National Inventory Report 2009 Sweden

Annexes

Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

Contents

Annex 1 Key Categories

Background tables for Key Category Analysis 1990-2007 including LULUCF are presented in Appendix 20B. The resulting Key Categories are presented in Appendix 20A and discussed in section 1.5 of the NIR.

1.1 Description of methodology used for identifying key categories

The analysis has been made for all years using the tier 1 level and trend assessment according to the IPCC Good Practice Guidance for the LULUCF sector section 5.4 and IPCC Good Practice Guidance section 7.2. The tier 1 method assesses the impacts of various source/sink categories on the level and the trend of the national emission inventory.

The identification is done in two steps, where key categories are first identified excluding LULUCF. Key categories are aggregated sources that together contribute with either 95% of the level or 95% of the overall trend of all greenhouse gas emissions in Sweden. Thereafter, still with the 95% thresholds, the same procedures are performed but including the LULUCF sector. Any new key category identified from the LULUCF sector will be added as key category to the original key source categories.

The analysis is performed for all direct greenhouse gases, i.e. CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, with all emissions converted to CO_2 equivalents. This is done by multiplying emissions for each greenhouse gas with the corresponding GWP-value (GWP-values are presented in Appendix 19).

1.1.1 Level assessment

For each source/sink and each GHG each year, the estimates of emissions/removals (E) in the national inventory in CO_2 equivalents are listed. At the bottom of the table the total of absolute values of all emissions/removals of GHG are summed (T). An absolute value is indicated by a star (*).

For each source/sink and each GHG, the level assessment (LA) is calculated as:

$$LA^* = \frac{E^*}{T^*}$$

The table is then sorted according to level assessments for all sources/sinks so that the source/sink per GHG with the biggest contribution (level assessment) will end up at the top of the table and the source/sink per GHG with the smallest contribution (level assessment) will end up at the bottom of the table. Finally the cumulative total of the level assessment is calculated.

Key categories are those that, when summed together in descending order of magnitude, add up to over 95% of the total emission estimates in the inventory for each year.

1.1.2 Trend assessment

For each year (year t), source and GHG, the source/sink category trend is calculated as:

$$Trend_{source/\sin k} = \frac{E_t - E_{1990}}{E_t}$$

The total trend is calculated as:

$$Trend_{total} = \frac{T_t - T_{1990}}{T_t}$$

Then the source/sink category trend assessment (TA) for each source/sink per GHG is calculated as:

$$TA^* = LA^* * \left| Trend_{source/\sin k} - Trend_{total} \right|$$

At the end of the table, the sum of trend assessments (∑TA) for all sources/sinks per GHGs is computed.

Then the percentage contribution to the overall trend (C%) is calculated for each source/sink per GHG as

$$C\% = \frac{TA^*}{\sum TA^*}$$

The table is sorted according to percentage contribution so that the source/sink per GHG with the biggest contribution to the overall trend will be in the top of the table and the source/sink per GHG with the smallest contribution to the overall trend will be at the bottom of the table.

Finally the cumulative total of percentage contribution is calculated in the same way as for the level assessment. Key source categories are those that, when summed together in descending order of magnitude, add up to more than 95% of the contribution to trend.

1.2 Reference to the key categories tables in the CRF

Table 7 of the CRF tables, Summary Overview for Key Categories, have not been filled for any years. The information is provided in Appendix 20A.

1.3 Information on the level of disaggregation

The aggregation level of sources without the LULUCF sector is in line with the aggregation found in reported CRF-tables (CRF 1, 2, 3, 4 and 6). This enables us to distinguish between, for example, stationary combustion in different sectors, which is important for the national analysis of greenhouse gas emissions. The aggregation level of sinks/sources for the LULUCF sector is made per land use category and reported greenhouse gas.

1.4 Tables 7.A1 - 7.A3 of the IPCC good practice guidance

Tables 7.A1 – 7.A3, Key Source Categories of the swedish inventory 1990-2007, are provided in Appendix 20B.

Annex 2

Detailed discussion of methodology and data for estimating emissions from fossil fuel combustion

1.1 Sources for activity data in CRF 1A and parts of CRF 1B

Activity data used in the energy sector is mainly based on statistics on fuel consumption. In sections1.1.1.-1.1.9 below, the various energy surveys, produced by Statistics Sweden and other data sources are described. Other data sources are described in sections 1.1.10-1.1.13.

1.1.1 Quarterly fuel statistics

Quarterly fuel statistics are used as follows:

- All years for data on stationary combustion in the CRF sector 1A1a, in CRF 1Ab (reference approach) for data on biomass, waste and peat, and finally in CRF 1Ad for data on feedstocks and non-energy use of fuels.
- 1990-1996 for information on in-house (own-produced) fuels in CRF 1A1b-c, 1A2, 1B1, 2C and 2D since the statistics of energy use in manufacturing industry did not cover own-produced fuels during these years.
- 1997-1999 and 2003 and all following years for stationary fuel-related emissions in CRF 1A1b-c, 1A2, 1B1, 2C and 2D.
- 2000-2002 for data on fuel combustion for back pressure power in CRF 1A2c-e, both sold and consumed at the producing plant. This is due to that the industrial energy statistics (which is the main data source for industries 2000-2002) has been found not to cover fuel consumption for back pressure power.

Quarterly fuel statistics are carried out as a postal sample survey sent to all working units.[1] The sample to the quarterly fuel statistics is based on the sample for the yearly statistics of energy use in manufacturing industry, except for electricity and heat production for which the quarterly fuel statistics is a total survey. Data are collected from all companies in electricity and heat production, all companies in the pulp and paper industry and all companies in the manufacturing industry with more than nine employees and annual fuel combustion of more than 325 tonnes oil equivalents.

[1] A company may consist of several working units, that is could be located in several places (factories).

The survey should cover all fuel consumption, both own-produced and purchased fuels. However, in some cases it has been noted by the inventory staff that not all in house fuels are covered. In those cases supplementary data has been collected to assure complete time series (section 1.1.9). In the survey form, respondents are also asked to specify whether fuels are used as raw materials or for energy purposes. This facilitates the use of the data for CRF table 1Ad, non-energy use of fuels.

To achieve a better sample frame, the quarterly fuel statistics are upgraded with information from the most recent year when the industrial energy statistics were a total survey, i.e. the sample frame for the quarterly fuel statistics for 1999 were upgraded with the information from the 1996 industrial energy survey, the sample frame for 2001 was upgraded with information from the 2000 industrial energy survey and the sample frame for 2006 was upgraded with information from the 2005 industrial energy survey. The response rate to the quarterly fuel statistics is almost 100 % for ISIC 40 (that is, CRF 1A1a) and about 90 % for industries. The non-respondents among the industries are often small companies, which mean that much more than 90% of consumed energy is covered in responses to the survey. To compensate for companies not included in the sample and companies not responding to the survey, all fuel consumption is enumerated with an enumeration factor which is produced from information on the line of business, number of employees and business volume from the most recent year when the statistics on energy use in manufacturing industry was a total survey (as discussed above). There is, however, no enumeration for manufacturing industries with less than 10 employees.

The quarterly fuel statistics for each year are compiled and ready for use at approximately the end of March the year after. This gives enough time to process the data for the greenhouse gas inventory. Until submission 2004 of the greenhouse gas inventory, the yearly statistics on energy use in manufacturing industry were preferred when possible. However, the quarterly fuel statistics is in submission 2005 and later the main data source for stationary combustion in CRF 1A1a-1A2f. This is due to the fact that the yearly statistics on energy use in manufacturing industry are compiled too late for the greenhouse gas inventory (actually after data should be submitted from Sweden), but also because the industrial energy statistics does not, for instance, cover fuel combustion for back pressure power. During the work with the inventory, it has become clear that for the purpose of the inventory, quarterly fuel statistics are better suited than statistics on energy use in manufacturing industry.

In the inventory, data on plant level and by fuel type is used. Data for the iron and steel industry is processed to suit the needs of the inventory, see also section 3.3.4 of the NIR. The properties of the quarterly fuel statistics are summarised in Table 1.

Table 1 Summarised properties of quarterly fuel statistics used in the inventory.

Year	Type of survey	Coverage	Adjustments	Quality
1990-1996	Quarterly sample survey to companies with more than 9 employees consuming more than >325 toe within manufacturing industries and to all companies in energy industries and pulp and paper industries	Working units in energy industries and manufacturing industries, all fuel combustion of in-house fuels	Enumeration to reach the level of industrial energy statistics	Good
1997-	Quarterly sample survey to companies with more than 9 employees consuming more than >325 toe within manufacturing industries and to all companies in energy industries and pulp and paper industries	Working units in energy industries and manufacturing industries, all fuel combustion	Enumeration to reach the level of industrial energy statistics	Good

1.1.2 Yearly statistics on energy use in manufacturing industry

The statistics on energy use in manufacturing industry are used for emissions from stationary combustion in the CRF sectors 1A1bc, 1A2, 1B1, 2C and 2D 1990-1996 and 2000-2002 (the latter except fuel combustion for back pressure power, which is not covered by industrial energy statistics but by quarterly fuel statistics). The energy use in manufacturing industry statistics for 1997-1999 is not used in the inventory since the quality was not considered sufficiently good to be used for emission calculations. Instead, data from the quarterly fuel statistics has been used for these years.

Since submission 2005, regarding emissions in 2003 and later years, energy use in manufacturing industry statistics are not used as a base for estimating emissions in the inventory. This is, as discussed in the chapter above, mainly because the inventory must be submitted before the energy use in manufacturing industry statistics are completed, but also because the energy use in manufacturing industry statistics does not cover fuel combustion for industrial back pressure power. Instead, quarterly fuel statistics are used and the energy use in manufacturing industry statistics is only used to verify or correct data for single plants if errors are suspected in the quarterly fuel statistics.

The energy use in manufacturing industry statistics are based on an annual survey of manufacturing companies. In 1990-1996, 2000 and from 2004, all companies with more than 9 employees are included. In 1997-1999 and in 2001-2003 it was conducted as a sample survey to companies with less than 50 and more than 9 employees, and as a total survey to all companies with more than 50 employees. In 1990-1996, only purchased fuels were surveyed but, since 1997, information on all fuel consumption has been collected except fuel combustion for back pressure. In the greenhouse gas inventory, fuel combustion for back pressure power s instead collected from the quarterly fuel statistics.

The response rate to the energy use in manufacturing industry statistics is about 85 %. To compensate for non-response, fuel consumption is enumerated with an enumeration factor based on the line of business, number of employees and business volume. There is no enumeration for manufacturing industries with less than 10 employees. A special form is sent to electricity producing companies within manufacturing industries, where the amounts of fuels used for electricity production and manufacturing purposes are specified. All manufacturing industries with electricity production are included in the survey every year. In the inventory, all data used are on plant level and by fuel type. An overview of the industrial energy statistics used in the inventory for 1990-2002 is given in Table 2.

Table 2 Summarised properties of industrial energy statistics used in the inventory.

Year	Type of survey	Coverage	Adjustments	Quality
1990-1996	Annual total survey to all companies with more than nine employees	Working units, purchased fuels, quantity and economic value of purchased fuels	Enumeration to represent all companies with more than 9 employees	Not so good quality for quantity, good quality for economic value
1997-1999	Annual total survey to all companies with at least 50 employees and a stratified sample of companies with 10-49 employees	Working units purchased and own-produced fuels	Enumeration to represent all companies with more than 9 employees	Good on national level and on coarse branch level, poor for single fuel types and single branches
2000	Annual total survey to all companies with more than nine employees	Working units, purchased and own-produced fuels	No adjustments	Excellent
2001-2002	Annual total survey to all companies with at least 50 employees and a stratified sample of companies with 10-49 employees	Working units, purchased and own-produced fuels	Enumeration to represent all companies with more than 9 employees	Good

1.1.3 One- and two-dwelling statistics

One- and two-dwelling statistics are used, together with holiday cottages statistics and multi-dwelling statistics, to calculate emissions from stationary combustion in households, CRF 1A4b.

This sample survey is conducted annually to collect data on the use of electricity and heat for a total of 7,000 one- and two-dwellings. Until 1999, the survey has a random sample from a real estate assessment, which includes all dwellings with a value higher than 50,000 SEK (about 5,600 €). From 2000, all dwellings used as permanent dwelling are included in the sample. Every third year, a postal survey collects data from agricultural properties. The sample in this sector is 3,000 objects. Activity data in the inventory is taken from yearly reports prepared by Statistics Sweden.[2] Data is on national level by fuel type and considered to be of relatively good quality.

[2] Statistics Sweden EN20SM, 1990-2007.

1.1.4 Holiday cottages statistics

Holiday cottages statistics, together with one- and two-dwelling statistics and multi-dwelling statistics, is used to calculate emissions from stationary combustion in households, CRF 1A4b.

Holiday cottages are defined as residences with no permanent residents. Energy consumption in holiday cottages has been surveyed only two times in the last thirty years, 1976 and 2001. In 2002, Statistics Sweden carried out a stratified sample survey to house owners, covering 1500 of the estimated 750 000 holiday cottages in Sweden 2001.[3] Results show that electricity and biomass combustion are the two dominating sources of heating in holiday cottages.[4]

1.1.5 Multi-dwelling statistics

Multi-dwelling statistics, together with one- and two-dwelling statistics and holiday cottages statistics, is used to calculate emissions from stationary combustion in households, CRF 1A4b.

This is a sample survey carried out each year, sent to the owners of 7,000 multi-dwelling buildings, covering the use of electricity and heat. The survey is based on a random sample from a real estate assessment. The real estate assessment includes all dwellings with an economic value higher than 50,000 SEK (about 5 600 €). Activity data in the inventory is taken from reports prepared by Statistics Sweden[2]. Data is on national level by fuel type and of relatively good quality. Statistics on biomass consumption in multi-dwelling buildings was not included in the survey until 2001.

1.1.6 Premises statistics

Premises statistics are used to calculate emissions from stationary combustion in the commercial and institutional sector, CRF 1A4a.

This survey is a sample survey carried out each year, covering the use of electricity and heat of about 8,000 premises. Premises situated in an industrial area are not covered in the dataset. These premises are covered in the yearly industrial energy statistics as well as in the quarterly fuel statistics and are reported in Manufacturing Industries and Construction (CRF 1A2). Activity data in the inventory is taken from reports prepared by Statistics Sweden[5]. Data is on national level by fuel type and of relatively good quality. Statistics on biomass consumption in premises was not included in the survey until 2001.

1.1.7 Statistics on the supply and delivery of petroleum products

Statistics on the supply and delivery of petroleum products are used to calculate emissions from mobile combustion. Data from the survey is used at national level and by fuel type. Emissions are reported in CRF 1A2f, 1A3, 1A4b, 1A4c, 1A5b,

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[3] Statistics Sweden, 2002
[4] Biomass consumption in holiday cottages stands for about 6 % of the total consumption of biomass in CRF 1A4b
[5] Statistics Sweden EN20SM, 1990-2007

1B2a v and 1C. These statistics are also used for the reference approach in CRF 1Ab for all fuels except biomass, waste and peat.

In the monthly postal survey, data is collected from all oil companies and other sellers who have stocks of petroleum products and coal. The survey also collects stock data from companies with a large consumption of oil in the manufacturing industries and energy industries. All 70 companies are included in the survey. Fuels used for domestic and international navigation are separated. The only fuels not covered are biomass, waste and peat.

All figures are double-checked by both Statistics Sweden and all wholesale dealers. The results are published by Statistics Sweden[5].

1.1.8 Statistics on the delivery of gas products

Statistics on the delivery of gas products are used to calculate emissions from natural gas from road transport (CRF 1A3b), pressure levelling losses of natural gas (CRF 1A5a) and transfer losses of gas works gas (CRF 1B2avi). Annual questionnaires are sent to all companies in Sweden that deliver natural gas and gasworks gas (less than ten companies). Consumption purposes are specified in the survey. Results of this survey are published by Statistics Sweden[5].

1.1.9 Other statistics from Statistics Sweden

Data used in the inventory for stationary fuel consumption in the construction sector, in all companies with less than 10 employees (CRF 1A2f), in agriculture and in forestry sectors (CRF 1A4c) is taken from Statistics Sweden[5]. Data is on national level and by fuel type. Fuel consumption for these subsectors has been estimated with extrapolations of older data, adjusted for each year on the basis of added value or number of working hours to estimate the fuel consumption. Total consumption for these sectors is checked against fuel deliveries, so that possible errors only occur in the allocation between these sectors.

Data on fuel consumption for the construction sector is based on a survey from 1985,[6] up-graded with the number of working hours for each year. Data on fuel consumption in the agricultural sector is based on two intermittent surveys, for gardening[7] and agriculture.[8] The first survey is a sample survey that collects data on energy use in greenhouses and has been carried out for 1990, 1993, 1996, 1999 and 2002. Data for intermediate years is estimated using number of working hours. The second sample survey collects data for energy use in the other parts of the agricultural business and has been performed for 1994 and 2002 (fuel consumption in households in the agricultural sector is not included here but is included in the one- and two-dwellings statistics). Data for intermediate years is estimated using annual changes in value added.

[6] Statistics Sweden, 1986
[7] Statistics Sweden JO36SM, 1991, 94, 97, 2000, 2003, 2006
[8] Statistics Sweden J63SM, 1995, 2003

Fuel consumption in the forestry sector has been studied thoroughly in 1985 and 2007[9]. Estimates for the years before 2005 are upgraded from the 1985 study with available statistics on the yearly felling volume 1990-1995 and from 1996 value added are used.

Fuel consumption in small companies (9 employees or less) is estimated using a model. Fuel consumption for companies with 10-49 employees is taken from the industrial energy statistics and the average use of fuel per employee is calculated. The two information sources are combined to estimate the fuel consumption in small companies.

Consumption of coal in coke ovens is used for calculation of energy transformation losses in the iron- and steel industry, CRF 1A2a (section 3.3.4.2). Data is based on information from the plants, published by Statistics Sweden.[10]

1.1.10 European Union Emission Trading Scheme (ETS)

Data from the European Union Emission Trading Scheme (ETS) is used since submission 2007 and emission year 2005 for a number of plants when the energy statistics are not available or considered to be of too low quality. As a result of a SMED study during 2006[11], ETS data is applied for four refinery plants (CRF 1A1b) for 2005, 2006 and 2007. In addition, ETS data is used for one plant in CRF 1A2e for 2006.

1.1.11 Environmental reports

Data on fuel consumption in refineries, CRF 1A1b and 1.B.2.C.2.1, is often collected from environmental reports in cases when the data sources mentioned above are not considered to be accurate. For one refinery, environmental reports are the only data source for the years 2002-2007. Environmental reports are also an important data source for fuel consumption in chemical industries, CRF 1A2c. For 2007, environmental report data was partly used for one plant in the primary steel industry, CRF 1A2b.

1.1.12 Companies

For earlier years, i.e. 2005 and before, data on fuel consumption in refineries, CRF 1A1b, and chemical industries, CRF 1A2c, was in many cases collected directly from the companies. Companies are sometimes also contacted to verify or correct data that is suspected to contain errors.

1.1.13 Other data sources for mobile combustion

For emissions from mobile combustion, CRF 1A2f, 1A3, 1A4b-c and 1A5, data from the Swedish National Rail Administration, the Swedish National Road Administration (SNRA), the Swedish Biogas Association, the Swedish Civil Aviation Authority (SCAA), the Swedish Armed Forces and several official reports is used.

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[9] ER 2007:15. Energianvändningen inom skogsbruket 2005
[10] Statistics Sweden, EN20SM 1990-2006.
[11] Backman & Gustafsson, 2006

1.2 Thermal values

Unless otherwise stated, thermal values for each fuel type are produced by Statistics Sweden based on information from energy surveys. All thermal values refer to net calorific values (NCV) as recommended by the IPCC Guidelines. All thermal values including references are enclosed in Appendix 19. Most thermal values are calculated on basis of chemical qualities and are considered to be of good quality.

In the inventory, activity data for 1990-2006 on many fuel types are reported in ton oil equivalents (toe), which is an energy unit. For these fuels the conversion factor of 41.87 GJ/toe is applied. In the energy surveys done by Statistics Sweden, these fuels are reported in mass unit/volume unit as well as the energy content (due to that the thermal value often varies a lot for these fuel types). To facilitate data processing, Statistics Sweden calculates the energy content in toe from this information and the result is then used in the greenhouse gas inventory. This implies that the energy content of fuels concerned is very precise.

For 2007 and coming years, energy data are taken directly from energy statistics data bases, enabling the use of company specific thermal values in the GHG inventory without performing the calculation of toe. Thermal values for 2007 are considered to be of excellent quality. However, these thermal values are too many and too diverse to all be shown in Appendix 19, and because of this some simplifications are made in Appendix 19.

Fuels that are standardized products, such as for instance residual fuel oil or liquefied petroleum gas (LPG) have got thermal values that do not change between years. In submission 2006 some revisions were made. It was concluded that the thermal value for biogas used for transports (this amount increases each year) is not known, and as a temporary solution the thermal value for natural gas is used.[12] The thermal value for ethanol is taken from the Swedish biogas association. Finally, the thermal value for Fatty Acid Methyl Ester (FAME) is of unknown quality.

1.2.1 Liquid fuels

For diesel oil the thermal value used in the inventory shows a decreasing trend. In Sweden, this fuel type is separated into three different fuel classes; diesel of environmental classes (EC) 1-3. EC 1 has the best environmental qualities, for instance lower content on aromatic hydrocarbons. EC 1 also has a lower thermal value. EC 3 affects the environment most and has a higher thermal value.[13] In 1990, EC 3 was the most common type of diesel. Over the years, the use of environmental class 3 has decreased and instead environmental class 2 and 1 are more common. In the inventory the mix of environmental class 1-3 used each year is taken into account when calculating a thermal value, which is appropriate for each year.

Thermal values for different oils (except oils used in navigation) are based on information from the Swedish Petroleum Institute (SPI), which in turn is based on

[12] Minutes from a meeting at the Swedish Energy Agency 21 June 2005.
[13] http://www.spi.se/produkter.asp?art=48 , 2005-10-17.

information from oil companies and is crosschecked with Swedish standards for calculating thermal values.

In submission 2005, thermal values for gas/diesel oil, tall oil and residual fuel oil in all sectors as well as kerosene in stationary combustion, were revised by the Swedish EPA. Thermal values for domestic heating oil and residual fuel oil for stationary combustion were altered due to new information from SPI. The thermal value for domestic heating oil was assumed to be equivalent to diesel oil environmental class 3, and thermal values for kerosene in stationary combustion were revised to improve consistency with thermal values for mobile combustion and with thermal values used in the industrial energy statistics.

Thermal values for marine diesel oil, marine gas oil and residual fuel oil used for navigation were reviewed and revised in a SMED study in 2004.[14] Data for other petroleum fuels are surveyed by Statistics Sweden, and the conversion factors of these fuels are set to 41.87 GJ/toe.

Thermal values for refinery gases and other oils in refineries are calculated for each operator and fuel. Data is collected on consumption of fuels in tonnes and corresponding thermal values. To fit the calculation system used in the inventory for the years 1990-2006, data for these years is converted to toe and the conversion factor thereby set to 41.87 GJ/toe. For the year 2007 (and coming years) the calculation routine has been slightly changed and thus this conversion step is no longer necessary.

The thermal value for petroleum coke is based on information from consumers taken from the different energy surveys done by Statistics Sweden and is therefore considered to be of good quality. The thermal value for diesel used for stationary combustion is according to SPI likely approximately the same mix of environmental classes as mobile diesel for each year. Using the same thermal values as for mobile diesel therefore give correct time series.

1.2.2 Solid fuels

For coke oven gas, blast furnace gas and steel converter gas the thermal values change between years, but there is no trend in the changes, just annual fluctuations due to the quality of used primary fuels each year. Thermal values used in the inventory are based on annual information from the consumers (quite few) on actual energy content, and the quality of the thermal value is considered to be very good. For carbon products such as coal and coke, it is difficult to establish the thermal value due to lack of information on energy content in imported fuels. For 2007, thermal values reported from the consumers are used when available. Slightly more than half of the reported observations of combusted coal in the energy statistics include specific thermal values. For coke, this share is about 75%. Where no thermal value is reported, the median value of reported thermal values is used. Hence, the thermal values used for 2007 are considered to be of very high quality. Data for peat and other solid fuels is reported to Statistics Sweden through a survey to con-

[14] Cooper & Gustafsson, 2004.

sumers in toe, and the conversion factors are thereby set to 41.87 GJ/toe for these fuels.

1.2.3 Gaseous fuels

Natural gas is a non-processed primary fuel, and hence the thermal value changes between years, however without any trend. All natural gas consumed in Sweden is imported from Denmark. Statistics Sweden receives annual information on current thermal values for natural gas from the Danish Energy Authority. Thermal values for 2001 and later years are according to information from the Danish Energy Authority. Thermal values for 1990-2000 are taken from the Danish NIR submission 2004.

1.2.4 Biomass

Data for 2006 and earlier for wood, black liquor, tall oil, landfill gas and other biomass, other petroleum fuels, other solid fuels and other not specified fuels is reported to Statistics Sweden by surveyed consumers in toe, and the conversion factors are thereby set to 41.87 GJ/toe for these fuels. For 2007, this is true for CRF 1.A.4 and partially for the construction industry (included inCRF 1.A.2.F). For the other sectors, only black liquor is reported in toe. Other biomass is reported in several different units, e.g. tonnes, m^3 or MWh, and thermal values are often reported together with the quantity. These thermal values are considered to be accurate. Where no thermal value is reported, the median value of reported thermal values is used.

1.2.5 Other fuels

Data for waste and other not specified fuels is reported to Statistics Sweden through a survey to consumers in toe, and the conversion factors are thereby set to 41.87 GJ/toe for these fuels. In 2007, waste was combusted within CRF 1A1a only and the reporting unit was tonnes. The thermal values for waste reported by the consumers are considered to be accurate, and thus these thermal values were used for 2007. For other not specified fuels the reporting units vary, and reported thermal values are used when available. Otherwise, a median thermal value for similar fuels is used.

1.3 Emission factors

Emission factors are enclosed in Appendix 19, where emission factors revised in this submission are typed in red.

Emission factors for CO_2 and SO_2 depend on the content of carbon and sulphur in the fuels. For SO_2, the emissions also depend on how efficient the emission control in the plant is, for instance if scrubbers are used. For most fuels, the CO_2 emission factors do not change over the years. One exception is the emission factor for CO_2 from diesel oil. As discussed for thermal values above (1.2.1), there are three environmental classes (EC) for diesel oil in Sweden, and the emission factor used each year reflects the mix of EC:s that year.

Other emission factors depend on area of consumption and/or the used combustion technique. The efficiency of emission control in the plant is also important. Therefore, these emission factors change over the years as ovens, combustion technique and emission control used becomes better.

1.3.1 Stationary combustion and fugitive emissions

National emission factors used in Submission 2004 and earlier were calculated by the Swedish EPA for 1990-1995. For 1996-2002, the same emission factors as for 1995 were applied. The emission factors were used for emissions from stationary combustion (and for fugitive emissions where no other sources were available). They are based on results of measurements and national studies as well as studies of international emission factors and judgements of their relevance to national conditions. Emission factors depend on the type of fuel, and the type of plant and abatement equipment.

During 2004, an inventory and review of emission factors for stationary combustion was conducted. The basis for this inventory was reported data from different national sources, such as the company's environmental reports, research reports etc. The study focused on common fuel types where the existing emission factors were uncertain or known to be inaccurate. The study is published in a SMED report.[15] The primary aim was to revise emission factors for stationary combustion for 1996-2002, but in a few cases it was necessary to revise emission factors for the early 1990s as well, to avoid inconsistencies. It was not possible to study existing emission factors for 1990-1995 in more detail since documentation and/or data sources were insufficient for these years. Resulting emission factors have been used since submission 2005.

