	7.7	0.6	2.2	0.035	0.002	0.4	260
37<=P<56	Stage II	5.5	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIA	3.9	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIB	3.9	0.4	2.2	0.035	0.002	0.0225	260
37<=P<56	Stage IV	3.9	0.4	2.2	0.035	0.002	0.0225	260
56<=P<75	<1981	7.7	2.0	5	0.035	0.002	1.4	290
56<=P<75	1981-1990	8.6	1.6	4.3	0.035	0.002	1	275
56<=P<75	1991-Stage I	11.5	1.2	3.5	0.035	0.002	0.4	260
56<=P<75	Stage I	7.7	0.4	1.5	0.035	0.002	0.2	260
56<=P<75	Stage II	5.5	0.3	1.5	0.035	0.002	0.2	260
56<=P<75	Stage IIIA	4.0	0.3	1.5	0.035	0.002	0.2	260

56<=P<75	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	260
56<=P<75	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	260
75<=P<130	<1981	10.5	2.0	5	0.035	0.002	1.4	280
75<=P<130	1981-1990	11.8	1.6	4.3	0.035	0.002	1	268
75<=P<130	1991-Stage I	13.3	1.2	3.5	0.035	0.002	0.4	255
75<=P<130	Stage I	8.1	0.4	1.5	0.035	0.002	0.2	255
75<=P<130	Stage II	5.2	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	255
75<=P<130	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	255
130<=P<560	<1981	17.8	1.5	2.5	0.035	0.002	0.9	270
130<=P<560	1981-1990	12.4	1.0	2.5	0.035	0.002	0.8	260
130<=P<560	1991-Stage I	11.2	0.5	2.5	0.035	0.002	0.4	250
130<=P<560	Stage I	7.6	0.3	1.5	0.035	0.002	0.2	250
130<=P<560	Stage II	5.2	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	250
130<=P<560	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	250

Basis factors for 4-stroke gasoline non road machinery

Engine	Size code	Size classe [S=ccm]	Emission Level	NO_x	VOC	CO	N_2O [g/kWh]	NH_3	TSP	Fuel
4-stroke	SH2	20<=S<50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH2	20<=S<50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH2	20<=S<50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH2	20<=S<50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH2	20<=S<50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH3	S>=50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH3	S>=50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH3	S>=50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SN1	S<66	<1981	1.2	26.9	822	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1981-1990	1.8	22.5	685	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1991-Stage I	2.4	18	548	0.002	0.03	0.08	603
4-stroke	SN1	S<66	Stage I	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN1	S<66	Stage II	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN2	66<=S<100	<1981	2.3	10.5	822	0.002	0.03	0.08	627
4-stroke	SN2	66<=S<100	1981-1990	3.5	8.7	685	0.002	0.03	0.08	599
4-stroke	SN2	66<=S<100	1991-Stage I	4.7	7	548	0.002	0.03	0.08	570
4-stroke	SN2	66<=S<100	Stage I	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN2	66<=S<100	Stage II	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN3	100<=S<225	<1981	2.6	19.1	525	0.002	0.03	0.08	601
4-stroke	SN3	100<=S<225	1981-1990	3.8	15.9	438	0.002	0.03	0.08	573
4-stroke	SN3	100<=S<225	1991-Stage I	5.1	12.7	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage I	5.1	11.6	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage II	5.1	9.4	350	0.002	0.03	0.08	546
4-stroke	SN4	S>=225	<1981	1.3	11.1	657	0.002	0.03	0.08	539
4-stroke	SN4	S>=225	1981-1990	2	9.3	548	0.002	0.03	0.08	514
4-stroke	SN4	S>=225	1991-Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage II	2.6	7.4	438	0.002	0.03	0.08	490

Basis factors for 2-stroke gasoline non road machinery

Engine	Size code	Size classe [ccm]	Emission Level	NO_x	VOC	CO	N_2O [g/kWh]	NH_3	TSP	Fuel
2-stroke	SH2	20<=S<50	<1981	1	305	695	0.002	0.01	7	882
2-stroke	SH2	20<=S<50	1981-1990	1	300	579	0.002	0.01	5.3	809
2-stroke	SH2	20<=S<50	1991-Stage I	1.1	203	463	0.002	0.01	3.5	735
2-stroke	SH2	20<=S<50	Stage I	1.5	188	379	0.002	0.01	3.5	720
2-stroke	SH2	20<=S<50	Stage II	1.5	44	379	0.002	0.01	3.5	500
2-stroke	SH3	S>=50	<1981	1.1	189	510	0.002	0.01	3.6	665
2-stroke	SH3	S>=50	1981-1990	1.1	158	425	0.002	0.01	2.7	609
2-stroke	SH3	S>=50	1991-Stage I	1.2	126	340	0.002	0.01	1.8	554
2-stroke	SH3	S>=50	Stage I	2	126	340	0.002	0.01	1.8	529
2-stroke	SH3	S>=50	Stage II	1.2	64	340	0.002	0.01	1.8	500
2-stroke	SN1	S<66	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage II	0.5	155	418	0.002	0.01	2.6	652

Fuel use and emission factors LPG fork lifts

NO_x [g/kWh]	VOC [g/kWh]	CO [g/kWh]	NH_3 [g/kWh]	N_2O [g/kWh]	TSP [g/kWh]	FC [g/kWh]
19	2.2	1.5	0.003	0.05	0.07	311

Fuel use and emission factors for All Terrain Vehicles (ATV's)

ATV type	NO_x [g/GJ]	VOC [g/GJ]	CO [g/GJ]	NH_3 [g/GJ]	N_2O [g/GJ]	TSP [g/GJ]	Fuel [kg/hour]
Professional	108	1077	16306	2	2	32	1.125
Private	128	1527	22043	2	2	39	0.75

Fuel use and emission factors for recreational craft

Fuel type	Vessel type	Engine	Engine type	Direktiv	Engine size	CO	VOC	N_2O	NH_3	NO_x	TSP	Fuel
					[kW]	[g/kWh]						
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	2003/44	8	202.5	45.9	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	Konv.	8	427	257.0	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	2003/44	8	202.5	24.0	0.03	0.002	7	0.08	426
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	Konv.	8	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Yawls and cabin boats	Out board	2-stroke	2003/44	20	162	36.5	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	2-stroke	Konv.	20	374	172.0	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	4-stroke	2003/44	20	162	14.0	0.03	0.002	10	0.08	426
Gasoline	Yawls and cabin boats	Out board	4-stroke	Konv.	20	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	2003/44	10	189	43.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	Konv.	10	427	257.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	2003/44	10	189	24.0	0.03	0.002	7	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	Konv.	10	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Speed boats	In board	4-stroke	2003/44	90	141	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	In board	4-stroke	Konv.	90	346	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	Out board	2-stroke	2003/44	50	145.8	31.8	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	2-stroke	Konv.	50	374	172.0	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	4-stroke	2003/44	50	145.8	14.0	0.03	0.002	10	0.08	426
Gasoline	Speed boats	Out board	4-stroke	Konv.	50	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	2-stroke	2003/44	45	147	32.2	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	2-stroke	Konv.	45	374	172.0	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	4-stroke	2003/44	45	147	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	4-stroke	Konv.	45	390	14.0	0.03	0.002	10	0.08	426
Diesel	Motor boats (27-34 ft)	In board		2003/44	150	5	1.7	0.035	0.002	8.6	1	275
Diesel	Motor boats (27-34 ft)	In board		Konv.	150	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (> 34 ft)	In board		2003/44	250	5	1.6	0.035	0.002	8.6	1	275
Diesel	Motor boats (> 34 ft)	In board		Konv.	250	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (< 27 ft)	In board		2003/44	40	5	1.8	0.035	0.002	9.8	1	281
Diesel	Motor boats (< 27 ft)	In board		Konv.	40	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Motor sailors	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Motor sailors	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Sailing boats (> 26 ft)	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Sailing boats (> 26 ft)	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281

CH_4 shares of VOC for diesel, gasoline and LPG

Fuel type	CH_4 share of VOC
Diesel	0.016
Gasoline 4-stroke	0.1
Gasoline 2-stroke	0.009
LPG	0.05

Deterioration factors for diesel machinery

Emission Level	NO_x	VOC	CO	TSP
<1981	0.024	0.047	0.185	0.473
1981-1990	0.024	0.047	0.185	0.473
1991-Stage I	0.024	0.047	0.185	0.473
Stage I	0.024	0.036	0.101	0.473
Stage II	0.009	0.034	0.101	0.473
Stage IIIA	0.008	0.027	0.151	0.473
Stage IIIB	0.008	0.027	0.151	0.473
Stage IV	0.008	0.027	0.151	0.473

Deterioration factors for gasoline 2-stroke machinery

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
2-stroke	SH2	20<=S<50	<1981	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1981-1990	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1991-Stage I	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	Stage I	0	0.29	0.24	0
2-stroke	SH2	20<=S<50	Stage II	0	0.29	0.24	0
2-stroke	SH3	S>=50	<1981	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1981-1990	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1991-Stage I	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	Stage I	0	0.266	0.231	0
2-stroke	SH3	S>=50	Stage II	0	0.266	0.231	0
2-stroke	SN1	S<66	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN1	S<66	Stage II	-0.33	0	1.109	5.103
2-stroke	SN2	66<=S<100	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN2	66<=S<100	Stage II	-0.33	0	1.109	5.103
2-stroke	SN3	100<=S<225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN3	100<=S<225	Stage II	-0.33	0	1.109	5.103
2-stroke	SN4	S>=225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	Stage I	-0.274	0	0.887	1.935
2-stroke	SN4	S>=225	Stage II	-0.274	0	0.887	1.935

Deterioration factors for gasoline 4-stroke machinery

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
4-stroke	SN1	S<66	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN1	S<66	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN4	S>=225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	Stage I	-0.599	1.095	1.307	1.095
4-stroke	SN4	S>=225	Stage II	-0.599	1.095	1.307	1.095
4-stroke	SH2	20<=S<50	<1981	0	0	0	0
4-stroke	SH2	20<=S<50	1981-1990	0	0	0	0
4-stroke	SH2	20<=S<50	1991-Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage II	0	0	0	0
4-stroke	SH3	S>=50	<1981	0	0	0	0
4-stroke	SH3	S>=50	1981-1990	0	0	0	0
4-stroke	SH3	S>=50	1991-Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage II	0	0	0	0

Transient factors for diesel machinery

Emission Level	Load	NO_x	VOC	CO	TSP	Fuel
<1981	High	0.95	1.05	1.53	1.23	1.01
1981-1990	High	0.95	1.05	1.53	1.23	1.01
1991-Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage II	High	0.95	1.05	1.53	1.23	1.01
Stage IIIA	High	0.95	1.05	1.53	1.23	1.01
Stage IIIB	High	1	1	1	1	1
Stage IV	High	1	1	1	1	1
<1981	Low	1.1	2.29	2.57	1.97	1.18
1981-1990	Low	1.1	2.29	2.57	1.97	1.18
1991-Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage II	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIA	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIB	Low	1	1	1	1	1
Stage IV	Low	1	1	1	1	1

Annual working hours, load factors and lifetimes for **agricultural tractors**

Tractor type	Annual working hours	Load factor	Lifetime (yrs)
Diesel	500 (0-7 years) 500-100 (7-16 years) 100 (>16 years)	0.5	30
Gasoline (certified)	100	0.4	37
Gasoline (non certified)	50	0.4	37

Annual working hours, load factors and lifetimes for **harvesters**

Annual working hours	Load factor	Lifetime (yrs)
250-100 (linear decrease 0-24 years)	0.8	25

Annual working hours, load factors and lifetime for **machine pool machinery**

Tractor type	Hours/yr	Load factor	Lifetime (yrs)
Tractors	750	0.5	7
Harvesters	100	0.8	11
Self-propelled vehicles	500	0.75	6

Operational data for other machinery types in agriculture

Machinery type	Fuel type	Load factor	Lifetime (yrs)	Hours	Size (kW)
ATV private	Gasoline	-	6	250	-
ATV professional	Gasoline	-	8	400	-
Bedding machines	Gasoline	0.3	10	50	3
Fodder trucks	Gasoline	0.4	10	200	8
Other (gasoline)	Gasoline	0.4	10	50	5
Scrapers	Gasoline	0.3	10	50	3
Self-propelled vehicles	Diesel	0.75	15	150	60
Sweepers	Gasoline	0.3	10	50	3

Annual working hours, load factors and lifetimes for **forestry machinery**

Machinery type	Hours	Load factors	Lifetime
Chippers	1200	0.5	6
Tractors (other)	100 (1990) 400 (2004)	0.5	15
Tractors (silvicultural)	800	0.5	6
Harvesters	1200	0.5	8
Forwarders	1200	0.5	8
Chain saws (forestry)	800	0.4	3

Annual working hours, load factors and lifetime for **fork lifts**

Hours/yr	Load factor	Lifetime (yrs)
1200 (>=50 kW and <=10 years old)	0.27	20
650 (>=50 kW and >10 years old)		
650 (<50 kW)		

Operational data for construction machinery

Machinery type	Load factor	Lifetime	Hours	Size
Track type dozers	0.5	10	1100	140
Track type loaders	0.5	10	1100	100 (1990) 150 (2004)
Wheel loaders (0-5 tons)	0.5	10	1200	20
Wheel loaders (> 5,1 tons)	0.5	10	1200	120
Wheel type excavators	0.6	10	1200	100
Track type excavators (0-5 tons)	0.6	10	1100	20
Track type excavators (>5,1 tons)	0.6	10	1100	120
Excavators/Loaders	0.45	10	700	50
Dump trucks	0.4	10	900 (1990) 1200 (2004)	60 (1990) 180 (2004)
Mini loaders	0.5	14	700	30
Telescopic loaders	0.5	14	1000	35

Stock and operational data for other machinery types in industry

Sector	Fuel type	Machinery type	Size (kW)	No	Load Factor	Hours
Construction machinery	Diesel	Tampers/Land rollers	30	2800	0.45	600
Construction machinery	Diesel	Generators (diesel)	45	5000	0.5	200
Construction machinery	Diesel	Kompressors (diesel)	45	5000	0.5	500
Construction machinery	Diesel	Pumps (diesel)	75	1000	0.5	5
Construction machinery	Diesel	Asphalt pavers	80	300	0.35	700
Construction machinery	Diesel	Motor graders	100	100	0.4	700
Construction machinery	Diesel	Refuse compressors	160	100	0.25	1300
Construction machinery	Gasoline	Generators (gasoline)	2.5	11000	0.4	80
Construction machinery	Gasoline	Pumps (gasoline)	4	10000	0.4	300
Construction machinery	Gasoline	Kompressors (gasoline)	4	500	0.35	15
Industry	Diesel	Refrigerating units (distribution)	8	3000	0.5	1250
Industry	Diesel	Refrigerating units (long distance)	15	3500	0.5	200
Industry	Diesel	Tractors (transport, industry)	50	3000	0.4	500
Airport GSE and other	Diesel	Airport GSE and other (light duty)	100	500	0.5	400
Airport GSE and other	Diesel	Airport GSE and other (medium duty)	125	350	0.5	300
Airport GSE and other	Diesel	Airport GSE and other (Heavy duty)	175	650	0.5	200
Building and construction	Diesel	Vibratory plates	6	3500	0.6	300
Building and construction	Diesel	Aereal lifts (diesel)	30	150	0.4	400
Building and construction	Diesel	Sweepers (diesel)	30	200	0.4	300
Building and construction	Diesel	High pressure cleaners (diesel)	30	50	0.8	500
Building and construction	Gasoline	Rammers	2.5	3000	0.4	80
Building and construction	Gasoline	Drills	3	100	0.4	10
Building and construction	Gasoline	Vibratory plates (gasoline)	4	2500	0.5	200
Building and construction	Gasoline	Cutters	4	800	0.5	50
Building and construction	Gasoline	Other (gasoline)	5	1000	0.5	40
Building and construction	Gasoline	High pressure cleaners (gasoline)	5	500	0.6	200
Building and construction	Gasoline	Sweepers (gasoline)	10	500	0.4	150
Building and construction	Gasoline	Slicers	10	100	0.7	150
Building and construction	Gasoline	Aereal lifts (gasoline)	20	50	0.4	400

Operational data for the most important types of household and gardening machinery

Machinery type	Engine	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chain saws (private)	2-stroke	2	5	0.3	10
Chain saws (professional)	2-stroke	3	270	0.4	3
Cultivators (private-large)	4-stroke	3.7	5	0.6	5
Cultivators (private-small)	4-stroke	1	5	0.6	15
Cultivators (professional)	4-stroke	7	360	0.6	8
Hedge cutters (private)	2-stroke	0.9	10	0.5	10
Hedge cutters (professional)	2-stroke	2	300	0.5	4
Lawn movers (private)	4-stroke	2.5 (2000) 3.5 (2004)	25	0.4	8
Lawn movers (professional)	4-stroke	2.5 (2000) 3.5 (2004)	250	0.4	4
Riders (private)	4-stroke	11	50	0.5	12
Riders (professional)	4-stroke	13	330	0.5	5
Shrub clearers (private)	2-stroke	1	15	0.6	10
Shrub clearers (professional)	2-stroke	2	300	0.6	4
Trimmers (private)	2-stroke	0.9	20	0.5	10
Trimmers (professional)	2-stroke	0.9	200	0.5	4

Stock and operational data for other machines in household and gardening

Machinery type	Engine	No.	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chippers	2-stroke	200	10	100	0.7	10
Garden shredders	2-stroke	500	3	20	0.7	10
Other (gasoline)	2-stroke	200	2	20	0.5	10
Suction machines	2-stroke	300	4	80	0.5	10
Wood cutters	4-stroke	100	4	15	0.5	10

Operational data for **recreational craft**

Fuel type	Vessel type	Engine type	Stroke	Hours	Lifetime	Load factor
Gasoline	Other boats (<20 ft)	Out board engine	2-stroke	30	10	0.5
Gasoline	Other boats (<20 ft)	Out board engine	4-stroke	30	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	2-stroke	5	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	4-stroke	5	10	0.5
Gasoline	Speed boats	In board engine	4-stroke	75	10	0.5
Gasoline	Speed boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Speed boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Water scooters	Built in	2-stroke	10	10	0.5
Gasoline	Water scooters	Built in	4-stroke	10	10	0.5
Diesel	Motor boats (27-34 ft)	In board engine		150	15	0.5
Diesel	Motor boats (>34 ft)	In board engine		100	15	0.5
Diesel	Motor boats (<27 ft)	In board engine		75	15	0.5
Diesel	Motor sailors	In board engine		75	15	0.5
Diesel	Sailing boats (<26ft)	In board engine		25	15	0.5

Annex 2B-10: Stock data for non-road working machinery and equipment

Stock data for diesel tractors 1985-2006

Size (kW)	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
37	<1981	3882	3234	3106	2922	2861	2610	2605	2273	2193	1918	1796	1601	1449	1298	1148	993	833	664
37	1981-1990	635	879	889	883	915	887	945	883	918	869	888	871	876	882	892	900	906	903
37	1991-Stage I			25	107	153	201	278	354	445	496	554	568	572	576	582	587	592	590
37	Stage I													33	56	83	84	84	84
37	Stage II																23	53	162
45	<1981	25988	21650	20796	19563	19154	17475	17441	15219	14684	12840	12025	10715	9700	8690	7685	6646	5577	4447
45	1981-1990	5740	8770	8867	8805	9128	8848	9419	8807	9151	8668	8856	8681	8731	8800	8894	8974	9037	9006
45	1991-Stage I			203	202	209	203	216	202	210	199	203	199	200	202	204	206	207	207
49	1991-Stage I				154	281	485	602	618	702	749	765	750	754	760	768	775	780	778
52	1991-Stage I											247	358	360	363	367	370	373	372
52	Stage I													132	242	377	381	383	382
52	Stage II																68	147	241
56	1991-Stage I				201	338	428	747	943	1181	1280	1307	1281	1289	1299	1313	1325	1334	1329
60	<1981	54651	45529	43732	41140	40278	36747	36676	32004	30879	27001	25287	22533	20397	18273	16162	13976	11729	9351
60	1981-1990	11751	20542	20770	20624	21380	20725	22063	20628	21434	20304	20744	20333	20451	20612	20834	21019	21167	21096
60	1991-Stage I			863	857	888	861	917	857	891	844	862	845	850	856	866	873	879	876
63	1991-Stage I				468	855	1325	2014	2384	2837	3011	3076	3015	3033	3057	3090	3117	3139	3128
67	1991-Stage I											671	1343	1351	1361	1376	1388	1398	1393
67	Stage I													533	835	1113	1123	1131	1127
67	Stage II																375	729	1144
71	1991-Stage I				411	715	1179	1949	2507	3344	3594	3672	3600	3620	3649	3688	3721	3747	3735
78	<1981	14558	12128	11649	10959	10729	9789	9770	8525	8226	7192	6736	6002	5433	4868	4305	3723	3124	2491
78	1981-1990	4592	11323	11448	11368	11785	11424	12162	11371	11815	11192	11434	11208	11273	11361	11484	11586	11668	11628
78	1991-Stage I			1233	1503	1713	1945	2429	2561	2946	2994	3287	3436	3727	3756	3797	3830	3857	3844
78	Stage I														325	329	332	334	333
78	Stage II															227	310	400	463
86	1991-Stage I				108	193	333	589	880	1364	1532	1718	1876	2023	2039	2061	2079	2094	2087
86	Stage I														134	136	137	138	137
86	Stage II															91	343	530	760
93	1991-Stage I											149	245	325	327	331	334	336	335
93	Stage I														114	115	116	117	116
93	Stage II															107	186	313	512

97	1991-Stage I				71	175	443	962	1556	2327	2638	2695	2642	2657	2678	2707	2731	2750	2741
101	<1981	4659	3881	3728	3507	3433	3132	3126	2728	2632	2302	2156	1921	1739	1558	1378	1191	1000	797
101	1981-1990	1158	2377	2403	2387	2474	2398	2553	2387	2480	2350	2400	2353	2367	2385	2411	2432	2449	2441
101	1991-Stage I			266	264	274	266	283	264	275	260	696	1116	1567	1579	1596	1611	1622	1616
101	Stage I														232	234	236	238	237
101	Stage II															136	357	635	776
112	1991-Stage I				63	114	166	252	422	690	790	978	1265	1626	1639	1656	1671	1683	1677
112	Stage I														465	470	474	478	476
112	Stage II															337	732	1170	1763
127	1991-Stage I				12	36	81	193	279	408	457	590	707	847	854	863	871	877	874
127	Stage I														152	154	155	156	156
127	Stage II															78	268	453	591
131	<1981	798	665	639	601	588	537	536	467	451	394	369	329	298	267	236	204	171	137
131	1981-1990	288	887	897	890	923	895	952	890	925	876	895	878	883	890	899	907	914	911
131	1991-Stage I			97	97	100	97	103	97	100	95	97	95	96	96	97	98	99	99
157	1981-1990		15	15	15	16	15	16	15	16	15	15	15	15	15	15	16	16	16
157	1991-Stage I			9	23	39	102	232	357	545	648	784	900	905	912	922	930	937	934
157	Stage I													89	89	90	91	92	91
157	Stage II														149	415	695	1089	1085
157	Stage IIIA																		623
186	1991-Stage I											23	53	54	54	55	55	56	55
186	Stage I													47	48	48	49	49	49
186	Stage II														68	207	320	481	480
186	Stage IIIA																		272

Stock data for gasoline tractors 1985-2005

Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Certified	<1981	13176	12541	11906	11270	10635	10000	9053	8148	7285	6465	5687	4951	4258	3607	2998	2432	1908	1427	987	591	236
Non certified	<1981	26352	25082	23811	22541	21270	20000	19042	18041	16998	15913	14785	13616	12403	11149	9852	8512	7131	5707	4240	2732	1180

Stock data for harvesters 1985-2006

Size Group	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0<S<=50	<1981	26601	18915	17241	15607	14575	12673	10700	9491	6966	5446	3589	2873	1828	1236	718	251		
0<S<=50	1981-1990	519	591	594	601	635	636	633	683	641	686	672	715	748	754	777	826	840	703
50<S<=60	<1981	2703	2828	2847	2876	3040	3044	3029	3271	3068	2930	2235	1999	1549	1222	854	366		
50<S<=60	1981-1990	853	1333	1341	1355	1432	1434	1427	1541	1446	1548	1516	1612	1687	1702	1752	1863	1894	1675
50<S<=60	1991-Stage I			8	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11
60<S<=70	<1981	1786	1869	1881	1901	2009	2012	2002	2162	2028	2171	2127	2073	1626	1299	934	451		
60<S<=70	1981-1990	1138	2348	2363	2388	2524	2527	2515	2716	2547	2727	2671	2841	2973	2999	3087	3282	3338	3018
60<S<=70	1991-Stage I			8	16	18	21	22	24	23	24	24	25	26	27	27	29	30	29
70<S<=80	<1981	929	972	979	989	1045	1046	1041	1125	1055	1129	1106	1176	1231	1071	699	202		
70<S<=80	1981-1990	383	1493	1502	1518	1604	1606	1598	1726	1619	1733	1698	1806	1890	1906	1963	2086	2122	1953
70<S<=80	1991-Stage I			72	77	83	86	87	96	91	98	96	102	107	108	111	118	120	118
70<S<=80	Stage I											1	1	1	1	1	1	1	1
80<S<=90	<1981	323	338	340	344	363	364	362	391	367	393	385	409	428	432	445	202		
80<S<=90	1981-1990	383	1466	1475	1491	1575	1577	1570	1695	1590	1702	1667	1773	1856	1872	1927	2049	2083	1916
80<S<=90	1991-Stage I			61	158	181	200	200	217	207	222	217	231	242	244	251	267	272	265
80<S<=90	Stage I											1	1	1	1	1	1	1	1
90<S<=100	1981-1990	89	670	674	681	720	721	717	775	726	778	762	810	848	855	881	936	952	930
90<S<=100	1991-Stage I			180	257	320	329	351	382	367	393	385	410	429	433	445	473	481	471
90<S<=100	Stage I											1	1	1	1	1	1	1	1
100<S<=120	1981-1990		589	592	599	633	634	630	681	639	684	670	712	745	752	774	823	837	818
100<S<=120	1991-Stage I			129	253	316	375	440	567	586	673	660	702	734	740	762	811	824	805
100<S<=120	Stage I											2	2	2	2	2	3	3	3
120<S<=140	1981-1990		183	184	186	197	197	196	212	199	213	208	222	232	234	241	256	260	255
120<S<=140	1991-Stage I			70	148	189	215	319	484	626	804	860	918	964	972	1001	1064	1082	1057
120<S<=140	Stage I											21	26	30	31	32	34	34	33
120<S<=140	Stage II																3	3	3
120<S<=140	Stage IIIA																		1
140<S<=160	1991-Stage I				8	36	69	112	271	354	554	632	715	784	791	814	866	880	860
140<S<=160	Stage II														22	38	50	57	56
140<S<=160	Stage IIIA																		5