During 2002, an inventory and review of emission factors for NMVOC, 1988-2001, was conducted. For stationary combustion and fugitive emissions within the energy sector, emission factors were derived and used together with activity data from the official national energy statistics to calculate emissions. The emission factors developed for conditions during 1990-2001 are based on knowledge on the technical development and the general effects of that, as mentioned above. The known effects of this general development has been combined with information from companies legal Environmental Reports, where actual emission factors can be derived, and information from trade associations where experts have contributed their specific knowledge on the different sectors where combustion occurs. The study is published in a SMED report.[16] Resulting emission factors has been used since submission 2003.

For some fuels, no specific emission factors are available and thus emission factors from similar, more common fuels, are used. Fuels concerned are specified in Table 3.

[15] Boström et al. 2004
[16] Kindbom et al., 2003.

Table 3 Fuel types for which specific emission factors are not available in the inventory.

Fuel type	Emission factor used
Kerosene	Gas/diesel oil
Landfill gas	Natural gas
Other biomass	Wood
Other petroleum fuels	Swedish default for “other fuels”
Other solid fuels	Swedish default for “other fuels”
Other not specified fuels	Swedish default for “other fuels”
Refinery gases	Swedish default for “other fuels” except for CO_2, SO_2 and NO_X where national values are used

1.3.1.1 EMISSION FACTORS FOR CO_2 FOR COKE OVEN GAS, BLAST FURNACE GAS AND STEEL CONVERTER GAS

Emission factors for CO_2 for coke oven gas, blast furnace gas and steel converter gas for iron ore-based steel production are national or plant specific. The emission factor used for coke oven gas and steel converter gas come from the carbon balances that was used by one of the plants to calculate emissions in 2001. The carbon balances are made to control the flow of carbon and are based on the carbon content in incoming and outgoing materials:

Coke oven: coal + blast furnace gas
→ *coke oven gas* + coke + slag + tar + benzene

Blast furnace: coal + coke + iron pellets + limestone + briquettes
→ *blast furnace gas* + pig iron + slag + soot

Steel converter: crude iron + carbide
→ *steel converter gas* + crude steel + slag

The quality of the emission factor seems to be good for coke oven gas in 2001 and generally for steel converter gas. Unfortunately, carbon balances are only available for one plant and only for the years 2001 and 2002. Hence the uncertainty of the values is higher for the years surrounding 1990 (about +/-10 %) than for the years surrounding 2000 (about +/- 5 %).[17]

The emission factor for CO_2 for blast furnace gas is calculated by the Swedish Steel Producers’ Association. This emission factor is a mean value calculated on the basis of yearly values for a long period of time. The emission factor seems to be acceptable for Swedish conditions.

1.3.1.2 EMISSION FACTORS FOR CO_2 FROM REFINERY GAS, PETROLEUM COKE AND CARBIDE FURNACE GAS

Due to lack of information on the Swedish conditions, the emission factor used for refinery gases in submission 2005 was the IPCC Guidelines default values. The emission factor for carbide furnace gas used in submission 2005 was the same as

[17] Ivarsson, 2003.

the Swedish default fuel category “Other fuels”, and for petroleum coke, the same emission factor as for coke was used. In 2005, a study of the emission factors for CO_2 from refinery gas, petroleum coke and carbide furnace gas was carried out.[18] It resulted in revisions for all three fuels, as presented in Table 4.

Table 4 Emission factors on CO_2 for carbide furnace gas, refinery gas and petroleum coke used in submission 2005 and since submission 2006.

Fuel type	CO_2 factor used in submission 2005 ton CO_2/TJ	CO_2 factor since submission 2006 ton CO_2/TJ
Carbide furnace gas	60	145
Refinery gas	66.7	59.3
Petroleum coke	103	100

1.3.1.3 EMISSION FACTORS FOR SO_2 AND NO_X FROM REFINERY OIL AND GAS

In a study conducted by SMED in 2006[19], new specific emission factors for refinery gas and refinery oil were developed for the whole time series 1990-2004, which are applied since submission 2007.

1.3.1.4 EMISSION FACTORS FOR COMBUSTION OF BIOMASS IN HOUSEHOLDS

In submission 2005 and earlier, only one emission factor for each gas for combustion of biomass in households was accounted for, including all technologies and all biomass fuel types. Due to the significant variation in emissions from different kinds of residential biomass systems depending on type of combustion system, type of fuel and operation conditions, studies on biomass fuel consumption and emission factors in the residential sector were performed in 2005 and 2006.

In submission 2006, time series of activity data and CH_4 emission factors were reviewed and updated.[20] New methane emission factors for small scale combustion of wood log, pellets and wood chips/sawdust were determined (Table 5), and an improved method was used to calculate the emissions. In order to match the activity data categories, the emission factors were grouped by heating system category and fuel type. The results showed that methane emissions from wood log combustion are significantly higher compared to pellets combustion. However, significant variations in emission factors occur for specific combustion appliances and operational conditions.

During 2006, as a follow-up of the revision of methane emission factors in submission 2006, emission factors for N_2O, NO_X, CO, NMVOC and SO_2 for combustion of biomass in households were reviewed and occasionally revised (Table 5)[21].

[18] Nyström & Cooper, 2005.
[19] Nyström & Skårman, 2006
[20] Paulrud et al. 2005.
[21] Paulrud et al. 2006.

For N_2O emission factors, no new measurement studies were carried out and no new information from the literature was found, and thus no adjustments were made. For NO_X emission factors, data from mainly six Swedish studies was used. The emission of NO_X for pellets varied between 30-80 mg/MJ and for wood logs between 20-120 mg/MJ.

The emission factors for CO are mainly based on measured emission data from Swedish residential biomass combustion experiments in the field as well as in the laboratory. The variation in CO emissions is usually large and the levels may sometimes be very high, especially from wood log combustion (up to 23700 mg/MJ have been registered).

The previously used value for NMVOC is high, 1975 mg/MJ, in comparison to the previously used emission factor for methane, 250 mg/MJ. According to a Swedish study[22], the fraction of methane in VOC (sum of methane and NMVOC) is approximately 20-40 % by weight for pellet boilers and 30-70 % by weight for wood boilers. The revised emission factors for NMVOC now show significantly lower values compared to the previously used values. This is due to that the new emission factors are based on data from additional measurements in Swedish residential biomass combustion experiments in the field as well as in the laboratory.

In previous Swedish emission inventories, the SO_2 emission factors were based on an S-content of (0.07 wt % dry fuel) and the assumption that a majority of the sulphur is bound to the ash. In the 2006 study, a lower S-content was applied (0.01 wt %), but with the assumption that no sulphur is bound in the ash.

[22] Johansson, 2004.

Table 5 Emission factors for CH_4, N_2O, NO_X, CO, NMVOC and SO_2 determined from small scale combustion of wood logs, pellets and wood chip using different combustion technologies. All data are presented as mg/MJ fuel.

Combustion technology	Fuel	Emission factor (average)					
		CH_4	N_2O	NO_X	CO	NMVOC	SO_2
Boilers	Wood logs	254	5	80	4000	300	10
	Wood chips	203	5	80	1000	150	10
	Pellets	3	5	65	300	6	10
Stoves	Wood logs	430	5	80	2500	150	10
	Wood chips	344	5	80	1000	150	10
	Pellets	7	5	65	300	6	10
Open fire places	Wood logs	318	5	80	4000	200	10
	Wood chips	*	*	*	*	*	*
	Pellets	*	*	*	*	*	*
All technologies	All biomass	250**	5**	60**	2000**	1975**	30**

* Not relevant. **EF Value in submission 2006.

1.3.2 Mobile combustion

Emission factors used for mobile combustion calculations are country-specific and default values from IPCC Guidelines and CORINAIR. These emission factors are further described in NIR sections 3.3.10-3.3.14.

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1.4 Allocation of fuels for mobile combustion

This section describes the allocation and distribution of the delivered amount of fuels on subsectors.

1.4.1 Gasoline

Data on the delivered amounts of gasoline at national level is provided by the national statistics on supply and delivery of petroleum products (1.1.7). To separate emissions from fossil fuels from emissions from bio-fuels, the ethanol admixture is subtracted from the total delivered amount of gasoline and reported as biomass under CRF 1A3b. Data on the amount of ethanol admixture in gasoline is available from 2001. Today ethanol admixture in gasoline accounts for 5 % of the total delivered amount of gasoline. The ethanol reported as biomass also includes the volume of ethanol used as bi-fuel (E85). After subtracting the volume of ethanol admixture, the remaining volume of gasoline is distributed over different subsectors according to Figure 1.

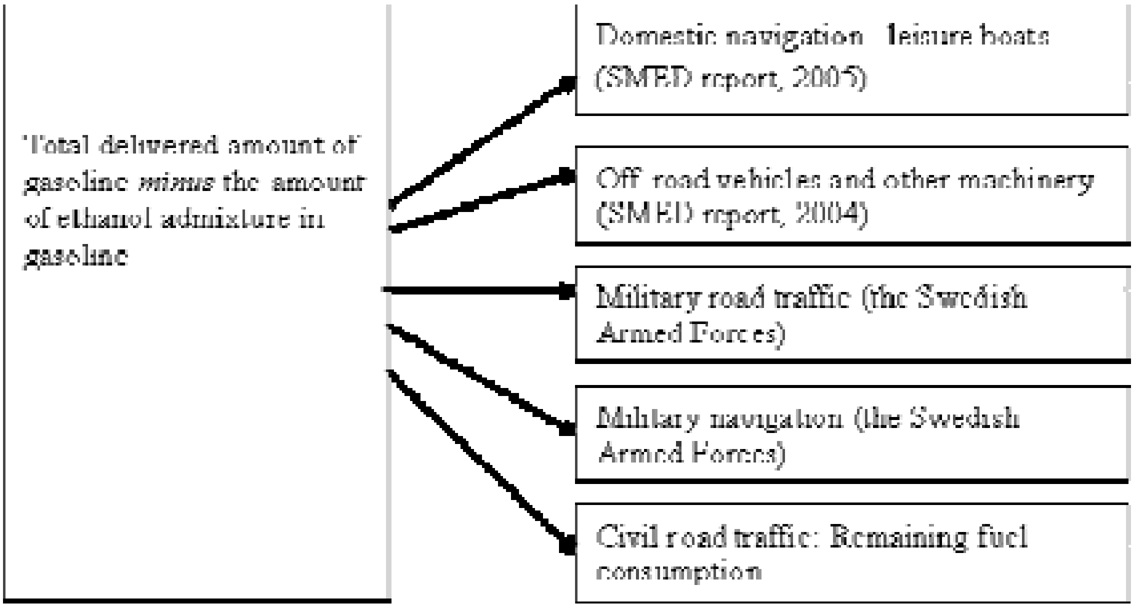

Figure 1 Gasoline distribution by subsector and source.

The gasoline consumption from domestic navigation is based on a survey produced by Statistics Sweden on gasoline consumption by leisure boats[23]. The results from the survey indicate no evidence of any trend in gasoline consumption and the result of the survey (gasoline consumption by leisure boats is estimated to 32 500 m3/year) is being used as a volume estimate for the whole time period

Gasoline consumption from off-road vehicles and other machinery (CRF 1A2f, 1A3e, 1A4b and 1A4c) is calculated using a recently developed SMED method based on a study made in 2008.[24]

Exact amounts of gasoline consumed by military road transport and navigation, CRF 1A5b, are provided by the Swedish Armed Forces. The volume of total gasoline deliveries remaining after the gasoline consumed by the four prior mentioned subsectors is withdrawn is assumed to be consumed within the subsector civil road traffic, CRF 1A3b.

A comparison between the volume of gasoline allocated to the civil road traffic sector through this top-down approach and the volume of gasoline consumed according to the bottom-up ARTEMIS (Assessment and Reliability of Transport Emission Models and Inventory Systems) model, used by the National Road Administration (Section 1.5), indicates a good correspondence between the two estimates. The bottom-up approach estimates a slightly higher consumption in the early 90's but the difference in estimated gasoline consumption between the top-down and bottom-up approach is decreasing by time (Figure 2).

[23] Statistics Sweden, 2005
[24] Fridell, Jernström & Lindgren, 2008

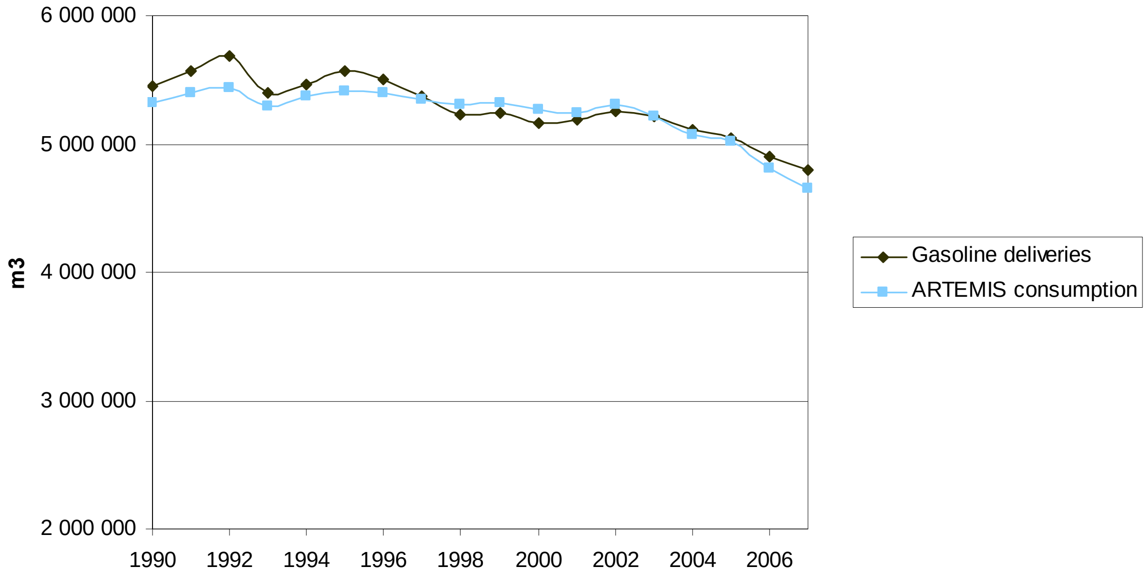

Figure 2 Bottom-up estimated gasoline fuel consumption versus top-down allocated gasoline consumption.

The approximate distribution of gasoline on subsectors in 2007 is shown in Figure 3.. Civil road traffic accounts for almost all gasoline consumption, followed by off-road vehicles and other machinery. Gasoline consumption from domestic navigation and military activities is relatively low.

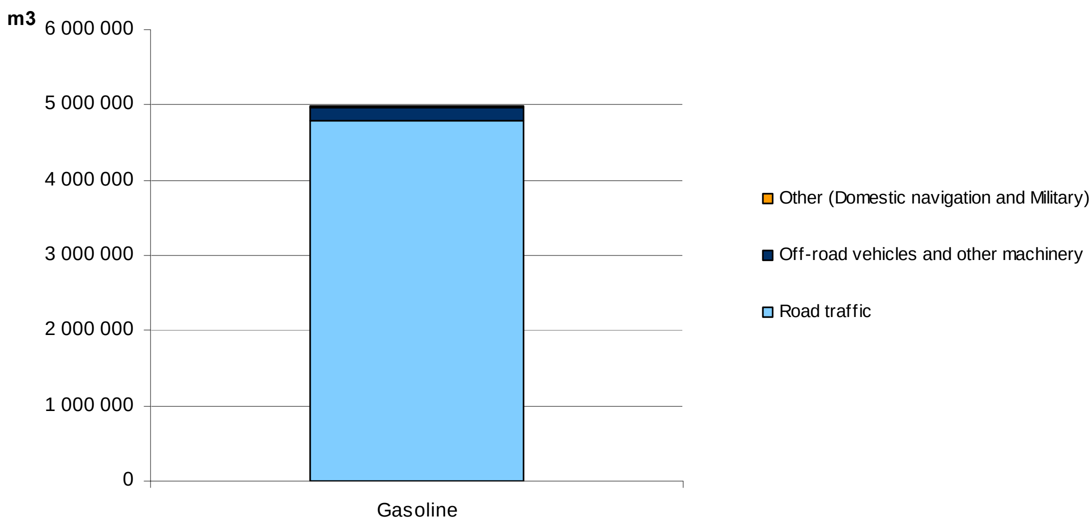

Figure 3 Distribution of gasoline by subsector.

1.4.2 Diesel

Data on the total amount of diesel oil delivered at national level are provided by the statistics on supply and delivery of petroleum products (Section 1.1.7). The use of diesel by international bunkers is specified as discussed in NIR section 3.3.21. The remaining volume of diesel is distributed over different subsectors following a three-step process.

The total amount of delivered diesel includes both diesel used for stationary combustion and FAME admixture. In the first step, the volume used for stationary combustion and the volume of FAME admixture is subtracted from the total deliveries. FAME is reported as biomass under CRF 1A3b. The volume of FAME admixture in diesel has increased considerably since 2006 when bio-diesel, including a 5 % admixture of FAME, was introduced to the Swedish market. The FAME reported as biomass also includes the volume of pure FAME (100%) sold on the Swedish market.

In the second step, parts of the delivered diesel are allocated to those subsectors for which accurate and precise information on diesel consumption is available (Table 6). For Railways information on diesel consumption is collected from the Swedish National Rail Administration and for Military activities from the Swedish Armed Forces.

Table 6 Subsectors with accurate and precise information on diesel consumption, by source.

Subsector	CRF	Estimation of amount of diesel consumed
Railway	1A3c	Exact amount given by the Swedish National Rail Administration
Military road transport	1A5b	Exact amount given by the Swedish Armed Forces
Military navigation	1A5b	Exact amount given by the Swedish Armed Forces
Military abroad	1C2	Exact amount given by the Swedish Armed Forces

In the third and last step, the remaining amount of the total delivered diesel is allocated over subsectors where the estimated diesel consumption is more uncertain. These are fisheries, domestic navigation, and civil road traffic. For off-road vehicles and other machinery, the consumption estimated by the recently developed method[25] used in submission 2009 is considered to be more accurate and therefore none of the remaining amount of total delivered diesel is allocated to these sectors (CRF 1A2f, 1A3e and 1A4b-c).

The allocation is made proportionally to the estimated consumption of each subsector. The consumption estimates of each subsector are based on sources according to Table 7. Figure 4 gives a brief overview of the distribution of diesel among different subsectors.

[25] Fridell, Jernström & Lindgren, 2008.

Table 7 Subsectors with uncertain diesel consumption, by source.

Subsector	CRF	Estimation of amount of diesel consumed
Fisheries	1A4c	SMED report, 2005
Domestic navigation	1A3d	Statistics Sweden, EN31SM
Off-road vehicles and other machinery	1A2f, 1A3e, 1A4b-c	SMED report, 2008
Civil road traffic	1A3b	ARTEMIS model estimation from the Swedish National Road Administration.

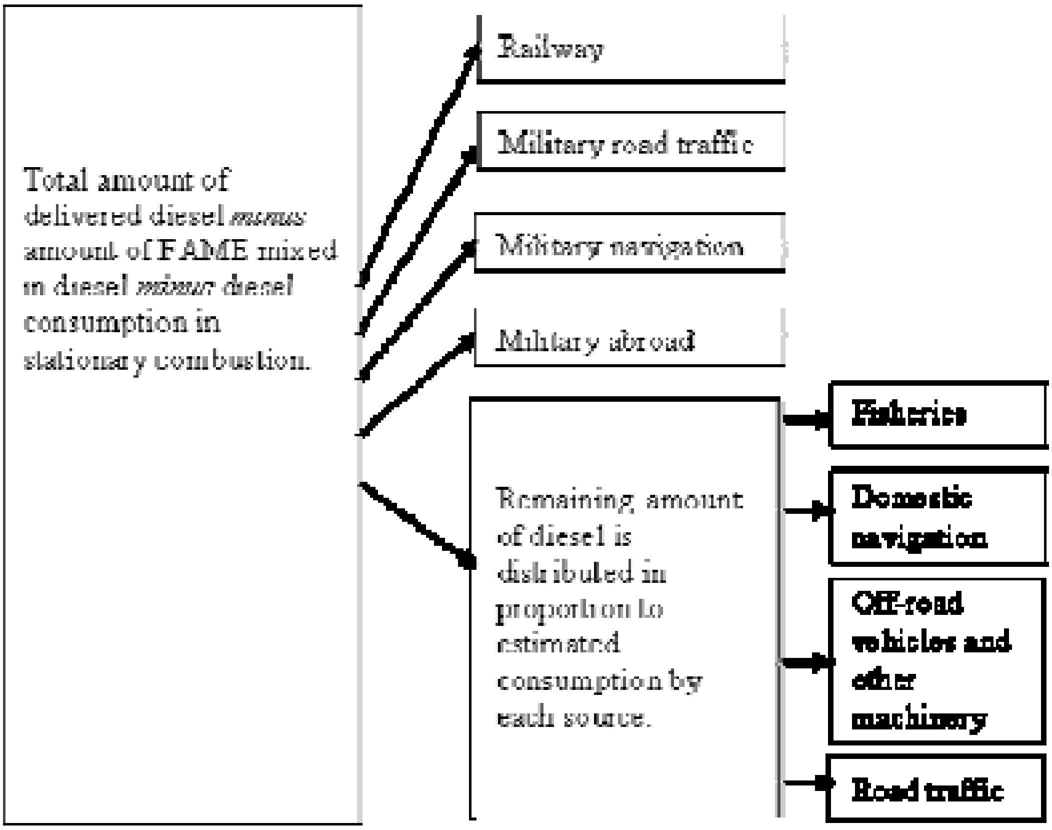

Figure 4. Model for allocating the total amount of delivered diesel on subsectors

The estimate of the Swedish fishing fleet's diesel consumption is based on a survey on energy consumption within the fishing industry by SCB[26] together with data on the Swedish fishing fleets total installed effect in kW from the Swedish board of fisheries. The estimate on fuel consumption provided by SCB refer to 2005, and for the previous and following years the fuel consumptions is estimated by adjusting the 2005 value according to the development in total installed effect. The installed effect is available from 1995, for the years prior to 1995 it is estimated through extrapolation.

[26] Statistics Sweden 2006

The estimate for diesel consumption from domestic navigation (also called marine diesel oil) is provided by the statistics on supply and delivery of petroleum products, see 1.1.7.

The estimate for diesel consumption from off-road vehicles and other machinery (CRF 1A2f, 1A3e, 1A4b and 1A4c) is based on a SMED study from 2008.[27] In the study, diesel consumption was estimated for the year 2006. The consumption by different kinds of vehicles is estimated from the number and age distribution of vehicles, motor effect etc. For the years 2000, 2002, 2004, 2006 and 2007 the exact numbers and age distributions of tractors within different sectors (1A4c, 1A4b and 1A2f) are taken from SCB:s register of vehicles, and these numbers are used to calculate the number and age distribution for other kinds of vehicles. The numbers in other years are interpolated. The exact numbers of tractors within different sectors in 1990 and 1995 are also taken from SCB:s register, but since the age distribution is not available for these years, the age distribution from 2000 is used for the 1990's, while the number of vehicles are interpolated between 1990 and 1995 and 1995 and 2000, respectively.

Diesel consumption from civil road traffic is estimated by the ARTEMIS model ((Section 1.5).

A comparison between estimated diesel consumption according to the bottom-up ARTEMIS model and the top-down adjusted diesel delivery statistics approach gives a slightly higher consumption for the bottom-up approach (Figure 5). The trend is approximately the same for the two different estimates.

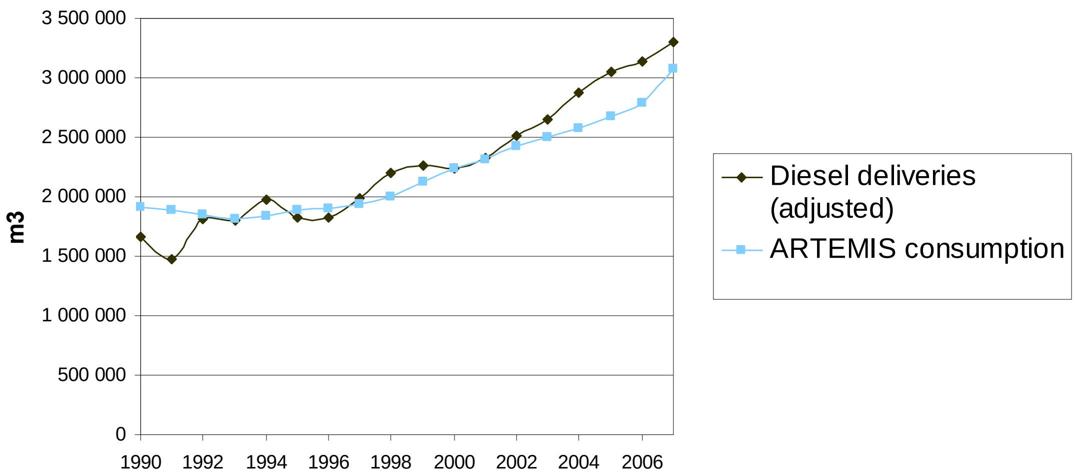

Figure 5 Bottom-up estimated diesel consumption versus top-down allocated diesel.

Figure 6 shows the approximate distribution of the delivered amount of diesel oil in 2007. As for gasoline, diesel from civil road traffic accounts for the majority of the consumption. However, diesel from off-road vehicles and other machinery also contributes to a considerable amount of the total diesel consumption.

[27] Fridell, Jernström & Lindgren 2008

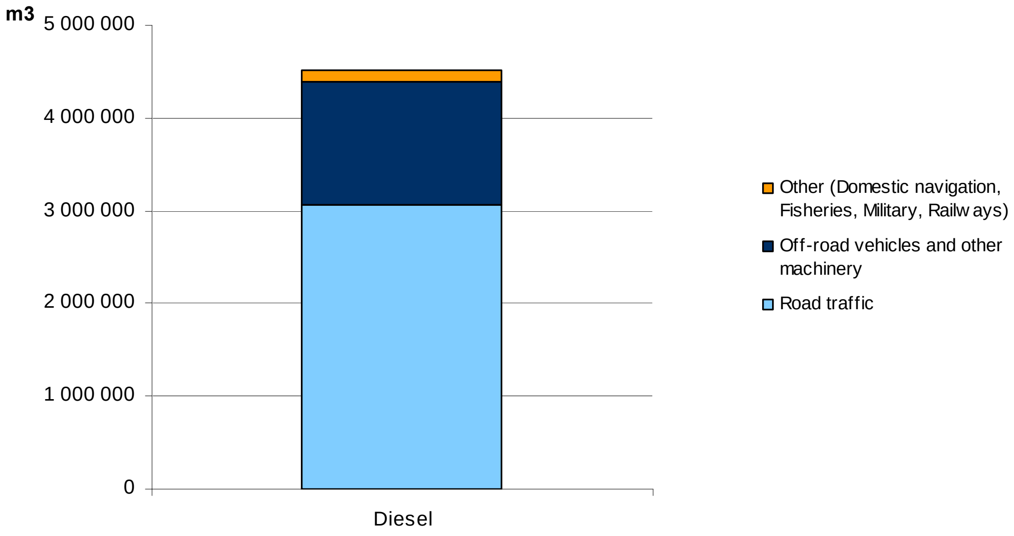

Figure 6 Distribution of diesel oil by subsector

1.4.2.1 ENVIRONMENTAL CLASSES OF DIESEL OIL

Diesel oil is refined into three categories; so called environmental classes 1-3. These have been gradually introduced from 1991. Today, environmental class 1 diesel accounts for about 99 % of the total delivered amount of diesel. The shift in consumption of diesels of different environmental classes has a significant impact on the emissions. Table 8 shows the characteristics for environmental class 1-3 regarding thermal values and emission factors for CO_2. The transition in consumption from exclusively environmental class 3 diesels in 1990 to more or less exclusively environmental class 1 diesels today has contributed to a 3 % decrease in CO_2 emissions from diesel.

Information on the diesel distribution on environmental classes has been collected from the Swedish National Road Administration for the years 1990-1993 and from Statistics Sweden for 1994 and later years. The Swedish Petroleum Institute (SPI) has assisted with information regarding thermal values and emission factors for CO_2[28]. SMED has calculated yearly averages of thermal values and emission factors.

[28] Swedish Petroleum Institute, www.spi.se. August 2005.

Table 8 Impact from different environmental class diesel on thermal value and emission factors for CO_2.

Diesel	Thermal value (GJ/m^3)	Emission factor CO_2 (tons/TJ)	Weight 1990 (%)	Weight 2000 (%)	Weight 2006 (%)
Environmental class 1	35.28	72.00	0	94	99
Environmental class 2	35.28	72.56	0	0	0
Environmental class 3	35.82	74.26	100	6	1
Average 1990	35.82	74.26			
Average 2000	35.31	72.13			
Average 2007	35.28	72.01			

1.4.3 Marine distillate fuel

Marine distillate fuel is a group name covering marine diesel oil and marine gas oil used for navigation. Emissions from these fuels are reported as gas/diesel oil in the CRF. Marine diesel oil for domestic navigation is discussed under the diesel section, 1.4.2. Delivered amount of marine gas oil for navigation is provided by the statistics on supply and delivery of petroleum products (Section 1.1.7). The statistics on marine distillate fuels are reported separately for domestic and international navigation. The division on areas of use for marine distillate fuels is provided by the respondents of the survey on supply and delivery of petroleum products. The amounts of marine distillate fuel used for domestic navigation, CRF 1A3d, is shown in Figure 7.

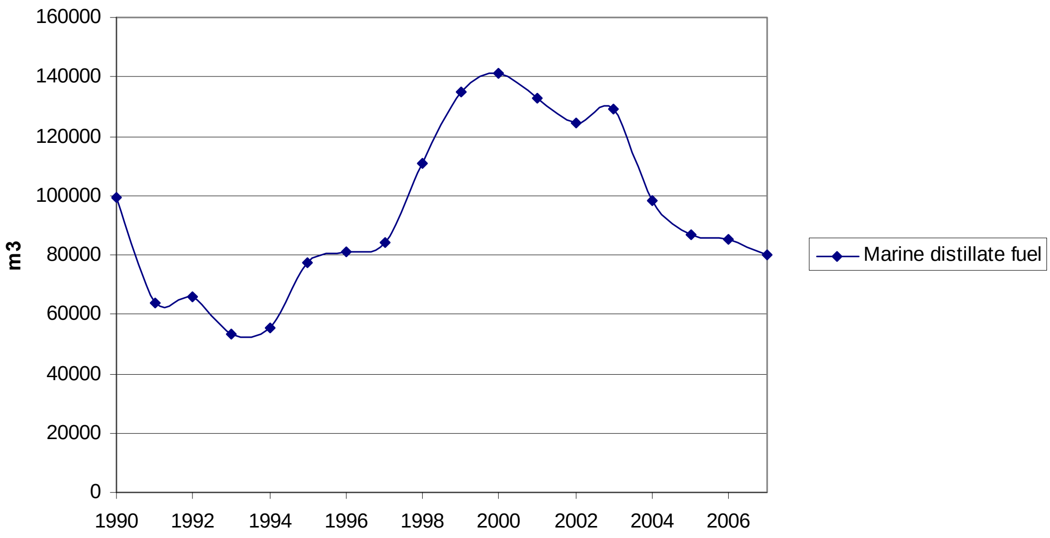

Figure 7 National fuel deliveries of marine diesel oil and marine gas oil (marine distillate fuel) 1990-2007.

1.4.4 Residual fuel oils

Delivered amounts of residual fuel oils for national and international navigation are provided via the statistics on supply and delivery of petroleum products (Section 1.1.7). The statistics on residual fuel oils are reported separately for domestic and international navigation.

1.4.5 Jet kerosene, jet gasoline and aviation gasoline

All jet kerosene, jet gasoline and aviation gasoline are assumed to be used for aviation. Delivered amounts of these fuels are provided at national level by the statistics on supply and delivery of petroleum products (Section 1.1.7). Delivered amounts of jet kerosene and aviation gasoline are distributed between military and civil aviation. The information on military consumption of aviation fuels provided by the Swedish Armed Forces is assumed to be correct and that the remaining amounts are allotted to civil aviation. Jet gasoline is only used by the military and has not been used after 1993.

1.4.6 Natural Gas and biofuels

Other fuels used for transport are ethanol, FAME, natural gas and biogas. All consumption is assumed to be in the road traffic sector, CRF 1A3b.

Ethanol and FAME are partly used as admixtures in gasoline and diesel, and partly used in more pure forms in bi-fuel vehicles. Information on delivered amounts of ethanol and FAME are provided at national level by the statistics on supply and delivery of petroleum products (Section 1.1.7). Data on delivered amount of natural gas for transport is provided by the statistics on the delivery of gas products (Section 1.1.8). Data on the consumption of biogas from 1996 is provided by the Swedish Biogas Association. Data for 1990-1995 is not available.

1.4.7 References

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Swedish Petroleum Institute, www.spi.se. August 2005.

1.5 The ARTEMIS road model

The ARTEMIS (Assessment and Reliability of Transport Emission Models and Inventory Systems) road model provides emission factors and emissions for segments and sub-segments of six main vehicle categories - passenger cars (PC), light commercial vehicles (LCV), heavy commercial vehicles (HCV), urban busses, coaches, and motorcycles including mopeds (MC) - for a large number of traffic situations, as well as for average speeds[29]. Segments are defined as groups of vehicles of similar size (e.g. passenger cars with swept engine volume between 1.4 and 2 litres, rigid trucks with weight between 14 and 20 tonnes) and similar technology (e.g. petrol engines, diesel engines, biofuel, CNG/petrol engines), whereas sub-segments are defined as groups of vehicles of similar size, technology and emission concept (e.g. pre-Euro, Euro 1, 2, 3, etc.) The emission factors are based on emission measurements according to different sets of real-world driving cycles, representative for typical European driving conditions[30]. The model calculates emissions separated into hot emissions, cold start emissions and evaporative emissions. An overview of the model structure with input and output parameters is given by Figure 8.

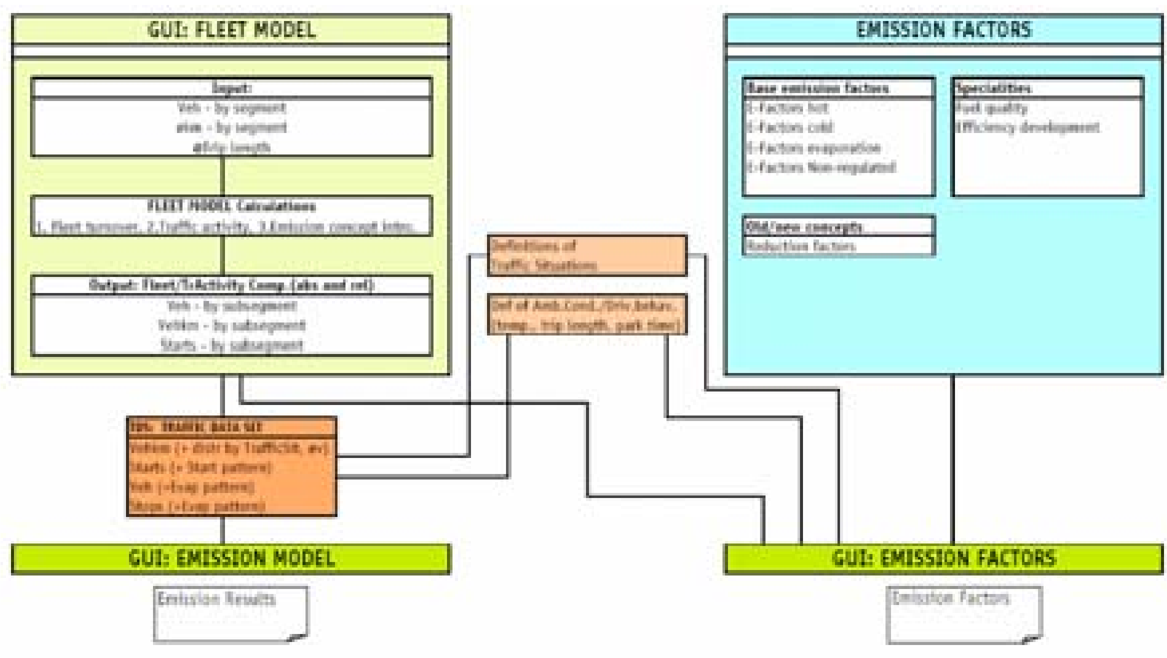


Figure 8: ARTEMIS model structure.

1.5.1 National fleet data

The Swedish road vehicle fleet for each year is described by means of the number of vehicles on category level, along with segment/sub-segment and age distribu-

29 Keller et al., 2005
30 André, 2004

tions, derived from the Swedish national vehicle register. This register is updated with new registrations and scrapped vehicles on a daily basis. Specific information on swept engine volume for passenger cars is not available from the national vehicle register. Instead, an independent fuel consumption dataset obtained from the Swedish Consumer Agency including swept engine volumes for a large number of car models available on the Swedish market, was used. This dataset has been matched with the national vehicle register, resulting in functions of swept engines volumes versus year of registration, engine power, and vehicle weight, for gasoline and diesel passenger cars separately.

The ARTEMIS model distinguishes between two types of busses: urban busses, mainly used for urban driving, and coaches, mainly used for rural and motorway driving. Due to lack of specific information in the national vehicle register, the distinction between urban busses and coaches had to be based on the ratio p/w, where p is equal to the maximum allowed number of passengers, and w is equal to the gross vehicle weight, both available from the national vehicle register. Busses with a p/w-value above 3.7 were classified as urban busses, whereas busses with a p/w-value below 3.75 were classified as coaches.

In the ARTEMIS model, trucks are split into two main categories: with and without trailer, respectively. Since there is no information on the use of trailers in the Swedish national vehicle register, trucks with trailers are described by means of vehicle transformation patterns in the ARTEMIS model. A transformation pattern defines the mileage distributions for each weight class, with and without trailer, respectively. The truck category "with trailer" is split further into different sizes of trailers expressed as the total weight (i.e. weight range, e.g. 20-28 tonnes) of the truck and trailer combination. The transformation patterns for Sweden were derived from traffic measurements on Swedish roads.

Vehicle fleet data from ARTEMIS is shown in Figure 9.

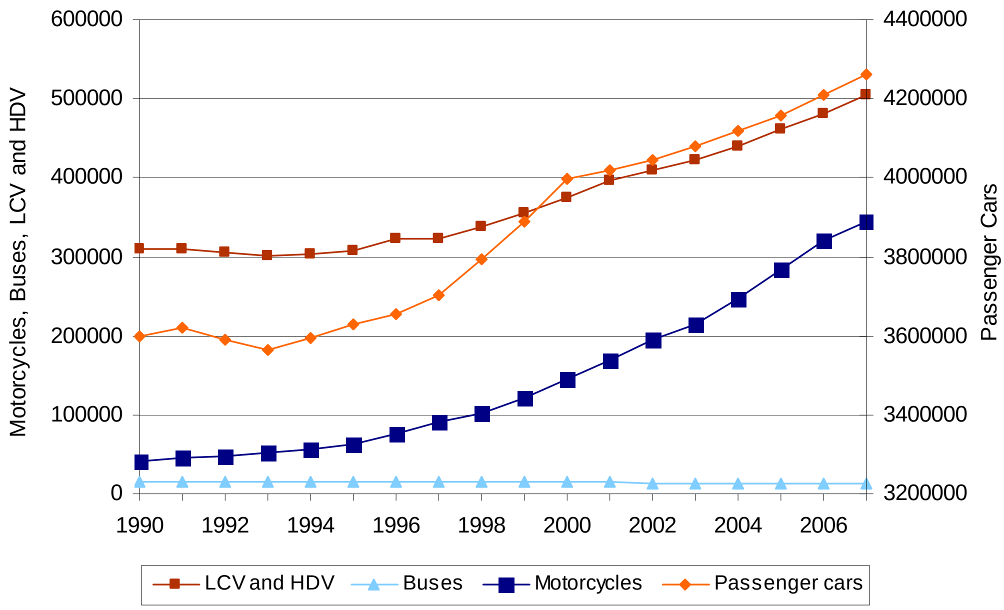


Figure 9: Vehicle fleet data by dec 31, numbers, 1990-2007 according to ARTEMIS.

1.5.2 Traffic activity data

1.5.2.1 VEHICLE MILEAGES, LOADS, TRIP LENGTHS AND FUELS

The ARTEMIS model requires yearly mileages per vehicle category Figure 10. For Sweden these are calculated by means of a national road mileage model[31]. Important inputs to this model are the overall mileage on roads, derived from traffic measurements on Swedish roads, along with the number of vehicles in different categories. The annual mileage per vehicle category is derived by dividing the total mileage per category with the number of vehicles per category. By applying the same number of vehicles together with the derived mileage, the ARTEMIS model will provide the same overall national mileage as the national road mileage model.

Yearly mileages per vehicle sub-segment level are used to distribute the total mileage on sub-segments. A method has been developed, which can assign all vehicles in the register an annual mileage, based on yearly odometer readings within the Swedish inspection & maintenance (I/M) programme[32]. This data is used for deriving mileage both per vehicle sub-segment, and as a function of vehicle age. For heavy commercial vehicles the ARTEMIS model requires mileage distributions of load factors empty (0% load), half-load (50% load), and fully loaded (100% load), by vehicle segment and vehicle age. This data is derived from a major national survey from 1997 on Swedish domestic road goods transport[33], including detailed information about both truck and trailer loads.

In order to estimate evaporative and cold start emissions, information on distributions of trip lengths and parking times, and on the seasonal and diurnal variation of ambient temperature is needed. Trip lengths and parking times can be derived from surveys, or from data from instrumented cars. For Sweden an average trip length according to surveys is 12 km, and according to instrumented cars 7 km[34]. Instrumented cars provide the trip length from engine start to engine stop. Even if instrumented car data just represents a few vehicles and use in few families, this data set has been considered more representative than the survey data, since the information requested is the distance travelled from engine start to engine stop[35]. Thus, available instrumented vehicle data was used to estimate trip lengths and parking times in Sweden.

31 Edwards et al., 1999
32 SIKA, 2003
33 Hammarström and Yahya, 2000
34 SNRA 1999
35 André et al., 1999

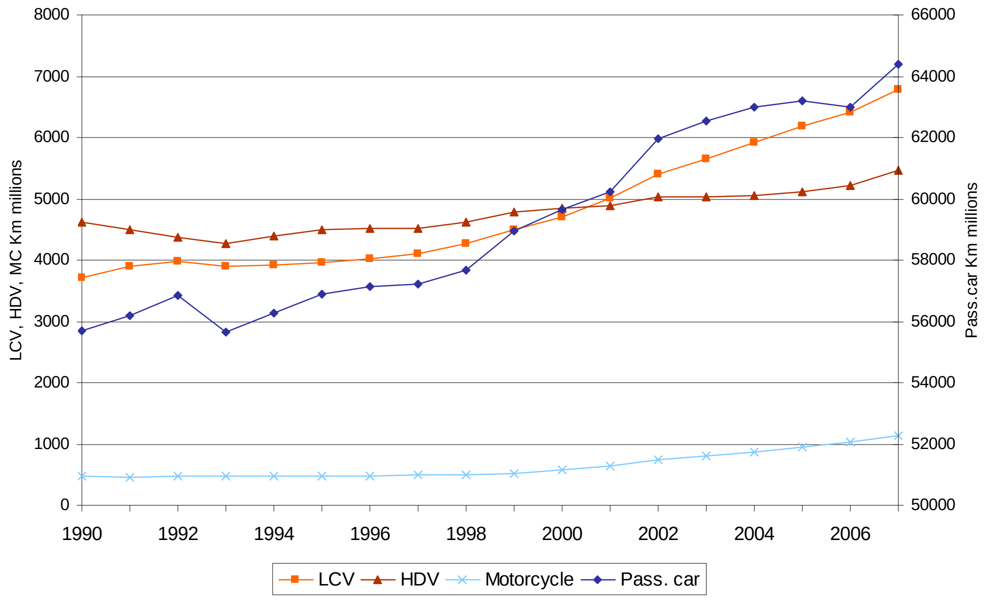


Figure 10: Vehicle mileages 1990-2007 according to ARTEMIS.

1.5.2.2 TRAFFIC SITUATIONS

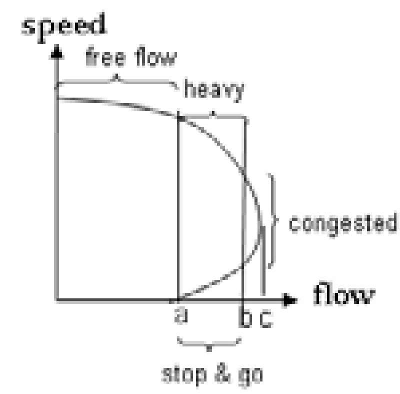
The ARTEMIS model includes 276 traffic situations, i.e. combinations of 69 road categories and for each of those four classes of traffic conditions or "levels of service", defining how disturbed the traffic is relative to undisturbed traffic - 1) Free Flow, 2) Heavy Traffic, 3) Saturated, and 4) Stop and Go conditions. Furthermore it is possible to add different level of grade; however this is not done for Sweden.

The national vehicle mileages for year 1990, 1995, 1998, 2000 and 2004 were initially estimated by means of the national vehicle mileage model[36]. Procedures were established to allocate the total vehicle mileage over 1) urban and rural roads, 2) road categories, 3) traffic conditions, and to fit the result to the traffic situations in ARTEMIS. Two national GIS road databases were employed. The first, VDB, contains all state road links attached with information about: length, road function, speed limit and ADT (average daily traffic) split on light- and heavy-duty vehicles. The second, NVDB, were used for municipal and private road links. NVDB contains information on road classification and road link length, but lacks information on ADT. Traffic simulations were performed for four regions in Sweden to represent the distribution of vehicle mileage over road categories for municipal and private roads. To separate between urban and rural road links, a GIS layer with polygons for built-up areas was utilized. Through this, the study was able to present new figures on the distribution of the overall vehicle mileage between urban and rural roads in Sweden: 41% and 59%, respectively (the distribution used earlier was 35% and 65%, respectively). State-owned rural and urban roads together with municipality-owned urban roads accounted for more than 90% of the overall vehicle mileage in 2004.

[36] Edwards et al., 1999

Furthermore, a model for distributing the urban vehicle mileage on cities of different size was demonstrated. Cities with inhabitant number exceeding 200,000 - only three in Sweden - accounted for between one fourth to almost one third of the overall vehicle mileage on urban roads. Available statistics on hourly flow conditions for different road types[37] were employed for describing the yearly variation of ADT (monthly, weekly, daily and hourly) on the different road types. The hours over the year were divided into groups based on their share of ADT for different road categories, entitled ranks (categories for rural roads were: share of ADT >0.12, 0.8-1.2, 0.4-0.8 and <0.04, categories for urban roads were: share of ADT >0.1, 0.07-0.1, 0.04-0.07 and <0.04). Using the available statistics, traffic flow and vehicle mileage at different rank-hours were calculated for each link of the state road network.

Similar calculations were carried out for the municipal and private road links in the four regions. The results, traffic flow per lane and hour were related to volume-delay functions, see Figure 11, and preliminarily classified into ARTEMIS traffic conditions 1-3. Hypothesis were formulated concerning the distribution of vehicle mileage for "Stop and Go"-conditions. This can not be estimated from volume delay functions alone, since it is not possible to decide whether a flow occurring between free flow (a) and congested (b) in Figure 11 is a case of demand exceeding capacity (Stop and Go) or if it is a lower flow (Heavy Traffic). To overcome this, two assumptions were made: Stop and Go would only occur on road links that had reached their capacity, c; and for these roads it was assumed that Stop and Go constituted a fixed share of the preliminary estimated vehicle mileage in the traffic condition "Heavy Traffic".



Road speed limit	Capacity (c in figure veh./lane*h)	Condition 1 "Free flow" (a in figure)	Condition 2 "Heavy" (a-b)	Condition 3 "Congested" (b in figure)
90+	2000	<1300	1300-1700	≥ 1700
70	1550	<600	600-1300	≥ 1300
50-	1150	<600	600-900	≥ 900

Figure 11: Traffic flow per lane and hour were related to volume-delay functions

By studying flow over the day for individual congested roads, see Figure 12, it could be seen that a local decrease in flow sometimes occurred within a congested period (i.e. when flow is near the capacity). This period was assumed to be a "Stop

[37] Björketun et al., 2005, Jensen, 1997

and Go”-period and calculations were made accordingly. The calculations finally resulted in a distribution of the vehicle mileage (light- and heavy-duty vehicles) over road categories and traffic conditions for the Swedish road network for the years 1990, 1995, 1998, 2000 and 2004.

Swedish road categories were translated to ARTEMIS traffic situations based on the description of road hierarchy, speed limit, function and design. Then it was possible to sum the vehicle mileage in Sweden over the ARTEMIS traffic situations for different years.

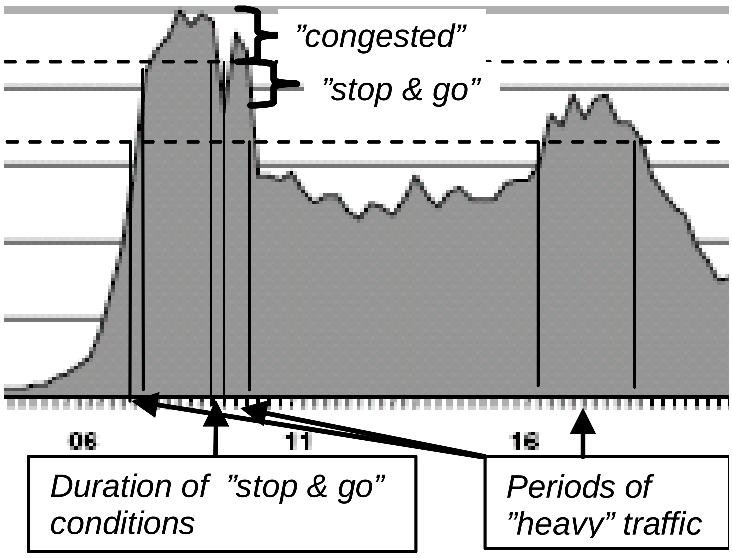


Figure 12: Flow over the day for individual congested roads

85 of the overall 276 ARTEMIS traffic situations were identified in Sweden in 2004, representing 33 road categories, for which the ARTEMIS traffic conditions "Free Flow" or "Heavy Traffic" were predominant. In fact, as much as 94% of the overall vehicle mileage driven in Sweden was characterised by free flow conditions. The ten most abundant ARTEMIS traffic situations all involved "Free Flow" conditions, and are presented in Table 9. The three most common road categories "Rural Distributor" (speed limits 90 and 70 km/h, respectively) and "Rural Motorway" (speed limit 110 km/h) accounted for more than 40% of the national vehicle mileage. Adding also urban road categories "Local Collector" and "Access Residential" (both with speed limit 50 km/h), and "Distributor" (speed limits 70 and 50 km/h, respectively), and two more rural categories ("Local Collector", 70 km/h, and "Trunk Road", 110 km/h), these ten most abundant road categories at free flow conditions accounted for about 80% of the national vehicle mileage. The share of the ARTEMIS "Stop and Go"-conditions of the overall mileage was as low 0.05%, and only occurred in the three major cities (having more than 200,000 inhabitants).

Further details concerning the methodology and the results are reported elsewhere[38].

Table 9: The ten most common traffic situations in Sweden in 2004, and their share of the total vehicle mileage.

Description of traffic situation			Vehicle mileage
Rural / Distributor-District connection	/ Speed limit: 90 km/h	/ Free flow	21.3%
Rural / Distributor-District connection	/ Speed limit: 70 km/h	/ Free flow	11.1%
Rural / Motorway	/ Speed limit: 110 km/h	/ Free flow	10.7%
Urban / Local collector	/ Speed limit: 50 km/h	/ Free flow	9.7%
Urban / Access-Residential	/ Speed limit: 50 km/h	/ Free flow	6.6%
Urban / Distributor-District connection	/ Speed limit: 70 km/h	/ Free flow	5.9%
Rural / Local collector	/ Speed limit: 70 km/h	/ Free flow	5.7%
Urban / Distributor-District connection	/ Speed limit: 50 km/h	/ Free flow	4.8%
Urban / Access-Residential	/ Speed limit: 30 km/h	/ Free flow	2.2%
Rural / Trunk road	/ Speed limit: 110 km/h	/ Free flow	2.0%
Total			79.9%

1.5.3 References

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1.6 Methodology for off-road vehicles and working machinery

Estimated emissions for off-road vehicles and other machinery are calculated with a bottom up method and are therefore considered to correspond to Tier 2.

Emissions of CO_2 and SO_2 for are based on the same thermal values and emission factors for diesel and gasoline as used for road traffic.

Fuel consumption and emissions of CO_2, SO_2, NO_X, NMVOC, CH_4, CO, N_2O are estimated based on a model developed by SMED in 2008. The calculations are based on the equations below:[39]

$$E = N \times Hr \times P \times Lf \times EF_{adj} \qquad (1)$$

Where:
- N = number of vehicles,
- Hr = yearly running time in hours,
- P = motor effect i kW,
- Lf = load factor, and
- EF_{adj} =adjusted emission factors in g kWh^{-1} according to equation below (applied for larger off road vehicles and snow scooters).

$$EF_{adj} = EF_l \times CAF \times TAF \times DF \times FAF \qquad (2)$$

Where:
- EF_l = emission regulations according to EU legislation in g kWh^{-1},
- CAF = adjustment factor for difference between regulation and value measured at certification,
- TAF = adjustment factor for transient (i.e.difference between static test cycle and real use of the machine),
- DF = adjustment factor for decline of the motor by increasing age, and

[39] Fridell, Jernström and Lindgren, 2008

- FAF = adjustment factor for difference between certification fuel and Swedish diesel of type "MK1".

All variables in the equations above are described as vectors with data for every year model the last 25 years.

For gasoline driven smaller off-road vehicles and machinery, emission factors are taken from Winther and Nielsen.[40] These are based on certification measurements, and the different emission classes are separated in the calculations. Emission factors for diesel driven smaller off-road vehicles and machinery are taken from Corinair[41].

Number of larger off-road vehicles of different types is based on a bottom up inventory for 2006. [42] Numbers of tractors per sector, year-model and motor effect interval are taken from Statistics Sweden's registers for 2000, 2002, 2004, 2006 and 2007, as are the number of tractors per sector and motor effect interval for 1990 and 1995. For other years, numbers are interpolated by year model etc., but the proportions of different vehicle types are assumed to be constant. Number of smaller vehicles and machinery are based on a bottom up inventory for 2002[43], and other years the number is updated with the same trend as for the larger vehicles.The number of snow scooters are taken from Statistics Sweden's register for each year.