160<S<=180	1991-Stage I	26	69	200	374	440	533	594	599	617	655	666	651
160<S<=180	Stage II								44	76	95	107	105
160<S<=180	Stage IIIA												8
180<S<=200	1991-Stage I		20	67	117	193	249	296	299	308	327	333	325
180<S<=200	Stage II								66	99	120	132	129
180<S<=200	Stage IIIA												8
200<S<=220	1991-Stage I				45	92	142	185	186	192	204	207	203
200<S<=220	Stage II								44	76	95	107	105
200<S<=220	Stage IIIA												8
220<S<=240	1991-Stage I					3	48	149	150	154	164	167	163
220<S<=240	Stage II								78	124	170	220	215
220<S<=240	Stage IIIA												55
240<S<=260	1991-Stage I					3	71	140	141	145	154	157	153
240<S<=260	Stage II								78	137	207	295	289
240<S<=260	Stage IIIA												102
260<S<=280	1991-Stage I					14	61	129	130	134	142	145	141
260<S<=280	Stage II								78	137	207	295	289
260<S<=280	Stage IIIA												102
280<S<=300	1991-Stage I							33	33	34	36	37	36
280<S<=300	Stage II								78	137	207	295	289
280<S<=300	Stage IIIA												102
300<S<=320	Stage II									28	61	104	102
300<S<=320	Stage IIIA												51

Stock data for fork lifts 1985-2006

FuelCode	Size (kW)	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Diesel	35	<1981	387	260	234	209	183	158	133	107	84	58	30							
Diesel	35	1981-1990	120	297	297	297	297	297	297	297	297	297	297	297	277	249	232	198	177	135
Diesel	35	1991-Stage I			26	49	65	93	131	168	218	247	275	304	304	304	304	304	304	304
Diesel	35	Stage II													23	53	75	89	117	152
Diesel	45	<1981	1612	1082	976	870	764	658	552	446	349	243	126							
Diesel	45	1981-1990	499	1233	1233	1233	1233	1233	1233	1233	1233	1233	1233	1233	1151	1036	964	820	734	559
Diesel	45	1991-Stage I			108	203	270	386	544	699	905	1063	1063	1063	1063	1063	1063	1063	1063	1063
Diesel	45	Stage I											151	303	422	524	664	664	664	664
Diesel	45	Stage II																104	232	452
Diesel	50	<1981	2173	1459	1316	1174	1031	888	745	602	471	328	170							
Diesel	50	1981-1990	673	1662	1662	1662	1662	1662	1662	1662	1662	1662	1662	1662	1551	1396	1299	1105	989	753
Diesel	50	1991-Stage I			145	273	363	519	732	940	1217	1469	1469	1469	1469	1469	1469	1469	1469	1469
Diesel	50	Stage I											240	461	682	897	1135	1135	1135	1135
Diesel	50	Stage II																187	447	818
Diesel	75	<1981	497	334	301	269	236	203	170	138	108	75	39							
Diesel	75	1981-1990	154	382	382	382	382	382	382	382	382	382	382	382	357	321	299	255	228	174
Diesel	75	1991-Stage I			33	63	84	120	169	217	281	354	354	354	354	354	354	354	354	354
Diesel	75	Stage I											70	162	234	311	311	311	311	311
Diesel	75	Stage II															58	129	208	326
Diesel	120	<1981	111	74	67	60	52	45	38	31	24	17	9							
Diesel	120	1981-1990	34	85	85	85	85	85	85	85	85	85	85	85	80	72	67	57	51	39
Diesel	120	1991-Stage I			7	14	19	27	38	49	63	97	97	97	97	97	97	97	97	97
Diesel	120	Stage I											32	71	89	118	118	118	118	118
Diesel	120	Stage II															16	38	58	112
LPG	33		5420	5215	5156	5068	4947	4863	4835	4792	4732	4765	4712	4718	4677	4655	4595	4494	4345	4220
LPG	40		4917	4730	4676	4596	4486	4410	4384	4344	4289	4295	4223	4218	4214	4244	4224	4166	4116	4048
LPG	50		2149	2067	2044	2008	1960	1926	1915	1897	1874	1926	1941	1897	1938	2003	2020	2018	2029	2061
LPG	78		97	93	92	91	89	88	88	87	86	90	92	88	95	98	99	104	104	114
LPG	120											1	2	2	2	3	3	3	3	3

Stock data for construction machinery 1985-2006

EquipmentName (Eng)	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Track type dozers	<1981	125																	
Track type dozers	1981-1990	125	250	221	193	166	139	114	89	66	43	21							
Track type dozers	1991-Stage I			25	48	71	93	114	134	153	172	189	206	201	177	154	132	128	125.00
Track type dozers	Stage II														20	38	56	86	100.00
Track type dozers	Stage IIIA																		25.00
Track type loaders	<1981	50																	
Track type loaders	1981-1990	50	100	89	79	68	58	48	38	28	19	9							
Track type loaders	1991-Stage I			10	20	29	39	48	57	66	75	83	91	91	81	71	62	61	70.50
Track type loaders	Stage II														9	18	26	40	56.40
Track type loaders	Stage IIIA																		14.10
Wheel loaders (0-5 tons)	1981-1990			186	331	434	496	517	496	434	331	186							
Wheel loaders (0-5 tons)	1991-Stage I			21	83	186	331	517	744	1013	1323	1674	2067	2046	1984	1881	1736	1444	1268.80
Wheel loaders (0-5 tons)	Stage II													227	496	806	1158	1444	1903.20
Wheel loaders (> 5,1 tons)	<1981	1250																	
Wheel loaders (> 5,1 tons)	1981-1990	1250	2500	2228	1960	1698	1441	1188	941	698	460	228							
Wheel loaders (> 5,1 tons)	1991-Stage I			248	490	728	960	1188	1411	1629	1841	1822	1802	1559	1322	1089	861	677	484.60
Wheel loaders (> 5,1 tons)	Stage I											228	450	668	881	871	861	902	969.20
Wheel loaders (> 5,1 tons)	Stage II															218	431	677	969.20
Wheel type excavators	<1981	500																	
Wheel type excavators	1981-1990	500	1000	862	732	611	498	394	298	211	132	62							
Wheel type excavators	1991-Stage I			96	183	262	332	394	447	491	528	493	459	372	293	223	162	118	74.00
Wheel type excavators	Stage I											62	115	160	196	179	162	157	148.00
Wheel type excavators	Stage II															45	81	118	148.00
Track type excavators (0-5 tons)	1981-1990			459	816	1071	1224	1275	1224	1071	816	459							
Track type excavators (0-5 tons)	1991-Stage I			51	204	459	816	1275	1837	2500	3265	4132	5101	5050	4897	4642	4285	3889	3599.20
Track type excavators (0-5 tons)	Stage II													561	1224	1990	2857	3889	5398.80
Track type excavators (>5,1 tons)	<1981	1000																	
Track type excavators (>5,1 tons)	1981-1990	1000	2000	1798	1596	1394	1194	993	794	594	396	198							
Track type excavators (>5,1 tons)	1991-Stage I			200	399	598	796	993	1190	1387	1583	1581	1579	1380	1181	983	785	683	536.40
Track type excavators (>5,1 tons)	Stage I											198	395	591	787	786	785	910	1072.80
Track type excavators (>5,1 tons)	Stage II															197	393	683	1072.80
Excavators/Loaders	<1981	2100																	
Excavators/Loaders	1981-1990	2100	4200	3807	3408	3003	2592	2175	1752	1323	888	447							
Excavators/Loaders	1991-Stage I			423	852	1287	1728	2175	2628	3087	3552	3575	3599	3170	2735	2295	1848	1370	937.60
Excavators/Loaders	Stage I											447	900	1359	1824	2295	2310	2283	2344.00

Excavators/Loaders	Stage II																462	913	1406.40
Dump trucks	<1981	250																	
Dump trucks	1981-1990	250	500	489	469	441	404	358	304	241	169	89							
Dump trucks	1991-Stage I			54	117	189	269	358	455	561	676	711	745	682	611	530	442	385	300.80
Dump trucks	Stage I											89	186	292	407	530	552	642	752.00
Dump trucks	Stage II																110	257	451.20
Mini loaders	<1981	1800	800	635	447	235													
Mini loaders	1981-1990	1000	2000	2118	2237	2355	2473	2332	2168	1980	1768	1532	1273	990	684	354			
Mini loaders	1991-Stage I			212	447	706	989	1296	1626	1980	2357	2758	3183	3301	3419	3537	3656	2756	2293.71
Mini loaders	Stage II													330	684	1061	1462	1531	1720.29
Telescopic loaders	1981-1990							149	265	348	398	414	398	348	265	149			
Telescopic loaders	1991-Stage I							83	199	348	530	746	994	1160	1326	1491	1657	1740	1837.14
Telescopic loaders	Stage II													116	265	447	663	966	1377.86

Stock data for machine pools 1985-2006

EquipmentName (Eng)	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Tractors (machine pools)	<1981	1236																	
Tractors (machine pools)	1981-1990	3091	4100	3643	2808	2368	1786	1214	604										
Tractors (machine pools)	1991-Stage I			607	1123	1776	2382	3035	3624	4324	4210	4336	3956	4069	3323	2566	2066	1421	947
Tractors (machine pools)	Stage I														554	513	517	474	474
Tractors (machine pools)	Stage II															513	1033	1421	1895
Harvesters (machine pools)	<1981	969	139																
Harvesters (machine pools)	1981-1990	807	1385	1385	1197	927	794	712	512	421	282	162	78						
Harvesters (machine pools)	1991-Stage I			139	266	348	454	593	615	737	751	729	778	779	651	531	472	300	257
Harvesters (machine pools)	Stage II														65	118	177	171	171
Harvesters (machine pools)	Stage IIIA																		43
Self-propelled vehicles (machine pools)	1981-1990					72	61	38											
Self-propelled vehicles (machine pools)	1991-Stage I					72	122	190	263	278	277	295	289	314	237	203	153	99	50
Self-propelled vehicles (machine pools)	Stage II														47	102	153	199	199
Self-propelled vehicles (machine pools)	Stage IIIA																		50

Stock data for household and gardening 1985-2006

EquipmentName (Eng)	Emission Level	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Lawn movers (private)	<1981	253125																	
Lawn movers (private)	1981-1990	421875	675000	590625	506250	421875	337500	253125	168750	84375									
Lawn movers (private)	1991-Stage I			84375	168750	253125	337500	421875	506250	590625	675000	675000	675000	675000	675000	675000	675000	595000	513750
Lawn movers (private)	Stage I																	85000	171250
Lawn movers (professional)	1981-1990	25000	25000	18750	12500	6250													
Lawn movers (professional)	1991-Stage I			6250	12500	18750	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	18750	12500
Lawn movers (professional)	Stage I																	6250	12500
Cultivators (private-large)	<1981	73333	36667	29333	22000	14667	7333												
Cultivators (private-large)	1981-1990	36667	73333	73333	73333	73333	73333	73333	66000	58667	51333	44000	36667	29333	22000	14667	7333		
Cultivators (private-large)	1991-Stage I			7333	14667	22000	29333	36667	44000	51333	58667	66000	73333	80667	88000	95333	102667	102667	95333
Cultivators (private-large)	Stage II																	7333	14667
Cultivators (private-small)	1981-1990	10000	10000	8000	6000	4000	2000												
Cultivators (private-small)	1991-Stage I			2000	4000	6000	8000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	8000	6000
Cultivators (private-small)	Stage II																	2000	4000
Cultivators (professional)	<1981	3750																	
Cultivators (professional)	1981-1990	6250	10000	8750	7500	6250	5000	3750	2500	1250									
Cultivators (professional)	1991-Stage I			1250	2500	3750	5000	6250	7500	8750	10000	10000	10000	10000	10000	10000	10000	8750	7500
Cultivators (professional)	Stage I																	1250	2500
Chain saws (private)	<1981	125000																	
Chain saws (private)	1981-1990	125000	250000	227250	204000	180250	156000	131250	106000	80250	54000	27250							
Chain saws (private)	1991-Stage I			25250	51000	77250	104000	131250	159000	187250	216000	245250	275000	280750	286500	292250	298000	268200	238400
Chain saws (private)	Stage I																	29800	59600
Chain saws (professional)	1981-1990	10000	10000	7333	4000														
Chain saws (professional)	1991-Stage I			3667	8000	13000	14000	15000	16000	17000	18000	19000	20000	27500	35000	42500	50000	33333	16667
Chain saws (professional)	Stage I																	16667	33333
Chain saws (forestry)	1981-1990	8000	8000	5048	2381														
Chain saws (forestry)	1991-Stage I			2524	4762	6714	6286	5857	5429	5000	4571	4143	3714	3286	2857	2429	2000	1333	667
Chain saws (forestry)	Stage I																	667	1333
Riders (private)	<1981	40950	11700	5880															
Riders (private)	1981-1990	29250	58500	58796	59388	54248	49167	44056	38828	33392	27660	21544	14954	7910					
Riders (private)	1991-Stage I			5880	11878	18083	24583	31469	38828	46748	55320	64631	74771	87015	101775	109920	119360	117741	114313
Riders (private)	Stage I																	10704	22863
Riders (professional)	1981-1990	4800	4800	3878	2966	2035	1056												
Riders (professional)	1991-Stage I			970	1978	3053	4224	5520	5760	6000	6240	6480	6720	7802	9726	12492	16100	15728	13398
Riders (professional)	Stage I																	3932	8932

Shrub clearers (private)	<1981	24000																	
Shrub clearers (private)	1981-1990	24000	48000	47520	46080	43680	40320	36000	30720	24480	17280	9120							
Shrub clearers (private)	1991-Stage I			5280	11520	18720	26880	36000	46080	57120	69120	82080	96000	107000	118000	129000	140000	126000	112000
Shrub clearers (private)	Stage I																	14000	28000
Shrub clearers (professional)	1981-1990	2000	2000	1650	1200	650													
Shrub clearers (professional)	1991-Stage I			550	1200	1950	2800	3000	3200	3400	3600	3800	4000	5500	7000	8500	10000	7500	5000
Shrub clearers (professional)	Stage I																	2500	5000
Hedge cutters (private)	<1981	6850																	
Hedge cutters (private)	1981-1990	6850	13700	15237	16128	16373	15972	14925	13232	10893	7908	4277							
Hedge cutters (private)	1991-Stage I			1693	4032	7017	10648	14925	19848	25417	31632	38493	46000	52900	59800	66700	73600	66240	58880
Hedge cutters (private)	Stage I																	7360	14720
Hedge cutters (professional)	1981-1990	1300	1300	1178	920	528													
Hedge cutters (professional)	1991-Stage I			393	920	1583	2380	2650	2920	3190	3460	3730	4000	4600	5200	5800	6400	4800	3200
Hedge cutters (professional)	Stage I																	1600	3200
Trimmers (private)	<1981	25500																	
Trimmers (private)	1981-1990	25500	51000	48086	44686	40800	36429	31571	26229	20400	14086	7286							
Trimmers (private)	1991-Stage I			5343	11171	17486	24286	31571	39343	47600	56343	65571	75286	77714	80143	82571	85000	76500	68000
Trimmers (private)	Stage I																	8500	17000
Trimmers (professional)	1981-1990	9000	9000	7071	4929	2571													
Trimmers (professional)	1991-Stage I			2357	4929	7714	10714	11143	11571	12000	12429	12857	13286	13714	14143	14571	15000	11250	7500
Trimmers (professional)	Stage I																	3750	7500

Stock data for small boats and pleasure crafts 1985-2006

Motortype	Boat type	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Diesel	Motor boats (27-34 ft)	1550	2228	2397	2567	2736	2906	3075	3244	3414	3583	3753	3922	4092	4261	4431	4600	4600	4600
Diesel	Motor boats (> 34 ft)	450	661	714	767	819	872	925	978	1031	1083	1136	1189	1242	1294	1347	1400	1400	1400
Diesel	Motor boats <(27 ft)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Diesel	Motor sailors	3500	3833	3917	4000	4083	4167	4250	4333	4417	4500	4583	4667	4750	4833	4917	5000	5000	5000
Diesel	Sailing boats (> 26 ft)	7500	9167	9583	10000	10417	10833	11250	11667	12083	12500	12917	13333	13750	14167	14583	15000	15000	15000
2-takt	Other boats (< 20 ft)	4000	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439	4300	4108	3862	3560	3200	2750	2250
2-takt	Yawls and cabin boats	4000	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439	4300	4108	3862	3560	3200	2750	2250
2-takt	Sailing boats (< 26 ft)	19000	18111	17889	17667	17444	17222	17000	16778	16390	15843	15144	14300	13317	12201	10960	9600	8250	6750
2-takt	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	2970	2910	2820	2700	2550	2370	2160	1920	1650	1350
2-takt	Water scooters	1000	1000	1000	1000	1000	1000	1000	1000	990	970	940	900	850	790	720	640	550	450
4-takt	Other boats (< 20 ft)									46	140	283	478	725	1027	1384	1800	2250	2750
4-takt	Yawls and cabin boats									46	140	283	478	725	1027	1384	1800	2250	2750
4-takt	Sailing boats (< 26 ft)									166	490	967	1589	2350	3243	4262	5400	6750	8250
4-takt	Speed boats (in board eng.)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
4-takt	Speed boats (out board eng.)									30	90	180	300	450	630	840	1080	1350	1650
4-takt	Water scooters									10	30	60	100	150	210	280	360	450	550

Engine sizes (kW) for recreational craft 1985-2006

Motor type	Boat type	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2-takt	Other boats (< 20 ft)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2-takt	Yawls and cabin boats	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
2-takt	Sailing boats (< 26 ft)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2-takt	Speed boats	25	31	32	33	35	36	38	39	40	42	43	44	46	47	49	50	50	50
2-takt	Water scooters	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4-takt	Other boats (< 20 ft)									8	8	8	8	8	8	8	8	8	8
4-takt	Yawls and cabin boats									20	20	20	20	20	20	20	20	20	20
4-takt	Sailing boats (< 26 ft)									10	10	10	10	10	10	10	10	10	10
4-takt	Speed boats (in board eng.)	45	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	90	90
4-takt	Speed boats (out board eng.)									40	42	43	44	46	47	49	50	50	50
4-takt	Water scooters									45	45	45	45	45	45	45	45	45	45
Diesel	Motor boats (27-34 ft)	70	88	92	97	101	106	110	114	119	123	128	132	137	141	146	150	150	150
Diesel	Motor boats (> 34 ft)	120	149	156	163	171	178	185	192	199	207	214	221	228	236	243	250	250	250
Diesel	Motor boats <(27 ft)	20	24	26	27	28	29	30	31	32	33	34	36	37	38	39	40	40	40
Diesel	Motor sailors	20	22	23	23	24	24	25	26	26	27	27	28	28	29	29	30	30	30
Diesel	Sailing boats (> 26 ft)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Annex 3B-11: Traffic data and different technical and operational data for Danish domestic ferries

Annual traffic data for ferries (no. of round trips) for Danish domestic ferries

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Korsør-Nyborg, DSB	9305	9167	9237	8959	8813	8789	8746	3258	0	0	0	0	0	0	0	0	0
Korsør-Nyborg, Vognmandsruten	7512	7363	7468	7496	7502	7828	7917	8302	3576	0	0	0	0	0	0	0	0
Halsskov-Knudshoved	10601	10582	11701	11767	12420	12970	13539	13612	5732	0	0	0	0	0	0	0	0
Kalundborg-Juelsminde	0	1326	1733	1542	1541	1508	856	0	0	0	0	0	0	0	0	0	0
Kalundborg-Århus	1907	2400	3162	2921	2913	3540	4962	4888	4483	1454	1870	1804	2037	1800	1750	1725	1724
Sjællands Odde-Ebeltoft	3908	3978	4008	3988	4325	4569	5712	8153	7851	7720	4775	4226	3597	3191	2906	2889	2690
Sjællands Odde-Århus	0	0	0	0	0	0	0	0	0	2339	1799	1817	1825	2359	2863	2795	2853
Hundested-Grenaa	1026	1025	1032	1030	718	602	67	0	0	0	0	0	0	0	0	0	0
København-Rønne	558	545	484	412	427	426	437	465	458	506	491	430	413	397	293	0	0
Køge-Rønne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	154	488	436
Kalundborg-Samsø	873	873	860	881	826	811	813	823	824	850	828	817	833	831	841	867	862
Tårs-Spodsbjerg	7656	8835	9488	9535	9402	9562	9000	9129	7052	6442	6477	6498	6468	6516	6497	6494	6460
Local ferries	176891	179850	181834	178419	202445	209129	182750	197489	200027	202054	201833	200130	208396	208501	206297	205564	203413

Ferry data: Service, name, engine year, main engine MCR (kW), engine type, specific fuel consumption (sfc), aux. engine (kW)

Ferry service	Ferry name	Engine year	Main engine MCR (kW)	Engine type	Sfc (g/kWh)	Aux engine (kW)
Halsskov-Knudshoved	ARVEPRINS KNUD	1963	8238	Slow speed (2-stroke)	220	1666
Halsskov-Knudshoved	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	1692
Halsskov-Knudshoved	HEIMDAL	1983	8309	Medium speed (4-stroke)	220	740
Halsskov-Knudshoved	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	1840
Halsskov-Knudshoved	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	1426
Halsskov-Knudshoved	KRAKA	1982	8309	Medium speed (4-stroke)	220	740
Halsskov-Knudshoved	LODBROG	1982	8309	Medium speed (4-stroke)	220	740
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	1360
Halsskov-Knudshoved	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	1360
Halsskov-Knudshoved	ROMSØ	1973	8826	Medium speed (4-stroke)	230	1728
Halsskov-Knudshoved	SPROGØ	1962	6400	Slow speed (2-stroke)	220	1840
Hundested-Grenaa	DJURSLAND	1974	9856	Medium speed (4-stroke)	230	900
Hundested-Grenaa	KATTEGAT	1995	23200	High speed (4-stroke)	205	1223
Hundested-Grenaa	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	235	1375
Hundested-Grenaa	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	1360
Kalundborg-Juelsminde	Mercandia I	1989	2950	High speed (4-stroke)	220	0
Kalundborg-Juelsminde	Mercandia II	1989	2950	High speed (4-stroke)	220	0
Kalundborg-Juelsminde	Mercandia III	1989	2950	High speed (4-stroke)	220	0
Kalundborg-Juelsminde	Mercandia IV	1989	2950	High speed (4-stroke)	220	0
Kalundborg-Samsø	HOLGER DANSKE	1976	2354	High speed (4-stroke)	225	600
Kalundborg-Samsø	KALUNDBORG	1952	3825	Slow speed (2-stroke)	235	570
Kalundborg-Samsø	KYHOLM	1998	2940	High speed (4-stroke)	195	864
Kalundborg-Samsø	VESBORG	1995	1770	High speed (4-stroke)	200	494
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	2220
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	3000
Kalundborg-Århus	ASK	1984	9840	Medium speed (4-stroke)	215	3000
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	1160
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	800
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	801
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	802
Kalundborg-Århus	CAT-LINK IV	1998	28320	High speed (4-stroke)	205	920
Kalundborg-Århus	CAT-LINK V	1998	28320	High speed (4-stroke)	205	920
Kalundborg-Århus	KATTEGAT SYD	1979	7650	Medium speed (4-stroke)	225	1366
Kalundborg-Århus	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	1840
Kalundborg-Århus	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	1426

Kalundborg-Århus	KRAKA	1982	8309	Medium speed (4-stroke)	220	740
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	2530
Kalundborg-Århus	NIELS KLIM	1986	12474	Slow speed (2-stroke)	215	4440
Kalundborg-Århus	PEDER PAARS	1985	12474	Slow speed (2-stroke)	215	4440
Kalundborg-Århus	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	1360
Kalundborg-Århus	ROSTOCK LINK	1975	8385	Medium speed (4-stroke)	230	2500
Kalundborg-Århus	SØLØVEN/SØBJØRNEN	1992	4000	High speed (4-stroke)	210	272
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	2220
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	3000
Kalundborg-Århus	URD	1981	9840	Medium speed (4-stroke)	215	3000
Korsør-Nyborg, DSB	ASA-THOR	1965	6472	Slow speed (2-stroke)	220	1305
Korsør-Nyborg, DSB	DRONNING INGRID	1980	18720	Medium speed (4-stroke)	220	2932
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	1692
Korsør-Nyborg, DSB	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	1426
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	1981	18720	Medium speed (4-stroke)	220	2932
Korsør-Nyborg, DSB	PRINS JOACHIM	1980	18720	Medium speed (4-stroke)	220	2932
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	1962	6400	Slow speed (2-stroke)	220	1840
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	1989	2950	High speed (4-stroke)	220	0
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	1989	2950	High speed (4-stroke)	220	0
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	1988	2950	High speed (4-stroke)	220	0

Ferry service	Ferry name	Engine year	Main engine MCR (kW)	Engine type	Sfc (g/kWh)	Aux engine (kW)
København-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	106	2889
København-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	109	2889
København-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	106	2889
København-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	109	2889
Køge-Rønne	DUEODDE	2005	8640	Medium speed (4-stroke)	183	1545
Køge-Rønne	HAMMERODDE	2005	8640	Medium speed (4-stroke)	183	1545
Køge-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	108	2889
Køge-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	108	2889
Sjællands Odde-Ebeltoft	MAI MOLS	1996	24800	Gas turbine	240	752
Sjællands Odde-Ebeltoft	MAREN MOLS	1975	12062	Medium speed (4-stroke)	230	1986
Sjællands Odde-Ebeltoft	MAREN MOLS 2	1996	11700	Slow speed (2-stroke)	180	2530
Sjællands Odde-Ebeltoft	METTE MOLS	1975	12062	Medium speed (4-stroke)	230	1986
Sjællands Odde-Ebeltoft	METTE MOLS 2	1996	11700	Slow speed (2-stroke)	180	2530
Sjællands Odde-Ebeltoft	MIE MOLS	1971	5884	Medium speed (4-stroke)	230	
Sjællands Odde-Ebeltoft	MIE MOLS 2	1996	24800	Gas turbine	240	752
Sjællands Odde-Århus	MADS MOLS	1998	28320	High speed (4-stroke)	205	920
Sjællands Odde-Århus	MAI MOLS	1996	24800	Gas turbine	240	752
Sjællands Odde-Århus	MAX MOLS	1998	28320	High speed (4-stroke)	205	920
Sjællands Odde-Århus	MIE MOLS	1996	24800	Gas turbine	240	752
Tårs-Spodsbjerg	FRIGG SYDFYEN	1984	1300	Medium speed (4-stroke)	220	780
Tårs-Spodsbjerg	ODIN SYDFYEN	1982	1180	Medium speed (4-stroke)	220	780
Tårs-Spodsbjerg	SPODSBJERG	1972	1530	Medium speed (4-stroke)	225	300
Tårs-Spodsbjerg	THOR SYDFYEN	1978	1176	Medium speed (4-stroke)	225	300

Ferry data: Sailing time (single trip)

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Halsskov-Knudshoved	ARVEPRINS KNUD	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	DRONNING MARGRETHE II	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	HEIMDAL	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	KNUDSHOVED	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	KONG FREDERIK IX	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	KRAKA	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	LODBROG	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	PRINSESSE ELISABETH	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	ROMSØ	60	60	60	60	60	60	60	60	60							
Halsskov-Knudshoved	SPROGØ	60	60	60	60	60	60	60	60	60							
Hundested-Grenaa	DJURSLAND	160	160	160	160	160											
Hundested-Grenaa	KATTEGAT						90	90									
Hundested-Grenaa	KONG FREDERIK IX					170											
Hundested-Grenaa	PRINSESSE ANNE-MARIE					165											
Kalundborg-Juelsminde	Mercandia I	160	160	160	160	160	160	160									
Kalundborg-Juelsminde	Mercandia II	160	160	160	160	160	160	160									
Kalundborg-Juelsminde	Mercandia III	160	160	160	160	160	160	160									
Kalundborg-Juelsminde	Mercandia IV	160	160	160	160	160	160	160									
Kalundborg-Samsø	HOLGER DANSKE			120	120	120	120	120	120	120							
Kalundborg-Samsø	KALUNDBORG	120	120	120													
Kalundborg-Samsø	KYHOLM									110	110	110	110	110	110	110	110
Kalundborg-Samsø	VESBORG									120							
Kalundborg-Århus	ASK		195	195	195	195	195	195	195	195	195						
Kalundborg-Århus	CAT-LINK I						80	85	90	95							
Kalundborg-Århus	CAT-LINK II						80	85	90	95							
Kalundborg-Århus	CAT-LINK III							85	90	95							
Kalundborg-Århus	CAT-LINK IV									80	80						
Kalundborg-Århus	CAT-LINK V									80	80						
Kalundborg-Århus	KATTEGAT SYD										195						
Kalundborg-Århus	KNUDSHOVED		190														
Kalundborg-Århus	KONG FREDERIK IX		190	190	190	190	190	190									
Kalundborg-Århus	KRAKA									195							
Kalundborg-Århus	MAREN MOLS											160	160	155	155	155	155
Kalundborg-Århus	METTE MOLS											160	160	155	155	155	155
Kalundborg-Århus	NIELS KLIM	185	185														

Kalundborg-Århus	PEDER PAARS	185	185														
Kalundborg-Århus	PRINSESSE ELISABETH		185														
Kalundborg-Århus	ROSTOCK LINK										195						
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90									
Kalundborg-Århus	URD		195	195	195	195	195	195	195	195	195						
Korsør-Nyborg, DSB	ASA-THOR	65	65	65	65	65	65	65	65								
Korsør-Nyborg, DSB	DRONNING INGRID	65	65	65	65	65	65	65	65								
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	65	65	65	65	65	65	65	65								
Korsør-Nyborg, DSB	KONG FREDERIK IX	75	75	75	75	75	75	75	75								
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	65	65	65	65	65	65	65	65								
Korsør-Nyborg, DSB	PRINS JOACHIM	65	65	65	65	65	65	65	65								
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	75	75	75	75	75	75	75	75								
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70							
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70							
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70							
København-Rønne	JENS KOFOED	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
København-Rønne	POVL ANKER	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
Køge-Rønne	DUEODDE																375
Køge-Rønne	HAMMERODDE																375
Køge-Rønne	JENS KOFOED															375	375
Køge-Rønne	POVL ANKER															375	375
Sjællands Odde-Ebeltoft	MAI MOLS							45	45	45	45	45	45	45	45	45	45
Sjællands Odde-Ebeltoft	MAREN MOLS	100	100	100	100	100	100	100									
Sjællands Odde-Ebeltoft	MAREN MOLS 2							100	100	100	95						
Sjællands Odde-Ebeltoft	METTE MOLS	100	100	100	100	100	100	100									
Sjællands Odde-Ebeltoft	METTE MOLS 2							100	100	100	95						
Sjællands Odde-Ebeltoft	MIE MOLS	105	105	105	105	105	105	105									
Sjællands Odde-Ebeltoft	MIE MOLS 2							45	45	45	45	45	45	45	45	45	45
Sjællands Odde-Århus	MADS MOLS										60	65	65	65	65	65	65
Sjællands Odde-Århus	MAI MOLS													65	65	65	65
Sjællands Odde-Århus	MAX MOLS										60	65	65	65	65	65	65
Sjællands Odde-Århus	MIE MOLS													65	65	65	65
Tårs-Spodsbjerg	FRIGG SYDFYEN	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	ODIN SYDFYEN	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	SPODSBJERG	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	THOR SYDFYEN	45	45	45	45	45	17	45	45	45	45	45	45	45	45	45	45

Ferry data: Load factor (% MCR)

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Halsskov-Knudshoved	ARVEPRINS KNUD	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	HEIMDAL	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	KNUDSHOVED	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	KONG FREDERIK IX	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	KRAKA	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	LODBROG	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	PRINSESSE ELISABETH	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	ROMSØ	85	85	85	85	85	85	85	85	85							
Halsskov-Knudshoved	SPROGØ	85	85	85	85	85	85	85	85	85							
Hundested-Grenaa	DJURSLAND	80	80	80	80	80											
Hundested-Grenaa	KATTEGAT						85	85									
Hundested-Grenaa	KONG FREDERIK IX					65											
Hundested-Grenaa	PRINSESSE ANNE-MARIE					85											
Kalundborg-Juelsminde	Mercandia I	75	75	75	75	75	75	75									
Kalundborg-Juelsminde	Mercandia II	70	70	70	70	70	70	70									
Kalundborg-Juelsminde	Mercandia III	70	70	70	70	70	70	70									
Kalundborg-Juelsminde	Mercandia IV	70	70	70	70	70	70	70									
Kalundborg-Samsø	HOLGER DANSKE			85	85	85	85	85	85	85							
Kalundborg-Samsø	KALUNDBORG	80	80	80													
Kalundborg-Samsø	KYHOLM									85	85	85	85	85	85	85	85
Kalundborg-Samsø	VESBORG									95							
Kalundborg-Århus	ASK		85	85	85	80	80	80	80	80	80						
Kalundborg-Århus	CAT-LINK I						95	90	90	85							
Kalundborg-Århus	CAT-LINK II						95	90	90	85							
Kalundborg-Århus	CAT-LINK III							95	95	90							
Kalundborg-Århus	CAT-LINK IV									95	95						
Kalundborg-Århus	CAT-LINK V									95	95						
Kalundborg-Århus	KATTEGAT SYD										85						
Kalundborg-Århus	KNUDSHOVED		85														
Kalundborg-Århus	KONG FREDERIK IX		85	85	85	85	85	85									
Kalundborg-Århus	KRAKA									85							
Kalundborg-Århus	MAREN MOLS											85	85	85	85	85	85
Kalundborg-Århus	METTE MOLS											85	85	85	85	85	85
Kalundborg-Århus	NIELS KLIM	85	85														

Kalundborg-Århus	PEDER PAARS	85	85														
Kalundborg-Århus	PRINSESSE ELISABETH		80														
Kalundborg-Århus	ROSTOCK LINK										80						
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90									
Kalundborg-Århus	URD		85	85	85	85	85	85	85	80	80						
Korsør-Nyborg, DSB	ASA-THOR	85	85	85	85	85	85	85	85								
Korsør-Nyborg, DSB	DRONNING INGRID	60	60	60	60	60	60	60	60								
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85								
Korsør-Nyborg, DSB	KONG FREDERIK IX	70	70	70	70	70	70	70	70								
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	60	60	60	60	60	60	60	60								
Korsør-Nyborg, DSB	PRINS JOACHIM	60	60	60	60	60	60	60	60								
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	70	70	70	70	70	70	70	70								
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70							
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70							
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70							
København-Rønne	JENS KOFOED	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
København-Rønne	POVL ANKER	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Køge-Rønne	DUEODDE																80
Køge-Rønne	HAMMERODDE																80
Køge-Rønne	JENS KOFOED															80	80
Køge-Rønne	POVL ANKER															80	80
Sjællands Odde-Ebeltoft	MAI MOLS							80	80	80	80	80	80	80	80	80	80
Sjællands Odde-Ebeltoft	MAREN MOLS	75	75	75	75	75	75	75									
Sjællands Odde-Ebeltoft	MAREN MOLS 2							80	80	80	85						
Sjællands Odde-Ebeltoft	METTE MOLS	75	75	75	75	75	75	75									
Sjællands Odde-Ebeltoft	METTE MOLS 2							80	80	80	85						
Sjællands Odde-Ebeltoft	MIE MOLS	85	85	85	85	85	85	85									
Sjællands Odde-Ebeltoft	MIE MOLS 2							80	80	80	80	80	80	80	80	80	80
Sjællands Odde-Århus	MADS MOLS										90	85	85	85	85	85	85
Sjællands Odde-Århus	MAI MOLS													75	75	75	75
Sjællands Odde-Århus	MAX MOLS										90	85	85	85	85	85	85
Sjællands Odde-Århus	MIE MOLS													75	75	75	75
Tårs-Spodsbjerg	FRIGG SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	ODIN SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	SPODSBJERG	75	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	THOR SYDFYEN	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80

Ferry data: Round trip shares (%)

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Halsskov-Knudshoved	ARVEPRINS KNUD	21.1	20.2	19.7	19.8	20.6	18.6	18.8	17.6	20.0							
Halsskov-Knudshoved	DRONNING MARGRETHE II	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							
Halsskov-Knudshoved	HEIMDAL	22.5	23.8	22.3	24.3	23.4	21.3	21.1	19.3	21.5							
Halsskov-Knudshoved	KNUDSHOVED	0.0	0.0	0.0	0.0	0.0	0.0	2.4	4.6	0.0							
Halsskov-Knudshoved	KONG FREDERIK IX	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0							
Halsskov-Knudshoved	KRAKA	24.3	25.4	22.7	23.4	21.1	20.4	20.3	19.9	21.0							
Halsskov-Knudshoved	LODBROG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	14.0							
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	0.0	0.0	0.0	0.0	0.0	5.5	2.4	0.0	0.0							
Halsskov-Knudshoved	PRINSESSE ELISABETH	0.0	0.0	0.0	2.5	0.1	0.0	0.0	0.0	0.0							
Halsskov-Knudshoved	ROMSØ	20.6	21.6	20.5	16.2	20.1	19.0	21.1	20.5	22.9							
Halsskov-Knudshoved	SPROGØ	9.1	9.0	14.8	13.8	14.7	14.9	13.9	11.0	0.6							
Hundested-Grenaa	DJURSLAND	100.0	100.0	100.0	100.0	50.0											
Hundested-Grenaa	KATTEGAT						100.0	100.0									
Hundested-Grenaa	KONG FREDERIK IX					5.0											
Hundested-Grenaa	PRINSESSE ANNE-MARIE					45.0											
Kalundborg-Juelsminde	Mercandia I	25.0	25.0	25.0	25.0	25.0	25.0	25.0									
Kalundborg-Juelsminde	Mercandia II	25.0	25.0	25.0	25.0	25.0	25.0	25.0									
Kalundborg-Juelsminde	Mercandia III	25.0	25.0	25.0	25.0	25.0	25.0	25.0									
Kalundborg-Juelsminde	Mercandia IV	25.0	25.0	25.0	25.0	25.0	25.0	25.0									
Kalundborg-Samsø	HOLGER DANSKE			95.0	100.0	100.0	100.0	100.0	100.0	92.0							
Kalundborg-Samsø	KALUNDBORG	100.0	100.0	5.0													
Kalundborg-Samsø	KYHOLM									6.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Kalundborg-Samsø	VESBORG									2.0							
Kalundborg-Århus	ASK		15.8	31.8	26.3	32.8	26.8	18.5	10.7	11.8	2.4						
Kalundborg-Århus	CAT-LINK I						17.2	25.4	27.5	11.4							
Kalundborg-Århus	CAT-LINK II						0.9	22.6	27.5	7.6							
Kalundborg-Århus	CAT-LINK III							8.5	23.6	19.1							
Kalundborg-Århus	CAT-LINK IV									22.9	25.8						
Kalundborg-Århus	CAT-LINK V									15.3	25.8						
Kalundborg-Århus	KATTEGAT SYD										2.4						
Kalundborg-Århus	KNUDSHOVED		4.0														
Kalundborg-Århus	KONG FREDERIK IX		4.0	0.0	6.6	0.0	0.0	1.5									
Kalundborg-Århus	KRAKA									2.4							
Kalundborg-Århus	MAREN MOLS											50.0	50.0	50.0	50.0	50.0	50.0
Kalundborg-Århus	METTE MOLS											50.0	50.0	50.0	50.0	50.0	50.0
Kalundborg-Århus	NIELS KLIM	50.0	19.8														

Kalundborg-Århus	PEDER PAARS	50.0	15.8														
Kalundborg-Århus	PRINSESSE ELISABETH		4.0														
Kalundborg-Århus	ROSTOCK LINK										21.8						
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		20.8	36.4	34.2	34.3	28.2	5.0									
Kalundborg-Århus	URD		15.8	31.8	32.9	32.8	26.8	18.5	10.7	9.5	21.8						
Korsør-Nyborg, DSB	ASA-THOR	12.6	13.4	13.1	11.1	9.3	8.9	9.2	6.3								
Korsør-Nyborg, DSB	DRONNING INGRID	26.2	27.6	25.9	28.3	28.0	28.8	28.2	31.0								
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	3.0	0.0	3.4	0.9	2.8	0.5	2.3	0.0								
Korsør-Nyborg, DSB	KONG FREDERIK IX	0.1	0.0	0.0	0.2	3.4	4.4	0.7	0.0								
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	26.8	28.1	26.9	28.8	28.2	29.3	28.6	31.9								
Korsør-Nyborg, DSB	PRINS JOACHIM	25.2	26.6	25.4	26.9	26.9	27.4	27.1	27.8								
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	6.1	4.3	5.3	3.8	1.4	0.7	3.9	3.0								
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0							
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0							
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0							
København-Rønne	JENS KOFOED	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
København-Rønne	POVL ANKER	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Køge-Rønne	DUEODDE																25.0
Køge-Rønne	HAMMERODDE																35.0
Køge-Rønne	JENS KOFOED															50.0	20.0
Køge-Rønne	POVL ANKER															50.0	20.0
Sjællands Odde-Ebeltoft	MAI MOLS							21.0	35.0	35.0	35.0	50.0	50.0	50.0	50.0	50.0	50.0
Sjællands Odde-Ebeltoft	MAREN MOLS	40.0	40.0	40.0	40.0	40.0	40.0	15.0									
Sjællands Odde-Ebeltoft	MAREN MOLS 2							18.0	15.0	15.0	15.0						
Sjællands Odde-Ebeltoft	METTE MOLS	40.0	40.0	40.0	40.0	40.0	40.0	17.0									
Sjællands Odde-Ebeltoft	METTE MOLS 2							15.0	15.0	15.0	15.0						
Sjællands Odde-Ebeltoft	MIE MOLS	20.0	20.0	20.0	20.0	20.0	20.0	5.0									
Sjællands Odde-Ebeltoft	MIE MOLS 2							9.0	35.0	35.0	35.0	50.0	50.0	50.0	50.0	50.0	50.0
Sjællands Odde-Århus	MADS MOLS										50.0	95.0	90.0	95.0	60.0	60.0	35.0
Sjællands Odde-Århus	MAI MOLS													1.0	10.0	15.0	15.0
Sjællands Odde-Århus	MAX MOLS										50.0	5.0	10.0	3.0	20.0	10.0	35.0
Sjællands Odde-Århus	MIE MOLS													1.0	10.0	15.0	15.0
Tårs-Spodsbjerg	FRIGG SYDFYEN	41.0	40.0	39.0	38.0	36.0	36.0	36.0	32.0	33.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Tårs-Spodsbjerg	ODIN SYDFYEN	41.0	40.0	39.0	38.0	36.0	36.0	36.0	32.0	33.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Tårs-Spodsbjerg	SPODSBJERG	4.0	2.0	8.0	8.0	9.0	8.0	8.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Tårs-Spodsbjerg	THOR SYDFYEN	14.0	18.0	14.0	16.0	19.0	20.0	20.0	17.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annex 2B-12: Fuel use and emission factors, engine specific (NO_x, CO, VOC (NMVOC and CH_4)), and fuel type specific (S-%, SO_2, PM) for ship engines

Specific fuel consumption and NO_x emission factors (g/kWh) per engine year for diesel ship engines

Year	High speed 4-stroke sfc (g/kWh)	Medium speed 4-stroke sfc (g/kWh)	Slow speed 2-stroke sfc (g/kWh)	High speed 4-stroke NO_X (g/kWh)	Medium speed 4-stroke NO_X (g/kWh)	Slow speed 2-stroke NO_X (g/kWh)
1949	265.5	255.5	235.5	7.3	8.0	14.5
1950	265.0	255.0	235.0	7.3	8.0	14.5
1951	264.5	254.5	234.5	7.3	8.0	14.5
1952	264.0	254.0	234.0	7.3	8.0	14.5
1953	263.5	253.5	233.5	7.3	8.0	14.5
1954	263.0	253.0	233.0	7.3	8.0	14.5
1955	262.4	252.4	232.4	7.3	8.0	14.5
1956	261.9	251.9	231.9	7.4	8.1	14.6
1957	261.3	251.3	231.3	7.5	8.2	14.7
1958	260.7	250.7	230.7	7.6	8.3	14.8
1959	260.1	250.1	230.1	7.7	8.4	14.9
1960	259.5	249.5	229.5	7.8	8.5	15.0
1961	258.9	248.9	228.9	7.9	8.6	15.1
1962	258.2	248.2	228.2	8.0	8.7	15.1
1963	257.6	247.6	227.6	8.1	8.8	15.2
1964	256.9	246.9	226.9	8.2	8.9	15.3
1965	256.1	246.1	226.1	8.3	9.0	15.4
1966	255.4	245.4	225.4	8.3	9.1	15.5
1967	254.6	244.6	224.6	8.4	9.2	15.6
1968	253.8	243.8	223.8	8.5	9.3	15.7
1969	253.0	243.0	223.0	8.6	9.4	15.8
1970	252.1	242.1	222.1	8.7	9.5	15.9
1971	251.2	241.2	221.2	8.8	9.6	16.0
1972	250.3	240.3	220.3	8.9	9.7	16.1
1973	249.3	239.3	219.3	9.0	9.8	16.2
1974	248.3	238.3	218.3	9.1	9.9	16.3
1975	247.3	237.3	217.3	9.2	10.0	16.4
1976	246.2	236.2	216.2	9.3	10.1	16.4
1977	245.0	235.0	215.0	9.3	10.2	16.5
1978	243.8	233.8	213.8	9.4	10.3	16.6
1979	242.6	232.6	212.6	9.5	10.4	16.7

1980	241.3	231.3	211.3	9.6	10.5	16.8
1981	239.9	229.9	209.9	9.7	10.6	16.9
1982	238.5	228.5	208.5	9.8	10.7	17.0
1983	237.0	227.0	207.0	9.9	10.8	17.4
1984	235.5	225.5	205.5	10.0	10.9	17.8
1985	233.9	223.9	203.9	10.1	11.0	18.2
1986	232.2	222.2	202.2	10.2	11.1	18.6
1987	230.5	220.5	200.5	10.3	11.3	19.0
1988	228.6	218.6	198.6	10.5	11.4	19.3
1989	226.7	216.7	196.7	10.6	11.6	19.5
1990	224.8	214.8	194.8	10.7	11.7	19.8
1991	222.7	212.7	192.7	10.9	11.9	20.0
1992	220.5	210.5	190.5	11.0	12.0	19.8
1993	218.3	208.3	188.3	11.1	12.1	19.6
1994	216.0	206.0	186.0	11.3	12.3	19.4
1995	213.6	203.6	183.6	11.4	12.4	19.3
1996	211.0	201.0	181.0	11.5	12.6	19.1
1997	208.4	198.4	178.4	11.7	12.7	18.9
1998	205.7	195.7	175.7	11.8	12.9	18.7
1999	202.9	192.9	172.9	11.9	13.0	18.5
2000	199.9	189.9	169.9	11.0	12.0	16.0

CO, VOC, NMVOC and CH_4 emission factors (g/kg fuel) for ship engines

	High speed 4-stroke CO	Medium speed 4-stroke CO	Slow speed 2-stroke CO	High speed 4-stroke VOC	Medium speed 4-stroke VOC	Slow speed 2-stroke VOC
1949	6.03	6.26	6.79	1.88	1.96	2.12
1950	6.04	6.27	6.81	1.89	1.96	2.13
1951	6.05	6.29	6.82	1.89	1.96	2.13
1952	6.06	6.30	6.84	1.89	1.97	2.14
1953	6.07	6.31	6.85	1.90	1.97	2.14
1954	6.08	6.33	6.87	1.90	1.98	2.15
1955	6.10	6.34	6.88	1.91	1.98	2.15
1956	6.11	6.35	6.90	1.91	1.99	2.16
1957	6.12	6.37	6.92	1.91	1.99	2.16
1958	6.14	6.38	6.93	1.92	1.99	2.17
1959	6.15	6.40	6.95	1.92	2.00	2.17
1960	6.17	6.41	6.97	1.93	2.00	2.18
1961	6.18	6.43	6.99	1.93	2.01	2.18
1962	6.20	6.45	7.01	1.94	2.01	2.19
1963	6.21	6.46	7.03	1.94	2.02	2.20
1964	6.23	6.48	7.05	1.95	2.03	2.20
1965	6.25	6.50	7.08	1.95	2.03	2.21
1966	6.26	6.52	7.10	1.96	2.04	2.22
1967	6.28	6.54	7.12	1.96	2.04	2.23
1968	6.30	6.56	7.15	1.97	2.05	2.23
1969	6.32	6.58	7.17	1.98	2.06	2.24
1970	6.35	6.61	7.20	1.98	2.06	2.25
1971	6.37	6.63	7.23	1.99	2.07	2.26
1972	6.39	6.66	7.26	2.00	2.08	2.27
1973	6.42	6.69	7.29	2.01	2.09	2.28
1974	6.44	6.71	7.33	2.01	2.10	2.29
1975	6.47	6.74	7.36	2.02	2.11	2.30
1976	6.50	6.77	7.40	2.03	2.12	2.31
1977	6.53	6.81	7.44	2.04	2.13	2.33
1978	6.56	6.84	7.48	2.05	2.14	2.34
1979	6.60	6.88	7.53	2.06	2.15	2.35
1980	6.63	6.92	7.57	2.07	2.16	2.37
1981	6.67	6.96	7.62	2.08	2.17	2.38
1982	6.71	7.00	7.67	2.10	2.19	2.40

1983	6.75	7.05	7.73	2.11	2.20	2.42
1984	6.79	7.10	7.79	2.12	2.22	2.43
1985	6.84	7.15	7.85	2.14	2.23	2.45
1986	6.89	7.20	7.91	2.15	2.25	2.47
1987	6.94	7.26	7.98	2.17	2.27	2.49
1988	7.00	7.32	8.05	2.19	2.29	2.52
1989	7.06	7.38	8.13	2.21	2.31	2.54
1990	7.12	7.45	8.22	2.22	2.33	2.57
1991	7.18	7.52	8.30	2.25	2.35	2.59
1992	7.25	7.60	8.40	2.27	2.37	2.62
1993	7.33	7.68	8.50	2.29	2.40	2.66
1994	7.41	7.77	8.60	2.31	2.43	2.69
1995	7.49	7.86	8.72	2.34	2.46	2.72
1996	7.58	7.96	8.84	2.37	2.49	2.76
1997	7.68	8.06	8.97	2.40	2.52	2.80
1998	7.78	8.18	9.11	2.43	2.56	2.85
1999	7.89	8.30	9.26	2.46	2.59	2.89
2000	8.00	8.43	9.42	2.50	2.63	2.94

	High speed 4-stroke NMVOC	Medium speed 4-stroke NMVOC	Slow speed 2-stroke NMVOC	High speed 4-stroke CH_4	Medium speed 4-stroke CH_4	Slow speed 2-stroke CH_4
1949	1.83	1.90	2.06	0.06	0.06	0.06
1950	1.83	1.90	2.06	0.06	0.06	0.06
1951	1.83	1.91	2.07	0.06	0.06	0.06
1952	1.84	1.91	2.07	0.06	0.06	0.06
1953	1.84	1.91	2.08	0.06	0.06	0.06
1954	1.84	1.92	2.08	0.06	0.06	0.06
1955	1.85	1.92	2.09	0.06	0.06	0.06
1956	1.85	1.93	2.09	0.06	0.06	0.06
1957	1.86	1.93	2.10	0.06	0.06	0.06
1958	1.86	1.93	2.10	0.06	0.06	0.07
1959	1.86	1.94	2.11	0.06	0.06	0.07
1960	1.87	1.94	2.11	0.06	0.06	0.07
1961	1.87	1.95	2.12	0.06	0.06	0.07
1962	1.88	1.95	2.13	0.06	0.06	0.07
1963	1.88	1.96	2.13	0.06	0.06	0.07
1964	1.89	1.96	2.14	0.06	0.06	0.07
1965	1.89	1.97	2.14	0.06	0.06	0.07
1966	1.90	1.98	2.15	0.06	0.06	0.07
1967	1.90	1.98	2.16	0.06	0.06	0.07
1968	1.91	1.99	2.17	0.06	0.06	0.07
1969	1.92	2.00	2.17	0.06	0.06	0.07
1970	1.92	2.00	2.18	0.06	0.06	0.07
1971	1.93	2.01	2.19	0.06	0.06	0.07
1972	1.94	2.02	2.20	0.06	0.06	0.07
1973	1.95	2.03	2.21	0.06	0.06	0.07
1974	1.95	2.04	2.22	0.06	0.06	0.07
1975	1.96	2.04	2.23	0.06	0.06	0.07
1976	1.97	2.05	2.24	0.06	0.06	0.07
1977	1.98	2.06	2.26	0.06	0.06	0.07
1978	1.99	2.07	2.27	0.06	0.06	0.07
1979	2.00	2.09	2.28	0.06	0.06	0.07
1980	2.01	2.10	2.30	0.06	0.06	0.07
1981	2.02	2.11	2.31	0.06	0.07	0.07
1982	2.03	2.12	2.33	0.06	0.07	0.07

1983	2.05	2.14	2.34	0.06	0.07	0.07
1984	2.06	2.15	2.36	0.06	0.07	0.07
1985	2.07	2.17	2.38	0.06	0.07	0.07
1986	2.09	2.18	2.40	0.06	0.07	0.07
1987	2.10	2.20	2.42	0.07	0.07	0.07
1988	2.12	2.22	2.44	0.07	0.07	0.08
1989	2.14	2.24	2.47	0.07	0.07	0.08
1990	2.16	2.26	2.49	0.07	0.07	0.08
1991	2.18	2.28	2.52	0.07	0.07	0.08
1992	2.20	2.30	2.55	0.07	0.07	0.08
1993	2.22	2.33	2.58	0.07	0.07	0.08
1994	2.25	2.35	2.61	0.07	0.07	0.08
1995	2.27	2.38	2.64	0.07	0.07	0.08
1996	2.30	2.41	2.68	0.07	0.07	0.08
1997	2.33	2.44	2.72	0.07	0.08	0.08
1998	2.36	2.48	2.76	0.07	0.08	0.09
1999	2.39	2.51	2.81	0.07	0.08	0.09
2000	2.43	2.55	2.85	0.08	0.08	0.09