The yearly running time, motor effect, the load factor and the different adjustment factors in equations above are taken from Wetterberg[44] and Flodström[45].

The fuel adjustment factor, FAF, and the certification adjustment factor, CAF, for larger vehicles in equation (2) are taken from Lindgren (2007).[46] The TAF and DF factors are taken from the Nonroad model[47]. Fuel consumption for snow scooters are taken from Winther and Nielsen 2006[48] and DF and emission factors from the Nonroad model[49] are used.

Emission factors for smaller gasoline driven vehicles and machinery are taken from Winther and Nielsen. These are based on certification measurements, and the emissions are calculated separately for each emission class.

For all types of vehicles and machinery, the emission factors for SO_2 and CO_2 are adjusted according to fuel specifications for each year.

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Annex 3

Other detailed methodological descriptions for individual source or sink categories

Annex 3:1, Brief description of the Excel-model for calculation of emissions of fluorinated gases.

Background

In 2000 the first inventory of actual emissions of fluorinated greenhouse gases in Sweden was performed, covering the time period 1990-99 (Kindbom et. al 2001). At this time a first version of an excel model was developed. In early 2004, the model was refined concerning the calculations from the accumulated bank. After the improvement the leakage factor for equipment produced one specific year is used throughout its lifetime. For several sub-sources the produced newer equipment has been assigned lower annual leakage, while the older equipment still is assigned the original higher leakage rate in the calculations.

In 2005 a thorough update of the calculations and the model was made since additional information had become available, indicating that an update of the way of utilizing background data, and of the calculation methodology was necessary (Kindbom, K. 2005).

Activity data used for calculating emissions from the categories stationary refrigeration (HFCs and PFCs) and electrical insulation (SF_6) were revised in cooperation with Product Register staff at the Swedish Chemicals Inspectorate. Furthermore, national calculation methodologies for emissions from semi-conductor manufacture and from foam blowing were studied in relation to the descriptions in IPCC Good Practice Guidance (2000). The result from these comparisons was that the methodology for calculating emissions from semi-conductor manufacture was revised according to the Tier 1 methodology given in IPCC Good Practice Guidance, while the national method for calculating emissions from foam blowing was retained.

Due to improved information during the course of the work, revisions of emission calculations were also made for mobile air conditioning and for metered dose inhalers. Additionally, from the improved information on fluorinated substances followed that the reporting of potential emissions, where previously only data from 1995 and on were covered, could be made complete for the whole time series.

Structure of the excel model

The model consists of an excel file with:

- 19 sheets, one sheet for each sub-source considered (plus 3 sheets for aggregated sub-sources) where all input data from 1990 until present are registered and where calculations of accumulated amounts and actual emissions occur.
- one summary sheet where emissions for each year from 1990 are transferred from the sub-source sheets and are summarized by year, substance and source.
- one sheet where background information such as GWP-values are automatically taken into the calculations in the summary sheet.

The individual sub-source sheets may look slightly different as far as the input data cells are concerned. These have been adapted to suit the actual input data available and needed for the calculations. For all sub-sources calculations are however made concerning annual accumulated bank and actual emissions by substance. Where appropriate also imported and exported amounts in products are calculated.

Input data and calculated data

Every sub-source sheet has input cells for each year where the production, import and export of F-gases for that particular source is entered. For each year an expected lifetime, leakage factors and a minimum content factor is given. Each sub-source then has its specific composition of use of species of HFC, PFC and SF_6, which are calculated separately. For each component the leakage in each year is calculated taking into account the leakage from production, the leakage from the accumulated bank and from decommissioning. In these calculations each year uses the leakage factor for that years production until minimum content is reached or the expected lifetime is reached.

Changes in accumulated amounts each year resulting from additional amounts of HFC, PFC and SF_6 imported and used within the country, as well as the decline in accumulated stock caused by exports or emissions from operating systems, have been taken into consideration.

Most calculations is made with standard worksheet functions in excel. But to simplify the worksheets some VBA functions have been written. These are:

Function **get_emission** (SheetName, ColName, RowName)

Used in the summary sheet to collect results on actual emissions from the detailed sub-source sheets.

Function **accumulated_minus_leakage** (year_range, cond_range, _
year, sum_range, leakage_range, min_content)

Calculates the sum of each years additions of HFC, PFC and SF_6 minus the leakage taking into account the different leakage factors for each year and the minimum content in each equipment.

Function **leakage_per_year** (year_range, cond_range, _
year, sum_range, leakage_range, min_content)
Calculates the sum of the leakage of the accumulated bank.

Development of new functionalities in the model in 2005

Most of the information necessary for a complete reporting of fluorinated greenhouse gases according to the guidelines was already present as background data in the model. The model until 2005 however efficiently supported only the compilation of annual actual emissions. The development in 2005 in particular applied to the information required in the background tables in the CRF reporting system, and to the reporting of potential emissions.

New definitions relating to the reporting requirements were developed and included in all source specific data sheets. These cover all required data in the CRF background tables, such as the amounts of chemical filled in new manufactured products, accumulated stock and remaining amounts at decommissioning, as well as the emission factors for production, during use and at decommissioning.
Some adjustment and development relating to specific sources and calculation sheets were also made:

- an aggregation of sources in the group of stationary refrigeration and air conditioning, with previously seven separate sources/sheets were aggregated into three calculation sheets.
- the calculations for metered dose inhalers and technical (other) aerosols were split on two separate sheets.
- the calculations of emissions of SF_6 from electrical equipment was split on two separate sheets, one for emissions from manufacture of gas insulated switchgear and one for electrical insulation.
- a harmonisation of the presentation of columns and calculations in the different sheets/sources in the model was also made, since source specific improvements and changes over time had made the calculation sheets develop along different lines.
- sheets for registering and adjustment of import and export data from the Product Register were added to the model. This enables the automatic calculation of volumes of chemicals not already accounted for in the model. As a result, surplus HFCs not already accounted for are automatically allocated to stationary refrigeration and accordingly for SF_6, which is automatically allocated to electrical insulation.

The model before did not support the reporting of potential emissions regarding import and export of chemicals in bulk. The sheets for registering and adjustment of import and export data from the Product Register also enables a compilation of the import and export in bulk as a basis for the reporting of potential emissions in the CRF-system.

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Annex 3:2

1.1 Land Use, Land-Use Change and Forestry (CRF sector 5)

In the following chapter we have put together additional information on methodological issues used in the inventory for the LULUCF-sector. The structure follows chapter “7.3 Methodological issues” in the NIR and we refer to the corresponding NIR-chapter where apporpriate.

1.1.1 Methodological issues, CRF-tables 5A, 5B, 5C, 5D, 5E and 5F

1.1.1.1 THE LULUCF-REPORTING DATABASE [NIR 7.3.1.2]

The reporting database is based on permanent sample plots inventoried by RIS. In total, around 40000 permanent sample plots were laid out during the period 1983-1987 covering the whole country. Thus all land and fresh-water areas are monitored. The permanent sample plots have been re-inventoried at intervals of 5-10 years. The land-use of each plot (or sub-plot for plots divided in two or more land use classes) is described from the year of the first inventory and every year thereafter. The land-use of years between inventories has been interpolated. In table 10 below the structure of the reporting database and the inventories are illustrated

Each single sample plot has been inventoried in one of ten inventory intervals When all plots of a specific reporting year have been re-inventoried at least once after the specific reporting year the figures will be re-calculated based on all sample plots. Theoretically, both the current and the re-calculated reporting will be unbiased. However, the accuracy will be better in the latter case.

Table 10 A single sample plot is inventoried in one of ten inventory intervals. Blue background refers to measurements and no colour refers to interpolated data. Type

1	2	3	4	5	6	7	8	9	10
1983	1983	-	-	-	-	-	-	-	-
1984	1984	1984	1984	-	-	-	-	-	-
1985	1985	1985	1985	1985	1985	-	-	-	-
1986	1986	1986	1986	1986	1986	1986	1986	-	-
1987	1987	1987	1987	1987	1987	1987	1987	1987	1987
1988	1988	1988	1988	1988	1988	1988	1988	1988	1988
1989	1989	1989	1989	1989	1989	1989	1989	1989	1989
1990	1990	1990	1990	1990	1990	1990	1990	1990	1990
1991	1991	1991	1991	1991	1991	1991	1991	1991	1991
1992	1992	1992	1992	1992	1992	1992	1992	1992	1992
1993	1993	1993	1993	1993	1993	1993	1993	1993	1993
1994	1994	1994	1994	1994	1994	1994	1994	1994	1994
1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
1996	1996	1996	1996	1996	1996	1996	1996	1996	1996
1997	1997	1997	1997	1997	1997	1997	1997	1997	1997
1998	1998	1998	1998	1998	1998	1998	1998	1998	1998
1999	1999	1999	1999	1999	1999	1999	1999	1999	1999
2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
2002	2002	2002	2002	2002	2002	2002	2002	2002	2002
2003	2003	2003	2003	2003	2003	2003	2003	2003	2003
2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
2007	2007	2007	2007	2007	2007	2007	2007	2007	2007
2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
2009	2009	2009	2009	2009	2009	2009	2009	2009	2009
2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
2011	2011	2011	2011	2011	2011	2011	2011	2011	2011
2012	2012	2012	2012	2012	2012	2012	2012	2012	2012
2013	2013	2013	2013	2013	2013	2013	2013	2013	2013
2014	2014	2014	2014	2014	2014	2014	2014	2014	2014

1.1.1.2 SAMPLE BASED ESTIMATIONS [NIR 7.3.1.4]

The sample frame consists of a map covering the whole land and fresh water area of Sweden. A sea archipelago zone where islands covered by vegetation might occur is also included in the frame (but no sea area is reported). The frame is divided into about 30 strata and a specific number of sample units are sampled per stratum. Each cluster (tract) of sample plots is assumed to be the sample unit. The inventoried area of tract number *j* will represent a large area in the estimations of area weight and the sum of all represented areas will be equal to the total county area (A_i).

$$Area\ weight_{ij} = \frac{A_i}{n_i \cdot a_{ij}}$$

where $Area\ weight_{ij}$ = the area that tract *j* within county *i* will represent, n_i = number of sampled tracts within county *i*, and a_{ij} = the inventoried area of tract *j* within county *i*. In a consistent manner the $Area\ weight_{ij}$ will be the same for each year from 1990 onward. Whole plots or plot parts may change land use category by time but the total tract area will always represent the same area. At the county level, the reported value (e.g. the Δ- carbon for land use category Forest land remaining Forest land) will be estimated by a ratio estimator[50].

$$\hat{Y}_i = A_i \frac{\hat{X}_i}{\hat{A}_i}$$

where $\hat{Y}_i$ = the ratio estimated value, A_i = the measured area (of year 1984 by the national land survey; Lantmäteriet[51]). $\hat{X}_i$ = the estimated value of the variable of interest according to Horvitz-Thompson and $\hat{A}_i$ = the estimated area according to Horvitz-Thompson. Index *i* refers to county.

The two values estimated by the Horvitz-Thompson estimator are calculated similarly, e.g. as:

$$\hat{X}_i = Area\,weight_{ij} \sum_{j=1}^{n_i} x_{ij}$$

where x_{ij} = is the inventoried value of tract *j* (within county *i*).

Finally the reported value on national level, $\hat{Y}$, is estimated as:

$$\hat{Y} = \sum_{i=1}^{N} \hat{Y}_i$$

where *N* = the total number of counties in Sweden.

Sweden will only report "human induced" carbon changes, where "human induced" has the interpretation of "managed", i.e. the biomass stock change on unmanaged land are set to zero. However, the "actual" stock on unmanaged land is considered when calculating stock changes after conversions between unmanaged and managed land and vice versa. All areas, managed or unmanaged, are reported.

1.1.1.3 METHODOLOGY LIVING BIOMASS CRF 5A, 5B, 5C, 5D, 5E AND 5F [NIR 7.3.1.6]

A national methodology (Tier 3) is used. The aboveground biomass per fractions is estimated by applying Marklund's[52] biomass functions to calliper and sample trees on permanent sample plots of the NFI[53]. The below-ground biomass is estimated by Peterssons and Ståhl's[54] biomass functions applied to the same trees. The conversion factor 0.49 is used to convert biomass to carbon[55]. Estimates are based on

50 Thompson, 1992
51 Lantmäteriet, http://www.lantmateriet.se/
52 Marklund, 1987 and 1988
53 Ranneby et al., 1987
54 Petersson and Ståhl, 2006
55 National Board of Forestry, 2000

repeated measurements and the stock change of for example year 2000 is calculated as the difference in stock of years 2000-1999.

Marklund's single tree allometric regression functions (table 11) were developed for predicting biomass of the tree fractions needles (not leaves), branches, bark and stem for Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and birch (*Betula pendula* and *Betula pubescens*). The total fresh weight of each tree (in total, about 1300 trees) and the fresh weight of samples from different fractions were measured in the field. The dry weight of each sample, defined as the constant weight at 105° Celsius, was measured at the laboratory. The calculations of dry weight per fraction were based on these measurements. The trees were selected from 123 stands from different parts of Sweden, covering a wide variety of stand and site conditions.

Petersson and Ståhl developed allometric single tree below ground biomass functions for Scots pine, Norway spruce and birch in Sweden (table 11). The idea was to calibrate an existing comprehensive data set of about 600 trees inventoried by Marklund, that only covered the stump and coarse roots, by a new data set that covered roots down to 2 mm diameter. The new data set consisted of about 80 trees acquired using the same design as Marklund, but complemented by a detailed inventory of the fine root fractions remaining in the ground. The old data set was calibrated before the two data sets were merged. The merged data set was used for deriving the functions.

Table11 The simplest biomass functions applied to trees only measured for stem diameter at breast height (1.3 m) and species. TVSTEM=dry weight, stem including bark [kg], TVLGREN=dry weight, branches and needles (not leaves) [kg], TVBARR=dry weight, needles (not leaves) [kg], TVROTSTU=dry weight, stump and roots down to 2 mm [0.1 kg], D=stem diameter at breast height (1.3 m) [cm] and dbh=stem diameter at breast height (1.3 m) [mm]

Biomass function	Unit	Reference
Scots pine (Pinus sylvestris)		
TVSTEM=exp(11.3264*D/(D+13.)-2.338)	[kg]	Marklund, T-1
TVLGREN=exp(9.1015*D/(D+10.)-2.8604)	[kg]	Marklund, T-13
TVBARR=exp(7.7681*D/(D+7.)-3.7983)	[kg]	Marklund, T-17
TVROTSTU=exp(3.44275+((dbh/(dbh+113))*11.06537)+((0.35449**2)/2.))/100.	[0.1 kg]	Petersson & Ståhl
Norway spruce (Picea abies)		
TVSTEM=exp(11.3341*D/(D+14.)-2.0571)	[kg]	Marklund, G-1
TVLGREN=exp(8.5242*D/(D+13.)-1.2804)	[kg]	Marklund, G-11
TVBARR=exp(7.8171*D/(D+12.)-1.9602)	[kg]	Marklund, G-15
TVROTSTU=exp(4.58761+((dbh/(dbh+138))* 10.44035)+((0.32308**2)/2.))/100.	[0.1 kg]	Petersson & Ståhl
Birch (Betula pendula and B. pubescens)		
TVSTAM=exp(11.0735*D/(D+8.)-3.0932)	[kg]	Marklund, B-1
TVLGREN=exp(10.2806*D/(D+10.)-3.3633)	[kg]	Marklund, B-11
TVROTSTU=exp(6.17080+((dbh/(dbh+225))* 10.01111)+((0.36266**2)/2.))/100.	[0.1 kg]	Petersson & Ståhl

1.1.1.4 METHODOLOGY DEAD ORGANIC MATTER CRF-TABLES 5A, 5B, 5C, 5D, 5E AND 5F [NIR 7.3.1.7]

A national methodology (Tier 3) is used to estimate the dead organic matter pool. The pool includes different sub-pools that are estimated slightly differently. The reported stock change is the annual average change in the trend in carbon stock of the pool between 1993 and 2004 except for the dead wood and coarse litter. The inventory of dead wood began in 1995 (for northern Sweden, 1994) and this year's reporting is based on up to approximately 18000 sample plots inventoried in 1995/1999, 1996/2000 and 1997/2001 and re-inventoried in 2004, 2005 and 2006, respectively.

The carbon content in dead wood is assessed by first measuring the volume of dead wood and then converting to carbon by multiplying by constants. Different constants are used per decay class and species[56]. For all inventory occasions, the reported figures are estimated by the same monitoring design using the same conversion factors, and data for years between inventories are interpolated. The re-

[56] Sandström et al., 2007

ported figures between 1990 and 1997 are based on the trend between 1995/1999 and 2004 (approximately 6000 sample plots), and the figures of 1998 are based on the trends 1995/1999-2004 and 1996/2000-2005 (12000 plots). The figures of year 1999 are based on the trends 1995/1999-2004, 1996/2000-2005 and 1997/2001-2006 (approximately 18000 plots). The reported figures between 2000 and 2004 are based on all the four trends (about 24000 plots) and the figures of 2005 are based on the trends 1996/2000-2005, 1997/2001-2006 and 1998/2002-2007 (about 18000 plots). The figures of 2006 are based on the trend 1997/2001-2006 and 1998/2002-2007 (about 12000 plots). Finally, the reported figures of 2007 are based on the trend 1998/2002 and 2007 (6000 plots). Due to an ambition to increase the amount of dead wood, the amount of carbon for this pool probably increased in the early 1990s.

Sandström et al. developed conversion factors from volume per decay class to biomass for the species Norway spruce, Scots pine and birch in Sweden. About 2500 discs were collected from logs in managed forests located on 290 NFI[57] sample plots and in 11 strips located in preserved forests. Thus the data represented different site-, stand-, species- and dead wood properties in Sweden. Per species and decay class, the volume per sample was measured. The dry weight of each sample, defined as the constant weight at 85°C, was measured at the laboratory. The carbon content[58] per dry weight biomass for Norway spruce and Scots pine was estimated to 50.0 and 51.2 % respectively, based on a sub-sample. The conversion factors decreased significantly by decay class and the average dry densities were 0.226, 0.239 and 0.275 [$g \cdot cm^{-3}$], for Norway spruce, Scots pine and birch, respectively. Belowground dead wood originating from stump and root systems of dead trees is not reported this year.

The carbon in the litter pool is estimated based on three different sources (i) coarse litter (ii) annual litter fall and (iii) litter < 2 mm. Coarse litter is defined as dead organic material with a “stem diameter” between 10-100 mm and originating from dead trees. Coarse litter is not inventoried but calculated as 15 % of the aboveground dead wood. Litter fall for coniferous species is calculated using empirical functions (table 12) and litter fall for deciduous species by biomass functions based on leaf biomass. This fraction of litter is regarded as an annual pool. The remaining part of this pool after one year is included in the O horizon and thus measured by the soil inventory. The fine litter (< 2 mm) is estimated by sampling the O or H horizon sample which is taken on an area basis, weighed and analysed for carbon content.

57 Ranneby et al., 1987
58 Kjeldahl, 1883

Table12 Functions used to estimate the litter part of the dead organic matter pool. The following abbreviations are used; CL=coarse litter, DW=dead wood, AL=Annual litterfall, NS=Norway Spruce, PS=Scots pine, D=decidous, Lat=Latitude, BA=basal area, Age=tree age, ND=number of decidous stems ha^{-1}, ABHD=average diameter at breast height (1.3 m), C=carbon, Cconc=Carbon concentration in %, SDW=sample dry weight in Mg, SA=sampled area in ha, TL=total litter)

Coarse litter	**Unit**
CL=0.15•DW	[kg •ha-1]
CCL=0.5•CL/1000	[Mg•ha-1]
Annual litterfall (AL)	
ALNS=16509-245.8•Lat+5.22•BANS	[kg •ha-1][59]
ALPS=6906-102.3•Lat+46.4*BAPS-4.5•Age	[kg •ha-1][60]
ALD= ND•0.00371•ABDH$^{1.11993}$	[kg •ha-1][61]
CAL=0.5• (ALNS+ALPS+ALD)/1000	[Mg•ha-1]
Fine litter<2 mm	
CFL=SDW•Cconc•0.01/SA	[Mg•ha-1]
Total litter carbon	
CTL=CCL+CAL+CFL	[Mg•ha-1]

1.1.1.5 METHODOLOGY SOIL ORGANIC CARBON FOREST LAND AND GRASSLAND ON MINERAL SOILS CRF 5A AND 5C [NIR 7.3.1.9]

The method is a Tier 3 method. The estimates are based on repeated measurements of several variables. The basic function used to determine the amount of carbon in a soil layer is based on the amount of carbon in a certain soil layer and the fraction of fine earth:

$$SOCi = Ci \cdot Wfei,$$

where SOC_i is the amount of carbon found in soil layer i [Mg•ha^{-1}] and C_i is the carbon concentration [%] in the fine earth fraction (<2 mm) and *Wfe*, is the amount of fine earth in the soil layer [Mg•ha^{-1}]. The amount of fine earth is dependent on the bulk density and amount of gravel, stones and boulders in the soil, hereafter referred to as stoniness. There are no direct measurements of stoniness in the MI during the period 1993 to 2002. However, measurements of the stoniness started in 2003 and will be completed for all plots in 2012 using a modified Viro method[62]. Since data on stoniness is not expected to change, the reported data can be recalculated for the whole reporting period at the end of the commitment period.
For this reporting period the relationships between stoniness data collected 2003 and 2004 and a measured boulder frequency available for all the plots is used. Separate relationships were determined for the categories till, poorly sorted waterlaid sediments and well-sorted waterlaid sediments. It is important to note that any error in the estimate of stoniness have no influence on direction of change in carbon pool but might affect the magnitude of the change slightly (Table 13).

59 Berg et al., 1999a
60 Berg et al., 1999b
61 Johansson, 1999
62 Viro, 1952.

Table 13 Stoniess correction coefficients.

Boulders (number/plot)	Parent material class	Stoniness (vol-%)
0	Well sorted sediment.	3.64
1-10	Well sorted sediment	4.72
11-50	Well sorted sediment	8.10
51-100	Well sorted sediment	ND
>100	Well sorted sediment	ND
0	Poorly sorted sediments and glacial till	23.6
1-10	Poorly sorted sediments and glacial till	31.2
11-50	Poorly sorted sediments and glacial till	37.5
51-100	Poorly sorted sediments and glacial till	46.9
>100	Poorly sorted sediments and glacial till	54.2

Bulk density (BD) is not measured for the mineral soil samples. Bulk density is instead predicted using a pedotransfer function,

$$BD = 1.5463 \cdot e^{-0.3130\sqrt{C_i}} + 0.00207AD$$

where C_i is the carbon concentration [%] in the fine earth fraction (<2 mm) and AD the average depth of the soil layer in cm.

After the estimates for stoniness and bulk density have been made the carbon amount in each sampled soil horizon at each plot is determined. Thereafter the soil carbon in soil horizons not sampled is determined by interpolation between layers.

1.1.1.6 METHODOLOGY SOIL ORGANIC CARBON FOREST LAND AND GRASSLAND ON ORGANIC SOILS CRF 5A AND 5C [NIR 7.3.1.10]

The method is a Tier 2 method. The annual below ground litter input was estimated using annual above ground litter production from the NFI and the assumption that the fraction of below ground litter production is equal to the above ground litter production. The proportion of decomposed carbon assumed to correspond to the input to the soil organic carbon pool was set to 20% of the annual litter production.

The emission factors for heterotrophic respiration derived from the calculations made by von Arnold et .al. (2005)[63]was used to calculate the emissions from drained organic forest soils. The emission factors were 3.0 t CO_2-C ha^{-1} $year^{-1}$ (range 2.49-3.51) for well drained soils and 1.9 t CO_2-C ha^{-1} $year^{-1}$ (range 1.45-2.35) for poorly drained soils. Undisturbed organic soils was assumed to be in balance and accordingly no emissions or removals was estimated on these soils.. The total area of organic soils and the sub-area of drained soils was estimated from the NFI-database. Of the drained soils, the well-drained soil part was estimated to 91%.

[63] von Arnold et. al. 2005

Table 14 The area, below ground litter input and total emission on organic forest soils.

	Area of organic forest soils	Area of drained organic forest soils		Litter input	Total emissions
		Well-drained	Poorly drained		
Year	[Mha]			ton C/ha	
1990	4.7	1.02	0.11	0.25	-0.43
1991	4.7	1.02	0.11	0.25	-0.43
1992	4.7	1.02	0.11	0.25	-0.43
1993	4.7	1.02	0.11	0.25	-0.43
1994	4.7	1.02	0.11	0.25	-0.43
1995	4.7	1.02	0.11	0.25	-0.43
1996	4.7	1.03	0.11	0.25	-0.44
1997	4.7	1.03	0.11	0.25	-0.44
1998	4.7	1.03	0.11	0.25	-0.44
1999	4.7	1.03	0.11	0.25	-0.44
2000	4.7	1.03	0.11	0.25	-0.44
2001	4.7	1.04	0.10	0.25	-0.44
2002	4.7	1.04	0.10	0.25	-0.44
2003	4.7	1.04	0.10	0.25	-0.44
2004	4.8	1.05	0.11	0.25	-0.44
2005	4.8	1.04	0.10	0.25	-0.44
2006	4.7	1.03	0.10	0.25	-0.44

1.1.1.7 METHODOLOGY SOIL ORGANIC CARBON CROPLAND ON ORGANIC SOILS CRF 5B [NIR 73.1.12]

The emission factor for cropland on organic soils has been estimated using data from eight Swedish sites where the mean annual subsidence rates for peat soils cultivated with different crops have been studied[64]. First, the mean annual carbon loss per cm soil subsidence, hereafter referred to as the carbon loss factor (CLF), was calculated;

$$CLF = C_{ox} \cdot BD \cdot C_c$$

where C_{ox} is the carbon oxidation rate given as a fraction of total subsidence rate in cm yr^{-1}, BD is the bulk density in g cm^{-3}, C_c the carbon concentration in % of the soil material. Carbon oxidation has been calculated to make up 30 – 40 % of the total subsidence and a fixed value of 35 % has been used. Assuming a bulk density of 0.2 g cm^{-3} and a carbon concentration of the oxidized soil layer of 45 % the CLF was estimated to 3.15 Mg C ha^{-1} cm^{-1}.

[64] Berglund, 1989

Total carbon emissions from organic soils in Sweden were estimated using the formula:

$$CO_2 - C\ emmission = \sum SR_i \cdot area_i \cdot CLF$$

where areai and SRi denotes the area and the subsidence rate of crop type i. The background data for subsidence rates are for pasture 0.5 cm yr^{-1}, for lay 1.0 cm yr^{-1}, for cereals 1.5 cm yr^{-1} and for row crops 2.5 cm yr^{-1}. The relative area proportion of the different crop types are 38, 36, 24 and 1.4 %, respectively, and the total area of organic soils under agricultural production is 249 800 ha[65]. The area proportion was changed in submission 2008 (reporting year 2006) due to the study refferd to above. There is no additional information on when or how fast the land-use has changed and therefore the change caused an abrupt decrease of the emissions from these soils between 2005 and 2006.