S-%, SO_2 and PM emission factors (g/kg fuel and g/GJ) per fuel type for diesel ship engines

Fuel type	SNAPCode	Year	S %	SO_2 (g/kg)	TSP (g/kg)	PM_{10} (g/kg)	$PM_{2,5}$ (g/kg)	SO_2 (g/GJ)	TSP (g/GJ)	PM_{10} (g/GJ)	$PM_{2,5}$ (g/GJ)
Fuel	National sea	1990	2.6	52.8	6.1	6.0	6.0	1291.0	149.2	147.8	147.0
Fuel	National sea	1991	2.4	47.0	4.9	4.9	4.8	1149.1	120.2	119.0	118.4
Fuel	National sea	1992	1.8	36.0	3.3	3.2	3.2	880.2	79.8	79.0	78.6
Fuel	National sea	1993	2.4	47.8	5.1	5.0	5.0	1168.7	123.9	122.6	122.0
Fuel	National sea	1994	2.6	52.4	6.0	6.0	5.9	1281.2	147.0	145.6	144.8
Fuel	National sea	1995	3	59.0	7.7	7.6	7.6	1442.5	188.0	186.1	185.2
Fuel	National sea	1996	2.6	51.4	5.8	5.7	5.7	1256.7	141.7	140.2	139.5
Fuel	National sea	1997	2.7	54.8	6.6	6.5	6.5	1339.9	160.8	159.2	158.4
Fuel	National sea	1998	2	39.4	3.7	3.7	3.6	963.3	90.6	89.7	89.2
Fuel	National sea	1999	2	39.4	3.7	3.7	3.6	963.3	90.6	89.7	89.2
Fuel	National sea	2000	1.8	36.2	3.3	3.3	3.2	885.1	80.4	79.6	79.2
Fuel	National sea	2001	1.7	34.0	3.0	3.0	3.0	831.3	74.1	73.4	73.0
Fuel	National sea	2002	1.5	30.2	2.6	2.6	2.6	738.4	64.3	63.7	63.3
Fuel	National sea	2003	1.6	32.4	2.9	2.8	2.8	792.2	69.8	69.1	68.8
Fuel	National sea	2004	2	39.6	3.7	3.7	3.7	968.2	91.3	90.4	89.9
Fuel	National sea	2005	2	40.0	3.8	3.8	3.7	978.0	92.6	91.7	91.3
Fuel	National sea	2006	1.9	38.8	3.6	3.6	3.6	948.7	88.6	87.7	87.3
Fuel	National sea	2007	1.3	25.0	2.2	2.1	2.1	611.2	53.0	52.5	52.2
Fuel	National sea	2008	1.3	25.0	2.2	2.1	2.1	611.2	53.0	52.5	52.2
Fuel	International sea	1990	3	59.2	7.7	7.7	7.6	1447.4	189.4	187.5	186.6
Fuel	International sea	1991	2.9	57.8	7.4	7.3	7.2	1413.2	179.8	178.0	177.1
Fuel	International sea	1992	2.9	57.6	7.3	7.2	7.2	1408.3	178.5	176.7	175.8
Fuel	International sea	1993	3.2	64.0	9.3	9.2	9.1	1564.8	226.5	224.2	223.1
Fuel	International sea	1994	3	60.6	8.2	8.1	8.0	1481.7	199.6	197.6	196.6
Fuel	International sea	1995	3.3	66.0	10.0	9.9	9.8	1613.7	244.0	241.6	240.4
Fuel	International sea	1996	3.4	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	1997	3.5	69.0	11.2	11.0	11.0	1687.0	272.9	270.2	268.8
Fuel	International sea	1998	3.4	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	1999	3.5	69.0	11.2	11.0	11.0	1687.0	272.9	270.2	268.8
Fuel	International sea	2000	3.4	67.2	10.4	10.3	10.3	1643.0	255.2	252.6	251.4
Fuel	International sea	2001	3.4	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	2002	3.4	68.8	11.1	11.0	10.9	1682.2	270.9	268.2	266.8
Fuel	International sea	2003	3.1	62.2	8.7	8.6	8.5	1520.8	211.8	209.7	208.6
Fuel	International sea	2004	3.2	64.0	9.3	9.2	9.1	1564.8	226.5	224.2	223.1

Fuel	International sea	2005	3.5	70.0	11.6	11.5	11.4	1711.5	283.2	280.4	279.0
Fuel	International sea	2006	3.4	67.0	10.4	10.3	10.2	1638.1	253.3	250.8	249.5
Fuel	International sea	2007	1.5	30.0	2.6	2.6	2.6	733.5	63.8	63.2	62.9
Fuel	International sea	2008	1.5	30.0	2.6	2.6	2.6	733.5	63.8	63.2	62.9
Diesel	-	1990	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1991	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1992	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1993	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1994	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1995	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1996	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1997	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1998	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1999	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2000	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2001	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2002	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2003	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2004	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2005	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2006	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2007	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2008	0.1	2.0	0.9	0.9	0.9	46.8	21.5	21.3	21.2

Annex 2B-13: Fuel sales figures from DEA, and further processed fuel consumption data suited for the Danish inventory

Categories	1985	1990	1995	2000	2001	2002	2003	2004	2005	2006
Agriculture and forestry, DEA statistics										
- LPG	88	438	204	179	190	159	153	138	121	117
- gasoline	425	274	161	38	39	28	42	51	52	20
- gas/diesel oil	9 199	10 528	11 585	13 689	13 437	13 706	13 463	12 934	12 440	12 988
Gartneri, DEA statistics										
- LPG	8	50	23	19	20	17	16	14	12	12
- gasoline	10	10	18	4	4	3	5	6	6	2
- gas/diesel oil	1 705	1 409	1 138	698	581	529	556	488	431	450
Fishery, DEA statistics										
- LPG	-	42	16	13	19	21	20	18	20	20
- gasoline	-	9	8	67	3	3	0	0	0	1
- kerosene	7	26	4	25	1	1	1	1	1	0
- gas/diesel oil	9 152	10 422	8 277	9 347	8 908	8 888	8 428	7 337	7 340	7 762
- fuel oil	27	285	19	-	-	4	84	35	126	86
Manufacturing industry, DEA statistics										
- LPG	2 860	2 032	2 234	1 819	1 526	1 405	1 472	1 488	1 478	1 482
- gasoline	262	177	110	97	69	42	26	30	21	32
- gas/diesel oil	15 576	12 259	10 401	8 635	10 099	9 155	9 964	10 515	10 023	9 130
- fuel oil	29 465	15 989	14 000	8 221	7 395	7 818	6 916	6 940	6 055	8 527
Building and construction, DEA statistics										
- LPG	305	500	501	165	179	236	226	228	224	248
- gasoline	19	34	25	33	24	26	27	27	27	27
- gas/diesel oil	5 313	3 548	5 317	5 950	6 356	6 226	6 226	6 227	6 338	6 187
Housing, DEA statistics										
- gasoline	1 006	1 131	1 233	1 355	1 317	1 313	1 303	1 288	1 250	1 228
Road transport, DEA statistics										
- gasoline	66 037	74 326	80 998	88 975	86 474	86 247	85 611	84 629	82 118	80 631
- gas/diesel oil	45 609	54 746	58 561	64 282	66 254	66 814	70 875	75 422	79 686	86 422
- bioethanol	-	-	-	-	-	-	-	-	-	151
Non-road categories sum, DEA statistics										
- LPG	2 955	2 520	2 461	2 018	1 736	1 581	1 641	1 640	1 612	1 610
- gasoline	1 722	1 626	1 547	1 525	1 453	1 412	1 404	1 402	1 356	1 308
- gas/diesel oil	31 793	27 744	28 441	28 972	30 473	29 616	30 209	30 164	29 232	28 755
Non-road, NERI model										

- LPG	1232	1185	1099	1071	1073	1084	1079	1065	1049	1038
- gasoline	2998	2770	2521	2458	2622	2833	3090	3391	3604	3807
- gas/diesel oil	26357	26800	25798	24630	24893	25053	25233	25558	26199	27495
Recreational craft, NERI model										
- gasoline	270	309	358	396	400	403	404	404	393	382
- gas/diesel oil	219	343	537	777	831	886	944	1 002	1 002	1 002
Non-road, added 0203 and 0301										
- gas/diesel oil	5436	944	2642	4342	5580	4563	4976	4606	3033	1260
- LPG	1724	1335	1362	947	662	497	563	575	562	572
Non-road, added 0203										
- gas/diesel oil	1864	406	1182	2156	2567	2193	2309	2050	1335	589
- LPG	56	259	125	93	80	55	58	53	46	46
Non-road, added 0301										
- gas/diesel oil	3572	538	1460	2186	3013	2370	2667	2557	1697	671
- LPG	1668	1076	1237	854	582	442	505	522	516	526
Non-road, added road transport										
- gasoline	-1276	-1145	-975	-932	-1169	-1421	-1686	-1990	-2248	-2499
Fisheries, added national sea transport										
- fuel oil	27	285	19	0	0	4	84	35	126	86
Fisheries, consumed by recreational craft										
- gasoline	0	9	8	67	3	3	0	0	0	1
National sea transport, input NERI model										
- LPG	3	2	2	0	-	-	0	0	0	0
- kerosene	5	0	1	1	1	1	1	1	1	0
- gas/diesel oil	3 074	2 782	6 049	3 367	3 240	3 780	3 828	3 463	4 358	3 699
- fuel oil	2 541	3 845	1 592	1 509	1 513	2 068	1 907	1 704	1 506	1 367
Fisheries, input NERI model										
- LPG	-	42	16	13	19	21	20	18	20	20
- gasoline	-	-	-	-	-	-	-	-	-	-
- kerosene	7	26	4	25	1	1	1	1	1	0
- gas/diesel oil	8 932	10 080	7 740	8 570	8 077	8 001	7 484	6 335	6 338	6 760
National sea transport, output NERI model										
- gas/diesel oil	4 942	4 942	6 655	4 371	4 173	4 083	4 081	4 182	4 135	4 087
- fuel oil	3 843	3 843	2 653	715	671	659	647	673	679	645
- kerosene	5	0	1	1	1	1	1	1	1	-
- LPG	3	2	2	0	-	-	0	0	0	-
Fisheries, output NERI model										
- gas/diesel oil	7 064	7 920	7 134	7 566	7 145	7 699	7 230	5 616	6 561	6 371

- kerosene	7	26	4	25	1	1	1	1	1	0
- LPG	-	42	16	13	19	21	20	18	20	20
National sea transport, added 0301										
- fuel oil	-1 302	3	-1 061	794	842	1 409	1 260	1 032	826	722
Road transport, NERI excl. traded fuels										
- gasoline	64 492	72 882	79 674	87 713	84 907	84 426	83 521	82 235	79 477	77 751
- gas/diesel oil	45 609	54 746	58 561	64 282	66 254	66 814	70 875	75 422	79 686	86 422
- bioethanol	-	-	-	-	-	-	-	-	-	151
Road transport, input NERI model incl. traded fuels										
- gasoline	62 077	66 279	80 101	83 312	81 852	81 963	81 878	80 593	77 835	76 109
- gas/diesel oil	49 016	59 947	64 013	69 196	70 916	72 552	78 766	84 209	88 474	95 210
- bioethanol	-	-	-	-	-	-	-	-	-	151

Annex 2B-14: Emission factors and total emissions in CollectER format

2006 emission factors for SO_2, NO_x; NMVOC, NH_3 and TSP

Year	SNAP ID	Category	Fuel type	Mode	Fuel [GJ]	SO_2 [g/GJ]	NO_X [g/GJ]	NMVOC [g/GJ]	CO [g/GJ]	NH_3 [g/GJ]	TSP [g/GJ]
2006	070101	Passenger cars	Diesel	Highway driving	3047512	0.47	319.73	8.50	43.43	0.47	32.38
2006	070101	Passenger cars	Gasoline 2-stroke	Highway driving	0	2.28	288.90	2357.34	3490.86	0.80	48.15
2006	070101	Passenger cars	Gasoline conventional	Highway driving	1166772	0.46	1343.32	329.92	2679.96	0.89	10.34
2006	070101	Passenger cars	LPG	Highway driving	10850179	0.46	139.28	29.28	765.90	32.76	0.70
2006	070102	Passenger cars	Diesel	Rural driving	76	0.00	1151.70	187.09	3914.25	0.00	10.06
2006	070102	Passenger cars	Gasoline 2-stroke	Rural driving	6706578	0.47	298.46	11.92	70.03	0.52	24.88
2006	070102	Passenger cars	Gasoline conventional	Rural driving	0	2.28	352.84	2476.82	2594.44	0.69	41.51
2006	070102	Passenger cars	LPG	Rural driving	2563993	0.46	1160.25	451.68	3105.49	0.98	11.56
2006	070103	Passenger cars	Diesel	Urban driving	24974459	0.46	108.34	31.59	581.58	42.19	0.65
2006	070103	Passenger cars	Gasoline 2-stroke	Urban driving	153	0.00	1248.46	305.18	1146.38	0.00	14.49
2006	070103	Passenger cars	Gasoline conventional	Urban driving	6925310	0.47	277.96	29.76	153.91	0.38	38.96
2006	070103	Passenger cars	LPG	Urban driving	0	2.28	51.89	4470.04	7400.54	0.33	19.72
2006	070201	Light duty vehicles	Diesel	Highway driving	2993855	0.46	635.40	867.63	7933.84	0.64	11.15
2006	070201	Light duty vehicles	Gasoline conventional	Highway driving	28058644	0.46	140.53	226.74	2522.10	15.58	0.74
2006	070202	Light duty vehicles	Diesel	Rural driving	192	0.00	615.77	445.18	1341.15	0.00	11.72
2006	070202	Light duty vehicles	Gasoline conventional	Rural driving	4788870	0.47	302.09	29.56	174.62	0.36	40.25
2006	070203	Light duty vehicles	Diesel	Urban driving	61484	0.46	1370.99	170.51	2991.20	0.81	16.19
2006	070203	Light duty vehicles	Gasoline conventional	Urban driving	416547	0.46	106.70	12.03	470.62	24.66	0.53
2006	070301	Heavy duty vehicles	Diesel	Highway driving	14589910	0.47	318.07	33.03	159.08	0.39	36.08
2006	070301	Heavy duty vehicles	Gasoline	Highway driving	217332	0.46	1190.37	262.92	2319.12	0.76	15.27
2006	070302	Heavy duty vehicles	Diesel	Rural driving	1470765	0.46	93.87	17.05	352.33	27.04	0.43
2006	070302	Heavy duty vehicles	Gasoline	Rural driving	14197799	0.47	332.66	55.23	189.77	0.28	47.26
2006	070303	Heavy duty vehicles	Diesel	Urban driving	262798	0.46	624.60	724.30	7474.97	0.44	8.84
2006	070303	Heavy duty vehicles	Gasoline	Urban driving	1773812	0.46	107.04	125.85	2939.26	7.88	0.42
2006	0704	Mopeds	Gasoline	Mopeds & Motorcycles < 50 cm3	12661976	0.47	773.65	26.25	156.24	0.32	20.35
2006	070501	Motorcycles	Gasoline	Highway driving	15735	0.46	1039.09	475.21	7620.01	0.28	55.42
2006	070502	Motorcycles	Gasoline	Rural driving	19035878	0.47	797.33	34.88	162.64	0.32	20.65
2006	070503	Motorcycles	Gasoline	Urban driving	32016	0.46	1143.00	821.44	8382.01	0.30	60.96
2006	0801	Military	Diesel		631564	0.47	538.08	35.10	158.94	0.34	30.51
2006	0801	Military	Jet fuel	< 3000 ft	109686	22.99	250.57	24.94	229.89	0.00	1.16
2006	0801	Military	Jet fuel	> 3000 ft	987175	22.99	250.57	24.94	229.89	0.00	1.16

2006	0801	Military	Gasoline		6603	0.46	206.69	260.01	2050.72	25.15	2.58
2006	0801	Military	Aviation gasoline		3638	22.99	859.00	1242.60	6972.00	1.60	10.00
2006	0802	Railways	Diesel		3064383	0.47	1155.92	74.96	204.41	0.20	39.02
2006	0802	Railways	Kerosene		1002148	93.68	868.57	168.09	450.77	0.17	103.58
2006	0802	Railways	Gasoline		381525	0.46	446.85	2050.43	15870.55	0.09	90.85
2006	0803	Inland waterways	Diesel		645303	948.66	1748.91	59.46	196.16		88.60
2006	0803	Inland waterways	Gasoline		4087478	93.68	1288.42	50.25	136.65	0.00	23.21
2006	080402	Maritime activities	Residual oil		0						
2006	080402	Maritime activities	Diesel		0						
2006	080402	Maritime activities	Kerosene		0	1101.71	1393.60	56.90	180.90		139.40
2006	080402	Maritime activities	LPG		6371456	93.68	1355.43	56.36	185.92	0.00	23.21
2006	080403	Maritime activities	Residual oil		313	2.30	50.00	3.00	20.00		5.00
2006	080403	Maritime activities	Diesel		0	2.28	64.34	10809.60	18485.10	0.10	23.25
2006	080403	Maritime activities	Kerosene		20010	0.00	1249.00	384.94	443.00	0.00	0.20
2006	080403	Maritime activities	Gasoline		31564684	1638.14	2053.70	60.73	200.35		253.29
2006	080403	Maritime activities	LPG		13116246	93.68	1516.56	55.34	182.57		23.21
2006	080404	Maritime activities	Residual oil		157817	22.99	287.66	27.15	148.43		1.16
2006	080404	Maritime activities	Diesel		91473	22.83	859.00	1242.60	6972.00	1.60	10.00
2006	080501	Air traffic	Jet fuel	Dom. < 3000 ft	242148	22.99	289.45	33.27	200.52		1.16
2006	080501	Air traffic	Aviation gasoline		1412	22.83	859.00	1242.60	6972.00	1.60	10.00
2006	080502	Air traffic	Jet fuel	Int. < 3000 ft	516295	22.99	279.30	20.57	127.01		1.16
2006	080502	Air traffic	Aviation gasoline		2684753	22.99	238.63	8.64	62.41		1.16
2006	080503	Air traffic	Jet fuel	Dom. > 3000 ft	14611522	2.34	779.40	83.90	420.46	0.18	62.65
2006	080504	Air traffic	Jet fuel	Int. > 3000 ft	382327	0.46	107.59	1143.22	21833.70	1.41	29.26
2006	0806	Agriculture	Diesel		159065	2.34	650.75	50.31	296.03	0.18	34.88
2006	0806	Agriculture	Gasoline		75313	0.46	73.12	6684.07	16521.92	0.08	76.48
2006	0807	Forestry	Diesel		12724048	2.34	738.43	93.38	414.76	0.18	77.29
2006	0807	Forestry	Gasoline		163110	0.46	197.21	1491.92	13052.28	0.10	13.85
2006	0808	Industry	Diesel		1038180	0.00	1328.11	146.09	104.85	0.21	4.89
2006	0808	Industry	Gasoline		3186399	0.46	86.20	2522.22	27536.91	0.09	24.90
2006	0808	Industry	LPG		210424	22.99	275.95	35.84	193.29		1.16
2006	0809	Household and gardening	Gasoline		733	22.83	859.00	1242.60	6972.00	1.60	10.00
2006	80501,00	Air traffic, Copenhagen airport	Jet fuel	Dom. < 3000 ft	2718218	22.99	341.71	44.14	223.20	0.00	1.16
2006	80501,00	Air traffic, Copenhagen airport	Aviation gasoline		206	22.83	859.00	1242.60	6972.00	1.60	10.00
2006	80502,00	Air traffic, Copenhagen airport	Jet fuel	Int. < 3000 ft	983181	22.99	274.14	18.44	66.15	0.00	1.16
2006	80502,00	Air traffic, Copenhagen airport	Aviation gasoline		30232427	22.99	315.36	11.20	34.29	0.00	1.16
2006	80503,00	Air traffic, Copenhagen airport	Jet fuel	Dom. > 3000 ft	631564	0.47	538.08	35.10	158.94	0.34	30.51

2006	80504,00	Air traffic, Copenhagen airport	Jet fuel	Int. > 3000 ft		109686	22.99	250.57	24.94	229.89	0.00	1.16

2006 emissions for SO_2, NO_x; NMVOC, NH_3 and TSP

Year	Category	Mode		SO_2 [tons]	NO_X [tons]	NMVOC [tons]	CO [tons]	NH_3 [tons]	TSP [tons]
2006									
2006	Passenger cars	Highway driving	70101	7	4053	729	11570	358	118
2006	Passenger cars	Rural driving	70102	16	7682	2027	22957	1060	213
2006	Passenger cars	Urban driving	70103	17	7770	9166	95586	442	324
2006	Light duty vehicles	Highway driving	70201	2	1575	157	1216	12	194
2006	Light duty vehicles	Rural driving	70202	8	5037	564	3343	46	530
2006	Light duty vehicles	Urban driving	70203	8	5077	1198	9872	18	674
2006	Heavy duty vehicles	Highway driving	70301	6	9812	340	2098	4	259
2006	Heavy duty vehicles	Rural driving	70302	9	15214	690	3364	6	395
2006	Heavy duty vehicles	Urban driving	70303	6	10561	649	2771	4	330
2006	Mopeds		704	0	18	1941	2158	0	30
2006	Motorcycles	Highway driving	70501	0	49	206	2985	0	5
2006	Motorcycles	Rural driving	70502	0	86	571	6519	1	13
2006	Motorcycles	Urban driving	70503	0	57	916	7081	1	16
2006	Evaporation		706			4017			
2006	Military		801	26	619	56	391	0	21
2006	Railways		802	1	3542	230	626	1	120
2006	Inland waterways		803	94	1041	951	6507	0	138
2006	National sea traffic		80402	995	6395	244	685	0	152
2006	Fishing		80403	597	8661	367	1193	0	148
2006	International sea traffic		80404	52936	84716	2643	8719		8300
2006	Air traffic, Dom. < 3000 ft.		80501	11	183	126	707	0	1
2006	Air traffic, Int. < 3000 ft.		80502	68	1000	130	667	0	3
2006	Air traffic, Dom. > 3000 ft.		80503	34	414	29	131	0	2
2006	Air traffic, Int. > 3000 ft.		80504	757	10175	362	1204	0	38
2006	Agriculture		806	34	11429	1663	14491	3	927
2006	Forestry		807	0	109	511	1291	0	11
2006	Industry		808	30	10807	1583	7515	2	991
2006	Household and gardening		809	1	275	8037	87744	0	79

Non-exhaust emission factors, activity data and total non-exhaust emissions of TSP, PM_{10} and $PM_{2.5}$ in 2006

Year	Source	Category	Mileage [kmkveh]	TSP [mg/km]	PM_{10} [mg/km]	$PM_{2.5}$ [mg/km]	TSP [tons]	PM_{10} [tons]	$PM_{2.5}$ [tons]
2006	Brake wear	Passenger cars	36034120	7.6	7.5	3.0	274	269	107
2006	Brake wear	Light duty vehicles	12639008	13.7	13.4	5.3	173	170	68
2006	Brake wear	Heavy duty vehicles	3604488	34.8	34.1	13.6	125	123	49
2006	Brake wear	Buses	955350	47.3	46.4	18.5	45	44	18
2006	Brake wear	Mopeds	248759	6.2	6.1	2.4	2	2	1
2006	Brake wear	Motorcycles	848283	4.2	4.2	1.7	4	4	1
2006	Road abrasion	Passenger cars	36034120	15.0	7.5	4.1	541	270	146
2006	Road abrasion	Light duty vehicles	12639008	15.0	7.5	4.1	190	95	51
2006	Road abrasion	Heavy duty vehicles	3604488	76.0	38.0	20.5	274	137	74
2006	Road abrasion	Buses	955350	76.0	38.0	20.5	73	36	20
2006	Road abrasion	Mopeds	248759	6.0	3.0	1.6	1	1	0
2006	Road abrasion	Motorcycles	848283	6.0	3.0	1.6	5	3	1
2006	Tyre wear	Passenger cars	36034120	12.4	7.5	5.2	448	269	188
2006	Tyre wear	Light duty vehicles	12639008	20.5	12.3	8.6	258	155	109
2006	Tyre wear	Heavy duty vehicles	3604488	59.8	35.9	25.1	215	129	90
2006	Tyre wear	Buses	955350	29.4	17.7	12.4	28	17	12
2006	Tyre wear	Mopeds	248759	6.4	3.8	2.7	2	1	1
2006	Tyre wear	Motorcycles	848283	5.6	3.3	2.3	5	3	2
2006	Total	Passenger cars					1263	808	441
2006	Total	Light duty vehicles					621	420	227
2006	Total	Heavy duty vehicles					615	389	213
2006	Total	Buses					146	97	49
2006	Total	Mopeds					5	3	2
2006	Total	Motorcycles					13	9	5

Heavy metal emission factors and total emissions for 1990 and 2006 in CollectER format

SNAP ID	Category	Fuel type	Mode	Arsenic [g/GJ]	Cadmium [g/GJ]	Chromium [g/GJ]	Copper [g/GJ]	Mercury [g/GJ]	Nickel [g/GJ]	Lead [g/GJ]	Selenium [g/GJ]	Zinc [g/GJ]
070101	Passenger cars	Diesel	Highway driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070101	Passenger cars	Gasoline 2-stroke	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070101	Passenger cars	Gasoline conventional	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070101	Passenger cars	Gasoline catalyst	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070101	Passenger cars	LPG	Highway driving		0,000000	0,000000	0,000000		0,000000	0,000000	0,000000	0,000000
070102	Passenger cars	Diesel	Rural driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070102	Passenger cars	Gasoline 2-stroke	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070102	Passenger cars	Gasoline conventional	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070102	Passenger cars	Gasoline catalyst	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070102	Passenger cars	LPG	Rural driving		0,000000	0,000000	0,000000		0,000000	0,000000	0,000000	0,000000
070103	Passenger cars	Diesel	Urban driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070103	Passenger cars	Gasoline 2-stroke	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070103	Passenger cars	Gasoline conventional	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070103	Passenger cars	Gasoline catalyst	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070103	Passenger cars	LPG	Urban driving		0,000000	0,000000	0,000000		0,000000	0,000000	0,000000	0,000000
070201	Light duty vehicles	Diesel	Highway driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070201	Light duty vehicles	Gasoline conventional	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070201	Light duty vehicles	Gasoline catalyst	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070202	Light duty vehicles	Diesel	Rural driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070202	Light duty vehicles	Gasoline conventional	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070202	Light duty vehicles	Gasoline catalyst	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070203	Light duty vehicles	Diesel	Urban driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070203	Light duty vehicles	Gasoline conventional	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070203	Light duty vehicles	Gasoline catalyst	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070301	Heavy duty vehicles	Diesel	Highway driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070301	Heavy duty vehicles	Gasoline	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070302	Heavy duty vehicles	Diesel	Rural driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070302	Heavy duty vehicles	Gasoline	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070303	Heavy duty vehicles	Diesel	Urban driving		0,000234	0,001171	0,039812		0,001639	0,000000	0,000234	0,023419
070303	Heavy duty vehicles	Gasoline	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
0704	Mopeds	Gasoline			0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070501	Motorcycles	Gasoline	Highway driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070502	Motorcycles	Gasoline	Rural driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831
070503	Motorcycles	Gasoline	Urban driving		0,000228	0,001141	0,038813		0,001598	0,000685	0,000228	0,022831