1.1.1.8 METHODOLOGY CO_2 EMISSION FROM MINERALIZATION WHEN EXTRACTING PEAT CRF 5D [NIR 7.3.1.13]

The emitted CO_2 [M ton•yr^1] from extracted peat areas is calculated as the product of the extracted area and an emission factor:

$CO_2 = P \bullet EF$

where *P*=production area [ha] and *EF*=emission factor [M ton•ha^{-1}•yr^{-1}]. The production area is the area suitable for peat extraction and this area is part of the concession area for peat extraction. Peat extraction is only ongoing on part of the production area. The peat extraction is usually proceeding many years on the same production area until this area is closed down and restored. Former managed peat land is usually restored by saturation by water or by conversion to Forest land. The water saturation will probably stop most carbon mineralization and Wetlands converted to Forest land is reported under Wetlands converted to Forest. Production areas are obtained from Svenska Torvproducentföreningen[66]. The emission factor (6 [ton CO_2•ha^{-1}•yr^{-1}]) is based on studies made by Kasimir-Klemedtsson et al.[67] and by Sundh et al.[68], (Table 15).

[65] Berglund and Berglund, 2005
[66] Svenska Torvproducentföreningen, 2006
[67] Kasimir-Klemedtsson et al., 2000
[68] Sund et al., 2000

Table15 The production area and emission associated with mineralization when extracting peat on Wetlands. An emission factor of 6 [ton CO_2•ha^{-1}•yr^{-1}] have been used.

Year	Production area [ha]	Emission, CO_2 [M ton•yr^{-1}]
1990	6600	0.040
1991	6100	0.037
1992	6600	0.040
1993	6400	0.038
1994	7000	0.042
1995	7700	0.046
1996	6800	0.041
1997	8100	0.049
1998	6700	0.040
1999	9700	0.058
2000	10400	0.062
2001	10500	0.063
2002	10200	0.061
2003	9400	0.056
2004	8000	0.048
2005	10300	0.062
2006	6200	0.037
2007	10300	0.062

1.1.2 CRF 5(I), 5(II), 5(III), 5(IV) and 5(V) [NIR 7.3.2]

1.1.2.1 METHODOLOGY DIRECT N_2O EMISSIONS FROM N FERTILIZATION, CRF 5(I) [NIR 7.3.2.1]

The reported annual $N_2O_{direct\,fertilizer}$ [Gg•yr^{-1}] is calculated as:

$$N_2O_{direct\,fertilizer} = F_{synt} \bullet EF \bullet 44/28$$

where F_{synt}= is the amount of synthetic fertilizer nitrogen applied [Gg•yr^{-1}] and EF is the emission factor for N_2O emissions from N-inputs (IPCC-default emission factor of 1.25 %[69]). F_{synt} is adjusted for volatilisation by a fixed loss rate of 10 %. Finally, N_2O-N is converted by multiplying N by 44/28 (Table 16).

[69] Intergovernmental Panel on Climate Change, 2003

Table 16 The annual amount of synthetic fertilizer sold for application in forestry and the annual direct N_2O emission from nitrogen fertilization

	Synthetic fertilizer, N [Gg•yr^{-1}]			Emission, N_2O [Gg•yr^{-1}]
Year	Large scale forestry	Small scale forestry	Total	Total
1990	10.418	0.061	10.48	0.185
1991	6.043	0.061	6.10	0.108
1992	4.232	0.061	4.29	0.076
1993	3.748	0.061	3.81	0.067
1994	3.293	0.061	3.35	0.059
1995	3.824	0.061	3.88	0.069
1996	3.457	0.061	3.52	0.062
1997	2.710	0.061	2.77	0.049
1998	2.747	0.061	2.81	0.050
1999	3.601	0.061	3.66	0.065
2000	3.536	0.061	3.60	0.064
2001	2.983	0.061	3.04	0.054
2002	2.039	0.061	2.10	0.037
2003	2.430	0.061	2.49	0.044
2004	3.055	0.061	3.12	0.055
2005	4.563	0.061	4.62	0.082
2006	4.903	0.061	4.96	0.088
2007	6672	0.061	6.73	0.119

1.1.2.2 METHODOLOGY N_2O EMISSIONS FROM DISTURBANCE ASSOCIATED WITH LAND-USE CONVERSION TO CROPLAND, CRF 5(III) [NIR 7.3.2.3]

A Tier 1 methodology is used. The reported annual N_2O emission from disturbance associated with land use conversion to Cropland (N_2O_{conv} [Gg•yr^{-1}]) is calculated according to equation 3.3.15 in IPCC GPG for LULUCF (IPCC[70])

$$N_2O_{conv} = \Delta C_{min} \cdot \frac{1}{C:N_{ratio}} \cdot EF \cdot 44/28$$

where ΔC_{min}= is the annual emission of carbon due to soil mineralization (IPCC[71]), $C{:}N_{ratio}$= the average ratio between carbon and nitrogen in the soil (a constant of 15; IPCC), EF= the emitted proportion N_2O from N (a constant of 1.25 %; IPCC) and 44/28 is used to convert N to N_2O. 2.5 % of the carbon is assumed to be mineralised. The amount of carbon is calculated as the area converted times a constant of 120 ton C per ha. Summary results are found in Table 17.

[70] Intergovernmental Panel on Climate Change, 2003
[71] Intergovernmental Panel on Climate Change, 2003

Table 17 Annual N_2O emission from disturbance associated with land use conversion to Cropland (Conversions from Settlements should not be reported and the emission factors used in calculation might be incorrect for this type of conversion).

	N_2O emission associated with conversion to Cropland [Gg•yr^{-1}]	
Year	**Forest land**	**Grassland**
1990	0.006	0.064
1991	0.006	0.082
1992	0.006	0.086
1993	0.006	0.106
1994	0.006	0.118
1995	0.007	0.129
1996	0.007	0.138
1997	0.007	0.151
1998	0.010	0.151
1999	0.010	0.150
2000	0.015	0.158
2001	0.015	0.171
2002	0.011	0.187
2003	0.012	0.203
2004	0.015	0.222
2005	0.014	0.234
2006	0.018	0.258
2007	0.030	0.223

1.1.2.3 METHODOLOGY CARBON FROM AGRICULTURAL LIME APPLICATION, CRF 5(IV) [NIR 7.3.2.4]

The reported annual carbon emission from agricultural lime application (C_{lime}; [Gg•yr^{-1}]) is calculated as::

$$C_{lime}=M_{limestone}\bullet EF_{limestone}+M_{dolomite}\bullet EF_{dolomite}$$

where $M_{limestone}$=annual amount of sold calcic limestone [Gg•yr^{-1}], $M_{dolomite}$=annual amount of sold calcic dolomite [Gg•yr^{-1}], $EF_{limestone}$=emission factor for limestone=0.120, and $EF_{dolomite}$=emission factor for dolomite=0.122. Carbon (C) is converted to carbon dioxide (CO_2) by the conversion factor 44/12 (Table 18).

Table 18 Annual CO_2 equivalents from emission of lime products.

	Annual CO_2 emissions from liming [$Gg•yr^{-1}$]								
	Dolomite products		Limestone products						
Year	Dolomite	Mg-lime	Lime-stone	Find-ground raw lime	Lime for gardens	Lime from steel-production	Lime from sugar production	Other lime-products	Total
1990	25	32	35	12	21	14	30	1	170
1991	17	28	31	14	17	5	21	0	134
1992	11	20	21	16	14	5	22	0	109
1993	12	22	30	16	14	4	32	0	130
1994	13	26	39	27	11	4	36	0	156
1995	12	25	48	31	12	4	35	0	169
1996	17	37	54	35	10	4	35	0	193
1997	15	37	52	23	9	6	32	0	174
1998	14	21	27	21	9	2	36	0	131
1999	17	34	30	28	6	7	35	0	156
2000	17	28	30	36	7	5	34	0	156
2001	10	29	25	32	6	3	31	0	137
2002	17	20	30	23	4	5	29	2	131
2003	18	27	20	19	3	4	29	7	128
2004	16	27	18	15	3	4	28	12	122
2005	15	26	16	10	3	4	26	17	117
2006	8	19	10	8	3	3	24	16	91
2007	7	31	13	10	3	2	23	29	119

1.1.2.4 EMISSIONS FROM BIOMASS BURNING, CRF 5(V) [NIR 7.3.2.5]

Calculations of biomass burning are based on the standing stock and on assumptions on the amount of biomass burned. Based on the above ground standing stock of living and dead biomass[72] and by assuming that 25 % of the biomass is burned, the amount of carbon burned is assumed to be 5.78, 1.02 and 0.72 C [$Mg•ha^{-1}$] for the categories "Forest", "Sparsely covered by trees" and "No tree cover", respectively. The biomass of dead wood constitute about 0.3-0.6 % of this biomass. When controlled burning is performed for regeneration or nature conservation purposes, respectively, 1.15 and 5.78 C [$Mg•ha^{-1}$] are assumed to be released. The annual emission of carbon dioxide (CO_2-burning [$Gg•yr^{-1}$]) due to burning of wildfires or controlled burning is calculated as:

$$CO_{2}\text{-}_{burning}=A•B•44/12$$

where A=the annual burned area [$ha•yr^{-1}$], B=amount of carbon burned [$Gg•ha^{-1}$].

The annual emission of nitrous dioxide ($N_2O_{burning}$ [$Gg•yr^{-1}$]) due to burning of wildfires or controlled burning is calculated as:

[72] Ranneby et al., 1987

$$N_2O_{burning}=A \bullet B \bullet 0.01 \bullet 0.007 \bullet 44/28$$

The annual emission of methane (CH_4-$_{burning}$ [$Gg \bullet yr^{-1}$]) due to burning of wildfires or controlled burning is calculated as:

$$CH_4\text{-}_{burning}=A \bullet B \bullet 0.012 \bullet 16/12$$

Emissions are presented in Table 19.

Table 19. Annual emission from biomass burning.

	Fire category [ha•yr^{-1}]					Annual emission		
	Wildfire			Controlled burning		CO_2	N_2O	CH_4
Year	Forest	Sparsely covered by trees	No tree cover	Regene-ration	Bio-diversity	[Gg•yr^{-1}]	[Gg•yr^{-1}]	[Gg•yr^{-1}]
1990	567	647	924	459	0	19	0.00056	0.082
1991	567	647	924	155	0	18	0.00053	0.076
1992	567	647	924	201	0	18	0.00053	0.077
1993	567	647	924	334	0	18	0.00055	0.080
1994	567	647	924	152	0	18	0.00053	0.076
1995	567	647	924	177	0	18	0.00053	0.077
1996	567	647	924	455	0	19	0.00056	0.082
1997	3810	1092	1484	1720	0	96	0.00288	0.419
1998	74	123	216	570	0	5	0.00015	0.022
1999	792	282	227	2293	200	32	0.00097	0.141
2000	783	323	430	1138	400	32	0.00096	0.140
2001	411	277	542	2144	600	33	0.00099	0.143
2002	874	403	1322	3002	800	53	0.00159	0.232
2003	1321	1016	1663	2073	1000	66	0.00198	0.288
2004	896	550	437	2694	1200	59	0.00177	0.257
2005	665	474	423	1888	1400	54	0.00163	0.238
2006	4206	495	480	2693	1410	91	0.00273	0.397
2007	523	312	255	1230	377	12	0,00037	0,053

1.1.3 Uncertainties and time series consistency [NIR 7.4]

1.1.3.1 LIVING BIOMASS CRF 5A, 5B, 5C, 5D, 5E AND 5F [NIR 7.4.2]

The estimated accuracy of the living biomass pool depends mainly on the sample design of the NFI. Results from the control inventory of the NFI indicate that measurement errors, registration errors and errors caused by the instruments (calli-pers) could be assumed to be close to zero. Potential bias induced by incorrectly specified models and an unrepresentative derivation data could probably be ig-nored.

The reported estimated standard errors of the estimates are calculated by for-mulas for a ratio estimator[73]. The tracts (clusters) are assumed to be sample units

[73] Thompson, 1992

and these units are assumed to be randomly distributed within strata. Small trees, shrubs and other vegetation, such as herbs, are not included in the figures. It is assumed that the net change in the stock of this vegetation is small.

A ratio estimator is calculated on county level:

$$\hat{Y}_i = A_i \frac{\hat{X}_i}{\hat{A}_i} = A_i \frac{\sum x_{ij}}{\sum a_{ij}} = A_i \cdot R_i$$

where $\hat{Y}_i$ = the ratio estimated value for county *i* (for example the change in biomass stock), A_i = the measured area of county *i*, $\hat{X}_i$ = the estimated value of the variable of interest according to Horvitz-Thompson for county *i* and $\hat{A}_i$ = the estimated area according to Horvitz-Thompson for county *i*. $\sum x_{ij}$ is the sum of the variable of interest over sampling units (tract) *j* within county *i*. $\sum a_{ij}$ is the total inventoried area over sampling units (tract) *j* within county *i*. The estimated variance on county level is calculated as:

$$\hat{Var}\left(\hat{Y}_i\right) \approx \frac{A_i^2}{\left(\sum a_{ij}\right)^2} \cdot n_i \cdot S^2_{x_{ij} - R_i \cdot a_{ij}}$$

where n_i=the number of sampling units (tracts) within county *i* and $S^2_{x_{ij} - R_i \cdot a_{ij}}$ is the standard deviation based on x_{ij}-$R_i \cdot a_{ij}$. Each county constitute a stratum and the estimated variance over all strata (whole Sweden) is calculated as:

$$\hat{Var}\left(\hat{Y}_{Swe}\right) = \sum_{i=1}^{N} \hat{Var}\left(\hat{Y}_i\right)$$

where *N*=number of strata (counties in Sweden), $\hat{Var}\left(\hat{Y}_{Swe}\right)$ = the estimated variance for the reported estimate on national level and the corresponding standard error of this estimate is:

$$SE = \sqrt{\hat{Var}\left(\hat{Y}_{Swe}\right)}$$

Finally, the reported Uncertainty is calculated as:

$$Uncertainty = 2 \cdot SE$$

Annex 4

CO_2 reference approach and comparison with sectoral approach and relevant information on the national energy balance

1.2 Reference approach, CRF 1Ab

The reference approach includes all domestic fuel consumption in Sweden regardless of sector since it is not possible to separate fuels consumed in Fugitive emissions from fuel, CRF 1B, and Industrial processes, CRF 2, on this level. The reference approach is based on the supply of fuels. The main source is the supply and delivery of petroleum products statistics, but foreign trade statistics is also used. Since biomass, waste and peat are not covered in the supply and delivery statistics, data from Statistics Sweden[74] is used for those fuels. The data from Statistics Sweden is derived from almost all the surveys discussed in Annex 2, sections 1.1.1-1.1.9.

During 2007, the underlying statistics for reference approach were overhauled by SMED and where considered needed to be updated[75]. In addition, CO_2 emissions derived from non-energy use of fuels and reported under CRF 1B and CRF 2 (e.g. flaring of gases and iron and steel process emissions) are since submission 2008 also included under CRF 1Ad and linked to the CRF 1Ab as carbon stored. This will facilitate a more accurate reporting in CRF 1Ac where all CO_2 emissions are accounted for and thus eliminate the need for the previously applied national comparison of reference and sectoral approach.

Stocks, imports and exports of biomass, waste and peat are presently not known.

Data on international bunkers for navigation is given in the supply and delivery statistics. International bunkers for aviation are calculated from information from SCAA (see NIR, section 3.3.10).

Emission factors used in the reference approach are the same as those used in the Sectoral Approach, multiplied by 12/44 to convert the emission factor for CO_2 to an emission factor for carbon (C). Exceptions from this rule are emission factors for fuel types presented in Table 20.

[74] Statistics Sweden EN20SM 1990-2006.
[75] Gustafsson, 2007a

Table 10 Special emission factors used for the reference approach.

Fuel type	Emission factor used in the Reference Approach Gg C/TJ	Source for emission factor
Crude oil	20.25	Swedish emission factor for Domestic heating oil
Bitumen	28.09	Swedish emission factor for Coke
Refinery feedstocks	20.25	Swedish emission factor for Domestic heating oil
Other oil	20.25	Swedish emission factor for Domestic heating oil
Lignite	24.74	Former Swedish emission factor for Coal
Gaseous biomass	15.41	Swedish emission factor for Natural gas

1.3 Feedstocks and non-energy use of fuels, CRF 1Ad

Activity data on feedstocks and non-energy use of fuels is collected from the quarterly fuel statistics. As also noted in section 1.1.1, in the survey form for the quarterly fuel statistics, respondents are among many other things asked to specify whether fuels are used as raw materials or for energy purposes. This facilitates the use of data for CRF table 1Ad, non-energy use of fuels.

Data on carbon from coke, bound in produced ferroalloys is collected directly from the only ferroalloy producer and is added to the remaining data on carbon from coke. Estimates of carbon stored are derived by multiplying given energy amount with emission factors for CO_2 (as given in section 1.2 and Appendix 19) multiplied by 12/44 (the weight of one atom of carbon is by definition 12/44 the weight of one molecule of CO_2).

CO_2 emissions derived from non-energy use of fuels and reported under CRF 1B and CRF 2 (e.g. flaring of gases and iron and steel process emissions) are added under CRF 1Ad and linked to the CRF 1Ab as carbon stored.

1.4 Detailed comparison of the reference approach and the sectoral approach

In order to follow the recommendations in IPCC Good Practice Guidance and ensure that no omissions or double counting occurs, it is necessary to compare the results in the sectoral approach (calculated bottom-up) with the results in the reference approach (calculated top-down). Large differences indicate possible errors, and according to the IPCC Good Practice Guidance, differences should be investigated if they are larger than ± 2 %.

As discussed in section 1.2, the reference approach shows all domestic fuel consumption, regardless of sector. On this level it is not possible to separate fugitive emissions (CRF 1B) or emissions from fuel combustion in industrial processes (CRF 2C-D). These emissions are included as non-energy use of fuels in CRF 1Ad and linked to the reference approach CRF 1Ab as carbon stored and thus accounted for in CRF 1Ac. The CRF Reporter however does not accurately calculate the difference of CO_2 emissions between reference and sectoral approach; other fuels are not included in the reference approach. This calls for national calculations of the comparison of reference and sectoral approach for CO_2 emissions to enable proper analyses.

Transformation losses

In submission 2004 and earlier, there was a big difference in reported energy consumption for solid fuels. This was due to the fact that transformation losses (energy losses) in the iron and steel industry were not included in the sectoral approach. CO_2 emissions and other emissions were correctly reported and thus not affected. In submission 2005, transformation losses of energy were estimated and reported under CRF 1A5a in the sectoral approach. This resulted in smaller differences between the reference and sectoral approaches.

Data sources in the Sectoral Approach not covered in the Energy Statistics

Flaring is included in the sectoral approach and reported in CRF 1B1c and 1.B.2.C.2.1. These energy amounts are not covered in energy statistics used for the Reference Approach. Also, CO2 reported in CRF 2C1 2005-2007 is partly collected from data sources not covered by the Energy Statistics. For the purpose of the Greenhouse Gas Inventory the Sectoral Approach is more correct than the Reference Approach. The Swedish energy statistics used in the reference approach are not originally intended nor fully adapted for the emission estimations.

Differences between Reference Approach and Sectoral Approach are because of this shown also excluding data sources not covered in the energy statistics.

1.4.1 Results

Figure 13 shows the remaining differences in fuel consumption and CO_2 emissions between reference and sectoral approach 1990-2007, when the reference approach takes CO_2 emissions from other fuels into account. It is obvious that fuel consumption and CO_2 emissions from the sectoral approach exceed the reference approach for most years. For a number of years the difference is larger than ± 2%. Differences in emissions of CO2 are shown also when excluding data sources not covered in the energy statistics.

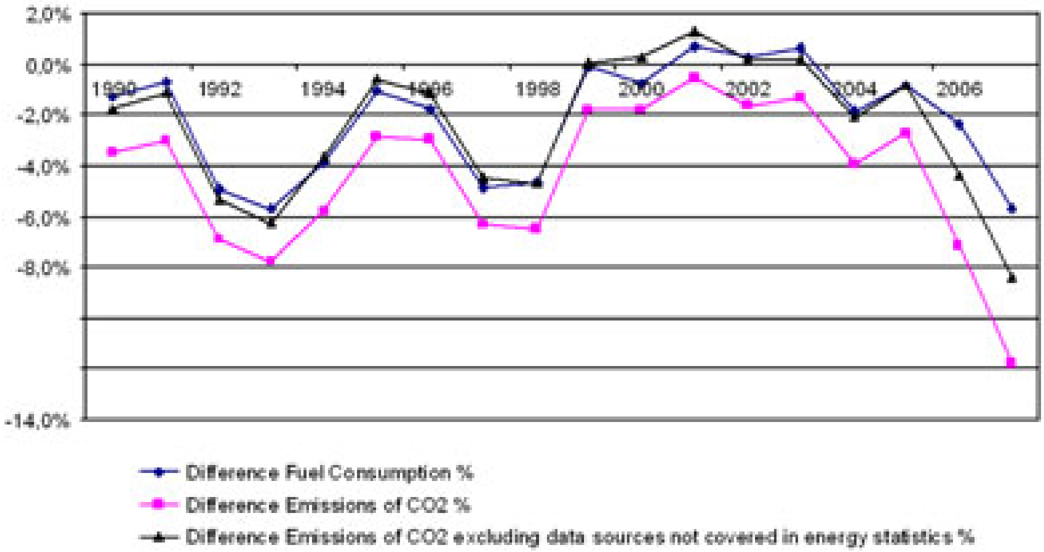


Figure 13. Differences between reference and sectoral approach. Note that CO_2 emissions from other fuels are accounted for in the reference approach, as compared to the CRF Reporter.

1.4.2 Analysis of differences

Data sources in the Sectoral Approach not covered in the Energy Statistics

Data sources in the Sectoral Approach not covered in the Energy Statistics contributes with a difference for CO2 of 1.5% - 3.4% for different years. For many years, this is the dominating reason for differences in the two data sets. Differences due to other reasons are shown with the black line in figure 13 above.

Statistical differences in energy balances

Statistical differences in energy balances contributes to a large share of the remaining differences especially in the 1990's. This was discovered in a SMED study in 2007[76]. That is to say, similar differences between fuel supply and fuel consumption are found in the energy balances.

[76] Gustafsson, 2007a

Figure 14 show the comparison of fuel consumption from the energy balances and the sectoral approach of submission 2007 that was perfomed in the 2007 SMED study. It is obvious that differences in this comparison are significantly lower compared to the reference and sectoral approach presented in CRF 1Ac.

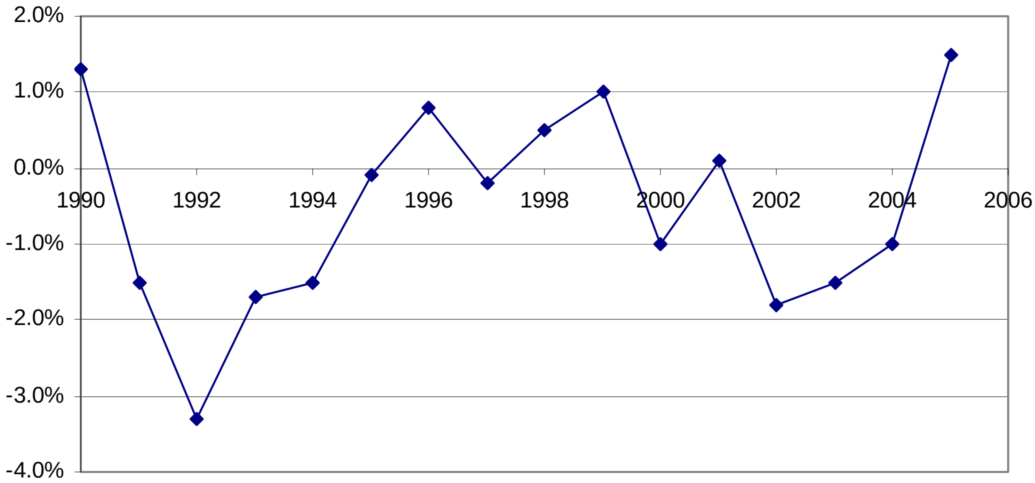


Figure 14 Differences in fuel consumption between energy balances and sectoral approach 1990-2005.

Crude oil

Remaining differences are considered to mainly be referring to crude oil in the Reference Approach.

In Sweden, crude oil is imported from a variety of regions depending on current relative prices. Crude oil in different regions has differing carbon contents, and as a consequence of this, the carbon emission factor for crude oil in the reference approach should be set differently for each year as it probably varies significantly. This has not been prioritized and the Swedish carbon factor for domestic heating oil is used for all years. Crude oil accounts for a large share of the total energy content and the total carbon emissions in the reference approach. The choice of emission factor for crude oil will therefore have a great impact on the differences between reference and sectoral approach. In particular, when differences in CO_2 emissions and differences in energy amount diverge for liquid fuels, this is probably caused by the large uncertainty for the carbon emission factor for crude oil in the reference approach.

The result of a SMED study in 2007[77] indicates that the emission factor for crude oil is biased and that a variable factor may be more suitable. It was however not recommended to adjust historical values due to large uncertainties in underlying data, but to conduct intermittent surveys of the crude oil calorific value and carbon content in the future.

When studying figure 13 it is obvious that differences are too large in 2006 and 2007. Differences have of course been studied carefully. Background data and all calculations are doublechecked and no errors have been found. Differences mainly

[77] Gustafsson, 2007a

refer to the Reference Approach since CO2 emissions in the Reference Approach are decreasing with as much as 7 % between 2006 and 2007 which seems a bit odd. CO_2 emissions in the Sectoral Approach are decreasing with 2% in the same time period which is much more plausible. The decrease is mainly found in liquid fuels, and most notably for Crude Oil. Because of this development of the Reference Approach, data in the Reference Approach will be carefully reviewed and, if appropriate, revised in submission 2010 if new data will become available.

1.5 National energy balance

The information in this section is taken from Statistics Sweden.[78] Tables referred to can be found at the Statistics Sweden website.[79]

The purpose of energy balances is to give a brief description of supply, transformation and final consumption of energy for follow-up and analysis of Sweden's maintenance of energy.

Before the oil crisis in 1973, the main purpose of the energy statistics was to account for the supply of specific types of energy. Due to the oil crisis the need to relate the oil problems to energy issues in general increased, as well as the interest in more extensive information about energy consumption. For that reason, energy balance models were developed both nationally and internationally with the purpose to describe the entire flow of energy for different energy carriers, from extraction and import through transformation to export or domestic consumption. Principles for the presentation of Swedish energy balances were compiled by Statistics Sweden in cooperation with the Swedish Energy authority and the Council of Transport (that was later closed down). In the official statistics, quarterly energy balances with relatively brief accounts for the energy consumption side have been published since 1975. Yearly energy balances with a more detailed and thoroughly account for the energy consumption side have been compiled since 1987, with time series back to 1983.

1.5.1 Methodological comments

1.5.1.1 BALANCE SHEETS OF ENERGY SOURCES

The balance sheets of energy sources are showing the total supply and consumption of energy sources expressed in original units, i.e. units recorded in the primary statistics – mainly commercial units, tables 1:1 and 7:1. The production of derived energy commodities is recorded on the supply – side of the balance sheets of energy sources, which is not the case in the energy balance sheets. The balance sheets of energy sources also include specifications of input–output and energy consumption in energy conversion industries, tables 2:2 and 8:2.

[78] EN 20 SM 0705
[79] Ibid.

1.5.1.2 ENERGY BALANCE SHEETS

The energy balance sheets are based on data primary recorded in the balance sheets of energy sources, here expressed in a common energy unit, TJ (terajoule), tables 4:4 and 10:4. The production of derived energy is here recorded in a second flow-step comprising energy turnover in energy conversion and is also specified in complementary input-output tables for energy conversion industries, tables 5:5 and 11:5.

The following items are shown in the energy balance sheets:

1.1 Inland supply of primary energy
1.3 Import
1.4 Export
1.5 Changes in stocks
1.6 Statistical differences (supply-level)
1 Gross consumption of primary energy and equivalents
2 Bunkering for foreign shipping
3 Input for conversion into derivative energy forms (sources)
1.2 Gross production by energy conversion industries
4 Consumption by energy producing industries
5 Losses in transport and distribution
6 Consumption for non-energy purposes
7 Final inland consumption
7.1 Agriculture, fishing
7.2 Forestry
7.3 Mining and manufacturing
7.3.1 Industry statistics' level
7.3.2 Small establishment's consumption (calculated)
7.3.3 Other (non specified)
7.4 Construction
7.5 Government services
7.6 Transport
7.7 Other services
7.8 Households (housing and other)
8 Statistical differences (non-specified consumption)

Gross consumption of primary energy and equivalents (1) is calculated from the following items: Inland supply (1.1), Import (1.3), Export (1.4) Changes in stocks (1.5) and Statistical differences (1.6). The gross consumption is calculated as (1) = (1.1) + (1.3) – (1.4) – (1.5) – 1.6).

Concerning wood, wood waste, sulphite and sulphate lyes, peat and wastes the total consumption for energy purpose is recorded as inland supply of primary energy. The efficiency of the hydroelectric power stations has been estimated to about 85 per cent.

Nuclear energy corresponds to measured heat released in reactors, which is recorded as inland supply of primary energy.

Bunkering for foreign shipping (2) covers supply to bunkers for seagoing ships of all flags. Supplies for inter-national air traffic are evaluated as final inland consumption.

Input for conversion into derivative energy (3) covers the input of crude oil and other feed stocks in refineries, coal for conversion to coke and coke-oven gas in coke-oven plants, the estimated net quantity of coke that is converted into blastfurnace gas (100 per cent efficiency in the conversion is assumed), electricity for pumping in pumping stations, the fuel consumption in conventional thermal power plants, heating (or heat-electric) plants and gasworks, consumption of fuels for production of electric energy in industrial back pressure power stations and consumed nuclear fuel and utilised primary hydro power in nuclear power plants respectively hydro-electric power plants.

Production of derivative energy (1.2). The production is calculated gross, i.e. including own consumption and losses in transmission and distribution.

Consumption by energy producing industries (4) covers the consumption of electric energy, fuel oils, gases etc. for the operation of power stations, thermal power plants, refineries, coke-oven plants and gasworks.

Losses in transport and distribution (5) covers losses in deliveries of electric energy, gas work gas, coke-oven gas, blast-furnace gas and district heating.

Consumption for non-energy purposes (6) covers products that are used as input in chemical industries as raw material as well as other non-energy purposes.

Final inland consumption (7) covers all consumption not covered by titles 1–8.

The efficiency of the final consumption in not considered in the balance sheets. The quantities (recalculated to terajoules= 1012 joules) as recorded under final consumption refer to the total energy actually consumed by the consumers including conversion losses.

Statistical differences (8) between total consumption measured from supply-side respectively actual consumption statistics.

1.6 References

Gustafsson, T. 2007a. Översyn av rapportering till Reference Approach, bränsleanvändning för icke-energiändamål samt jämförelsen mellan Reference och Sectoral Approach. (eng. Overhaul of reporting of the reference approach, the non-energy use of fuels and the comparison of reference and sectoral approach). SMED report 2007

Schöllin, M. 2002. CO_2 emissions inventories harmonisation- the Swedish case. Report made by Statistics Sweden, Energy Statistics. Eurostat file no. 200045500002.

Statistics Sweden EN20SM 1990-2007. Årliga energibalanser (Yearly Energy Balance Sheets). Energy statistics.

Statistics Sweden EN20SM 1990-2006. Årliga energibalanser (Yearly Energy Balance Sheets). Energy statistics.

Annex 5

Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

General assessment of completeness

The Swedish inventory covers both emissions and removals in Sweden, all greenhouse gases required and all relevant sources and sinks with a few exceptions. A general assessment of the completeness in the Swedish Greenhouse Gas Inventory is given in chapter 1.8 in the main National Inventory Report.

Below the CRF Table 9(a) lists all instances of the use of the notation key NE, not estimated, in the Swedish inventory for the year 2007, including short explanations to why these are not estimated. Further explanations and justifications are given in the following paragraphs.

Energy

In the energy sector emissions of CH4 and N2O from biomass used in CRF 1A5b (military transportation) 1999-2001 and CRF 1A3b (road transportation) 1990-2007 are not estimated. Data are currently not available but emissions are expected to be minor.

Also in the energy sector, emissions from CRF 1B2C1 (venting) and CRF 1B2C22 (flaring of gaseous fuels) are not estimated for all years and all gases. Data are currently not available but emissions are expected to be insignificant. It is possible that the notation key could be changed to NO in future submissions.

Source category	GHG
1.AA.3.B Road Transportation	CH_4, N_2O
1.AA.5.B Military use	CH_4, N_2O
1.B.2.A.3 Transport	CH_4, CO_2
1.B.2.C.1.1 Oil	CH_4, CO_2
1.B.2.C.1.2 Gas	CH_4, CO_2
1.B.2.C.1.3 Combined	CH_4, CO_2
1.B.2.C.2.2 Gas	CH_4, CO_2, N_2O

Industrial Processes

In the industrial processes sector there is primarily a possible underreporting of CH_4 from chemical industry and from metal production. Emissions from the source specified below have not been estimated, but are expected to be minor.

Source category	GHG
2.A.7 Non-iron ore mining and dressing	CO_2
2.B.5 Base chemicals for plastic industry	CH_4
2.B.5 Other inorganic chemical prod	CH_4
2.B.5 Other non-specified	CH_4, N_2O
2.B.5 Pharmaceutical industry	CH_4
2.B.5.1 Carbon Black	CH_4
2.C.1.3 Sinter	CH_4
2.C.1.4 Coke	CH_4
2.C.2 Ferroalloys Production	CH_4
2.C.3 Aluminium Production	CH_4
2.C.5 Non-ferrous metals	CH_4
2.D.2 Food and Drink	CO_2
2.F.P3.1 In bulk	SF_6

Solvent and other product use

All source categories are covered in the inventory.

Agriculture

All source categories are covered in the inventory.

Land Use, Land Use Change and Forestry

CH_4 emissions are only reported from biomass burning and N_2O from fertilization and from coversion to cropland. There are no other reliable data for other emissions of these gases. N_2O emissions from drained organic soils may be a significant source but reliable methods for estimating is still lacking. Some land-use change categories are uncommon and CO_2 not reported for soil organic carbon and dead organic matter. The emissions from these land-use conversions are very small since the area is small and have no significant influence on the overall emissions reported.

Waste

In the Waste sector data have not been available to estimate the emissions presented below. From waste incineration (6.C) there are clear indications from measurements that possible emissions are minor.

Source category	GHG
6.A.1 Managed Waste Disposal on Land	CO_2
6.B.1 6.B.1 Industrial Wastewater	CH_4
6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	CH_4
6.C.1 Biogenic	CH_4, N_2O
6.C.2 Other non-specified	CH_4, N_2O

Sources and sinks not estimated (NE)			
GHG	**Sector**	**Source/sink category**	**Explanation**
CH4	1 Energy	1.AA.3.B 1.AA.3.B Road Transportation	No data available
CH4	1 Energy	1.AA.3.B 1.AA.3.B Road Transportation	No data available
CH4	1 Energy	1.AA.5.B Military use	No data available
CH4	1 Energy	1.B.2.A.3 Transport	Presently no data available
CH4	1 Energy	1.B.2.C.1.1 Oil	No data available
CH4	1 Energy	1.B.2.C.1.2 Gas	No data available
CH4	1 Energy	1.B.2.C.1.3 Combined	No data available
CH4	1 Energy	1.B.2.C.2.2 Gas	Presently no data available
CO2	1 Energy	1.B.2.A.3 Transport	No data available
CO2	1 Energy	1.B.2.C.1.1 Oil	No data available
CO2	1 Energy	1.B.2.C.1.2 Gas	No data available
CO2	1 Energy	1.B.2.C.1.3 Combined	No data available
CO2	1 Energy	1.B.2.C.2.2 Gas	Presently no data available
N2O	1 Energy	1.AA.3.B 1.AA.3.B Road Transportation	No data available
N2O	1 Energy	1.AA.5.B Military use	No data available
N2O	1 Energy	1.B.2.C.2.2 Gas	Presently no data available
CH4	2 Industrial Processes	2.B.5 Base chemicals for plastic industry	No data available
CH4	2 Industrial Processes	2.B.5 Other inorganic chemical prod	No data available
CH4	2 Industrial Processes	2.B.5 Other non-specified	No data available
CH4	2 Industrial Processes	2.B.5 Pharmaceutical industry	No data available
CH4	2 Industrial Processes	2.B.5.1 Carbon Black	No data available
CH4	2 Industrial Processes	2.C.1.3 Sinter	No data available
CH4	2 Industrial Processes	2.C.1.4 Coke	No data available
CH4	2 Industrial Processes	2.C.2 Ferroalloys Production	No data available

CH4	2 Industrial Processes	2.C.3 Aluminium Production	No data available
CH4	2 Industrial Processes	2.C.5 Non-ferrous metals	No data available
CO2	2 Industrial Processes	2.A.7 Non-iron ore mining and dressing	No data available
CO2	2 Industrial Processes	2.D.2 Food and Drink	No data available
N2O	2 Industrial Processes	2.B.5 Other non-specified	No data available
SF6	2 Industrial Processes	2.F.P3.1 In bulk	Exported amounts of SF6 are not known
Carbon	5 LULUCF	5.A.2.1-5 Land converted to Forest Land	Occurs on too few sample plots - data uncertain[1]
Carbon	5 LULUCF	5.B.2.1-5 Land converted to Cropland	Occurs on too few sample plots - data uncertain[1]
Carbon	5 LULUCF	5.C.2.1-5 Land converted to Grassland	Occurs on too few sample plots - data uncertain[1]
Carbon	5 LULUCF	5.D.1 Wetlands remaining Wetlands	Wetlands are considered unmanaged and not reported
Carbon	5 LULUCF	5.D.2.1-5 Land converted to Wetlands	Wetlands are considered unmanaged and not reported
Carbon	5 LULUCF	5.E.1 Settlements remaining Settlements	Occurs on too few sample plots - data uncertain[1]
Carbon	5 LULUCF	5.E.2.1-5 Land converted to Settlements	Occurs on too few sample plots - data uncertain[1]
Carbon	5 LULUCF	5.F.2.1-5 Land converted to Other Land	Other land is considered unmanaged and not reported
CH4	5 LULUCF	5.A.1 Forest Land remaining Forest Land	This code is not reported by Sweden due to data unavailability
CH4	5 LULUCF	5.B.1 Cropland remaining Cropland	This code is not reported by Sweden due to data unavailability
CH4	5 LULUCF	5.D.2 Land converted to Wetlands	Wetlands are considered unmanaged and not reported
CH4	5 LULUCF	5.E.1 Settlements remaining Settlements	This code is not reported by Sweden due to data unavailability
CH4	5 LULUCF	5.E.2 Land converted to Settlements	This code is not reported by Sweden due to data unavailability
CH4	5 LULUCF	5.F.2 Land converted to Other Land	This code is not reported by Sweden due to data unavailability
N2O	5 LULUCF	5.A.1 Forest Land remaining Forest Land	This code is not reported by Sweden due to data unavailability
N2O	5 LULUCF	5.B.1 Cropland remaining Cropland	This code is not reported by Sweden due to data unavailability
N2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Occurs on too few sample plots - data uncertain[1]
N2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Occurs on too few sample plots - data uncertain[1]
N2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Occurs on too few sample plots - data uncertain[1]
N2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Occurs on too few sample plots - data uncertain[1]
N2O	5 LULUCF	5.D.2 Land converted to Wetlands	Wetlands are considered unmanaged and not reported

N2O	5 LULUCF	5.E.1 Settlements remaining Settlements	This code is not reported by Sweden due to data unavailability
N2O	5 LULUCF	5.E.2 Land converted to Settlements	This code is not reported by Sweden due to data unavailability
N2O	5 LULUCF	5.F.2 Land converted to Other Land	This code is not reported by Sweden due to data unavailability
CH4	6 Waste	6.B.1 6.B.1 Industrial Wastewater	No data available
CH4	6 Waste	6.B.1 6.B.1 Industrial Wastewater	No data available
CH4	6 Waste	6.B.1 6.B.1 Industrial Wastewater	No data available
CH4	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	No data available
CH4	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	No data available
CH4	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	No data available
CH4	6 Waste	6.C.1 Biogenic	Presently no data available
CH4	6 Waste	6.C.2 Other non-specified	Presently no data available
CO2	6 Waste	6.A.1 Managed Waste Disposal on Land	No data available
N2O	6 Waste	6.C.1 Biogenic	Presently no data available
N2O	6 Waste	6.C.2 Other non-specified	Presently no data available

[1] NE for dead organic matter and soil organic carbon but living biomass is reported

Annex 6

Additional information regarding reporting under the Kyoto Protocol and other information

Annex 6:1 The Swedish National System

Annex 6:2 The Quality System as part of the National System

Annex 6:3 Changes in the National Registry

Annex 6:4 Assigned Amount and Commitment Period Reserve

Annex 6:5 Holdings and transactions of Kyoto Protocol Units

Annex 6:6 Legal entities authorised to participate in CDM

Annex 6:7 Legal entities authorised to participate in JI

Annex 6:8 Legal entities authorised to participate in article 17 of the Kyoto-Protocol

Annex 6:1

The Swedish National System

Introduction

Under Article 5 of the Kyoto Protocol each party in Annex 1 has to introduce a national system for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol by 1 January 2007. The national system is to be designed in compliance with UNFCCC decision 20/CP.7. Under the terms of Decision No. 280/2004/EC of the European Parliament and of the Council, the national system has to be in place by the end of 2005. The national system has to ensure the function of all the institutional, legal and procedural arrangements required to calculate emissions and removals of greenhouses gases.

A quality system has been introduced in the framework of the national system to ensure that the inventory and reporting are systematically planned, prepared and followed up in accordance with specified quality requirements so that the inventory is continuously developed and improved. The quality system relates to both the government agencies and the work of the consultants.

The aim of the Swedish national system which came into force on 1 January 2006 is to ensure that climate reporting to the secretariat of the Convention (UNFCCC) and the European Commission complies with specified requirements. This means, among other things,

- estimating and reporting anthropogenic GHG emissions and removals in accordance with the Kyoto Protocol,
- assisting Sweden in meeting its commitments under the Kyoto Protocol,
- facilitating the review of submitted information,
- ensuring and improving the quality of the Swedish inventory and
- guaranteeing that submitted data is officially approved.

The national system has to ensure the level of quality in the inventory, i.e. ensure that the inventory is transparent, consistent, comparable, complete and accurate. These principles guide the Swedish EPA, other government agencies and consultants who assist in the inventory and reporting.

Changes in the National System

There has been no significant changes to the national system since last submission, however, a new system for handling emission data, named Technical Production System (TPS) was developed in 2006 and was for the first time used in the submission 2007. The introduction of TPS has enhanced and improved efficiency for QA/QC of inventory emission data. TPS is a multi-user solution and serves several organisations involved in the GHG inventory. Earlier there was a potential error during copy and paste in different stages of calculation and compilation process. These problems are now limited due to the usage of TPS. Before TPS the national peer review of data, performed as a part of the QA/QC, excel files were used as a basis for the review. Now the reviewers have easy access to the inventory emission data in the database and increased possibilities for analyses. For example, plotting time series and making comparisons between different years and submissions. SMED consortium and the Swedish EPA also use TPS to analyze, review and quality assure and quality control data. In this sense TPS includes a function (fields for QC flags) for approving data at several levels by authorised personals. TPS is also used to import data from previous calculation steps and to exports data to CRF-Reporter, which has made this process easier. Data from previous submissions are stored in TPS. Moreover, TPS is used as a basis for development of trends "Description and interpretation of emission trends in relation to source" in the NIR.

Legal arrangements of the Swedish national system

Ordinance (2005:626) Concerning Climate Reporting provides the basis for the national system and describes the roles and responsibilities of the government agencies in the context of climate reporting.

There is legislation in Sweden which is not primarily intended to apply to climate reporting but indirectly supports the work by providing a basis for the estimation of greenhouse gas emissions and removals. Under Chapter 26 Section 19 of the Environmental Code (1998:808), there is an obligation for annual environmental reports to be submitted for certain environmentally hazardous activities so that government agencies can undertake supervision.

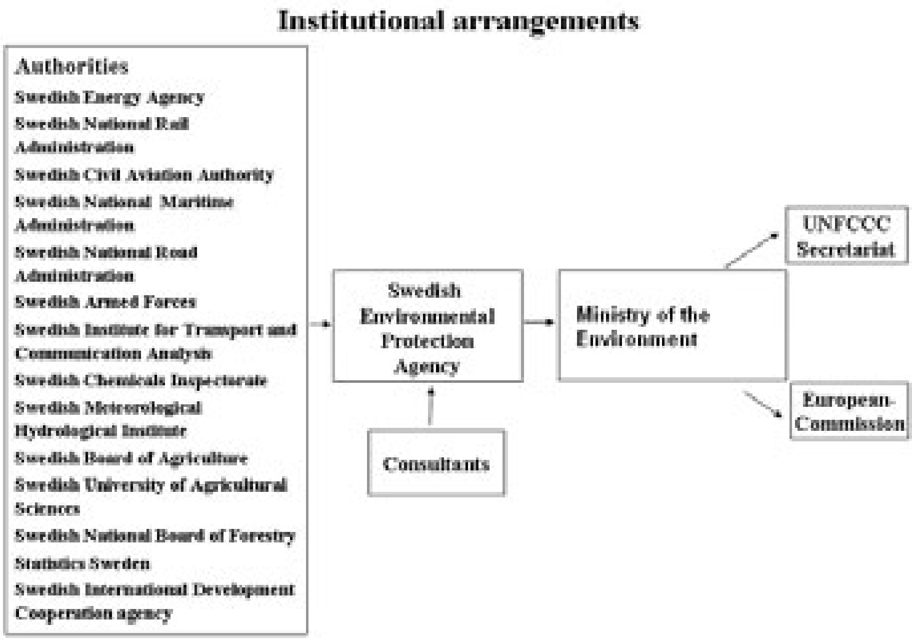
The General Statistics Act (SFS 2001: 99) and the associated Ordinance (1992:1668) Concerning Official Statistics impose an obligation on companies and other organisations to submit annual figures. The figures then serve as a basis for estimating greenhouse gas emissions and removals in several sectors.

The Swedish EPA engages consultants with expert skills to conduct the inventory and reporting in the area of climate change. During the spring of 2005, the Swedish EPA completed a negotiated procurement of services under the terms of the Public Procurement Act. After procurement had been completed, a framework contract was signed with the consortium Swedish Environmental Emissions Data (SMED), consisting of the Swedish Meteorological and Hydrological Institute (SMHI), Statistics Sweden (SCB), the Swedish University of Agricultural Sciences (SLU) and the Swedish Environmental Research Institute (IVL). The contract between the Swedish EPA and SMED runs for nine years.

Institutional arrangements of the Swedish national system

The illustration below and the associated text describe in broad terms which organisations are involved in the work of compiling documentation for the yearly inventory report and for other reporting to the European Commission and the Convention (UNFCCC).

The Swedish Environmental Protection Agency has responsibility on behalf of the Ministry of Environment for drawing up documentation for the required reporting. This means that the Swedish EPA ensures that the documentation for the yearly inventory report and other reports is sent to the Ministry of Sustain-able Development. The Swedish EPA is thus responsible for coordinating the national work for Swedish climate reporting and maintaining the reporting system required for reporting.



Sections 6-19 of the Ordinance (2005:626) Concerning Climate Reporting describe the tasks of the government agencies in the context of the yearly inventory and reporting activity. Depending on the role of the government agencies in climate-reporting activity, this responsibility may range for example from supplying data and producing emission factors/calorific values to carrying out calculations to estimate emissions or conducting a national peer review.

Energy sector (including transport)

If the Swedish EPA is to be able to calculate emissions from the energy sector (including transport), there is a need for documentation from the Swedish Energy Agency, the National Rail Administration, the Swedish Civil Aviation Authority, the National Maritime Administration, the National Road Administration and the Swedish Armed Forces. The Swedish Energy Agency is responsible for conducting peer reviews of the energy sector and the Swedish Institute for Transport and

Communications Analysis (SIKA) for the transport sector. The Swedish Energy Agency also assists the Swedish EPA in the work of developing documentation concerning flexible mechanisms and emissions projections as well as extracts from and information about changes to the national register.

Industrial processes sector

In order to calculate emissions from the industrial processes sector, the Swedish EPA needs to receive documentation from the Swedish Chemicals Inspectorate, which presents data from the product register for certain fluorinated greenhouse gases. The Swedish EPA and the Swedish Chemicals Inspectorate are responsible for conducting peer reviews in the industrial processes sector, where the Swedish Chemicals Inspectorate in particular is responsible for a peer review of fluorinated greenhouse gases being conducted. The Swedish EPA reviews other areas in the industrial processes sector.

Solvent and other product use sector

For the solvent and other product use sector there is a need for the Swedish EPA to receive documentation from the Swedish Chemicals Inspectorate, which presents data from the product register for the calculation of volatile organic compounds (NMVOC) emissions. The Swedish Chemicals Inspectorate is also appointed to conduct a peer review in this sector.

Agriculture sector

In order to calculate emissions from the agricultural sector, there is a need for the Swedish EPA to receive documentation from the Swedish Board of Agriculture and Statistics Sweden. In this sector, the Swedish Board of Agriculture is responsible for conducting peer reviews.

Land use, land-use change and forestry sector

To enable the Swedish EPA to calculate emissions from the land use, land-use change and forestry sector (LULUCF), there is a need for documentation from the Swedish University of Agricultural Sciences, Statistics Sweden, the National Board of Forestry, the Swedish Meteorological and Hydrological Institute (SMHI) and the Swedish Board of Agriculture. The National Board of Forestry is responsible for conducting a peer review in this sector other than the parts which relate to agriculture, where the Swedish Board of Agriculture is responsible for a peer review being carried out.

Waste sector

The Swedish EPA is appointed as the sector authority in the waste sector. The Swedish EPA uses data from sources as Swedish Association of the Waste Management, Statistics Sweden, the Swedish Forest Industries Federation and the Swedish EPA in the calculation of emissions and conducts peer reviews in this sector.

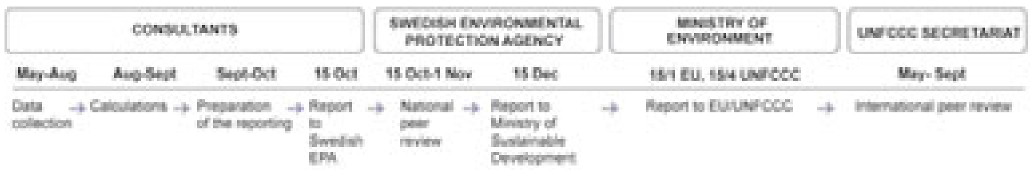
Reporting relating to efforts in developing countries

With regard to reporting in relation to efforts which relate to developing countries, the Swedish International Development Cooperation Agency (Sida) is responsible for presenting documentation to the Swedish EPA.

On behalf of the Swedish EPA, consultants process the documentation received from the government agencies, as well as support data produced by the Swedish EPA itself, and carries out calculations to estimate Swedish greenhouse gas emissions, as well as compiling the result in the yearly inventory report. They also assist in certain development projects which are required for the reporting to meet specified requirements. When consultants calculate emissions from certain sectors such as industrial processes and solvent and other product use, in addition to documentation from the government agencies, environmental reports and documentation are required from other industry organisations and companies.

Procedural arrangements of the Swedish National system

The illustration below shows a process description of Swedish inventory and reporting activity



The Swedish EPA's consultants gather data and information from various government agencies, organisations and companies over the period from May to August with the aim of being able to carry out emission calculations. The calculations are performed in models, statistics programs and calculation programs in August and September. Over the period from September to October, the material is put together in a reporting format and data is reviewed by both the inventory personnel and national peer reviewers.

The Swedish Environmental Protection Agency supplies documentation for Swedish climate reporting to the Ministry of Environment 20 working days before the reporting date.

The Ministry attends to joint preparation of the reporting documentation. The Ministry of Environment reports to the European Commission on 15 January and the secretariat of the Convention on 15 April. Reported data relates to emissions year X-2, in other words emissions which took place during 2004 are reported in 2006.

The secretariat of the Convention then administers an international peer review of Swedish reporting. The results from this review form part of the planning documentation with a view to improving the quality of the Swedish inventory.

Annex 6:2

The Quality System as part of the National System

Introduction

In compliance with UNFCCC Decision 20/CP.7 and in accordance with decisions within the EU, the Swedish EPA and other government agencies and consultants have introduced internal quality systems to ensure a high level of quality in the annual inventory and reporting.

The responsibilities of the Swedish EPA and the other government agencies for the quality system are described in Ordinance (2005:626) Concerning Climate Reporting. Under Section 3, the Swedish EPA and other government agencies which take part in the climate-reporting work have to ensure that the methodologies applied in the reporting and inventories of emissions and removals attain the quality required for it to be possible for Swedish climate reporting to be done in the correct manner and with correct information. The government agencies also have to have internal routines to plan, prepare, check and act/follow up the quality work and consult one another with the aim of developing and maintaining a coordinated quality system.

The responsibility of the consultants to maintain and develop an internal quality system is described in the framework contract between the Swedish EPA and the consultants.

To ensure quality, IPCC Good Practice Guidance is followed. This guidance indicates what “Good Practice” means by describing different approaches to ensure that the inventory is accurate in the sense that it is systematic and that the estimates made of emissions are plausible and that uncertainties are reduced as far as practicable.

The structure of the system complies with the PDCA cycle (Plan, Do, Check, Act), which is an adopted model for how systematic quality and environmental management activity is to be undertaken according to international standards to ensure that quality is maintained and developed.

The figure below shows the plan, do, check, act cycle for the inventory.

The Swedish EPA has drawn up a document which describes the coordinated quality system for climate reporting[80]. This document contains references to normative and descriptive documents which govern the inventory and reporting. As large parts of the operational inventory work are carried out by government agencies and consultants, there are also references under each section of the document to the internal quality systems of the government agencies and consultants. One of the purposes of the document is to describe how the coordinated quality system works as a whole and how its different parts work together.

Inventory planning

Requirements, decisions and guidelines

The Swedish EPA and affected government agencies and consultants annually plan the inventory and reporting on the basis of new international and national requirements, decisions and guidelines which exist within the framework of climate reporting. The Swedish EPA and other government agencies take part in international negotiations and working groups to ensure that applicable requirements, decisions and guidelines are interpreted and complied with.

Quality objectives and activity plans

The Swedish EPA annually draws up quality objectives and activity plans with a view to steadily developing and improving the inventory and reporting. The activity plans describe the action to be taken to attain the quality objectives, which is responsible and what resources have been earmarked for the purpose.

[80] Manual for Sweden's national quality system for inventory and reporting in accordance and decisions within the EU

Quality plans

Each government agency which supplies data to the Swedish EPA has an internal quality system containing a quality plan with references to necessary quality control routines to ensure the quality of data and to ensure that the documentation is supplied to the Swedish EPA at the right time and in the right format. The consultants have documents for each sector describing how calculations of emissions and sink removals are to be done, as well as how the quality control and quality assurance are carried out to ensure a high level of quality during and after performance of the calculations. These documents are regularly updated ahead of future inventory and reporting.