SNAP ID	Category	Fuel type	Mode	Arsenic [mg/GJ]	Cadmium [mg/GJ]	Chromium [mg/GJ]	Copper [mg/GJ]	Mercury [mg/GJ]	Nickel [mg/GJ]	Lead [mg/GJ]	Selenium [mg/GJ]	Zinc [mg/GJ]
0801	Military	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0801	Military	Jet fuel	< 3000 ft	0,00	0,23	1,14	38,81	0,00	1,60	0,00	0,23	22,83
0801	Military	Jet fuel	> 3000 ft	0,00	0,23	1,14	38,81	0,00	1,60	0,00	0,23	22,83
0801	Military	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
0801	Military	Aviation gasoline		0,00	0,23	1,14	38,81	0,00	1,60	12785,39	0,23	22,83
0802	Railways	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0802	Railways	Kerosene										
0802	Railways	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
0803	Inland waterways	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0803	Inland waterways	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
080402	National sea traffic	Residual oil		12,22	0,73	4,89	12,22	0,49	733,50	4,89	9,78	22,00
080402	National sea traffic	Diesel		1,17	0,23	0,94	1,17	1,17	1,64	2,34	4,68	11,71
080402	National sea traffic	Kerosene										
080402	National sea traffic	LPG										
080403	Fishing	Residual oil		12,22	0,73	4,89	12,22	0,49	733,50	4,89	9,78	22,00
080403	Fishing	Diesel		1,17	0,23	0,94	1,17	1,17	1,64	2,34	4,68	11,71
080403	Fishing	Kerosene										
080403	Fishing	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
080403	Fishing	LPG										
080404	International sea traffic	Residual oil		12,22	0,73	4,89	12,22	0,49	733,50	4,89	9,78	22,00
080404	International sea traffic	Diesel		1,17	0,23	0,94	1,17	1,17	1,64	2,34	4,68	11,71
080501	Air traffic, other airports	Jet fuel	Dom. < 3000 ft		0,23	1,14	38,81		1,60	0,00	0,23	22,83
080501	Air traffic, other airports	Aviation gasoline			0,23	1,14	38,81		1,60	13505,69	0,23	22,83
080502	Air traffic, other airports	Jet fuel	Int. < 3000 ft		0,23	1,14	38,81		1,60	0,00	0,23	22,83
080502	Air traffic, other airports	Aviation gasoline			0,23	1,14	38,81		1,60	13505,69	0,23	22,83
080503	Air traffic, other airports	Jet fuel	Dom. > 3000 ft		0,23	1,14	38,81		1,60	0,00	0,23	22,83
080504	Air traffic, other airports	Jet fuel	Int. > 3000 ft		0,23	1,14	38,81		1,60	0,00	0,23	22,83
0806	Agriculture	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0806	Agriculture	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
0807	Forestry	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0807	Forestry	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
0808	Industry	Diesel			0,23	1,17	39,81		1,64		0,23	23,42
0808	Industry	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
0808	Industry	LPG										
0809	Household and gardening	Gasoline			0,23	1,14	38,81		1,60	0,68	0,23	22,83
080501	Air traffic, CPH. airport	Jet fuel	Dom. < 3000 ft		0,23	1,14	38,81		1,60		0,23	22,83
080501	Air traffic, CPH. airport	Aviation gasoline			0,23	1,14	38,81		1,60	13505,69	0,23	22,83
080502	Air traffic, CPH. airport	Jet fuel	Int. < 3000 ft	0,00	0,23	1,14	38,81	0,00	1,60	0,00	0,23	22,83
080502	Air traffic, CPH. airport	Aviation gasoline		0,00	0,23	1,14	38,81	0,00	1,60	13505,69	0,23	22,83
080503	Air traffic, CPH. airport	Jet fuel	Dom. > 3000 ft	0,00	0,23	1,14	38,81	0,00	1,60	0,00	0,23	22,83
080504	Air traffic, CPH. airport	Jet fuel	Int. > 3000 ft	0,00	0,23	1,14	38,81	0,00	1,60	0,00	0,23	22,83

Year	Category	Mode	SNAP ID	Arsenic [kg]	Cadmium [kg]	Chromium [kg]	Copper [kg]	Mercury [kg]	Nickel [kg]	Lead [kg]	Selenium [kg]	Zinc [kg]
1990	Passenger cars	Highway driving	70101		2	9	315		13	11099	2	185
1990	Passenger cars	Rural driving	70102		6	28	966		40	34269	6	568
1990	Passenger cars	Urban driving	70103		8	40	1350		56	47403	8	794
1990	Light duty vehicles	Highway driving	70201		1	3	87		4	324	1	51
1990	Light duty vehicles	Rural driving	70202		2	9	318		13	1347	2	187
1990	Light duty vehicles	Urban driving	70203		2	11	385		16	1966	2	226
1990	Heavy duty vehicles	Highway driving	70301		2	10	346		14	15	2	203
1990	Heavy duty vehicles	Rural driving	70302		4	19	632		26	44	4	372
1990	Heavy duty vehicles	Urban driving	70303		3	16	533		22	51	3	314
1990	Mopeds		704		0	0	14		1	422	0	9
1990	Motorcycles	Highway driving	70501		0	0	4		0	113	0	2
1990	Motorcycles	Rural driving	70502		0	0	7		0	210	0	4
1990	Motorcycles	Urban driving	70503		0	0	8		0	247	0	5
1990	Evaporation		706									
1990	Military		801		0	2	64		3	64	0	38
1990	Railways		802		1	5	160		7	0	1	94
1990	Inland waterways		803		0	1	26		1	455	0	15
1990	National sea traffic		80402	53	4	23	53	8	2827	30	61	142
1990	Fishing		80403	9	2	7	9	9	13	19	37	93
1990	International sea traffic		80404	363	24	150	363	28	20956	167	334	764
1990	Air traffic, Dom. < 3000 ft.		80501		0	1	40		2	1534	0	24
1990	Air traffic, Int. < 3000 ft.		80502		0	2	84		3	490	0	50
1990	Air traffic, Dom. > 3000 ft.		80503		1	3	90		4		1	53
1990	Air traffic, Int. > 3000 ft.		80504		5	25	852		35		5	501
1990	Agriculture		806		4	20	684		28	1043	4	403
1990	Forestry		807		0	1	19		1	502	0	11
1990	Industry		808		2	12	411		17	258	2	242
1990	Household and gardening		809		0	2	60		2	2273	0	35

Year	Category	Mode	SNAP ID	Arsenic [kg]	Cadmium [kg]	Chromium [kg]	Copper [kg]	Mercury [kg]	Nickel [kg]	Lead [kg]	Selenium [kg]	Zinc [kg]
2006	Passenger cars	Rural driving	70101		3.46	17.29	587.74		24.20	8.23	3.46	345.73
2006	Passenger cars	Urban driving	70102		7.86	39.29	1335.85		55.00	18.86	7.86	785.79
2006	Light duty vehicles	Highway driving	70103		8.71	43.56	1480.95		60.98	21.27	8.71	871.14
2006	Light duty vehicles	Rural driving	70201		1.23	6.15	209.21		8.61	0.33	1.23	123.06
2006	Light duty vehicles	Urban driving	70202		3.80	19.01	646.38		26.61	1.16	3.80	380.22
2006	Heavy duty vehicles	Highway driving	70203		3.79	18.95	644.30		26.53	1.39	3.79	379.00
2006	Heavy duty vehicles	Rural driving	70301		2.97	14.84	504.72		20.78	0.01	2.97	296.89
2006	Heavy duty vehicles	Urban driving	70302		4.46	22.32	759.11		31.25	0.02	4.46	446.53
2006	Mopeds		70303		3.11	15.56	529.03		21.78	0.02	3.11	311.19
2006	Motorcycles	Highway driving	704		0.05	0.24	8.13		0.33	0.14	0.05	4.78
2006	Motorcycles	Rural driving	70501		0.04	0.22	7.55		0.31	0.13	0.04	4.44
2006	Motorcycles	Urban driving	70502		0.10	0.50	17.01		0.70	0.30	0.10	10.01
2006	Evaporation		70503		0.12	0.60	20.44		0.84	0.36	0.12	12.02
2006	Military		706									
2006	Railways		801	0.00	0.40	2.00	68.11	0.00	2.81	46.52	0.40	40.07
2006	Inland waterways		802		0.70	3.59	121.99		5.03		0.70	71.77
2006	National sea traffic		803		0.32	1.61	54.70		2.25	0.26	0.32	32.18
2006	Fishing		80402	12.67	1.41	7.00	12.67	5.10	480.03	12.72	25.44	62.06
2006	International sea traffic		80403	7.45	1.47	5.99	7.45	7.45	10.45	14.91	29.82	74.61
2006	Air traffic, Dom. < 3000 ft.		80404	401.07	26.06	166.68	401.07	30.81	23174.21	185.04	370.09	848.01
2006	Air traffic, Int. < 3000 ft.		80501		0.11	0.53	17.87		0.74	1245.30	0.11	10.51
2006	Air traffic, Dom. > 3000 ft.		80502	0.00	0.68	3.38	114.95	0.00	4.74	21.84	0.68	67.62
2006	Air traffic, Int. > 3000 ft.		80503	0.00	0.34	1.71	58.19	0.00	2.40	0.00	0.34	34.23
2006	Agriculture		80504	0.00	7.57	37.53	1277.52	0.00	52.67	0.00	7.57	751.50
2006	Forestry		806		3.45	17.53	596.52		24.57	0.26	3.45	350.93
2006	Industry		807		0.05	0.27	9.26		0.38	0.05	0.05	5.44
2006	Household and gardening		808		2.96	15.07	512.87		21.13	0.11	2.96	301.72
2006	Passenger cars	Rural driving	809		0.73	3.63	123.66		5.10	2.18	0.73	72.75

PAH emission factors and total emissions for 1990 and 2006 in CollectER format

Year	SNAP ID	Category	Fuel type	Mode	Dioxins/ Furans [g/GJ]	Flouranthene [g/GJ]	Benzo(b) flouranthene [g/GJ]	Benzo(k) flouranthene [g/GJ]	Benzo(a) pyrene [g/GJ]	Benzo(g,h,i) perylene [g/GJ]	indeno(1,2,3-c,d) pyrene [g/GJ]
1990	070101	Passenger cars	Diesel	Highway driving	2,34E-04	2,34E-02	7,01E-10	1,22E-02	7,48E-04	6,78E-04	8,18E-04
1990	070101	Passenger cars	Gasoline 2-stroke	Highway driving	2,97E-04	2,97E-02					
1990	070101	Passenger cars	Gasoline conventional	Highway driving	2,25E-04	2,25E-02	1,34E-08	8,54E-03	5,55E-04	4,27E-04	4,69E-04
1990	070101	Passenger cars	Gasoline catalyst	Highway driving	0,00E+00	0,00E+00					
1990	070101	Passenger cars	LPG	Highway driving	2,34E-04	2,34E-02	8,52E-10	1,49E-02	9,09E-04	8,24E-04	9,94E-04
1990	070102	Passenger cars	Diesel	Rural driving	2,97E-04	2,97E-02					
1990	070102	Passenger cars	Gasoline 2-stroke	Rural driving	2,24E-04	2,24E-02	1,51E-08	9,58E-03	6,23E-04	4,79E-04	5,27E-04
1990	070102	Passenger cars	Gasoline conventional	Rural driving	0,00E+00	0,00E+00					
1990	070102	Passenger cars	Gasoline catalyst	Rural driving	2,34E-04	2,34E-02	5,33E-10	9,30E-03	5,68E-04	5,15E-04	6,21E-04
1990	070102	Passenger cars	LPG	Rural driving	2,97E-04	2,97E-02					
1990	070103	Passenger cars	Diesel	Urban driving	2,25E-04	2,25E-02	1,02E-08	6,47E-03	4,20E-04	3,23E-04	3,56E-04
1990	070103	Passenger cars	Gasoline 2-stroke	Urban driving	0,00E+00	0,00E+00					
1990	070103	Passenger cars	Gasoline conventional	Urban driving	2,34E-04	2,34E-02	4,87E-10	8,51E-03	5,19E-04	4,70E-04	5,68E-04
1990	070103	Passenger cars	Gasoline catalyst	Urban driving	2,97E-04	2,97E-02	1,27E-08	8,09E-03	5,26E-04	4,04E-04	4,45E-04
1990	070103	Passenger cars	LPG	Urban driving	2,34E-04	2,34E-02	5,33E-10	9,31E-03	5,68E-04	5,15E-04	6,22E-04
1990	070201	Light duty vehicles	Diesel	Highway driving	2,97E-04	2,97E-02	1,20E-08	7,63E-03	4,95E-04	3,81E-04	4,19E-04
1990	070201	Light duty vehicles	Gasoline conventional	Highway driving	2,34E-04	2,34E-02	3,98E-10	6,95E-03	4,25E-04	3,85E-04	4,64E-04
1990	070201	Light duty vehicles	Gasoline catalyst	Highway driving	2,97E-04	2,97E-02	7,18E-09	4,56E-03	2,96E-04	2,28E-04	2,51E-04
1990	070202	Light duty vehicles	Diesel	Rural driving	2,34E-04	2,34E-02	1,06E-09	2,09E-03	5,26E-04	7,80E-04	9,74E-05
1990	070202	Light duty vehicles	Gasoline conventional	Rural driving	2,97E-04	2,97E-02					
1990	070202	Light duty vehicles	Gasoline catalyst	Rural driving	2,34E-04	2,34E-02	1,12E-09	2,21E-03	5,57E-04	8,25E-04	1,03E-04
1990	070203	Light duty vehicles	Diesel	Urban driving	2,97E-04	2,97E-02					
1990	070203	Light duty vehicles	Gasoline conventional	Urban driving	2,34E-04	2,34E-02	9,11E-10	1,79E-03	4,51E-04	6,68E-04	8,34E-05
1990	070203	Light duty vehicles	Gasoline catalyst	Urban driving	2,97E-04	2,97E-02					
1990	070301	Heavy duty vehicles	Diesel	Highway driving	2,97E-04	2,97E-02					
1990	070301	Heavy duty vehicles	Gasoline	Highway driving	2,97E-04	2,97E-02	2,00E-08	1,27E-02	8,24E-04	6,34E-04	6,97E-04
1990	070302	Heavy duty vehicles	Diesel	Rural driving	2,97E-04	2,97E-02	2,39E-08	1,52E-02	9,86E-04	7,59E-04	8,34E-04
1990	070302	Heavy duty vehicles	Gasoline	Rural driving	2,97E-04	2,97E-02	2,41E-08	1,53E-02	9,94E-04	7,65E-04	8,41E-04
1990	070303	Heavy duty vehicles	Diesel	Urban driving	2,34E-04	2,34E-02	7,01E-10	1,22E-02	7,48E-04	6,78E-04	8,18E-04
1990	070303	Heavy duty vehicles	Gasoline	Urban driving	2,97E-04	2,97E-02					
1990	0704	Mopeds	Gasoline		2,25E-04	2,25E-02	1,34E-08	8,54E-03	5,55E-04	4,27E-04	4,69E-04
1990	070501	Motorcycles	Gasoline	Highway driving	0,00E+00	0,00E+00					
1990	070502	Motorcycles	Gasoline	Rural driving	2,34E-04	2,34E-02	8,52E-10	1,49E-02	9,09E-04	8,24E-04	9,94E-04
1990	070503	Motorcycles	Gasoline	Urban driving	2,97E-04	2,97E-02					

Year	SNAP ID	Category	Fuel type	Mode	Dioxins/ Furans [g/GJ]	Flouranthene [g/GJ]	Benzo(b) flouranthene [g/GJ]	Benzo(k) flouranthene [g/GJ]	Benzo(a) pyrene [g/GJ]	Benzo(g,h,i) perylene [g/GJ]	indeno(1,2,3-c,d) pyrene [g/GJ]
2006	070101	Passenger cars	Diesel	Highway driving	0,00E+00	1,28E-02	7,82E-04	7,09E-04	8,56E-04	1,66E-03	8,07E-04
2006	070101	Passenger cars	Gasoline 2-stroke	Highway driving							
2006	070101	Passenger cars	Gasoline conventional	Highway driving	1,39E-08	8,82E-03	5,73E-04	4,41E-04	4,85E-04	1,15E-03	4,41E-04
2006	070101	Passenger cars	Gasoline catalyst	Highway driving	0,00E+00	8,84E-04	1,96E-04	2,45E-04	1,96E-04	3,93E-04	2,95E-04
2006	070101	Passenger cars	LPG	Highway driving							
2006	070102	Passenger cars	Diesel	Rural driving	8,35E-10	1,46E-02	8,91E-04	8,07E-04	9,75E-04	1,89E-03	9,19E-04
2006	070102	Passenger cars	Gasoline 2-stroke	Rural driving							
2006	070102	Passenger cars	Gasoline conventional	Rural driving	1,53E-08	9,74E-03	6,33E-04	4,87E-04	5,36E-04	1,27E-03	4,87E-04
2006	070102	Passenger cars	Gasoline catalyst	Rural driving	0,00E+00	9,87E-04	2,19E-04	2,74E-04	2,19E-04	4,39E-04	3,29E-04
2006	070102	Passenger cars	LPG	Rural driving							
2006	070103	Passenger cars	Diesel	Urban driving	5,54E-10	9,68E-03	5,91E-04	5,36E-04	6,47E-04	1,26E-03	6,10E-04
2006	070103	Passenger cars	Gasoline 2-stroke	Urban driving							
2006	070103	Passenger cars	Gasoline conventional	Urban driving	9,99E-09	6,34E-03	4,12E-04	3,17E-04	3,49E-04	8,25E-04	3,17E-04
2006	070103	Passenger cars	Gasoline catalyst	Urban driving	0,00E+00	5,38E-04	1,19E-04	1,49E-04	1,19E-04	2,39E-04	1,79E-04
2006	070103	Passenger cars	LPG	Urban driving							
2006	070201	Light duty vehicles	Diesel	Highway driving	5,29E-10	9,23E-03	5,64E-04	5,11E-04	6,17E-04	1,20E-03	5,81E-04
2006	070201	Light duty vehicles	Gasoline conventional	Highway driving	1,27E-08	8,09E-03	5,26E-04	4,04E-04	4,45E-04	1,05E-03	4,04E-04
2006	070201	Light duty vehicles	Gasoline catalyst	Highway driving	0,00E+00	6,18E-04	1,37E-04	1,72E-04	1,37E-04	2,75E-04	2,06E-04
2006	070202	Light duty vehicles	Diesel	Rural driving	5,78E-10	1,01E-02	6,17E-04	5,59E-04	6,75E-04	1,31E-03	6,36E-04
2006	070202	Light duty vehicles	Gasoline conventional	Rural driving	1,20E-08	7,63E-03	4,95E-04	3,81E-04	4,19E-04	9,91E-04	3,81E-04
2006	070202	Light duty vehicles	Gasoline catalyst	Rural driving	0,00E+00	5,84E-04	1,30E-04	1,62E-04	1,30E-04	2,59E-04	1,95E-04
2006	070203	Light duty vehicles	Diesel	Urban driving	4,16E-10	7,26E-03	4,43E-04	4,02E-04	4,85E-04	9,42E-04	4,57E-04
2006	070203	Light duty vehicles	Gasoline conventional	Urban driving	6,92E-09	4,39E-03	2,85E-04	2,20E-04	2,42E-04	5,71E-04	2,20E-04
2006	070203	Light duty vehicles	Gasoline catalyst	Urban driving	0,00E+00	3,37E-04	7,49E-05	9,36E-05	7,49E-05	1,50E-04	1,12E-04
2006	070301	Heavy duty vehicles	Diesel	Highway driving	1,03E-09	2,03E-03	5,12E-04	7,59E-04	9,48E-05	7,59E-05	1,33E-04
2006	070301	Heavy duty vehicles	Gasoline	Highway driving							
2006	070302	Heavy duty vehicles	Diesel	Rural driving	1,05E-09	2,07E-03	5,21E-04	7,72E-04	9,65E-05	7,70E-05	1,35E-04
2006	070302	Heavy duty vehicles	Gasoline	Rural driving							
2006	070303	Heavy duty vehicles	Diesel	Urban driving	8,54E-10	1,68E-03	4,23E-04	6,26E-04	7,82E-05	6,25E-05	1,10E-04
2006	070303	Heavy duty vehicles	Gasoline	Urban driving							
2006	0704	Mopeds	Gasoline								
2006	070501	Motorcycles	Gasoline	Highway driving	2,02E-08	1,28E-02	8,32E-04	6,40E-04	7,04E-04	1,66E-03	6,40E-04
2006	070502	Motorcycles	Gasoline	Rural driving	2,41E-08	1,53E-02	9,96E-04	7,66E-04	8,43E-04	1,99E-03	7,66E-04
2006	070503	Motorcycles	Gasoline	Urban driving	2,44E-08	1,55E-02	1,01E-03	7,75E-04	8,52E-04	2,01E-03	7,75E-04

Year	SNAP ID	Category	Fuel type	Mode	Dioxins/ Furans [ng/GJ]	Flouranthene [microg/GJ]	Benzo(b) flouranthene [microg/GJ]	Benzo(k) flouranthene [microg/GJ]	Benzo(a) pyrene [microg/GJ]	Benzo(g,h,i) perylene [microg/GJ]	indeno(1,2,3-c,d) pyrene [microg/GJ]
1990	0801	Military	Diesel		0,23	23,42	0,71	4391,42	570,64	568,31	289,75
1990	0801	Military	Jet fuel	< 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	0801	Military	Jet fuel	> 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	0801	Military	Gasoline		0,23	22,83	6,27	5257,47	277,33	116,39	141,99
1990	0801	Military	Aviation gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	0802	Railways	Diesel		0,23	23,42	0,70	1365,92	348,03	388,90	57,47
1990	0802	Railways	Kerosene								
1990	0802	Railways	Gasoline		0,23	22,83	6,27	5257,47	277,33	116,39	141,99
1990	0803	Inland waterways	Diesel		0,23	23,42	0,71	4391,42	570,64	568,31	289,75
1990	0803	Inland waterways	Gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080402	National sea traffic	Residual oil		9,78	22,00	13,42	5190,00	270,00	50,00	20,00
1990	080402	National sea traffic	Diesel		4,68	11,71	12,01	7420,00	640,00	300,00	150,00
1990	080402	National sea traffic	Kerosene								
1990	080402	National sea traffic	LPG								
1990	080403	Fishing	Residual oil		9,78	22,00	13,42	5190,00	270,00	50,00	20,00
1990	080403	Fishing	Diesel		4,68	11,71	12,01	7420,00	640,00	300,00	150,00
1990	080403	Fishing	Kerosene								
1990	080403	Fishing	Gasoline		0,23	22,83	11,42	3420,09	342,47	146,12	244,29
1990	080403	Fishing	LPG								
1990	080404	International sea traffic	Residual oil		9,78	22,00	13,42	4120,00	200,00	90,00	70,00
1990	080404	International sea traffic	Diesel		4,68	11,71	12,01	7420,00	640,00	300,00	150,00
1990	080501	Air traffic. other airports	Jet fuel	Dom. < 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080501	Air traffic. other airports	Aviation gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080502	Air traffic. other airports	Jet fuel	Int. < 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080502	Air traffic. other airports	Aviation gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080503	Air traffic. other airports	Jet fuel	Dom. > 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080504	Air traffic. other airports	Jet fuel	Int. > 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	0806	Agriculture	Diesel		0,23	23,42	0,71	4391,42	570,64	568,31	289,75
1990	0806	Agriculture	Gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	0807	Forestry	Diesel		0,23	23,42	0,71	4391,42	570,64	568,31	289,75
1990	0807	Forestry	Gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	0808	Industry	Diesel		0,23	23,42	0,71	4391,42	570,64	568,31	289,75
1990	0808	Industry	Gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	0808	Industry	LPG								
1990	0809	Household and gardening	Gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080501	Air traffic. CPH. airport	Jet fuel	Dom. < 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080501	Air traffic. Copenhagen airport	Aviation gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080502	Air traffic. Copenhagen airport	Jet fuel	Int. < 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080502	Air traffic. Copenhagen airport	Aviation gasoline		0,23	22,83	5,11	4328,53	209,06	71,27	114,03
1990	080503	Air traffic. Copenhagen airport	Jet fuel	Dom. > 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00
1990	080504	Air traffic. Copenhagen airport	Jet fuel	Int. > 3000 ft	0,23	22,83	0,00	0,00	0,00	0,00	0,00

Year	SNAP ID	Category	Fuel type	Mode	Dioxins/ Furans [g/GJ]	Flouranthene [g/GJ]	Benzo(b) flouranthene [g/GJ]	Benzo(k) flouranthene [g/GJ]	Benzo(a) pyrene [g/GJ]	Benzo(g,h,i) perylene [g/GJ]	indeno(1,2,3-c,d) pyrene [g/GJ]
2006	801	Military	Diesel		0.71	0,71	4349,86	510,47	495,91	255,72	464,46
2006	801	Military	Jet fuel	< 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	801	Military	Jet fuel	> 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	801	Military	Gasoline		6.89	6,89	2151,74	179,80	115,04	118,07	357,51
2006	801	Military	Aviation gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	802	Railways	Diesel		0.72	0,72	1411,28	359,58	401,81	59,38	50,80
2006	803	Inland waterways	Diesel		0.71	0,71	4349,86	510,47	495,91	255,72	464,46
2006	803	Inland waterways	Gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	80402	National sea traffic	Residual oil		13.42	13,42	5190,00	270,00	50,00	20,00	70,00
2006	80402	National sea traffic	Diesel		12.01	12,01	7420,00	640,00	300,00	150,00	1430,00
2006	80402	National sea traffic	Kerosene								
2006	80402	National sea traffic	LPG								
2006	80403	Fishing	Residual oil		13.42	13,42	5190,00	270,00	50,00	20,00	70,00
2006	80403	Fishing	Diesel		12.01	12,01	7420,00	640,00	300,00	150,00	1430,00
2006	80403	Fishing	Kerosene								
2006	80403	Fishing	Gasoline		11.42	11,42	3420,00	342,00	146,00	244,00	489,00
2006	80403	Fishing	LPG								
2006	80404	International sea traffic	Residual oil		13.42	13,42	4120,00	200,00	90,00	70,00	260,00
2006	80404	International sea traffic	Diesel		12.01	12,01	7420,00	640,00	300,00	150,00	1430,00
2006	80501	Air traffic. other airports	Jet fuel	Dom. < 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80501	Air traffic. other airports	Aviation gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	80502	Air traffic. other airports	Jet fuel	Int. < 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80502	Air traffic. other airports	Aviation gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	80503	Air traffic. other airports	Jet fuel	Dom. > 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80504	Air traffic. other airports	Jet fuel	Int. > 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	806	Agriculture	Diesel		0.71	0,71	4349,86	510,47	495,91	255,72	464,46
2006	806	Agriculture	Gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	807	Forestry	Diesel		0.71	0,71	4349,86	510,47	495,91	255,72	464,46
2006	807	Forestry	Gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	808	Industry	Diesel		0.71	0,71	4349,86	510,47	495,91	255,72	464,46
2006	808	Industry	Gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	808	Industry	LPG								
2006	809	Household and gardening	Gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95