Key Source analysis

With the assistance of consultants, the Swedish EPA carries out an annual analysis to identify the emission sources to which priority is to be given under the inventory work, known as Key Source Categories. The result of the Key Source analysis represents an important basis for the annual planning of the inventory, and together with other underlying data can provide guidance on what areas need to be improved and whether any development projects need to be set up.

Estimations of uncertainty

The Swedish EPA makes an estimate of the uncertainties contained in data and emission factors in cooperation with government agencies and consultants. The assumptions on which the estimation of uncertainty is based are documented for each emission source.

Preparation of the inventory

Training, awareness and skills

Training, awareness and skills in climate reporting are essential to maintain the level of quality required according to specified requirements. Skills are ensured for the Swedish EPA and the majority of the government agencies involved in the work by the government agency being the sector government agency with staff who have particular skills in different specialist areas.

Skills on the part of consultants are ensured in accordance with the requirements laid down in the framework contract between the Swedish EPA and the consult-ants. The skills levels of consultants are continuously reviewed.

Calculation of emissions and removals of greenhouse gases

In cooperation with affected government agencies and consultants, the Swedish EPA has identified various types of documents which are normative and descriptive of the inventory and reporting work. There are documents describing the quality systems of the government agencies, containing quality plans with references to work documentation which describe how data is produced and supplied to the

Swedish EPA. The consultants have work documentation which describes how emissions and removals of greenhouse gases are calculated for each sector. There are also documented routines and checklists for quality control and quality assurance.

Both the government agencies and the consultants have routines which describe how these documents are to be identified, kept, updated and archived and how they are to be reviewed and approved. The documents serve as important support material so that the work can be continuously monitored. The documents are also used in conjunction with quality audits and peer reviews which are conducted at international and national level.

Inventory checking

Quality control

The Swedish EPA has introduced routines for quality control in cooperation with affected government agencies and consultants[81]. This quality control is the check that is made during the inventory on different types of data, emission factors and calculations that have been made. The quality control takes place according to general requirements (Tier 1) which apply to all types of data used as support material for the reporting, and specific requirements for quality control (Tier 2) which are applied to certain types of data and/or emission sources.

Quality assurance

Quality assurance[82] comprises national peer reviews which are conducted when the inventory has been carried out. In cooperation with affected government agencies, the Swedish EPA conducts a peer review of the inventory at national level. The peer review is defined in the Ordinance (2005:626) Concerning Climate Reporting as a review of calculations, assumptions and results of inventories which are covered by climate reporting, where the review is conducted by a person who has not taken part in the inventory preparation.

The Swedish EPA is responsible for coordinating the annual peer review in consultation with affected government agencies. This means, among other things, ensuring that the peer reviewers have received the necessary training.

The peer review is conducted annually when the inventory has been carried out and the consultants have sent the annual inventory report to the Swedish EPA. The review covers calculations which have been performed and assumptions on which the estimation of emissions has been based. This entails a review of documents

[81] Quality control comprises general methods of checking that the collection of data and the calculations performed are in agreement with standardised procedures for estimating emissions, calculating uncertainties and archiving and reporting data. Higher levels of quality control also cover the review of emission sources, selection of methods and review of activity data and emission factors.

[82] Quality assurance comprises a system of procedures where independent people (peers) review whether a desired quality of data has been attained to ensure that the inventory contains the best conceivable estimate of emissions and sinks on the basis of available scientific and technical data.

which describe the choice of activity data, emission factors, completeness of reporting, consistent time series, routines for quality control and so on. The aim is to ensure that results, the assumptions which have been made and the methodologies which have been applied are plausible.

The Swedish EPA conducts quality audits on its own internal work with the assistance of peer personnel within the Swedish EPA or external quality auditors. The Swedish EPA is responsible for consultants conducting internal quality audit during the inventory.

International peer review

The Swedish EPA has drawn up routines for handling the independent reviews under the UNFCCC and Kyoto Protocol. If it emerges in connection with an international independent review that the government agency's methods or routines need to be amended, under Section 3, second paragraph, of Ordinance (2005: 626) Concerning Climate Reporting the government agency has to take the measures required after consultation with the Swedish EPA.

Deviations, corrective and preventive measures

The Swedish EPA has drawn up routines for handling deviations and corrective and preventive measures in cooperation with affected government agencies and consultants. The purpose is to intercept deviations at an early stage and decide on corrective and preventive measures. These measures may result in new quality targets for the inventory work. Handling deviations and discovering improvements is important in maintaining and developing the quality of inventory and reporting work.

Follow-up and continuous improvement of the inventory

The inventory and reporting are to be steadily developed and improved. This necessitates following up and evaluating the work when the inventory has been conducted. In consultation with affected government agencies and consultants, the Swedish EPA has devised routines to continuously follow up the work and after the inventory has been conducted to hold a debriefing meeting to discuss the past year's inventory and reporting. There are special routines in connection with peer reviews and quality audits for how deviations and proposals for improvements are to be documented and sent to the Swedish EPA.

The result of the follow-up provides the basis for the Swedish EPA's planning of the next year's inventory and reporting. Measures and prioritised and quality targets and activity plans are drawn up. In this way the systematic approach of the quality system is maintained and the inventory and reporting are continuously improved.

Annex 6:3

Changes in the National Registry

Summary of performed changes

The changes of the registry since the last national inventory report are; implementation of the connection to the ITL (International transaction log), upgrading the registry software Greta, and change of contact person designated by the party.

Connection to the ITL (International transaction log)

The Swedish Emission trading registry, SUS, has up to the October 6th been connected to the CITL (Community Independent Transaction Log).
All member states performed a successful connection of their national registries to the ITL (International transaction log) on the October 15 2008. The connection enables the transfer of emission reduction units from CDM- and JI-projects. This means that the emission reduction units (CER and ERU) now can be transferred to accounts in the national registries, including the Swedish emission trading registry, SUS.

Upgrade of the Greta software

To be able to meet up to the requirements according to the Commission Registry Regulation and the connection to the ITL, a new software version was developed, Greta software version 3.0. The scope of the development of the Greta version 3.0 was to develop software that was compatible with the UNFCCC Data Exchange Standard (DES ver. 1.1.1) and the Commission Registry Regulation (No 2216/2004 and No 916/2007).
Sweden upgraded the Greta software from version 2.2 till version 3.0 during the go live-process with the ITL, which were performed between October 6th and October 16th 2008.

The functionality implemented in this version is:

Issuance

- Issue of AAUs
- issue of RMUs
- Issue of EU Allowances by conversion of AAUs

Transfer

- Internal Transfer
- External Transfer

Cancellation
- Cancellation

Retirement
- Propose EU Cancellation & Retirement
- Propose Kyoto Retirement

Conversion
- Conversion of AAUs into ERUs
- Conversion of RMUs into ERUs

Carry-over
- Carry-over
- Carry-over Clean-up

Management of lCERs and tCERs
- Expiry of tCERs and lCERs
- Cancel & Replace lCERs (Allocation)
- Expiry Date Change
- Cancel & Replace lCERs (select units)
- Expiry Clean-up

Cancellation and Replacement
- Cancellation & Replacement

EU Compliance
- Surrender of Allowances, CERs and ERUs

Commitment Period Reserve Monitoring
- CPR Parameter Maintenance & CPR Monitoring

Notification Handling
- Accept Notification
- View Notification

Reports
- UN Reports

Before implementation the new software version was thoroughly tested. The tests were performed by the developers, Defra, the Working Group A (a working group consisting of Greta-licensees (NL, SE, IE UK and NO)), Annex H test against UNFCCC/ITL and finally through tests with the CITL.

Change of contact person designated by the party

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Annex 6:4

Assigned Amount and Commitment Period Reserve

Assigned Amount

The assigned amount pursuant to Article 3, paragraphs 7 and 8, has been calculated in accordance with the annex to decision 13/CMP.1. Sweden's base year is 1990 and the Party has chosen 1995 as the base year for HFCs, PFCs and SF_6. Sweden's quantified emission limitation is 92 per cent as included in Annex B to the Kyoto Protocol. As Sweden is part of the European Community, whose Member States will meet their reduction commitment jointly in accordance with Article 4 of the Kyoto Protocol, Sweden's quantified emission limitation is 104 per cent. Sweden's assigned amount is calculated based on the Party's Article 4 commitment.
In the Initial Report of Sweden the assigned amount was calculated to be 375,864,317 tonnes CO_2 eq. The calculation was based on Sweden's original base year emissions, excluding land-use change – 72,281.599 Gg CO_2 eq. – and its Kyoto Protocol target of 104 per cent.

However, in response to inventory issues identified during the review of the Initial Report, Sweden submitted revised estimates of its base year inventory, which resulted in a recalculation of the assigned amount. Based on the revised estimates for Sweden's base year emissions – 72,151.646 Gg CO_2 eq. – the assigned amount is calculated to be 375,188,561 tonnes CO_2 eq.

Commitment Period Reserve (CPR)

Sweden will maintain, in its National Registry, a commitment period reserve which should not fall short of 90 percent of Sweden's assigned amount.
The commitment period reserve, as carbon dioxide equivalents, in the Swedish National Registry will be: 337 669 705 ton CO2-equivalents

Annex 6:5

Holdings and transactions of Kyoto Protocol Units

Each Party must include information on its aggregate holdings and transactions of Kyoto Protocol units in its annual report. The reporting will be submitted according to the special report standard, the Standard Electronic Format (SEF) with the annual inventory on 15 April of the first reporting year. Sweden is required to begin the annual reporting in 2009.

Annex 6:6, Legal entities authorised to participate in CDM

Description of legal entities authorised to participate in mechanisms under Article 12 (Clean Development Mechanism) of the Kyoto Protocol.

Nr	Date forLoA decision	Project Title	Project Participant	Host Country	Emission reductions	Registration reference
1	2005-05-25	18 MW Biomass Power Project in Tamil-nadu, India	Swedish Energy Agency SICLIP	India	66 821/year	24 Dec 2005 Ref nr 0111
2	2005-09-20	Moema Bagasse Cogeneration Project (MBCP)	Swedish Energy Agency SICLIP	Brazil	13 139/year	9 Mar 2006 Ref nr 0190
3	2005-09-20	Santa Elisa Bagasse Cogeneration Project (SEBCP)	Swedish Energy Agency SICLIP	Brazil	45 801/year	20 Feb 2006 Ref nr 0178
4	2005-09-20	Vale do Rosário Bagasse Cogeneration (VRBC)	Swedish Energy Agency SICLIP	Brazil	25 277/year	3 Mar 2006 Ref nr 0199
5	2006-02-06	Grid connected bagasse based cogene-ration project of Ugar Sugar Works Lim-ited (USWL)	Carbon Asset Services AB Tekniska verken i Linköping	India	63 934/year	6 Mar 2006 Ref nr 0189
6	2006-02-28	Electricity Generation at 8 MW Captive Power Plant Using Enthalpy of Flue Gases from Blast Furnance Operation of Kalyani Steels Limited in Karnataka state of India	Carbon Asset Services AB	India	62 958/year	29 Sep 2006 Ref nr 0427
7	2006-02-28	Sri Balaji 6 MW Non-conventional Re-newable sources Biomass Power Project	Carbon Asset Services AB	India	28 590/year	21 May 2006 Ref nr 0362
8	2006-02-28	Vajra and Chaskaman Small Hydro Projects of Vindhyachal Hydro Power Ltd., Maharashtra, India	Carbon Asset Services AB	India	19 132/year	15 May 2006 Ref nr 0273

9	2006-06-27	Northwind Wind Bangui Bay	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Republic of the Philip-pines	56 788/year	9 Sep 2006 Ref nr 0453
10	2006-06-27	Indocement Alternative Fuels	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Republic of Indonesia	27 383/year	28 Sep 2006 Ref nr 0493
11	2006-06-27	Indocement Blended Cement	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Republic of Indonesia		26 Oct 2006 Ref nr 0526
12	2006-06-27	Alta Mogiana Bagasse Cogeneration	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Brazil	12 024/year	20 Feb 2006 Ref nr 0181
13	2006-06-27	Cote Small-scale Hydropower Plan	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Costa Rica	6 431/year	3 Mar 2006 Ref nr 0251
14	2006-06-27	Jepirachi Wind Power	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Colombia	18 028/year	1 Apr 2006 Ref nr 0194
15	2006-06-29	Indur 7.5 MW Non-Conventional Renew-able Sources Biomass Power Project	Carbon Asset Services AB	India	35 116/year	10 jun 2006 Ref nr 0391
16	2006-06-29	Perpetual 7.5 MW Non-Conventional Renewable Sources Biomass Power Project	Carbon Asset Services AB	India	20 332/year	16 jun 2006 Ref nr 0390
17	2006-07-26	Liaoning Kangping 24.63 Wind-farm Project	Carbon Asset Management AB	China	42 328/year	Ref 0537

18	2006-07-26	Liaoning Zhangwu 24.63 Wind-farm Project	Carbon Asset Management AB	China	35 119/year	Ref 0539
19	2006-08-22	SIDPL Methane Extraction and Power Generation Project	Carbon Asset Services AB	India	31 966/year	3 Sep 2006 Ref 0498
20	2006-08-22	SESL 6 MW Municipal Solid Waste based Power Project Vijayawada Andrha Pradesh	Carbon Asset Services AB	India	64 599/year	15 April 2007 Ref nr 0959
21	2006-08-22	Shalivahana Non-Conventional Renew-able Sources Biomass Project	Carbon Asset Services AB	India	20 852/year	13 February 2007 Ref nr 0591
22	2006-08-22	SRGEL Non-Conventional Renewable Sources Biomass Power Project	Carbon Asset Services AB	India	20 806/year	23 Sep 2006-09-19 Ref nr 0546
23	2006-08-24	Process Waste Heat utilization for power generation at Phillips Carbon Black Limited, Gujarat	Carbon Asset Services Sweden AB	India	45 721/year	29 May 2006 Ref nr 0309
24	2006-08-24	Waste heat based 7 MW Captive Power Project Godawari Power and Ispat Ltd (GPIL)	Carbon Asset Services Sweden AB	India	17 829/year	16 April 2006 Ref nr 0264
25	2006-08-24	Project for HFC23 Decomposition at Changshu 3F Zhonghao New Chemical Materials Co. Ltd, Changshu, Jiangsu Province	The International Bank for Reconstruction and Develop-ment (Trustee of the First Tranche of the Umbrella Carbon Facility)	China	10 437 249/year	8 Aug 2006 Ref nr 0306
26	2006-08-24	Moldava Soil Preservation Project	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	Moldava		
27	2006-09-12	Xiaogushan Hydropower	The International Bank for Reconstruction and Develop-ment (Trustee of Prototype Carbon Fund)	China	312 891/year	11 Aug 2006 Ref nr 0378

28	2006-09-12	El Canadá	The International Bank for Reconstruction and Development (Trustee of Prototype Carbon Fund)	Guatemala	11 8527/Year	2 December 2006 Ref nr 0606
29	2006-09-12	GHG Emission Reduction by Thermal Oxidation of HFC23 in Jiangsu Meilan Chemical CO. Ltd., Jiangsu Province, China	The International Bank for Reconstruction and Development (Trustee of Prototype Carbon Fund)	China	84 11432	4 Jun 2006 Ref nr 0011
30	2006-10-02	Inner Mongolia 100 MW Huitengxile Wind Farm	The International Bank for Reconstruction and Development (Trustee of Prototype Carbon Fund)	China		9 April 2007 Ref nr 0870
31	2006-10-09	Nova América Bagasse Cogeneration Project (NABCP)	Nynäs Refining AB	Brazil	12 027/year	20 Feb 2006 Ref nr 0179
32	2006-10-10	La Esperanza Hydroelectric Project	Göteborg Energi AB	Guatemala	37 032/year	19 Aug 2005 Ref nr 0009
33	2006-10-10	Santa Rosa	Göteborg Energi AB	Peru	13 845/year	23 Oct 2005 Ref nr 0088
34	2006-10-10	Biogas Support Program - Nepal (BSP-Nepal) Activity-1	Göteborg Energi AB	Nepal	46 990/year	27 Dec 2005 Ref nr 0136
35	2006-10-10	Biogas Support Program - Nepal (BSP-Nepal) Activity-2	Göteborg Energi AB	Nepal	46 893/year	27 Dec 2005 Ref nr 0139
36	2006-10-10	Olavarría Landfill Gas Recovery Project	Göteborg Energi AB	Argentina	18 688/year	06 Jan 2006 Ref nr 0140
37	2006-10-10	Moldova Biomass Heating in Rural Communities	Göteborg Energi AB	Moldova	17 888/year	20 Jan 2006 Ref nr 0159
38	2006-10-10	Moldova Biomass Heating in Rural Communities 2	Göteborg Energi AB	Moldova	17 888/year	20 Jan 2006 Ref nr 0160
39	2006-10-10	KMS Power 6 MW Renewable Sources Biomass Power Project	Carbon Asset Services Sweden AB	India	16 266/year	4 Jun 2006 Ref nr 0374

40	2006-11-28	6.5 MW Waste Heat Recovery Project in Huasheng Tianya Cement Co.Ltd	Carbon Asset Management Sweden AB	China	39 387/year	10 June 2007 Ref nr 1038
41	2006-11-28	Guangrun Hydropower Project in Hubei Province	Göteborg Energi	China	78 048/year	27 April 2007 Ref nr 904
42	2006-12-04	Bundled Wind Power Project in Tamil Nadu, India, Co-ordinated by Tamil Nadu Spinning Mills Association (TASMA)	Carbon Asset Services Sweden AB	India		
43	2007-01-16	Gansu Qilianshan Cement 6000 KW Waste Heat Recovery	SICLIP	China	27 158/year	15 July 2007 Ref nr 1046
44	2007-01-16	Gansu Datang Yumen 49.3 MW Wind Power Project	SICLIP	China	97 002/year	16 July 2007 Ref nr 1081
45	2007-01-16	Switching of fuel from naphtha to natural gas in the captive power plant (CPP) at Dahej complex of Gujarat Alkalies and Chemicals Limited	Carbon Asset Services AB	India	99 462/year	29 Sep 2006 Ref nr 0494
46	2007-01-16	Colombo Bagasse Cogeneration Project	ABN AMRO Bank London Branch NV	Brazil	28 018/year	3 Mar 2006 Ref nr 0180
47	2007-02-27	26 MW Biomass (Cogeneration) based Power Generation Project Activity	Carbon Asset Services AB	India	40 246/year	28 December 2006 Ref nr 0846
48	2007-04-17	Moldava Energy Conservation and Greenhouse Gases Emissions Reduction Project	Göteborg Energi	Moldava	11 576/year	8 December 2005 Ref nr 0173
49	2007-04-25	NSL 27.65 MW Wind Power Project in Karnataka, India	Carbon Asset Services AB	India	57 248/year	12 February 2007 Ref nr 0998
50	2007-06-26	Ningxia Shapotou Hydropower of Yellow River	Carbon Asset Management Sweden AB	China	45 2192/year	4 November 2007 Ref nr 1284
51	2007-06-26	China Guanmenyan Hydropower	Carbon Asset Management Sweden AB	China	84 868/year	1 February 2008 Ref nr 1365
52	2007-06-26	China Chalinhe Hydropower	Carbon Asset Management Sweden AB	China	233 000/year	

53	2007-06-26	China Ganluo Kaijianqiao Hydropower	Carbon Asset Management Sweden AB	China	214 000/year	Ref nr 1432
54	2007-09-18	Jiuxiaohe and Sanhekou Small Hydroe-lectric Bundle Project	Carbon Asset Management Sweden AB	China	50 000/year	
55	2007-06-26	Ningxia Yinyi 49.50 MW Wind Farm Projectr	Carbon Asset Management Sweden AB	China	98 282/year	18 December 2007 Ref nr 1269
56	2007-06-26	Waste Gases utilization for Combined Cycle Power Plant in Handan Iron and Steel Group	Carbon Asset Management Sweden AB	China	665 544/year	15 October 2007 Ref nr 1262
57	2007-07-09	Power Generation (20MW) by utilizing Coke Oven Gas of China Coal and Coke Jiuxin Limited in Linshi, Shanxi, P.R. China	Carbon Asset Management Sweden AB	China	67 000/year	17 February 2008 Ref nr 1390
58	2007-07-09	Maocaoping 8 MW Small Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	24 196/year	31 March 2008 Ref nr 1489
59	2007-07-09	Zhongzhou 16.5 MW Hydropower Project	Carbon Asset Management Sweden AB	China	52 323/year	17 June 08 Ref nr 1333
60	2007-08-02	China Yuliangwan Small Hydropower Project	Carbon Asset Management Sweden AB	China	30 845/year	6 Jan 08 Ref nr 1391
61	2007-08-02	Pihe 9.6MW Small Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	32 177/year	12 June 2008 Ref nr 1496
62	2007-08-02	Yichang Yihua Waste Heat Recovery and Utilization Project	Carbon Asset Management Sweden AB	China	195 034/year	1 February 2008 Ref nr 1340
63	2007-08-02	Pushihe Erji 10 MW Small Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	31 338/year	3 Apr 2008 Ref nr 1430
64	2007-08-02	Aluhe 12.6 MW Small Hydropower Pro-ject in Yunnan Province	Carbon Asset Management Sweden AB	China	36 958/year	3 April 2008 Ref nr 1439
65	2007-08-02	SRGEL Non-Conventional Energy Sources Biomass Power Project	Svenska Cellulosa AB	India	20 806/year	23 Sep 2006 Ref nr 0546
66	2007-08-02	Grid-connected bagasse based cogene-ration of Ugar Sugar works Ltd	Svenska Cellulosa AB	India	63 934/year	6 Mar 2006 Ref nr 0189

67	2007-08-02	Shalivahana Non-conventional Renew-able Sources Biomass Power Project	Svenska Cellulosa AB	India	23 121/year	13 Feb 2007 Ref nr 0591
68	2007-08-06	China Changniping Hydropower Project	Carbon Asset Management Sweden AB	China	77 444/year	16 June 2008 Ref nr 1367
69	2007-08-06	China Shangbao Small Hydropower Project	Carbon Asset Management Sweden AB	China	56 383/year	9 Dec 2007 Ref nr 1376
70	2007-08-06	Mujiajia Yuji 18.9MW Hydropower	Carbon Asset Management Sweden AB	China	56 313/year	
71	2007-08-06	Mujiajia Erji 10MW Small Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	30 356/year	Ref nr 1504
72	2007-08-06	Lishiluo Erji 6.4MW Small Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	17 124/year	12 June 2008 Ref nr 1485
73	2007-08-06	Chuandongxia Small Hydropower Project	Carbon Asset Management Sweden AB	China	20 530/year	
74	2007-08-06	Bapan 12.7MW Hydropower Project	Carbon Asset Management Sweden AB	China	34 759/year	
75	2007-08-06	Hunan Yanling Bundled Hydropower Project	Carbon Asset Management Sweden AB	China	40 086/year	
76	2007-08-13	Hebei Quzhai Cement 9000kW Waste Heat Recovery Project	Carbon Asset Management Sweden AB	China	52 878/year	
77	2007-09-04	China Xinhuan Xincun Small Hydropower Project	Carbon Asset Management Sweden AB	China	19 519/year	
78	2007-09-04	China Tongwan Hydropower Project	Carbon Asset Management Sweden AB	China	593 000/year	
79	2007-09-04	Qinghai Jinshaxia 70MW Hydropower Project	Carbon Asset Management Sweden AB	China	208 345/year	
80	2007-09-04	Qinghai Qinggangxia 43.8MW Hydro-power Project	Carbon Asset Management Sweden AB	China	147 982/year	
81	2007-09-11	Pingyuan Tongli WHR Project	Carbon Asset Management Sweden AB	China	53 375/year	

82	2007-09-11	Huanghe Tongli WHR Project	Carbon Asset Management Sweden AB	China	53 375/yearc
83	2007-09-11	Yuhe Tongli WHR Project	Carbon Asset Management Sweden AB	China	106 740/year
84	2007-09-11	Yulong Tongli WHR Project	Carbon Asset Management Sweden AB	China	53 375/year
85	2007-09-18	Wuya River Small-scale Hydropower Plant Project	Carbon Asset Management Sweden AB	China	34 547/year
86	2007-09-18	Suleiba 14.8MW Small Hydropower Project in Guangdong	Carbon Asset Management Sweden AB	China	48 221/year
87	2007-10-02	Liuyang Shuangjiangkou, Renziqiao and Hedong 6.4MW Bundled Hydropower Project	Carbon Asset Management Sweden AB	China	26 183/year
88	2007-10-02	Yuexi Dayan Small Hydropower Project	Carbon Asset Management Sweden AB	China	49 113/year
89	2007-10-02	China Yanzhou Hydropower Expanded Project	Carbon Asset Management Sweden AB	China	58 476/year
90	2007-10-02	Jiangsu Huaerrun WHR Project	Carbon Asset Management Sweden AB	China	31 715/year
91	2007-10-02	China Tuanjie Small Rundle Hydropower Project	Carbon Asset Management Sweden AB	China	24 004/year
92	2007-10-18	China Wuyahe Small Hydropower Project	Carbon Asset Management Sweden AB	China	34 547/year
93	2007-10-18	Suleiba 14.8 MW Small Hydropower in Guangdong Province	Carbon Asset Management Sweden AB	China	48 221/year
94	2007-11-13	Jielong Small-Scale Hydropower Project	EcoSecurities Group PLC	China	29 495/year
95	2007-11-13	Huangyutang Hydro Power Project in Guizhou Province	EcoSecurities Group PLC	China	43 299/year
96	2007-11-13	Changpinghe Yiyi and Erji 10.4 MW Bundled Small Hydropower Project	EcoSecurities Group PLC	China	28 710/year

97	2007-11-13	Liujiashan 10 MW Small Hydropower Project in Jiangxi Province	EcoSecurities Group PLC	China	23 696/year	
98	2007-11-13	Liyutang Small Hydropower Project	EcoSecurities Group PLC	China	42 661/year	
99	2007-11-13	14 MW Bundled Small Hydropower Project in Xiping and Puhe	EcoSecurities Group PLC	China	39 662/year	
100	2007-11-13	Sichuan Miyaluo Hydroelectric Station	EcoSecurities Group PLC	China	64 357/year	
101	2007-11-13	Shilong Small-Scale Hydro Power Project	EcoSecurities Group PLC	China	43 536/year	
102	2007-11-13	Siliping Small-Scale Hydro Power Project	EcoSecurities Group PLC	China	42 589/year	
103	2007-11-13	Yuejiang Small-Scale Hydropower Project	EcoSecurities Group PLC	China	44 950/year	
104	2007-11-13	Huadian Ningxia Ningdong Yangjiayao 45MW Wind-farm Project	Carbon Asset Management Sweden AB	China	93 938/year	
105	2007-11-20	China Niaoerchao Hydropower Project	Carbon Asset Management Sweden AB	China	60 503/year	
106	2007-11-20	China Jintan Hydropower Project	Carbon Asset Management Sweden AB	China	52 428/year	
107	2007-11-20	Zhongjieneng Suqian 2x12 MW Biomass Direct Burning Power Plant Project	Vitol SA	China	123 055/year	
108	2007-11-27	Hebei Hydroelectric Company Limited 15 MW Small Hydropower Project	Carbon Asset Management Sweden AB	China	49 889/year	
109	2007-11-27	Hejiang County Yuanxing Hydro Project	EcoSecurities Group PLC	China	52 045/year	
110	2008-01-15	Nanzhahe Cascade Hydropower Project	Standard Bank PLC	China	31 134/year	
111	2008-01-15	Dali 8.0MW Hydropower Project	Standard Bank PLC	China	26 230/year	
112	2008-01-15	China Tuojiang Small Hydropower Project	Carbon Asset Management Sweden AB	China	48 135/year	17 Aug 08 Ref nr 1782
113	2008-01-15	Lushui Bajiaohe Small Hydropower Project	Carbon Asset Management Sweden AB	China	61 590/year	
114	2008-01-15	Fugong County Small-scale Hydropower Bundled Project	Carbon Asset Management Sweden AB	China	28 715/year	