2006	80501	Air traffic. Copenhagen airport	Jet fuel	Dom. < 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80501	Air traffic. Copenhagen airport	Aviation gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	80502	Air traffic. Copenhagen airport	Jet fuel	Int. < 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80502	Air traffic. Copenhagen airport	Aviation gasoline		5.11	5,11	4328,53	209,06	71,27	114,03	688,95
2006	80503	Air traffic. Copenhagen airport	Jet fuel	Dom. > 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00
2006	80504	Air traffic. Copenhagen airport	Jet fuel	Int. > 3000 ft	0.00	0,00	0,00	0,00	0,00	0,00	0,00

Year	Category	Mode	SNAP ID	Dioxins/ Furans [kg]	Flouranthene [kg]	Benzo(b) flouranthene [kg]	Benzo(k) flouranthene [kg]	Benzo(a) pyrene [kg]	Benzo(g,h,i) perylene [kg]	indeno(1,2,3-c,d) pyrene [kg]
1990	Passenger cars	Highway driving	70101	0.10	72.32	4.67	3.66	4.07	9.40	3.72
1990	Passenger cars	Rural driving	70102	0.35	250.39	16.16	12.67	14.10	32.54	12.88
1990	Passenger cars	Urban driving	70103	0.33	233.33	15.06	11.80	13.14	30.32	12.01
1990	Light duty vehicles	Highway driving	70201	0.00	18.00	1.11	0.99	1.18	2.34	1.11
1990	Light duty vehicles	Rural driving	70202	0.01	70.49	4.33	3.86	4.63	9.15	4.35
1990	Light duty vehicles	Urban driving	70203	0.01	61.49	3.78	3.37	4.03	7.98	3.79
1990	Heavy duty vehicles	Highway driving	70301	0.01	18.07	4.56	6.76	0.84	0.67	1.18
1990	Heavy duty vehicles	Rural driving	70302	0.02	34.97	8.82	13.07	1.63	1.31	2.28
1990	Heavy duty vehicles	Urban driving	70303	0.01	23.86	6.02	8.92	1.11	0.89	1.56
1990	Mopeds		704							
1990	Motorcycles	Highway driving	70501	0.00	0.97	0.06	0.05	0.05	0.13	0.05
1990	Motorcycles	Rural driving	70502	0.00	2.17	0.14	0.11	0.12	0.28	0.11
1990	Motorcycles	Urban driving	70503	0.00	2.57	0.17	0.13	0.14	0.33	0.13
1990	Evaporation		706							
1990	Military		801	0.00	0.67	0.08	0.08	0.04	0.08	0.04
1990	Railways		802	0.00	5.48	1.40	1.56	0.23	0.20	0.36
1990	Inland waterways		803	0.00	2.84	0.26	0.22	0.13	0.40	0.18
1990	National sea traffic		80402	0.11	56.61	4.20	1.67	0.82	7.34	5.95
1990	Fishing		80403	0.10	58.77	5.07	2.38	1.19	11.33	9.35
1990	International sea traffic		80404	0.52	203.91	13.15	6.06	3.74	24.06	19.44
1990	Air traffic. Dom. < 3000 ft.		80501	0.00	0.49	0.02	0.01	0.01	0.08	0.03
1990	Air traffic. Int. < 3000 ft.		80502	0.00	0.16	0.01	0.00	0.00	0.02	0.01
1990	Air traffic. Dom. > 3000 ft.		80503	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	Air traffic. Int. > 3000 ft.		80504	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	Agriculture		806	0.02	75.51	9.56	9.43	4.86	9.56	4.96
1990	Forestry		807	0.00	2.12	0.15	0.11	0.08	0.32	0.13
1990	Industry		808	0.01	45.37	5.83	5.79	2.96	5.71	2.99
1990	Household and gardening		809	0.01	6.69	0.32	0.11	0.18	1.06	0.38

Year	Category	Mode	SNAP ID	Dioxins/ Furans [kg]	Flouranthene [kg]	Benzo(b) flouranthene [kg]	Benzo(k) flouranthene [kg]	Benzo(a) pyrene [kg]	Benzo(g,h,i) perylene [kg]	indeno(1,2,3-c,d) pyrene [kg]
2006	Passenger cars	Highway driving	70101	0.02	58.94	5.18	5.34	5.30	10.67	6.17
2006	Passenger cars	Rural driving	70102	0.04	147.50	13.07	13.51	13.38	26.90	15.62
2006	Passenger cars	Urban driving	70103	0.03	101.15	8.68	8.85	8.87	17.88	10.20
2006	Light duty vehicles	Highway driving	70201	0.00	44.97	2.79	2.54	3.04	5.92	2.90
2006	Light duty vehicles	Rural driving	70202	0.01	149.92	9.30	8.48	10.13	19.72	9.65
2006	Light duty vehicles	Urban driving	70203	0.01	104.84	6.50	5.93	7.08	13.79	6.75
2006	Heavy duty vehicles	Highway driving	70301	0.01	25.71	6.49	9.61	1.20	0.96	1.68
2006	Heavy duty vehicles	Rural driving	70302	0.02	39.33	9.92	14.70	1.84	1.47	2.57
2006	Heavy duty vehicles	Urban driving	70303	0.01	22.21	5.60	8.30	1.04	0.83	1.45
2006	Mopeds		704							
2006	Motorcycles	Highway driving	70501	0.00	2.49	0.16	0.12	0.14	0.32	0.12
2006	Motorcycles	Rural driving	70502	0.01	6.72	0.44	0.34	0.37	0.87	0.34
2006	Motorcycles	Urban driving	70503	0.01	8.16	0.53	0.41	0.45	1.06	0.41
2006	Evaporation		706							
2006	Military		801	0.00	2.78	0.32	0.31	0.16	0.30	0.17
2006	Railways		802	0.00	4.32	1.10	1.23	0.18	0.16	0.28
2006	Inland waterways		803	0.00	6.01	0.59	0.52	0.30	0.73	0.36
2006	National sea traffic		80402	0.06	33.68	2.79	1.26	0.63	5.89	4.84
2006	Fishing		80403	0.08	47.28	4.08	1.91	0.96	9.11	7.52
2006	International sea traffic		80404	0.58	227.37	14.71	6.78	4.18	26.96	21.79
2006	Air traffic. Dom. < 3000 ft.		80501	0.00	0.40	0.02	0.01	0.01	0.06	0.02
2006	Air traffic. Int. < 3000 ft.		80502	0.00	0.01	0.00	0.00	0.00	0.00	0.00
2006	Air traffic. Dom. > 3000 ft.		80503	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	Air traffic. Int. > 3000 ft.		80504	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	Agriculture		806	0.01	65.21	7.54	7.27	3.78	7.05	3.96
2006	Forestry		807	0.00	1.02	0.10	0.08	0.05	0.13	0.06
2006	Industry		808	0.01	56.05	6.53	6.32	3.27	6.02	3.40
2006	Household and gardening		809	0.02	13.79	0.67	0.23	0.36	2.20	0.78

Annex 2B-15: Fuel use and emissions in CRF format

Fuel

IPCC ID	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Industry-Other (1A2f)	11.7	11.7	11.6	11.6	11.6	11.5	11.5	11.5	11.5	11.5	11.6	11.7	11.7	11.9	11.9	12.0	12.1	12.3	12.4	12.5	13.0	13.9
Civil Aviation (1A3a)	3.6	3.3	3.7	3.8	3.6	3.4	2.8	2.7	2.6	2.7	2.8	2.8	2.9	2.7	2.4	2.1	2.2	1.9	1.9	1.8	1.9	2.0
Road (1A3b)	111.1	117.4	117.6	118.3	119.6	126.2	131.9	134.3	136.0	142.8	144.1	146.6	149.5	152.0	154.0	152.5	152.8	154.5	160.6	164.8	166.3	171.5
Railways (1A3c)	4.9	4.9	4.4	4.6	4.2	4.0	4.1	4.3	4.5	4.1	4.1	4.1	4.0	3.3	3.1	3.1	2.9	2.8	3.0	2.9	3.1	3.1
Navigation (1A3d)	9.3	9.3	9.3	9.4	9.4	9.4	9.5	9.7	9.6	9.7	10.2	11.2	10.9	8.8	7.3	6.3	6.1	6.0	6.1	6.3	6.2	6.1
Residential (1A4b)	1.6	1.6	1.6	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	2.0	2.2	2.5	2.8	3.0	3.2
Ag./for./fish. (1A4c)	24.4	26.0	23.8	25.5	25.3	25.7	25.7	24.3	23.8	22.9	23.4	22.2	21.2	20.6	21.3	22.0	21.7	22.2	21.8	20.4	21.4	21.6
Military (1A5)	5.5	4.3	5.0	2.7	2.3	1.6	3.9	1.9	3.3	3.5	3.4	2.4	2.3	2.8	2.5	1.5	1.3	1.2	1.3	3.3	3.7	1.7
Navigation int. (1A3d)	17.3	20.1	29.4	37.3	38.2	40.2	36.1	37.9	56.1	63.1	66.3	63.0	57.8	58.2	54.6	56.0	47.3	39.1	41.2	33.5	34.5	44.7
Civil Aviation int. (1A3a)	19.3	20.9	22.4	24.0	25.1	24.1	22.7	23.5	23.0	25.2	25.9	27.4	27.9	30.0	31.8	32.6	33.1	28.6	29.8	34.0	35.8	35.9

Emissions

pol_name	IPCC ID	Unit	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
SO_2	Industry-Other (1A2f)	[tons]	2402	1441	1440	1438	956	952	955	957	957	959	968
SO_2	Civil Aviation (1A3a)	[tons]	82	77	85	86	83	77	64	62	61	63	63
SO_2	Road (1A3b)	[tons]	11621	7862	7847	7857	5488	5767	5903	3820	1569	1669	1682
SO_2	Railways (1A3c)	[tons]	1152	695	618	641	393	376	382	263	105	95	96
SO_2	Navigation (1A3d)	[tons]	6363	6363	6367	6127	6130	5456	4232	2822	3522	4005	4502
SO_2	Residential (1A4b)	[tons]	4	4	4	4	4	4	4	4	4	4	4
SO_2	Ag./for./fish. (1A4c)	[tons]	4766	3484	3173	3073	2269	2303	2317	2186	2150	2072	2120
SO_2	Military (1A5)	[tons]	408	260	193	72	70	48	206	82	76	80	80
SO_2	Navigation int. (1A3d)	[tons]	18333	22047	36943	48034	48337	42404	34348	31152	59669	60081	66260
SO_2	Civil Aviation int. (1A3a)	[tons]	444	480	515	551	578	554	521	541	530	580	596
NO_X	Industry-Other (1A2f)	[tons]	10903	10964	11011	11044	11065	11081	11282	11440	11558	11677	11882
NO_X	Civil Aviation (1A3a)	[tons]	1203	1132	1237	1252	1208	1123	920	902	900	940	958
NO_X	Road (1A3b)	[tons]	92561	98284	98292	99080	100344	105933	107409	106683	104339	103482	99888
NO_X	Railways (1A3c)	[tons]	6025	6063	5391	5589	5145	4913	4995	5284	5485	4971	5015
NO_X	Navigation (1A3d)	[tons]	11778	11798	11852	11902	11962	12020	11433	11104	11007	11236	11898
NO_X	Residential (1A4b)	[tons]	96	99	101	103	103	104	111	118	125	130	136
NO_X	Ag./for./fish. (1A4c)	[tons]	18159	19915	18153	20143	20342	21066	21722	20824	20763	20524	21442
NO_X	Military (1A5)	[tons]	2340	2020	1625	980	873	494	1861	1011	1293	1273	1764
NO_X	Navigation int. (1A3d)	[tons]	23987	28474	43643	56580	58561	62285	55731	57636	89632	101094	106928
NO_X	Civil Aviation int. (1A3a)	[tons]	5663	6129	6569	7035	7313	7016	6586	6846	6702	7317	7517
NMVOC	Industry-Other (1A2f)	[tons]	2422	2395	2368	2339	2304	2266	2231	2191	2147	2107	2088
NMVOC	Civil Aviation (1A3a)	[tons]	216	213	190	198	193	186	168	164	161	191	206
NMVOC	Road (1A3b)	[tons]	80996	80718	80084	79593	77996	81811	82697	81762	79515	75265	70480
NMVOC	Railways (1A3c)	[tons]	393	396	352	365	336	321	326	345	358	324	327
NMVOC	Navigation (1A3d)	[tons]	1505	1505	1536	1566	1598	1630	1658	1699	1727	1761	1819
NMVOC	Residential (1A4b)	[tons]	4191	4166	4139	4112	4108	4104	4111	4094	4054	4070	4147
NMVOC	Ag./for./fish. (1A4c)	[tons]	6357	6417	6216	6284	6207	6149	5777	5298	4944	4638	4516
NMVOC	Military (1A5)	[tons]	601	469	175	490	315	54	172	94	129	124	159
NMVOC	Navigation int. (1A3d)	[tons]	880	1029	1527	1948	2003	2116	1900	1990	2993	3378	3560
NMVOC	Civil Aviation int. (1A3a)	[tons]	261	288	313	342	361	331	309	316	309	308	343
CH_4	Industry-Other (1A2f)	[tons]	63	63	62	61	61	60	58	57	56	54	53
CH_4	Civil Aviation (1A3a)	[tons]	8	8	8	8	8	7	6	6	6	7	7
CH_4	Road (1A3b)	[tons]	2378	2437	2450	2481	2472	2619	2658	2627	2592	2502	2370
CH_4	Railways (1A3c)	[tons]	15	15	14	14	13	12	13	13	14	12	13

CH_4	Navigation (1A3d)	[tons]	28	28	29	29	30	31	31	32	33	33	35
CH_4	Residential (1A4b)	[tons]	158	156	153	150	150	150	147	144	140	138	136
CH_4	Ag./for./fish. (1A4c)	[tons]	155	154	147	146	142	139	132	123	116	110	106
CH_4	Military (1A5)	[tons]	31	26	17	18	14	5	19	10	13	13	18
CH_4	Navigation int. (1A3d)	[tons]	27	32	47	60	62	65	59	62	93	104	110
CH_4	Civil Aviation int. (1A3a)	[tons]	25	27	30	32	33	31	29	30	29	31	35
CO	Industry-Other (1A2f)	[tons]	9863	9784	9702	9611	9502	9379	9294	9188	9070	8956	8910
CO	Civil Aviation (1A3a)	[tons]	1256	1241	1118	1167	1140	1098	989	955	930	1098	1180
CO	Road (1A3b)	[tons]	561271	540938	521944	476251	448416	459539	474997	465106	466804	435050	412018
CO	Railways (1A3c)	[tons]	1098	1105	982	1018	937	895	910	963	999	906	914
CO	Navigation (1A3d)	[tons]	5291	5291	5453	5613	5777	5941	6095	6287	6428	6610	6861
CO	Residential (1A4b)	[tons]	50434	49697	48935	48149	47970	47787	46848	45867	45027	44365	43997
CO	Ag./for./fish. (1A4c)	[tons]	61165	59707	57256	55768	53717	51734	48771	45427	42608	39735	37673
CO	Military (1A5)	[tons]	4168	3098	1315	3127	1948	425	1028	525	860	881	905
CO	Navigation int. (1A3d)	[tons]	2903	3396	5038	6427	6608	6981	6268	6566	9873	11143	11745
CO	Civil Aviation int. (1A3a)	[tons]	1103	1207	1289	1416	1564	1442	1357	1399	1388	1342	1421
CO_2	Industry-Other (1A2f)	[ktons]	852	852	851	849	845	842	843	843	842	841	848
CO_2	Civil Aviation (1A3a)	[ktons]	256	241	268	271	262	243	199	193	190	196	199
CO_2	Road (1A3b)	[ktons]	8160	8625	8636	8694	8789	9275	9690	9863	9987	10487	10585
CO_2	Railways (1A3c)	[ktons]	364	366	326	338	311	297	302	319	331	300	303
CO_2	Navigation (1A3d)	[ktons]	702	701	705	707	710	714	713	727	717	729	766
CO_2	Residential (1A4b)	[ktons]	114	114	113	113	113	113	113	114	115	116	118
CO_2	Ag./for./fish. (1A4c)	[ktons]	1806	1922	1758	1887	1874	1899	1903	1794	1760	1695	1728
CO_2	Military (1A5)	[ktons]	402	316	361	196	165	119	287	141	237	252	252
CO_2	Navigation int. (1A3d)	[ktons]	1320	1537	2261	2869	2936	3087	2762	2887	4300	4829	5061
CO_2	Civil Aviation int. (1A3a)	[ktons]	1391	1503	1613	1725	1809	1736	1632	1693	1659	1818	1867
N_2O	Industry-Other (1A2f)	[tons]	34	34	34	34	34	34	34	35	35	35	35
N_2O	Civil Aviation (1A3a)	[tons]	10	10	11	11	11	10	9	9	9	9	10
N_2O	Road (1A3b)	[tons]	275	289	289	293	295	312	335	352	365	398	414
N_2O	Railways (1A3c)	[tons]	10	10	9	9	9	8	8	9	9	8	8
N_2O	Navigation (1A3d)	[tons]	43	43	43	43	43	43	43	44	43	44	46
N_2O	Residential (1A4b)	[tons]	2	2	2	2	2	2	2	2	2	2	2
N_2O	Ag./for./fish. (1A4c)	[tons]	81	87	78	85	85	87	88	83	81	79	81
N_2O	Military (1A5)	[tons]	12	10	11	6	5	4	8	4	7	8	7
N_2O	Navigation int. (1A3d)	[tons]	83	97	142	180	185	194	174	182	270	304	318
N_2O	Civil Aviation int. (1A3a)	[tons]	47	50	54	58	61	59	56	58	57	63	64

NH_3	Industry-Other (1A2f)	[tons]	2	2	2	2	2	2	2	2	2	2	2
NH_3	Civil Aviation (1A3a)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tons]	62	64	64	66	66	70	248	441	623	946	1198
NH_3	Railways (1A3c)	[tons]	1	1	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tons]	3	3	3	3	3	3	3	3	3	3	3
NH_3	Military (1A5)	[tons]	1	1	0	0	0	0	1	0	0	0	1
NH_3	Navigation int. (1A3d)	[tons]		0						0	0		
NH_3	Civil Aviation int. (1A3a)	[tons]	0	0	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tons]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349
TSP	Civil Aviation (1A3a)	[tons]	5	5	5	5	5	5	4	4	4	4	4
TSP	Road (1A3b)	[tons]	4431	4764	4781	4722	4796	5053	5179	5026	5044	5164	4917
TSP	Railways (1A3c)	[tons]	247	249	222	229	211	202	205	217	225	204	206
TSP	Navigation (1A3d)	[tons]	948	948	953	948	953	781	612	451	561	646	773
TSP	Residential (1A4b)	[tons]	37	36	36	36	36	35	35	34	33	34	35
TSP	Ag./for./fish. (1A4c)	[tons]	2783	2820	2673	2723	2665	2628	2534	2362	2300	2119	2087
TSP	Military (1A5)	[tons]	103	103	51	18	26	12	116	69	66	57	120
TSP	Navigation int. (1A3d)	[tons]	3047	3663	6129	8024	8081	5677	4512	4139	8822	8348	10262
TSP	Civil Aviation int. (1A3a)	[tons]	23	24	26	28	30	28	27	28	27	29	30
PM_{10}	Industry-Other (1A2f)	[tons]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349
PM_{10}	Civil Aviation (1A3a)	[tons]	5	5	5	5	5	5	4	4	4	4	4
PM_{10}	Road (1A3b)	[tons]	4431	4764	4781	4722	4796	5053	5179	5026	5044	5164	4917
PM_{10}	Railways (1A3c)	[tons]	247	249	222	229	211	202	205	217	225	204	206
PM_{10}	Navigation (1A3d)	[tons]	940	939	944	939	944	774	607	447	556	641	767
PM_{10}	Residential (1A4b)	[tons]	37	36	36	36	36	35	35	34	33	34	35
PM_{10}	Ag./for./fish. (1A4c)	[tons]	2781	2818	2671	2721	2663	2626	2532	2360	2298	2117	2086
PM_{10}	Military (1A5)	[tons]	103	103	51	18	26	12	116	69	66	57	120
PM_{10}	Navigation int. (1A3d)	[tons]	3016	3626	6068	7944	8000	5620	4467	4098	8734	8264	10160
PM_{10}	Civil Aviation int. (1A3a)	[tons]	23	24	26	28	30	28	27	28	27	29	30
$PM_{2.5}$	Industry-Other (1A2f)	[tons]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349
$PM_{2.5}$	Civil Aviation (1A3a)	[tons]	5	5	5	5	5	5	4	4	4	4	4
$PM_{2.5}$	Road (1A3b)	[tons]	4431	4764	4781	4722	4796	5053	5179	5026	5044	5164	4917
$PM_{2.5}$	Railways (1A3c)	[tons]	247	249	222	229	211	202	205	217	225	204	206
$PM_{2.5}$	Navigation (1A3d)	[tons]	935	935	939	935	940	771	604	446	554	638	764
$PM_{2.5}$	Residential (1A4b)	[tons]	37	36	36	36	36	35	35	34	33	34	35

$PM_{2.5}$	Ag./for./fish. (1A4c)	[tons]	2780	2817	2670	2720	2662	2625	2531	2359	2297	2116	2085
$PM_{2.5}$	Military (1A5)	[tons]	103	103	51	18	26	12	116	69	66	57	120
$PM_{2.5}$	Navigation int. (1A3d)	[tons]	3001	3608	6037	7904	7959	5592	4445	4077	8690	8223	10108
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tons]	23	24	26	28	30	28	27	28	27	29	30
Arsenic	Civil Aviation (1A3a)	[kg]											
Arsenic	Navigation (1A3d)	[kg]						53	46	38	38	39	40
Arsenic	Ag./for./fish. (1A4c)	[kg]						9	10	9	8	8	8
Arsenic	Military (1A5)	[kg]										0	
Arsenic	Navigation int. (1A3d)	[kg]						363	302	276	475	505	514
Arsenic	Civil Aviation int. (1A3a)	[kg]											
Cadmium	Industry-Other (1A2f)	[kg]						2	2	2	2	2	2
Cadmium	Civil Aviation (1A3a)	[kg]						1	1	1	1	1	1
Cadmium	Road (1A3b)	[kg]						29	30	31	31	33	33
Cadmium	Railways (1A3c)	[kg]						1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]						4	4	4	3	4	4
Cadmium	Residential (1A4b)	[kg]						0	0	0	0	0	0
Cadmium	Ag./for./fish. (1A4c)	[kg]						6	6	6	6	5	5
Cadmium	Military (1A5)	[kg]						0	1	0	1	1	1
Cadmium	Navigation int. (1A3d)	[kg]						24	20	19	32	34	35
Cadmium	Civil Aviation int. (1A3a)	[kg]						6	5	5	5	6	6
Chromium	Industry-Other (1A2f)	[kg]						12	12	12	12	12	12
Chromium	Civil Aviation (1A3a)	[kg]						4	3	3	3	3	3
Chromium	Road (1A3b)	[kg]						146	152	155	157	165	166
Chromium	Railways (1A3c)	[kg]						5	5	5	5	5	5
Chromium	Navigation (1A3d)	[kg]						24	22	19	19	20	20
Chromium	Residential (1A4b)	[kg]						2	2	2	2	2	2
Chromium	Ag./for./fish. (1A4c)	[kg]						28	28	27	26	25	26
Chromium	Military (1A5)	[kg]						2	5	2	4	4	4
Chromium	Navigation int. (1A3d)	[kg]						150	127	118	199	213	218
Chromium	Civil Aviation int. (1A3a)	[kg]						28	26	27	26	29	30
Copper	Industry-Other (1A2f)	[kg]						411	413	413	413	414	418
Copper	Civil Aviation (1A3a)	[kg]						131	107	104	102	106	107
Copper	Road (1A3b)	[kg]						4965	5184	5273	5337	5605	5657
Copper	Railways (1A3c)	[kg]						160	162	172	178	162	163
Copper	Navigation (1A3d)	[kg]						78	73	67	69	73	76
Copper	Residential (1A4b)	[kg]						60	60	61	61	62	63

Copper	Ag./for./fish. (1A4c)	[kg]	713	706	674	672	636	653
Copper	Military (1A5)	[kg]	64	154	76	128	136	136
Copper	Navigation int. (1A3d)	[kg]	363	302	276	475	505	514
Copper	Civil Aviation int. (1A3a)	[kg]	936	880	913	894	980	1006
Mercury	Civil Aviation (1A3a)	[kg]						
Mercury	Navigation (1A3d)	[kg]	8	8	9	9	9	9
Mercury	Ag./for./fish. (1A4c)	[kg]	9	10	9	8	8	8
Mercury	Military (1A5)	[kg]					0	
Mercury	Navigation int. (1A3d)	[kg]	28	26	30	40	47	51
Mercury	Civil Aviation int. (1A3a)	[kg]						
Nickel	Industry-Other (1A2f)	[kg]	17	17	17	17	17	17
Nickel	Civil Aviation (1A3a)	[kg]	5	4	4	4	4	4
Nickel	Road (1A3b)	[kg]	204	213	217	220	231	233
Nickel	Railways (1A3c)	[kg]	7	7	7	7	7	7
Nickel	Navigation (1A3d)	[kg]	2828	2355	1826	1825	1943	1958
Nickel	Residential (1A4b)	[kg]	2	2	2	3	3	3
Nickel	Ag./for./fish. (1A4c)	[kg]	42	42	40	39	37	38
Nickel	Military (1A5)	[kg]	3	6	3	5	6	6
Nickel	Navigation int. (1A3d)	[kg]	20956	17236	15429	27162	28664	29023
Nickel	Civil Aviation int. (1A3a)	[kg]	39	36	38	37	40	41
Lead	Industry-Other (1A2f)	[kg]	258	187	160	67	12	12
Lead	Civil Aviation (1A3a)	[kg]	1534	1423	1378	1328	1639	1788
Lead	Road (1A3b)	[kg]	97509	75857	68775	29817	54	55
Lead	Railways (1A3c)	[kg]	0	0	0	0		0
Lead	Navigation (1A3d)	[kg]	485	371	331	159	51	53
Lead	Residential (1A4b)	[kg]	2273	1666	1442	612	109	110
Lead	Ag./for./fish. (1A4c)	[kg]	1564	1069	859	346	71	67
Lead	Military (1A5)	[kg]	64	80	62	120	86	102
Lead	Navigation int. (1A3d)	[kg]	167	144	142	226	247	256
Lead	Civil Aviation int. (1A3a)	[kg]	490	465	452	456	153	175
Selenium	Industry-Other (1A2f)	[kg]	2	2	2	2	2	2
Selenium	Civil Aviation (1A3a)	[kg]	1	1	1	1	1	1
Selenium	Road (1A3b)	[kg]	29	30	31	31	33	33
Selenium	Railways (1A3c)	[kg]	1	1	1	1	1	1
Selenium	Navigation (1A3d)	[kg]	61	58	55	54	55	57
Selenium	Residential (1A4b)	[kg]	0	0	0	0	0	0

Selenium	Ag./for./fish. (1A4c)	[kg]	41	42	39	37	37	37
Selenium	Military (1A5)	[kg]	0	1	0	1	1	1
Selenium	Navigation int. (1A3d)	[kg]	334	289	284	451	495	512
Selenium	Civil Aviation int. (1A3a)	[kg]	6	5	5	5	6	6
Zinc	Industry-Other (1A2f)	[kg]	242	243	243	243	243	246
Zinc	Civil Aviation (1A3a)	[kg]	77	63	61	60	62	63
Zinc	Road (1A3b)	[kg]	2921	3050	3102	3140	3297	3328
Zinc	Railways (1A3c)	[kg]	94	95	101	105	95	96
Zinc	Navigation (1A3d)	[kg]	158	152	147	146	151	157
Zinc	Residential (1A4b)	[kg]	35	35	36	36	36	37
Zinc	Ag./for./fish. (1A4c)	[kg]	506	505	479	474	453	463
Zinc	Military (1A5)	[kg]	38	91	45	75	80	80
Zinc	Navigation int. (1A3d)	[kg]	764	664	660	1038	1141	1183
Zinc	Civil Aviation int. (1A3a)	[kg]	551	518	537	526	576	592
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	1	1	1	1	1	1
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0
Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	0	0	1	1	1
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	45	44	45	46	45	46
Flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	1	1
Flouranthene	Road (1A3b)	[kg]	789	795	789	771	757	718
Flouranthene	Railways (1A3c)	[kg]	5	5	6	6	6	6
Flouranthene	Navigation (1A3d)	[kg]	59	61	64	63	64	67
Flouranthene	Residential (1A4b)	[kg]	7	7	7	7	7	7
Flouranthene	Ag./for./fish. (1A4c)	[kg]	136	135	128	127	121	124
Flouranthene	Military (1A5)	[kg]	1	7	4	4	3	8
Flouranthene	Navigation int. (1A3d)	[kg]	204	190	212	294	340	361
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0

Benzo(b) flouranthene	Road (1A3b)	[kg]	65	66	66	65	66	65
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	2	1	1
Benzo(b) flouranthene	Navigation (1A3d)	[kg]	4	5	5	5	5	5
Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	15	15	14	14	13	13
Benzo(b) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	13	13	15	20	23	25
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	65	67	67	66	69	69
Benzo(k) flouranthene	Railways (1A3c)	[kg]	2	2	2	2	2	2
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	2	2	2	2	2	2
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	12	12	11	11	11	11
Benzo(k) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	6	6	7	9	11	12
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0
Benzo(a) pyrene	Road (1A3b)	[kg]	45	46	46	46	47	45
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	1	1	1	1	1
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	6	6	6	6	5	5
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	1
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	4	4	4	5	6	7
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	6	6	6	6	5	6
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	95	97	98	97	97	93
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	8	9	10	10	10	10
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	1	1	1	1	1	1
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	21	21	20	19	19	19
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	1	1	1	0	1

Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]					24	24	30	37	45	49
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]					0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]					3	3	3	3	3	3
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]					0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]					43	45	45	46	47	47
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]					0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]					6	7	8	8	8	8
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]					0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]					14	15	14	13	13	13
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]					0	0	0	0	0	1
indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]					19	20	24	30	36	39
indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]					0	0	0	0	0	0

pol_name	IPCC ID	Unit	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
SO_2	Industry-Other (1A2f)	[tons]	244	246	249	251	253	256	258	261	263	28	30
SO_2	Civil Aviation (1A3a)	[tons]	65	68	62	56	49	52	45	44	40	43	45
SO_2	Road (1A3b)	[tons]	1721	1744	1768	1088	352	353	357	371	381	77	79
SO_2	Railways (1A3c)	[tons]	95	93	78	40	7	7	7	7	7	1	1
SO_2	Navigation (1A3d)	[tons]	3454	2632	1541	1276	1116	1027	953	984	1138	1146	1089
SO_2	Residential (1A4b)	[tons]	4	4	4	4	4	4	5	6	6	1	1
SO_2	Ag./for./fish. (1A4c)	[tons]	982	867	871	947	1035	998	1051	1008	863	649	632
SO_2	Military (1A5)	[tons]	56	54	65	47	27	12	19	17	46	57	26
SO_2	Navigation int. (1A3d)	[tons]	62320	57078	48000	50568	56634	45358	31538	33060	28581	36544	52936
SO_2	Civil Aviation int. (1A3a)	[tons]	629	642	689	731	750	761	658	684	782	822	825
NO_X	Industry-Other (1A2f)	[tons]	12080	12248	12425	12262	12096	11869	11617	11214	10744	10664	10807
NO_X	Civil Aviation (1A3a)	[tons]	971	998	911	815	723	747	636	590	546	579	596
NO_X	Road (1A3b)	[tons]	96827	93041	89052	85941	81108	78485	74679	74275	72201	68519	66993
NO_X	Railways (1A3c)	[tons]	4977	4846	4089	3730	3727	3396	3396	3540	3478	3724	3542
NO_X	Navigation (1A3d)	[tons]	13458	12388	9973	8095	7284	7172	7372	7261	7407	7465	7436
NO_X	Residential (1A4b)	[tons]	140	144	149	151	153	167	183	202	223	249	275
NO_X	Ag./for./fish. (1A4c)	[tons]	21188	20367	20307	21710	22991	22865	23412	22477	20102	20944	20199
NO_X	Military (1A5)	[tons]	965	1219	1415	1096	551	719	486	542	1318	1335	619

NO_X	Navigation int. (1A3d)	[tons]	102221	94977	94125	91400	96911	81585	66095	71376	58906	62825	84716
NO_X	Civil Aviation int. (1A3a)	[tons]	7904	8058	8662	9204	9446	9610	8737	9097	10481	11037	11175
NMVOC	Industry-Other (1A2f)	[tons]	2095	2083	2074	1997	1926	1873	1815	1754	1676	1620	1583
NMVOC	Civil Aviation (1A3a)	[tons]	194	186	169	162	156	155	151	143	157	165	155
NMVOC	Road (1A3b)	[tons]	66214	60042	54906	48977	41599	37854	34307	31872	28154	25947	23171
NMVOC	Railways (1A3c)	[tons]	325	316	267	276	253	248	243	223	217	235	230
NMVOC	Navigation (1A3d)	[tons]	1899	1882	1787	1701	1636	1600	1559	1501	1436	1324	1195
NMVOC	Residential (1A4b)	[tons]	4231	4314	4395	4499	4602	5328	6082	6869	7685	7859	8037
NMVOC	Ag./for./fish. (1A4c)	[tons]	4210	3974	3699	3572	3421	3253	3085	2864	2593	2575	2541
NMVOC	Military (1A5)	[tons]	95	110	123	112	58	60	48	50	111	116	56
NMVOC	Navigation int. (1A3d)	[tons]	3398	3138	3158	3003	3126	2651	2190	2334	1914	2005	2643
NMVOC	Civil Aviation int. (1A3a)	[tons]	360	365	386	395	407	406	391	399	451	469	492
CH_4	Industry-Other (1A2f)	[tons]	53	53	53	51	50	49	48	47	46	45	44
CH_4	Civil Aviation (1A3a)	[tons]	7	7	7	6	5	5	5	5	6	7	6
CH_4	Road (1A3b)	[tons]	2265	2176	2090	1980	1861	1740	1636	1572	1480	1376	1290
CH_4	Railways (1A3c)	[tons]	12	12	10	11	10	10	9	9	8	9	9
CH_4	Navigation (1A3d)	[tons]	37	36	33	31	30	31	31	32	32	32	32
CH_4	Residential (1A4b)	[tons]	135	134	134	135	137	149	164	183	204	219	233
CH_4	Ag./for./fish. (1A4c)	[tons]	100	94	89	88	88	86	86	85	82	86	94
CH_4	Military (1A5)	[tons]	10	12	14	11	6	7	5	5	13	13	6
CH_4	Navigation int. (1A3d)	[tons]	105	97	98	93	97	82	68	72	59	62	82
CH_4	Civil Aviation int. (1A3a)	[tons]	37	38	40	41	42	42	41	42	47	49	52
CO	Industry-Other (1A2f)	[tons]	8963	8939	8907	8647	8395	8227	8030	7842	7600	7497	7515
CO	Civil Aviation (1A3a)	[tons]	1117	1085	973	932	895	888	860	832	855	858	838
CO	Road (1A3b)	[tons]	399617	346233	325320	290786	267325	256942	235566	225428	200562	192046	171521
CO	Railways (1A3c)	[tons]	907	883	745	717	694	637	627	611	599	648	626
CO	Navigation (1A3d)	[tons]	7130	7047	6876	6775	6804	6972	7173	7348	7549	7571	7192
CO	Residential (1A4b)	[tons]	44112	44229	44347	45103	45873	50280	56144	63688	72683	80610	87744
CO	Ag./for./fish. (1A4c)	[tons]	34865	32482	29849	27850	25867	24029	22187	20250	18206	17176	16976
CO	Military (1A5)	[tons]	627	617	704	706	407	327	321	315	734	823	391
CO	Navigation int. (1A3d)	[tons]	11211	10351	10417	9905	10313	8745	7225	7701	6316	6615	8719
CO	Civil Aviation int. (1A3a)	[tons]	1502	1564	1662	1743	1790	1797	1610	1670	1845	1914	1871
CO_2	Industry-Other (1A2f)	[ktons]	853	860	867	873	879	888	897	907	912	950	1021
CO_2	Civil Aviation (1A3a)	[ktons]	205	212	194	174	154	161	140	137	127	133	141
CO_2	Road (1A3b)	[ktons]	10764	10978	11166	11312	11202	11223	11352	11806	12115	12229	12594
CO_2	Railways (1A3c)	[ktons]	301	293	247	232	228	211	210	218	216	232	227

CO_2	Navigation (1A3d)	[ktons]	836	809	656	540	466	452	449	452	466	462	455
CO_2	Residential (1A4b)	[ktons]	120	122	124	127	129	143	161	182	205	220	233
CO_2	Ag./for./fish. (1A4c)	[ktons]	1645	1566	1521	1577	1626	1602	1644	1611	1507	1586	1599
CO_2	Military (1A5)	[ktons]	176	171	204	182	111	97	89	92	239	271	126
CO_2	Navigation int. (1A3d)	[ktons]	4803	4403	4414	4155	4279	3605	2966	3130	2545	2636	3433
CO_2	Civil Aviation int. (1A3a)	[ktons]	1971	2010	2159	2290	2350	2385	2059	2142	2449	2575	2583
N_2O	Industry-Other (1A2f)	[tons]	36	36	36	37	37	38	38	38	39	40	43
N_2O	Civil Aviation (1A3a)	[tons]	11	11	9	9	8	8	8	8	8	8	8
N_2O	Road (1A3b)	[tons]	430	442	447	450	443	429	421	420	421	406	402
N_2O	Railways (1A3c)	[tons]	8	8	7	6	6	6	6	6	6	6	6
N_2O	Navigation (1A3d)	[tons]	50	49	39	31	27	26	25	25	26	26	26
N_2O	Residential (1A4b)	[tons]	2	2	2	2	2	2	2	3	3	3	4
N_2O	Ag./for./fish. (1A4c)	[tons]	77	72	71	75	79	77	80	78	72	77	77
N_2O	Military (1A5)	[tons]	5	5	6	6	3	3	3	3	8	9	4
N_2O	Navigation int. (1A3d)	[tons]	302	277	278	262	269	227	187	197	160	166	216
N_2O	Civil Aviation int. (1A3a)	[tons]	69	70	75	80	82	82	72	75	85	89	89
NH_3	Industry-Other (1A2f)	[tons]	2	2	2	2	2	2	2	2	2	2	2
NH_3	Civil Aviation (1A3a)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tons]	1428	1862	2226	2492	2657	2536	2472	2376	2281	2123	1951
NH_3	Railways (1A3c)	[tons]	1	1	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tons]	0	0	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tons]	3	3	3	3	3	3	3	3	3	3	3
NH_3	Military (1A5)	[tons]	0	0	0	1	0	0	0	0	1	1	0
NH_3	Navigation int. (1A3d)	[tons]											
NH_3	Civil Aviation int. (1A3a)	[tons]	0	0	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tons]	1317	1284	1249	1193	1135	1121	1098	1075	1037	1002	991
TSP	Civil Aviation (1A3a)	[tons]	4	4	4	4	3	3	3	3	3	3	3
TSP	Road (1A3b)	[tons]	4814	4444	4191	3986	3732	3599	3360	3386	3177	3150	3101
TSP	Railways (1A3c)	[tons]	204	199	168	146	141	125	124	119	115	124	120
TSP	Navigation (1A3d)	[tons]	612	542	375	333	304	295	288	293	312	306	291
TSP	Residential (1A4b)	[tons]	36	38	39	40	41	50	58	67	76	78	79
TSP	Ag./for./fish. (1A4c)	[tons]	1893	1786	1637	1580	1510	1443	1377	1294	1194	1149	1086
TSP	Military (1A5)	[tons]	48	78	84	53	19	41	19	24	51	45	21
TSP	Navigation int. (1A3d)	[tons]	10169	9437	7917	8390	8994	7414	5254	4816	4293	6155	8300
TSP	Civil Aviation int. (1A3a)	[tons]	32	32	35	37	38	38	33	35	40	42	42

PM_{10}	Industry-Other (1A2f)	[tons]	1317	1284	1249	1193	1135	1121	1098	1075	1037	1002	991
PM_{10}	Civil Aviation (1A3a)	[tons]	4	4	4	4	3	3	3	3	3	3	3
PM_{10}	Road (1A3b)	[tons]	4814	4444	4191	3986	3732	3599	3360	3386	3177	3150	3101
PM_{10}	Railways (1A3c)	[tons]	204	199	168	146	141	125	124	119	115	124	120
PM_{10}	Navigation (1A3d)	[tons]	607	538	373	331	302	293	287	291	311	305	289
PM_{10}	Residential (1A4b)	[tons]	36	38	39	40	41	50	58	67	76	78	79
PM_{10}	Ag./for./fish. (1A4c)	[tons]	1892	1785	1636	1578	1508	1441	1375	1292	1192	1148	1084
PM_{10}	Military (1A5)	[tons]	48	78	84	53	19	41	19	24	51	45	21
PM_{10}	Navigation int. (1A3d)	[tons]	10068	9342	7838	8306	8904	7340	5201	4767	4250	6094	8217
PM_{10}	Civil Aviation int. (1A3a)	[tons]	32	32	35	37	38	38	33	35	40	42	42
$PM_{2.5}$	Industry-Other (1A2f)	[tons]	1317	1284	1249	1193	1135	1121	1098	1075	1037	1002	991
$PM_{2.5}$	Civil Aviation (1A3a)	[tons]	4	4	4	4	3	3	3	3	3	3	3
$PM_{2.5}$	Road (1A3b)	[tons]	4814	4444	4191	3986	3732	3599	3360	3386	3177	3150	3101
$PM_{2.5}$	Railways (1A3c)	[tons]	204	199	168	146	141	125	124	119	115	124	120
$PM_{2.5}$	Navigation (1A3d)	[tons]	605	536	371	330	301	293	286	291	310	304	288
$PM_{2.5}$	Residential (1A4b)	[tons]	36	38	39	40	41	50	58	67	76	78	79
$PM_{2.5}$	Ag./for./fish. (1A4c)	[tons]	1891	1785	1635	1578	1507	1441	1374	1292	1192	1147	1084
$PM_{2.5}$	Military (1A5)	[tons]	48	78	84	53	19	41	19	24	51	45	21
$PM_{2.5}$	Navigation int. (1A3d)	[tons]	10017	9295	7799	8264	8859	7303	5175	4743	4229	6063	8175
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tons]	32	32	35	37	38	38	33	35	40	42	42
Arsenic	Civil Aviation (1A3a)	[kg]				0	0	0	0	0	0	0	0
Arsenic	Navigation (1A3d)	[kg]	35	26	19	15	14	13	13	13	13	13	13
Arsenic	Ag./for./fish. (1A4c)	[kg]	8	6	7	8	9	8	9	8	7	8	7
Arsenic	Military (1A5)	[kg]				0	0	0	0	0	0	0	0
Arsenic	Navigation int. (1A3d)	[kg]	332	426	366	379	432	342	240	274	230	268	401
Arsenic	Civil Aviation int. (1A3a)	[kg]				0	0	0	0	0	0	0	0
Cadmium	Industry-Other (1A2f)	[kg]	2	2	3	2	3	3	3	3	3	3	3
Cadmium	Civil Aviation (1A3a)	[kg]	1	1	1	1	0	1	0	0	0	0	0
Cadmium	Road (1A3b)	[kg]	34	34	35	36	35	35	36	37	38	38	40
Cadmium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]	4	3	2	2	2	2	2	2	2	2	2
Cadmium	Residential (1A4b)	[kg]	0	0	0	0	0	0	1	1	1	1	1
Cadmium	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	5	5	5	5	5
Cadmium	Military (1A5)	[kg]	1	1	1	1	0	0	0	0	1	1	0
Cadmium	Navigation int. (1A3d)	[kg]	20	30	27	27	29	24	18	20	16	18	26
Cadmium	Civil Aviation int. (1A3a)	[kg]	6	6	7	7	8	8	7	7	8	8	8

Chromium	Industry-Other (1A2f)	[kg]	12	12	13	13	13	13	13	13	13	14	15
Chromium	Civil Aviation (1A3a)	[kg]	3	3	3	3	2	3	2	2	2	2	2
Chromium	Road (1A3b)	[kg]	169	173	175	178	176	176	179	186	191	192	199
Chromium	Railways (1A3c)	[kg]	5	5	4	4	4	3	3	3	3	4	4
Chromium	Navigation (1A3d)	[kg]	19	16	12	10	9	9	9	9	9	9	9
Chromium	Residential (1A4b)	[kg]	2	2	2	2	2	2	3	3	3	3	4
Chromium	Ag./for./fish. (1A4c)	[kg]	24	23	23	23	24	24	24	24	23	24	24
Chromium	Military (1A5)	[kg]	3	3	3	3	2	2	1	1	4	4	2
Chromium	Navigation int. (1A3d)	[kg]	133	182	161	164	184	147	106	120	100	114	167
Chromium	Civil Aviation int. (1A3a)	[kg]	31	32	34	36	37	38	33	34	39	41	41
Copper	Industry-Other (1A2f)	[kg]	421	425	429	432	435	440	445	450	454	474	513
Copper	Civil Aviation (1A3a)	[kg]	110	114	104	94	83	87	75	74	68	72	76
Copper	Road (1A3b)	[kg]	5754	5867	5968	6047	5989	6001	6072	6314	6481	6543	6750
Copper	Railways (1A3c)	[kg]	162	157	133	125	123	114	113	117	116	125	122
Copper	Navigation (1A3d)	[kg]	73	66	60	59	60	62	64	66	69	68	67
Copper	Residential (1A4b)	[kg]	64	65	66	67	69	76	86	96	109	117	124
Copper	Ag./for./fish. (1A4c)	[kg]	623	630	597	595	581	585	586	586	593	599	613
Copper	Military (1A5)	[kg]	95	92	110	98	60	52	48	50	129	146	68
Copper	Navigation int. (1A3d)	[kg]	332	426	366	379	432	342	240	274	230	268	401
Copper	Civil Aviation int. (1A3a)	[kg]	1063	1084	1164	1234	1267	1286	1110	1155	1320	1388	1392
Mercury	Civil Aviation (1A3a)	[kg]				0	0	0	0	0	0	0	0
Mercury	Navigation (1A3d)	[kg]	11	11	9	7	5	5	5	5	5	5	5
Mercury	Ag./for./fish. (1A4c)	[kg]	8	6	7	8	9	8	9	8	7	8	7
Mercury	Military (1A5)	[kg]				0	0	0	0	0	0	0	0
Mercury	Navigation int. (1A3d)	[kg]	14	46	50	44	43	38	34	34	27	26	31
Mercury	Civil Aviation int. (1A3a)	[kg]				0	0	0	0	0	0	0	0
Nickel	Industry-Other (1A2f)	[kg]	17	17	18	18	18	18	18	19	19	20	21
Nickel	Civil Aviation (1A3a)	[kg]	5	5	4	4	3	4	3	3	3	3	3
Nickel	Road (1A3b)	[kg]	237	242	246	249	247	247	250	260	267	269	278
Nickel	Railways (1A3c)	[kg]	7	6	5	5	5	5	5	5	5	5	5
Nickel	Navigation (1A3d)	[kg]	1553	986	645	543	534	501	492	483	503	507	482
Nickel	Residential (1A4b)	[kg]	3	3	3	3	3	3	4	4	4	5	5
Nickel	Ag./for./fish. (1A4c)	[kg]	36	35	34	35	36	35	36	36	33	35	35
Nickel	Military (1A5)	[kg]	4	4	5	4	2	2	2	2	5	6	3
Nickel	Navigation int. (1A3d)	[kg]	19856	23826	19820	20967	24364	19050	12906	15043	12715	15126	23174
Nickel	Civil Aviation int. (1A3a)	[kg]	44	45	48	51	52	53	46	48	54	57	57

Lead	Industry-Other (1A2f)	[kg]	12	0	0	0	0	0	0	0	0	0	0
Lead	Civil Aviation (1A3a)	[kg]	1640	1559	1399	1387	1369	1343	1328	1252	1304	1297	1245
Lead	Road (1A3b)	[kg]	55	57	58	58	57	56	56	56	55	53	52
Lead	Railways (1A3c)	[kg]	0	0	0	0	0	0	0				
Lead	Navigation (1A3d)	[kg]	55	27	21	16	14	13	13	13	13	13	13
Lead	Residential (1A4b)	[kg]	112	1	1	1	1	1	2	2	2	2	2
Lead	Ag./for./fish. (1A4c)	[kg]	63	13	14	16	18	17	18	17	13	16	15
Lead	Military (1A5)	[kg]	98	123	116	78	114	88	106	78	82	59	47
Lead	Navigation int. (1A3d)	[kg]	134	218	205	201	216	177	136	149	122	133	185
Lead	Civil Aviation int. (1A3a)	[kg]	126	145	145	124	118	114	113	106	111	117	22
Selenium	Industry-Other (1A2f)	[kg]	2	2	3	2	3	3	3	3	3	3	3
Selenium	Civil Aviation (1A3a)	[kg]	1	1	1	1	0	1	0	0	0	0	0
Selenium	Road (1A3b)	[kg]	34	34	35	36	35	35	36	37	38	38	40
Selenium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Selenium	Navigation (1A3d)	[kg]	59	53	41	33	28	26	26	26	26	26	26
Selenium	Residential (1A4b)	[kg]	0	0	0	0	0	0	1	1	1	1	1
Selenium	Ag./for./fish. (1A4c)	[kg]	35	29	30	34	39	37	39	37	30	34	33
Selenium	Military (1A5)	[kg]	1	1	1	1	0	0	0	0	1	1	0
Selenium	Navigation int. (1A3d)	[kg]	269	436	410	401	431	354	273	297	245	267	370
Selenium	Civil Aviation int. (1A3a)	[kg]	6	6	7	7	8	8	7	7	8	8	8
Zinc	Industry-Other (1A2f)	[kg]	248	250	252	254	256	259	262	265	267	279	302
Zinc	Civil Aviation (1A3a)	[kg]	65	67	61	55	49	51	44	43	40	42	45
Zinc	Road (1A3b)	[kg]	3384	3451	3511	3557	3523	3530	3572	3714	3812	3849	3971
Zinc	Railways (1A3c)	[kg]	95	93	78	73	72	67	67	69	68	73	72
Zinc	Navigation (1A3d)	[kg]	164	152	124	105	94	92	92	93	96	96	94
Zinc	Residential (1A4b)	[kg]	37	38	39	40	40	45	50	57	64	69	73
Zinc	Ag./for./fish. (1A4c)	[kg]	441	431	414	422	425	423	430	425	411	425	431
Zinc	Military (1A5)	[kg]	56	54	65	58	35	31	28	29	76	86	40
Zinc	Navigation int. (1A3d)	[kg]	607	1010	959	933	997	821	639	693	570	616	848
Zinc	Civil Aviation int. (1A3a)	[kg]	625	638	685	726	745	756	653	679	776	817	819
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	1	1	0	0	0	0	0	0	0	0	0
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0	0	0	0	0	0

Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	1	1	1	1	1	0	1	0	0	1
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	46	46	46	46	48	48	49	49	50	52	56
Flouranthene	Civil Aviation (1A3a)	[kg]	1	0	0	0	0	0	0	0	0	0	0
Flouranthene	Road (1A3b)	[kg]	683	650	621	599	582	571	575	601	629	666	712
Flouranthene	Railways (1A3c)	[kg]	6	6	5	4	4	4	4	4	4	4	4
Flouranthene	Navigation (1A3d)	[kg]	75	75	60	49	41	40	39	40	41	40	40
Flouranthene	Residential (1A4b)	[kg]	7	7	7	8	8	9	10	11	12	13	14
Flouranthene	Ag./for./fish. (1A4c)	[kg]	117	108	105	112	119	116	120	117	106	113	114
Flouranthene	Military (1A5)	[kg]	3	6	6	4	2	4	2	3	6	6	3
Flouranthene	Navigation int. (1A3d)	[kg]	349	322	343	311	306	266	232	238	191	188	227
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	6	6	6	6	7
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Road (1A3b)	[kg]	64	62	61	61	59	59	59	62	64	65	69
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1	1
Benzo(b) flouranthene	Navigation (1A3d)	[kg]	6	6	5	4	3	3	3	3	3	3	3
Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	1	1	1	1
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	13	12	11	12	12	12	12	12	11	12	12
Benzo(b) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	0	0	0	1	1	0
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	25	23	25	22	21	19	17	17	14	13	15
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	5	5	6	6	6	6
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	69	69	69	69	68	67	68	71	74	75	78
Benzo(k) flouranthene	Railways (1A3c)	[kg]	2	2	1	1	1	1	1	1	1	1	1
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	3	3	3	2	2	2	2	2	2	2	2
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	10	10	9	9	9	9	9	9	9	9	9
Benzo(k) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	0	0	0	1	1	0
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	11	11	12	10	10	9	8	8	6	6	7
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3	3
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Benzo(a) pyrene	Road (1A3b)	[kg]	44	44	43	43	42	42	43	45	47	50	53
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	2	1	1	1	1	1	1	1	1	1
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	5	5	5	5	5
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	7	6	7	6	6	5	4	5	4	4	4
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	5	5	5	5	5	5	5	5	5	6	6
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	90	88	86	84	82	81	83	86	90	95	100
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	12	13	11	8	7	7	7	7	7	7	7
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	1	1	1	1	1	1	2	2	2	2	2
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	18	16	15	16	18	17	18	17	15	16	16
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	1	1	0	0	0	0	0	1	1	0
Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]	48	45	52	45	41	37	35	35	28	25	27
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3	3
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]	46	47	47	47	47	47	48	50	52	55	58
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]	10	10	8	7	5	5	5	5	5	5	5
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	1	1	1	1	1
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]	12	11	11	12	13	12	13	12	11	12	12
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]	39	36	42	36	34	30	29	29	23	21	22
indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0	0

Annex 2B-16: Uncertainty estimates

Uncertainty estimation, SO_2

Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg SO_2	Input data Gg SO_2	Input data %	Input data %	%	%	%	%	%	%	%
Road Transportation	SO_2	5767	79	2	50	50,040	2,086	-0,043434611	0,0053	-2,1717305	0,014978514	2,17178218
Other mobile sources	SO_2	9216	1824	10	50	50,990	48,865	0,043335227	0,1217	2,16676133	1,721764221	2,76754886
Total	SO_2	14983,397	1903,533				2392,110					12,3759646
Total uncertainties					**Year (%):**		**48,909**			**Trend (%):**		**3,518**

Uncertainty estimation, NO_X

Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg NO_X	Input data Gg NO_X	Input data %	Input data %	%	%	%	%	%	%	%
Road Transportation	NO_X	105933	66993	2	50	50,040	30,347	-0,048606262	0,4274	-2,4303131	1,208959892	2,71440708
Other mobile sources	NO_X	50801	43475	10	100	100,499	39,551	0,048776687	0,2774	4,87766868	3,922715627	6,25934099
Total	NO_X	156734,22	110467,8				2485,229					46,5473554
Total uncertainties					**Year (%):**		**49,852**			**Trend (%):**		**6,823**

Uncertainty estimation, NMVOC

Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg NMVOC	Input data Gg NMVOC	Input data %	Input data %	%	%	%	%	%	%	%
Road Transportation	NMVOC	81811	23171	2	50	50,040	31,365	-0,083857371	0,2401	-4,1928686	0,678987322	4,24748991
Other mobile sources	NMVOC	14710	13796	10	100	100,499	37,507	0,084439458	0,1429	8,44394583	2,021436914	8,68253582
Total	NMVOC	96520,537	36966,926				2390,515					93,4275989
Total uncertainties					**Year (%):**		**48,893**			**Trend (%):**		**9,666**

Uncertainty estimation, CO

Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO	Input data Gg CO	Input data %	Input data %	%	%	%	%	%	%	%
Road Transportation	CO	459539	171521	2	50	50,040	29,313	-0,106222141	0,2974	-5,3111071	0,841081211	5,37729262
Other mobile sources	CO	117260	121282	10	100	100,499	41,628	0,106851197	0,2103	10,6851197	2,973634659	11,0911805
Total	CO	576798,46	292802,99				2592,107					151,929561
Total uncertainties					**Year (%):**		**50,913**			**Trend (%):**		**12,326**

Uncertainty estimation, NH_3

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 NH_3	Gg NH_3	%	%	%	%	%	%	%	%	%
Road Transportation	NH_3	70	1951	2	1000	1000,002	996,269	1,942090776	25,5880	1942,09078	72,37382721	1943,43885
Other mobile sources	NH_3	6	7	10	1000	1000,050	3,733	-1,958389605	0,0959	-1958,3896	1,355785593	1958,39007
Total	NH_3	76,247323	1958,3271				992566,569					7612246,24
Total uncertainties					**Year (%):**		**996,276**			**Trend (%):**		**2759**

Uncertainty estimation, TSP

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 TSP	Gg TSP	%	%	%	%	%	%	%	%	%
Road Transportation	TSP	6929	5764	2	50	50,040	34,528	0,082329955	0,4737	4,11649775	1,339819239	4,32904947
Other mobile sources	TSP	5240	2590	10	100	100,499	31,154	-0,082443734	0,2128	-8,2443734	3,009676808	8,77655098
Total	TSP	12169,131	8354,278				2162,752					95,7685164
Total uncertainties					**Year (%):**		**46,505**			**Trend (%):**		**9,786**

Uncertainty estimation, Arsenic

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Arsenic	0	0	2	1000	1000,002	0,000	0	0,0000	0	0	0
Other mobile sources	Arsenic	62	20	10	1000	1000,050	1000,050	0	0,3244	0	4,587284676	4,58728468
Total	Arsenic	62,035802	20,122554				1000100,000					21,0431807
Total uncertainties					**Year (%):**		**1000,050**			**Trend (%):**		**4,587**

Uncertainty estimation, Cadmium

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Cadmium	29	40	2	1000	1000,002	768,583	0,125094544	0,8986	125,094544	2,54175505	125,120364
Other mobile sources	Cadmium	15	12	10	1000	1000,050	231,430	-0,125495702	0,2706	-125,4957	3,826581144	125,554028
Total	Cadmium	44,162174	51,635574				644280,167					31418,9194
Total uncertainties					**Year (%):**		**802,671**			**Trend (%):**		**177,254**

Uncertainty estimation, Chromium

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Chromium	146	199	2	1000	1000,002	771,120	0,132250025	0,8919	132,250025	2,522584174	132,274081
Other mobile sources	Chromium	77	59	10	1000	1000,050	228,893	-0,132661293	0,2647	-132,66129	3,743733907	132,714107
Total	Chromium	222,58919	257,44446				647018,217					35109,4668
Total uncertainties					**Year (%):**		**804,374**			**Trend (%):**		**187,375**

Uncertainty estimation, Copper

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Copper	4965	6750	2	1000	1000,002	810,013	0,069914336	1,0256	69,9143361	2,900726771	69,9744854
Other mobile sources	Copper	1617	1583	10	1000	1000,050	189,998	-0,070269154	0,2405	-70,269154	3,401824735	70,3514495
Total	Copper	6582,1661	8333,7274				692220,943					9845,75506
Total uncertainties					**Year (%):**		**831,998**			**Trend (%):**		**99,226**

Uncertainty estimation, Mercury

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Mercury	0	0	2	1000	1000,002	0,000	0	0,0000	0	0	0
Other mobile sources	Mercury	17	13	10	1000	1000,050	1000,050	0	0,7414	0	10,48506129	10,4850613
Total	Mercury	16,931552	12,553151				1000100,000					109,93651
Total uncertainties					**Year (%):**		**1000,050**			**Trend (%):**		**10,485**

Uncertainty estimation, Nickel

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Nickel	204	278	2	1000	1000,002	333,728	0,071752112	0,0894	71,7521119	0,252932429	71,7525577
Other mobile sources	Nickel	2904	555	10	1000	1000,050	666,306	-0,071134753	0,1785	-71,134753	2,52484549	71,1795467
Total	Nickel	3108,0274	832,82283				555338,060					10214,9574
Total uncertainties					**Year (%):**		**745,210**			**Trend (%):**		**101,069**

Uncertainty estimation, Lead

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Lead	97509	52	2	1000	1000,002	38,000	-0,011851661	0,0005	-11,851661	0,001424831	11,8516615
Other mobile sources	Lead	6178	1322	10	1000	1000,050	962,048	0,011955993	0,0128	11,9559927	0,180354562	11,957353
Total	Lead	103687,19	1374,5549				926980,888					283,440171
Total uncertainties					**Year (%):**		**962,798**			**Trend (%):**		**16,836**

Uncertainty estimation, Selenium

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Selenium	29	40	2	1000	1000,002	381,533	0,127441224	0,2915	127,441224	0,824420743	127,443891
Other mobile sources	Selenium	107	64	10	1000	1000,050	618,499	-0,126718851	0,4725	-126,71885	6,681969402	126,894901
Total	Selenium	136,15551	104,01782				528107,987					32344,2611
Total uncertainties					**Year (%):**		**726,710**			**Trend (%):**		**179,845**

Uncertainty estimation, Zinc

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Zinc	2921	3971	2	1000	1000,002	789,885	0,088689313	0,9755	88,6893127	2,759143085	88,7322211
Other mobile sources	Zinc	1150	1056	10	1000	1000,050	210,127	-0,089074122	0,2595	-89,074122	3,669787133	89,1496862
Total	Zinc	4070,5212	5027,0836				668072,006					15821,0736
Total uncertainties					**Year (%):**		**817,357**			**Trend (%):**		**125,782**

Uncertainty estimation, Dioxins

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							
		g dioxins	g dioxins	%	%	%	%	%	%	%	%	%
Road Transportation	Dioxins	1	0	2	1000	1000,002	513,176	-0,087742156	0,1710	-87,742156	0,48361119	87,7434889
Other mobile sources	Dioxins	0	0	10	1000	1000,050	486,849	0,088229921	0,1622	88,2299208	2,293894582	88,2597354
Total	Dioxins	1,1042398	0,3679164				500371,923					15488,7007
Total uncertainties					**Year (%):**		**707,370**			**Trend (%):**		**124,454**

Uncertainty estimation, Flouranthene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Flouranthene	789	712	2	1000	1000,002	755,390	-0,000539727	0,6825	-0,5397274	1,930357761	2,00439186
Other mobile sources	Flouranthene	255	231	10	1000	1000,050	244,624	0,000542484	0,2210	0,54248397	3,12546575	3,17219561
Total	Flouranthene	1043,1634	942,48593				630454,650					14,0804118
Total uncertainties					**Year (%):**		**794,012**			**Trend (%):**		**3,752**

Uncertainty estimation, Benzo(b) flouranthene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Benzo(b) flouranthene	65	69	2	1000	1000,002	743,127	0,036256404	0,7481	36,2564045	2,116048173	36,3181019
Other mobile sources	Benzo(b) flouranthene	27	24	10	1000	1000,050	256,888	-0,036405964	0,2586	-36,405964	3,657254782	36,5892022
Total	Benzo(b) flouranthene	91,783839	92,402735				618228,469					2657,77425
Total uncertainties					**Year (%):**		**786,275**			**Trend (%):**		**51,554**

Uncertainty estimation, Benzo(k) flouranthene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Benzo(k) flouranthene	65	78	2	1000	1000,002	803,116	0,054844109	0,9009	54,8441086	2,548002441	54,9032655
Other mobile sources	Benzo(k) flouranthene	21	19	10	1000	1000,050	196,896	-0,055121871	0,2208	-55,121871	3,123250641	55,2102827
Total	Benzo(k) flouranthene	86,722989	97,277357				683762,935					6062,54388
Total uncertainties					**Year (%):**		**826,900**			**Trend (%):**		**77,862**

Uncertainty estimation, Benzo(a) pyrene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Benzo(a) pyrene	45	53	2	1000	1000,002	844,863	0,037917843	0,9508	37,9178432	2,689218041	38,0130862
Other mobile sources	Benzo(a) pyrene	11	10	10	1000	1000,050	155,146	-0,038153167	0,1746	-38,153167	2,469050388	38,2329751
Total	Benzo(a) pyrene	55,569428	62,536189				737864,227					2906,75511
Total uncertainties					**Year (%):**		**858,990**			**Trend (%):**		**53,914**

Uncertainty estimation, Benzo(g,h,i) perylene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	Benzo(g,h,i) perylene	95	100	2	1000	1000,002	760,366	0,034775432	0,7640	34,7754323	2,160827768	34,8425009
Other mobile sources	Benzo(g,h,i) perylene	36	32	10	1000	1000,050	239,648	-0,034931841	0,2408	-34,931841	3,405022998	35,0974034
Total	Benzo(g,h,i) perylene	131,41153	132,03436				635587,152					2445,8276
Total uncertainties					**Year (%):**		**797,237**			**Trend (%):**		**49,455**

Uncertainty estimation, indeno(1,2,3-c,d) pyrene

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							
		kg	kg	%	%	%	%	%	%	%	%	%
Road Transportation	indeno(1,2,3-c,d) pyr.	43	58	2	1000	1000,002	730,077	0,105809243	0,8569	105,809243	2,423756089	105,836999
Other mobile sources	indeno(1,2,3-c,d) pyr.	24	21	10	1000	1000,050	269,938	-0,10610308	0,3168	-106,10308	4,48056546	106,197641
Total	indeno(1,2,3-c,d) pyr.	67,521122	79,252984				605879,149					22479,4095
Total uncertainties					**Year (%):**		**778,382**			**Trend (%):**		**149,931**

Annex 2C

Agriculture

Annex 2C.1 Background information - NH_3 from Manure Management

1. N-excretion

In Table 2C.1 is given the average N-excretion for each NFR livestock category from 1985 to 2006. Notice that each livestock category is an aggregated average of different subcategories (see Table 6.3 in Chapter 6). The N-excretion is based on information from the Danish Institute of Agricultural Science.

Table 2C.1 Nitrogen excretion rates in average, 1985 – 2006 [kg N/hd/yr]

Livestock categories:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Dairy cattle	121.49	123.66	125.82	128.05	130.33	129.49	128.63	127.76	126.89	126.06	125.22
Non-dairy	35.73	35.77	35.91	36.13	36.33	36.57	36.68	36.80	36.92	36.64	36.56
Sheep	21.04	21.04	21.04	21.04	21.04	21.18	21.33	21.47	21.61	21.76	21.90
Goats	21.04	21.04	21.04	21.04	21.04	21.18	21.33	21.47	21.61	21.76	21.90
Horses	50.00	50.00	50.00	50.00	50.00	48.89	47.77	46.66	45.54	44.42	43.31
Swine	13.20	13.13	12.70	12.58	12.28	11.62	11.43	11.17	10.40	10.38	9.62
Poultry	0.50	0.52	0.53	0.60	0.60	0.65	0.66	0.58	0.59	0.66	0.62
Fur farming	6.18	5.30	4.76	3.93	3.60	4.80	5.04	4.64	6.77	5.65	5.53
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
N-excretion. total (M kg N/year)	318	315	303	298	295	292	292	293	296	285	276

Livestock categories:	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Dairy cattle	125.09	124.94	124.82	124.60	125.31	125.31	127.16	129.79	131.56	133.30	134.66
Non-dairy	36.62	36.74	36.77	37.00	37.15	37.56	37.54	37.44	38.39	38.74	38.00
Sheep	20.11	18.32	16.53	14.75	16.95	16.95	16.95	16.95	16.95	16.95	16.95
Goats	20.11	18.32	16.53	14.75	16.95	16.95	16.36	16.36	16.36	16.36	16.36
Horses	43.31	43.31	43.31	43.31	43.31	43.31	43.31	43.31	43.31	43.31	43.31
Swine	9.89	9.74	9.65	9.83	9.63	9.18	9.58	9.25	9.48	8.97	8.55
Poultry	0.60	0.62	0.62	0.57	0.55	0.57	0.59	0.66	0.75	0.73	0.63
Fur farming	5.34	4.64	4.37	4.87	4.63	4.62	4.61	4.61	5.09	5.38	5.18
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
N-excretion. total (M kg N/year)	276	274	278	270	270	273	275	270	274	271	259

2. Stable system

A systematic statement of the stabling of husbandry does not exist and the stabling is therefore based on estimate from the Danish Agricultural Advisory Centre (Rasmussen, J.B. and Lundgaard, N.H., pers. comm.). The structural development in the agricultural sector has an influence in change of stable types. The last few year new stables have been build and for most of these new stables tied-up stables are replaced by bigger stables with loose-holding. In 1985 85% of the dairy cattle were kept in tied-up stables and in 200 the part is reduced to 26%. In loose-holding systems the cattle have more space and this will increase the ammonia emission per animal compared to the tied-up stables. In Table 2C.2 the

distribution of stable type for dairy cattle and slaughtering pigs from 1985-2006 is listed.

Table 2C.2 The percentage distribution of stable type – Dairy cattle and slaughtering pigs 1985 – 2006

Distribution of stable type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Dairy cattle											
Tied-up stables	85	84	83	81	80	79	78	77	76	74	73
Loose-holdings with beds	14	15	15	16	17	18	18	19	20	21	21
Deep litter	1	1	2	2	3	3	4	4	5	5	6
Slaughtering pigs											
Full slatted floor	29	33	38	42	47	51	56	60	60	60	60
Partly slatted floor	30	29	27	26	24	23	21	20	21	23	24
Solid floor	40	36	33	29	26	22	19	15	14	12	11
Deep litter	1	2	2	3	3	4	4	5	5	5	5
Distribution of stable type	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cattle											
Tied-up stables	72	66	60	60	46	40	35	26	22	26	26
Loose-holdings with beds	22	26	30	30	43	49	54	63	67	66	66
Deep litter	6	8	10	10	11	11	11	11	11	8	8
Slaughtering pigs											
Full slatted floor	60	60	60	60	58	57	56	55	53	49	49
Partly slatted floor	25	26	28	29	31	33	34	35	38	38	38
Solid floor	9	8	6	5	5	4	4	4	3	7	7
Deep litter	6	6	6	6	6	6	6	6	6	6	6

3. Emission of ammonia

3.1 Stable

The emission from stables is thus determined by a number of different conditions that depends on stable type and the different kinds of manure disposal systems placed in these stables. Danish Institute of Agricultural Sciences has carried out a number of emission surveys and estimated emission coefficients for different types of stables (Poulsen *et al.*, 2001). In Table 2C.3 is shown the emission from Dairy cattle and slaughtering pigs in different stable systems.

Table 2C.3 Ammonia emission from stables 2006 – Dairy cattle and slaughtering pigs.

Livestock category	Manure system	Manure type	Ammonia emission
			pct NH_3-N of N ab Animal
Dairy cattle	Tied-up	Solid manure	5.0
		+ Liquid	5.0
	Tied-up	Slurry	3.0
	Loose-holding with beds, slatted floor	Slurry	8.0
	Loose-holding with beds, slatted floor, scrapes	Slurry	6.0
	Loose-holding with beds, solid floor	Slurry	10.0
	Deep litter (all)	Deep litter	6.0
	Deep litter, slatted floor	Deep litter	6.0
		+ Slurry	8.0
	Deep litter, slatted floor, scrapes	Deep litter	6.0
		+ Slurry	6.0
	Deep litter, solid floor, scrapes	Deep litter	6.0
		+ Slurry	10.0
Slaughtering pigs	Partly slatted floor	Slurry	16.0
	Solid floor	Slurry	11.0
	Deep litter	Solid manure	18.0
		+ Liquid	18.0
	Deep litter	Deep litter	15.0
	Partly slatted floor and partly deep litter	Deep litter	15.0
		+ Slurry	12.0

3.2 Storage

Livestock manure is collected either as solid manure or as slurry depending on stable type. In Table 2C.4 is shown the emission factor used for storage. It is assumed that the part of solid manure taken directly from the stable into the field is 80% from cattle, 25% from pigs, 50% sows, 15% from poultry and 5% from hens (Poulsen et al. 2001). The remaining part of the solid manure is deposited in stock piles in the field before field application.

By law all slurry tanks have to be covered by a crust in order to reduce ammonia emission. However, investigations show that that slurry tanks were incompletely covered earlier (COWI 2000), which result in a higher ammonia emission. In 2006 it is assumed that 5% of the tanks with pig slurry and 2% of tanks with cattle slurry are incompletely covered. This information has been incorporated in the emission inventory.

Table 2C.4 Emission factors for storage (Poulsen et al. 2001). Updated emf for cattle (solid and deep litter) – reference: Hanne Damgaard Poulsen pers. comm. 2006.

Animal category	Liquid manure	Slurry	Solid manure	Deep litter	
	Loss of NH_3-N in % of N ab stable				
Cattle	2.0	2.1	4.0	1.8	
Swine	2.0	2.4	25.0	6.5	Sows
	2.0	2.4	25.0	25.0	Piglets
	2.0	2.4	25.0	9.8	Slaughter pigs
Poultry	-	2.0	5.0	9.5	Hens and pullet
	-	-	-	12.8	Broilers
	-	-	-	15.0	Turkey. geese and ducks
Fur farming	0	2.0	15.0	-	
Sheep/goats	-	-	-	5.0	
Horses	-	-	-	5.0	

3.3 Spreading in fields

There is no statistical information on how the farmer handling the manure in practice. In calculation of emission from application of manure on the fields is used to different weighted emission factors, which distinguish between solid manure and liquid manure. In 2006 the emission factor for solid and liquid manure is estimated to 11% and 5% of N ab storage, respectively.

The weighted emission factor will vary from year to year depending on changes in the practice of spreading. The weighted emission factor is based on background estimates of time of spreading, application methods, spreading in growing crops or on bare soil and the time from spreading to ploughing in soil. In Table 2C.5 background information for 2006 are given.

Table 2C.5 Estimate for application method, time of spreading and time before the manure is incorporated in the soil (Based on information from the Organisation "Danish Agriculture")

Application methods 2006	Time of spreading	Percentage distribution of manure	Time before incorporation in soil			
			0	< 6 hours	>6 hours	Not incorporated
Liquid manure						
Incorporated	winter-spring	26	26	-	-	-
Incorporated	summer-autumn	6	6	-	-	-
Trailing horses	winter-spring	60	-	16	-	44
Trailing horses	spring-summer	5	-	-	-	5
Trailing horses	late summer-autumn	3	-	1	-	2
Broad spreading	winter-spring	-	-	-	-	-
Broad spreading	spring-summer	-	-	-	-	-
Broad spreading	late summer-autumn	-	-	-	-	-
Total		100	32	17	-	51
Solid manure						
Broad spreading	winter-spring	78	-	60	6	12
Broad spreading	spring-summer	2	-	-	-	2
Broad spreading	late summer-autumn	20	-	17	-	3
Total		100	-	77	6	17

Annex 2C.2 Background information - NH_3 from Agricultural Soils

1. Synthetic fertiliser

Since 1985 there has been a significant decrease in use of synthetic fertiliser. This is due to requirements to utilising of nitrogen in manure as outlined for example in the Action Plan on the Aquatic Environment. Further, the use of different fertiliser types has changed. At present, urea constitutes less than 1% of the total nitrogen used as fertiliser (Table 2C.6). It is estimated that 2.2% of the total nitrogen used in synthetic fertiliser is emitted as ammonia in 2005. It means the implied emission factor for 2005 is 2.2% compared to 10% in the EMEP-CLRTAP Guidebook.

Data on the use of synthetic fertiliser is based on the sale estimations collected by the Danish Plant Directorate (2006). Emission factors are received by The Faculty of Agricultural Sciences at the University of Aarhus (Sommer et al. 1992. 1994 and 1996).

The use of mineral fertiliser includes fertiliser used in parks, golf courses and private gardens. Approximately 1-2 percent of the mineral fertiliser can be related to this use out side the agriculture area.

Table 2C.6 Synthetic fertiliser consumption 2006 and emission factors.

Synthetic fertiliser year 2006	Emission factor[1]	Consumption[2]
		Mio. kg N
Fertiliser type		
Calcium and boron calcium nitrate	0.02	0.3
Ammonium sulphate	0.05	2.9
Calcium ammonium nitrate and other nitrate types	0.02	83.2
Ammonium nitrate	0.02	7.5
Liquid ammonia	0.01	4.7
Urea	0.15	0.6
Magnesium fertliser	0.02	16.4
Other nitrogen fertiliser	0.05	0.0
NPK-fertiliser	0.02	66.8
Diammonphosphate	0.05	0.6
Other NP fertiliser types	0.02	3.4
NK fertiliser	0.02	5.5
Emission of NH_3-N from synthetic fertiliser	0.02	191.8

[1] Danish Institute of Agricultural Sciences (Sommer *et al*. 1992. 1994 and 1996)

[2] The Danish Plant Directorate

2. Grazing

It is assumed that 15% of the manure from dairy cattle is deposited in the field, which corresponding to 55 days per year. For heifers 54% of the nitrogen in the manure is estimated deposited during grazing, 61% for suckling cows, 50% for horses and 73% for sheep and goats.

An emission factor of 7% of the total nitrogen content is assumed to evaporate as NH_3 (Jarvis *et al*. 1998a, Jarvis *et al*. 1989b and Bussink 1994). The emission factor is used on all animal categories.

3. Crops

In the Danish emission inventory it is chosen to include NH_3 emission from crops, despite the uncertainties related to this emission source. Literature research shows that the volatilisation from crop types differs considerably (Andersen *et al*. 1999). Recent investigation of four different crop types measured in two seasons shows that the can be a volatilisation between 0-5 kg NH_3-N per hectare (Schjoerring and Mattsson 2001). Until more precisely data are available an average emission of 5 kg NH_3-N for cash crops and 3 kg NH_3-N for grass is used in the Danish inventory. However, as for the emission ceiling given in the Gothenburg-Protocol and the EU NEC Directive the emission from crops is not taken into account.

Table 2C.7 Emission factor used to estimate the emission of ammonia from crops

Emission factor	Crops
	kg N/ha
Cash crops. beets and silage maize	5
Grass/clover in rotation	3
Permanent grass	3
Set-a side	0

4. Ammonia treated straw

Ammonia is used for conservation of straw for feeding. Investigations show that 80-90% of the supplied ammonia (given in NH_3-N) will emit (Andersen *et al*. 1999). However, the emissions can be reduced particularly if the right dose is used. Therefore it is estimated that the emission factor is 65% of the applied ammonia (given in NH_3-N). Information on ammonia used for treatment of straw is collected from ammonia suppliers.

As for the emission ceiling given in the Gothenburg-Protocol and the EU NEC Directive the emission from ammonia treated straw is not taken into account.

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This report is a documentation report on the emission inventories for Denmark as reported to the UNECE Secretariat under the Convention on Long Range Transboundary Air Pollution due by 15 February 2008. The report contains information on Denmark's emission inventories regarding emissions of (1) SO_x for the years 1980-2006, (2) NO_x, CO, NMVOC and NH_3 for the years 1985-2006; (3) Particulate matter: TSP, PM_{10}, $PM_{2.5}$ for the years 2000-2006, (4) Heavy Metals: Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn for the years 1990-2006, and (5) Polyaromatic hydrocarbons (PAH): Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno (1,2,3-cd)pyrene for the years 1990-2006. Further, the report contains information on back-ground data for emissions inventory.

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