115	2008-01-15	China Gaoyongdong Small Hydropower Project	Carbon Asset Management Sweden AB	China	30 178/year	
116	2008-01-15	Shuiliandong 6.25 MW Small Hydropower Project in Guizhou Province, China	Carbon Asset Management Sweden AB	China	22 863/year	
117	2008-01-15	Lushui Zijihe Small Hydropower Project	Carbon Asset Management Sweden AB	China	43 507/year	
118	2008-01-15	Yunnan Weixi Gedeng Hydropower Project	MGM Carbon Portfolio S.a r.l	China	42 809/year	
119	2008-01-15	Yunnan Weixi Jicha Hydropower Project	MGM Carbon Portfolio S.a r.	China	43 390/year	
120	2008-01-22	China Xieshui Small Rundle Hydropower Project in China	Carbon Asset Management Sweden AB	China	27 607/year	
121	2008-01-22	Bage and MengZhai 8.58 MW Bundled Small Hydropower Project in Guizhou Province China	Carbon Asset Management Sweden AB	China	25 435/year	
122	2008-01-22	Changtan Hydro Power Project in Guizhou Province	EcoSecurities Group PLC	China	16 447/year	1 Sep 08 Ref nr 1799
123	2008-01-22	Longzhou 1st Hydro Power Project	EcoSecurities Group PLC	China	32 435/year	
124	2008-01-29	China Hunan Yuzitang Small Hydropower Project	Carbon Asset Management Sweden AB	China	25 898/year	
125	2008-02-05	Longzhou 2nd Hydro Power Project	EcoSecurities Group PLC	China	38 138/year	
126	2008-02-05	Yunnan Lincan Zhenai Hydropower Project	EcoSecurities Group PLC	China	42 313/year	
127	2008-02-05	Lufeng 36MW Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	105 716/year	
128	2008-02-26	Puping Hydro Power Project	EcoSecurities Group PLC	China	58 222/year	
129	2008-03-04	13.5MW WHR Project in Hunan Niuli Cement Co Ltd	Carbon Asset Management Sweden AB	China	65 003/year	
130	2008-03-04	Hangudi 5MW Hydropower Project in Yunnan Province	Carbon Asset Management Sweden AB	China	18 254/year	

131	2008-03-04	Taizihe 15MW Bundled Small Hydro-power Project in Liaoning Province	Carbon Asset Management Sweden AB	China	67 249/year
132	2008-03-04	Lanpin Fengdianhe Small Hydropower Project	Carbon Asset Management Sweden AB	China	35 925/year
133	2008-03-18	Laowangzhuang Zhemujiu Small Hydro-power Project	Carbon Asset Management Sweden AB	China	41 798/year
134	2008-03-18	Lixian Yikeyin Small Hydropower Project	Carbon Asset Management Sweden AB	China	57 627/year
135	2008-03-18	Shanshuping 12 MW Small Hydropower Project in Sichuan Province, China	Carbon Asset Management Sweden AB	China	45 583/year
136	2008-03-18	Shaanxi Ziyang County Small-scale Hydropower Bundled Project	Carbon Asset Management Sweden AB	China	16 613/year
137	2008-03-18	Hunan Jinwei 5.0 MW Hydropower Project	Carbon Asset Management Sweden AB	China	16 982/year
138	2008-03-18	Lijiang Xinzhuhe Second Level Hydro-power Project	EcoSecurities Group PLC	China	53 303/year
139	2008-03-18	Yulong County Jinzhuang Third Level Hydropower Project	EcoSecurities Group PLC	China	54 217/year
140	2008-03-25	Daofu County Mengtuo Hydro Power Project	EcoSecurities Group PLC	China	90 471/year
141	2008-03-25	Sichuan Liangtan Hydropower Station Second Phase Project	EcoSecurities Group PLC	China	81 897/year
142	2008-03-25	Parlilitan 1 Hydro Power Plant	EcoSecurities Group PLC	Indonesia	27 673/year
143	2008-04-09	Guangnan Shangshilong Hydropower Project	EcoSecurities Group PLC	China	57 748/year
144	08-04-22	Boiler Fuel Conversion at Perstorp India Private Ltd	Perstorp Specialty Chemicals AB	India	17 178/year
145	08-04-22	Jiadu River Zhentong Power Project	EcoSecurities Group PLC	China	34 664/year
146	08-04-22	Wayao Forth Cascader Hydro Power Project in Yunnan Province	EcoSecurities Group PLC	China	35 400/year

147	08-05-20	Yangmingshan Three Level Hydropower Project	EcoSecurities Group PLC	China	24 835/year	
148	08-05-20	Datankou Hydrelectric Project	EcoSecurities Group PLC	China	34 293/year	
149	08-05-27	Banna Liusha River Fifth Level Power Plant Project	EcoSecurities Group PLC	China	39 872/year	
150	08-06-10	Jishou Huangliangxi 8 MW Hydropower Project	Carbon Asset Management Sweden AB	China	27 513/year	
151	08-06-10	Hunan Jinjiagou Small Hydropower Project	Carbon Asset Management Sweden AB	China	63 358/year	
152	08-06-10	Yunnan Liangmeihe River Cascade Hydropower Project	Carbon Asset Management Sweden AB	China	39 761/year	
153	08-06-10	Shanxi Changyuan 24MW Waste Heat Recovery and Utilization for Electricity Generation	Carbon Asset Management Sweden AB	China	131 550/year	
154	08-06-10	Zhumadian Zhjongyuan Gas-Steam Combined Cycel Power Plant in Henan, China	Carbon Asset Management Sweden AB	China	712 433/year	
155	08-06-17	Hunan Lizitang 9.6MW Hydropower Project of China	Carbon Asset Management Sweden AB	China	35 599/year	
156	08-06-24	Yuzaikou Small Hydropower Station	EcoSecurities Group Ltd	China	40 480/year	18 Dec 05 Ref nr 0126
157	08-06-24	Yuzaikou Small Hydropower Station	EcoSecurities Group PLC	China	40 480/year	18 Dec 05 Ref nr 0126
158	08-06-24	Qinan Hydro Power Project	Carbon Asset Management Sweden AB	China	47 767/year	
159	080701	Cuchildeo Hydroelectric Project	EcoSecurities PLC	Chile	4 485/year	
160	080715	Energeticos Jaremar – biogas recovery from Palm Oil Mill Effluent (POME) ponds, and heat & electricity generation, Honduras	Carbon Asset Management Sweden AB	Honduras	30 646/year	8 Mar 08 Ref nr 1483
161	080715	Xinning County Dalong Small-Scale Hydropower Bundled Project	Carbon Asset Management Sweden AB	China	28 665/year	

162	080819	Shaanxi Wanjiabao Mialiang Langhe Bundled Small Hydropower Project	Carbon Asset Management Sweden AB	China	37 669/year
163	080819	Yunnan Xinya River 3rd Level Hydropower Project	EcoSecurities Group PLC	China	29 604/year
164	080819	Gikoko Palembang – LFG Flaring Project	Asian Development Bank as Trustee for Asia Pacific Carbon Fund	Indonesia	45 201/year
165	080909	Gansu Jingtai 45MW Wind Power Project	Carbon Asset Management Sweden AB	China	83 174/year
166	080916	Guohua Chenbaerhu Qi Phase 1 49.5MW Wind Farm Project	Carbon Asset Management Sweden AB	China	118 782/year
167	080916	Guohua Chenbaerhu Qi Phase 1 49.5MW Wind Farm Project	Swedish Energy Agency	China	118 782/year
168	080916	Guohua Hebei Huanghua Phase II 49.5MW Windfarm Project	Carbon Asset Management Sweden AB	China	104 134/year
169	080916	Guohua Hebei Huanghua Phase II 49.5MW Windfarm Project	Swedish Energy Agency	China	104 134/year
170	080916	Guohua Tongliao Kezuo Zhongqi Phase II 49.54MW Wind Farm Project	Carbon Asset Management Sweden AB	China	121 117/year
171	080916	Guohua Tongliao Kezuo Zhongqi Phase II 49.54MW Wind Farm Project	Carbon Asset Management Sweden AB	China	121 117/year
172	080916	Guohua Xinbaerhu Zuoqi I 49.5MW Wind Farm Project	Carbon Asset Management Sweden AB	China	119 888/year
173	080916	Guohua Xinbaerhu Zuoqi I 49.5MW Wind Farm Project	Swedish Energy Agency	China	119 888/year
174	080916	Gikoko Palembang – LFG Flaring Project	Swedish Energy Agency	Indonesia	45 201/year
175	080916	Fugong Mukeji Hydropower Project in China	Carbon Asset Management Sweden AB	China	102 781/year
176	080916	Sichuan Miaopu Hydropower Project	Standard Bank PLC	China	137 563/year
177	080923	Gansu Jingtai 45MW Wind Power Project	Swedish Energy Agency	China	83 174/year

178	080930	Jilin Taobei Baoshan Wind Power Project	WCCI World Carbon Credit Investment Limited	China	115 513/year
179	081007	Hejiang County Yuanxing Hydro Project	EcoSecurities Carbon I Ltd	China	52 045/year
180	081007	Steam Optimisation Project at Guizhou Fertilizer Corporation Ltd	Carbon Asset Management Sweden AB	China	165 310/year
181	081014	Mengshan Hydro Power Project	EcoSecurities Group PLC	China	29 917/year
182	081014	Jinxiu Fengmuao Hydro Power Project	EcoSecurities Group PLC	China	19 298/year
183	081021	Paso Ancho Hydroelectric Project	EcoSecurities Carbon I Ltd	Panama	22 233/year
184	081021	Martinuv Espigão Hydroelectric Project	EcoSecurities Carbon I Ltd	Brazil	17 963/year

Annex 6:7

Legal entities authorised to participate in JI

Description of legal entities authorised to participate in mechanisms under Article 6 (Joint Implementation) of the Kyoto Protocol.

Date for LoA decision	**Project Title**	**Project Participant**		**Host Country**	**Average Emission Reductions**
1	2005-09-23	Colterm District Heating Company's Joint Implementation Project	Swedish Energy Agency SICLIP	Romania	34 671 tCO2e pa
2	2006-02-06	Vira Nigula Wind Farm	Swedish Energy Agency SICLIP	Estonia	66 748 tCO2e pa
3	2007-02-27	Vira Nigula Wind Farm	Nordic Environment Finance Corporation	Estonia	66 748 tCO2e pa
4	2007-02-27	Vanaküla Wind Power JI Project	Nordic Environment Finance Corporation	Estonia	25 397 tCO2e pa
5	2007-05-22	Benaiciai Wind Power Project	Nordic Environment Finance Corporation	Lithuania	26 172 tCO2e pa
6	2007-06-26	Lapes Landfill Gas Utilisation and Energy Generation	Nordic Environment Finance Corporation	Lithuania	33 431 tCO2e pa
7	2007-10-23	Waste Coke Oven Gas Utilization at OOO PO Khimprom, Kemerovo, Russia	Nordic Environment Finance Corporation	Russia	70 811 tCO2e pa
8	2008-01-15	Sudenai and Lendimai Wind Power Joint Implementation Project	Nordic Environment Finance Corporation	Lithuania	15 802 t CO2e pa

Annex 6:8

Legal entities authorised to participate in article 17 of the Kyoto Protocol

There are no provisions in Swedish law on which kyoto unit types legal entities are authorised to hold in the Swedish National Registry. This concerns legal entities authorised by the Member State to hold assigned amount units (AAUs), removal units (RMUs), emission reduction units (ERUs) and certified emission reductions (CERs), including temporary CERs (tCERS) and long-term CERs (lCERs).

All legal entities (person or organisation) authorized to participate in the Swedish national registry under the Kyoto mechanisms, must have a separate holding account for each legal entity according to the Data Exchange Standards (DES), appendix F,section 5.

Annex 7

Uncertainties

Methodology for Uncertainty analysis

Uncertainty estimates are performed for 1990 and the latest reported year for direct greenhouse gases, e.g. CO_2, CH_4, N_2O and F-gases. To simplify the methodology, there have not been any adjustments for correlation between gases, even though many of them have the same activity data and therefore are correlated.

Data in the inventory have been divided into seven sectors according to how the inventory work is organized (stationary combustion, mobile combustion, CO_2 from industrial processes, emissions of F-gases, other emissions from industrial processes and solvent and other products use, agriculture and, finally, waste). Work with uncertainty estimates is performed in one Excel file with one spreadsheet for each of the seven sectors. Every sector has, by those in the inventory staff with the most expertise on each sector, been divided into sources, according to where independencies between sources were assumed to exist. Each source was evaluated regarding uncertainties (%) on activity data (AD), emission factors (EF) or direct emissions (EM).

During 2005, a SMED study was carried out, aiming at improving the transparency and quality in the uncertainty estimates in the Swedish National Greenhouse Gas Inventory by making the underlying documentation and structures for uncertainty estimates more consistent and traceable[83]. That facilitated easier replication and updating of results as well as enabling internal and external reviews of assigned uncertainties. The study did not include improvement of single uncertainties, for instance by contacting external experts for better information on uncertainties on different sources. LULUCF was not included in the study.

Expert protocols

All assigned uncertainties (%) have been documented in Swedish in Expert Protocols as given in Figure 15.

[83] Gustafsson, 2005

Reference number:	1	**External review by:**	NN, 200x-xx-xx
Date:	2005-04-28	**Result of external review:**	approved/not approved
			(references to other material if necessary)
Expert:	NN		
Kvalifications:	eg working several years with this sector of the GHG inventory	**Approved by SEPA:**	NN, 200x-xx-xx
Documented by:	NN (expert or other person)	**Responsible authority according to National system:**	Name of authority

Estimated uncertainties:

Year	CRF	Activity	Activity data	Emission factor	Emissions	most likely value	minimum[1]	maximum[1]	probability distribution[2]	Foot-note
2004	1A1a	domestic heating oil	m3			according to indata	-2%	2%	normal	1
2004	1A1a	domestic heating oil		CO2		73,5	70	76	triangular	2
2004	1	Petroleum coke	tonne							x

[1] limits for 95% konfidence interval, that is 2,5% risk that the true value is below minimum and 2,5% risk that the true value is above maximum.
[2] If probability distribution is unknown the following applies:
if only minimum and maximum is given, assume a uniform distribution. If also a most likely value is given, assume a triangular distribution.

Basis for expert judgement including logic and scientifical reasons and references to other relevant material:

1)

2)

x)

Figure 15. Design of Expert protocols

In the protocols, specially designed to be in compliance with the recommendations in the IPCC Good Practice Guidance chapter 6.2.5 (IPCC 2000), information is provided on what uncertainties are estimated (what CRF codes concerned, what years, what type of AD, EF or EM etc), the value or range of the estimated uncertainty, explanations on the reasons behind the given values, name and qualification of the expert etc. All expert protocols are given a reference number and gathered in one Excel file. All in all, there are about thirty expert protocols documenting uncertainties in the Swedish GHG Inventory. This transparent documentation will enable replicating of results and facilitate updating of uncertainties when something in the inventory changes in the future.

Estimating uncertainties for each source

When estimating uncertainties for each source, a wide range of information has been used. IPCC recommendations have been studies as well as fluctuations in time series, comparison with other sources, studies of statistical differences and studies of reports that are the basis for instance for many emission factors. Below some comments are given on how the work was conducted for each sector.

CRF 1. Stationary combustion

Activity data on fuel consumption has been assumed to be uncorrelated between CRF sectors. Uncertainties for activity data are estimated for each year, fuel type and CRF sector. Uncertainties for emission factors are estimated for each greenhouse gas, year, fuel type and CRF sector.

Several expert elicitations have been performed, with SMED reports and information from the IPCC as the main basis for the expert judgements. In some cases no referenced information was available, and in those cases very rough expert judgements had to be made.

CRF 1. Mobile combustion

Activity data on fuel consumption are based on national statistics on fuel deliveries. Correlation therefore exists between the different CRF sectors when the fuel is allocated. Uncertainties for activity data are estimated on an aggregated level for each year and fuel type.

Uncertainties for emission factors of CO_2 are estimated by fuel type, whereas uncertainties for emission factors for CH_4 and N_2O are estimated by fuel type and CRF sector, e.g. CH_4 for gasoline in CRF 1A3e 1990.

Uncertainties on actual emissions have been estimated for emissions of CH_4 and N_2O from road traffic, CRF 1A3b.

Uncertainty estimates are mostly based on SMED reports and expert judgement, but in a few cases IPCC and CORINAIR default recommendations have been applied. Uncertainty estimates for activity data, emission factors and actual emissions for mobile combustion sources are set to be the same 1990 as the latest reported year.

CRF 2. Industrial processes, CO_2

The emission factors used in the calculations are based on IPCC defaults or on information on emission factors and/or emissions directly from the companies. Generally 5 % have been assigned as uncertainty to the emission factors when no other indications or relevant information affecting the uncertainty have been available.

CRF 2. Industrial processes, F-gases

Activity data for most sources in 2F1, refrigeration and air conditioning equipment, is based on national statistics. Uncertainty was assigned in cooperation with the Swedish Chemicals Inspectorate. Other activity data is obtained directly from producers or consumers, and uncertainty was discussed with relevant experts, if possible. Emission factors are IPCC default, country specific, obtained from producers/consumers or derived in discussion with national experts. Uncertainty estimates are to a large extent based on expert judgement.

CRF 2. Industrial processes, CH_4 and N_2O

For nitric acid production, uncertainty estimates was obtained from producers. For other sources, expert judgement or suggested uncertainties from IPCC Guidelines and Good Practice Guidance were used, if available. In estimating uncertainties by expert judgement for some sources, Environmental reports from comparable facilities were used as a basis for estimating reasonable uncertainty levels.

CRF 3. Solvent use

Activity data are obtained from national statistics at the Swedish Chemicals Inspectorate. Uncertainty estimates were discussed and assigned in cooperation with experts at the Products register at the Swedish Chemicals Inspectorate. Uncertainty estimates for the country specific emission factors used were estimated by expert judgement.

CRF 4. Agriculture

Uncertainty estimates are generally collected from the same source as emission estimates, for instance IPCC or nationally referenced data. When no uncertainty estimates were available, estimates from similar statistics were used instead. When neither uncertainty estimates nor any similar statistics were available, very rough expert judgements had to be made. Uncertainty estimates are assigned on an aggregated level very similar to the one presented in the NIR.

CRF 6. Waste

Uncertainty estimates are collected from IPCC (for emission factors) and IPCC combined with expert judgment (for activity data). Uncertainty estimates are assigned on the same aggregated level as presented in the NIR, which is per CRF sector (e.g. 6A Solid waste).

Updating uncertainties for each sector

Table 16 gives an example on how input data is given for estimating uncertainties for a single sector.

Table 16. Example of design of sectoral uncertainty estimates; CRF 2. Industrial Processes – CO_2

Year	IPPC source cate-gory	Source	Emis -sion	Acivity data	Activ-ity data unit	Activity data value	Emissions of CO2, Gg	Emission of CO2, Gg CO2 eq	Activity data uncer-tainty %	Emission factor uncer-tainty %	Emission data Uncer-tainty %	Activity Data uncer-tainty quality indicator	Emission factor uncertainty quality indicator	Emission data uncer-tainty quality indicator	Expert judgement reference number	Footnote reference number
1990	2A1	Cement production	CO2	Clinker prod.	Kton	2348	1271,95	1271,95	5	5		R	R		11	
1990	2A2	Lime production	CO2	Lime prod.	Kton	923	497,96	497,96	5	5		R	R, D		11	5
1990	2A3	Limestone- and dolomite use	CO2	Limestone- and dolomite use	Kton	234	109,43	109,43	7	5		R	D		11	
1990	2A4	Soda Ash use	CO2	Soda Ash use	Kton	95	39,56	39,56	7	5		R	D		11	
1990	2A7	Other mineral use	CO2	Leca production, (use of slagg)	Kton	58	3,36	3,36			10			R	11	
1990	2B4	Carbide production (Ca)	CO2	Carbide produc-tion (Ca)	kton	55	68,80	68,80	5	7		R	R		11	
1990	2C11	Iron and steel produc-tion	CO2	Steel production	kton	1819	129,23	129,23			5			R	11	
1990	2C12	Iron and steel produc-tion	CO2	Iron production	kton	2845	1666,91	1666,91	5	5					11	
1990	2C2	Ferroalloys produc-tion	CO2	Reducing agents	kton	77	243,00	243,00			5			R	11	
1990	2C3	Aluminium produc-tion	CO2	Al. Production	kton	93	133,12	133,12			5			R	11	
1990	2C5	Other metal produc-tion	CO2	Pb and Zn production	kton	70	203,84	203,84	7	5		R	R		11	
2004	2A1	Cement production	CO2	Clinker prod.	kton	2386	1284,43	1284,43	2	5		R	R		11	
2004	2A2	Lime production	CO2	Lime prod.	kton	1039	537,25	537,25	2	5		R	R, D		11	5
2004	2A3	Limestone- and dolomite use	CO2	Limestone- and dolomite use	kton	307	141,46	141,46	5	5		R	D		11	
2004	2A4	Soda Ash use	CO2	Soda Ash use	kton	72,96	30,30	30,30	7	5		R	D		11	
2004	2A7	Other meineral use	CO2	Leca production, (use of slag)	kton	140	7,65	7,65			5			R	11	
2004	2B4	Carbide prdocution (Ca)	CO2	Carbide produc-tion (Ca)	kton	43	53,38	53,38	5	5		R	R		11	
2004	2C11	Iron and steel produc-tion	CO2	Steel production	kton	1872	143,77	143,77			5			R	11	
2004	2C12	Iron and steel produc-tion	CO2	Iron production	kton	3992	1654,46	1654,46	5	5					11	
2004	2C2	Ferroalloys produc-tion	CO2	Reducing agents	kton	99,50	256,40	256,40			5			R	11	
2004	2C3	Aluminium produc-tion	CO2	Al. Production	kton	101	145,29	145,29			5			R	11	
2004	2C5	Other metal produc-tion	CO2	Pb and Zn production	kton	62	166,05	166,05	5	5		R	R		11	

In the sectoral spreadsheets, there is one row for each source, according to where independency between sources is assumed to exist. For each source, emissions may be derived either from activity data and emission factors or information on actual emission data from companies or models.

The first section (green colour headings) includes information on reference year, IPCC source category, GHG, description of activity data (if relevant), quantified activity data and emissions. The "green" data should be updated each submission.

The second section (yellow colour headings) includes information on uncertainty estimates for activity data and emission factors, and emission data in those cases only estimated emissions are available. As required by the IPCC Good Practice Guidance, quality indicators are given for activity data and each GHG Emission factor (D - IPCC default, M - Measurement based, R - National referenced data). The expert judgement reference number(s) refer to what expert protocol(s) are used for this source. The footnote reference number(s) refer to additional information in a footnote spreadsheet, for instance if a choice has been made between two different expert protocols concerning the same source and the rationale behind the choice. The "yellow" data should be reviewed each submission, to make sure that they are correctly linked to the corresponding "green" data. "Yellow" data are updated when better information is available, for instance if new studies on emission factors have been conducted and it has been possible to update the expert protocols.

Combining and aggregating uncertainties for all sectors

The uncertainty analysis is performed according the IPCC Guidelines Tier 1 method as described in Good Practice Guidance section 6.3.2, see especially table 6.1. Emissions in CO_2-equivalents (E) from all sources and all greenhouse gases are summarized into total national emissions (T).

For each source, the uncertainty for activity data (U_{AD}) and emission factors (U_{EF}) is estimated and given in percents. The combined uncertainty (CU) for activity data and emission factors – the uncertainty for the reported emissions from each source – is calculated as:

$$CU = \sqrt{U_{AD}^2 + U_{EF}^2}$$

In some cases, uncertainties for direct emissions (U_{EM}) are used instead of uncertainties for activity data and emission factors. In those cases the combined uncertainty is equal to the uncertainty for the direct emissions:

$$CU = U_{EM}$$

Uncertainties are as far as possible presented on the same aggregation level as the Key Source analysis. The purpose is to facilitate combined use of the two analyses, since both aim at showing what parts of the inventory are especially important and/or weak. This is very important information when planning and prioritising future inventories and, above all, using and evaluating the inventory results.

In order to estimate the uncertainty for the emissions of aggregated sources, the uncertainty contribution[84] for activity data (AU_{AD}), emission factors (AU_{EF}) and direct emissions (AU_{EM}) respectively is calculated, using the following formulas:

$$AU_{AD} = \frac{\sqrt{\sum \left(E_{AD} * U_{AD}\right)^2}}{\sum E_{AD}} \qquad AU_{EF} = \frac{\sqrt{\sum \left(E_{EF} * U_{EF}\right)^2}}{\sum E_{EF}}$$

$$AU_{EM} = \frac{\sqrt{\sum \left(E_{EM} * U_{EM}\right)^2}}{\sum E_{EM}}$$

E in this case represents the emission value of the aggregated source. Since each aggregated source is composed of several single sources, for some aggregated sources, estimates will be derived from both AD*EF and EM respectively. In these cases, values for U_{AD}, U_{EF} and U_{EM} will be shown in the resulting table. The combined uncertainty for aggregated sources is calculated as

$$CU_{AD,EF} = \sqrt{AU_{AD}^{\ 2} + AU_{EF}^{\ 2}}$$

$$CU_{AD,EF,EM} = \frac{\sqrt{\left(CU_{AD,EF} * E_{AD,EF}\right)^2 + \left(AU_{EM} * E_{EM}\right)^2}}{\sum \left(E_{AD,EF} + E_{EM}\right)}$$

Combined uncertainty as % of total national emissions for all gases (CU%) is calculated for each source as:

$$CU\% = \frac{CU * E}{T}$$

[84] An uncertainty contribution in e.g. activity data should be interpreted as the percentage error in the emission, given that no errors exist in the emission factors. Note that the sum of the percentage uncertainty in activity data and emission factors will be higher than the uncertainty in emissions of the aggregated sources.

Finally, the percentage uncertainty contribution in the total national emissions (U%) for each greenhouse gas and the percentage uncertainty for all greenhouse gases together are calculated as:

$$U\%_{CO2} = \sqrt{\sum_{CO2} CU\%^2}$$

$$U\%_{CH4} = \sqrt{\sum_{CH4} CU\%^2}$$

$$U\%_{N2O} = \sqrt{\sum_{N2O} CU\%^2}$$

$$U\%_{F-gases} = \sqrt{\sum_{F-gases} CU\%^2}$$

$$U\%_{CH4} = \sqrt{\sum_{CH4} CU\%^2}$$

Please note that with this method, the percentage uncertainty in total national emissions will be lower than the sum of the percentage uncertainty contribution in total national emissions for each greenhouse gas.

The equations AU_{AD}, AU_{EF} and AU_{EM} can be used for estimating the uncertainty contributions for AD, EF, and EM respectively on the uncertainty of total national emissions for all gases.

Results

Table 117. Tier 1 uncertainty assessment for national total emissions of CO_2 equivalents in 2007 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 2007	Activity data uncertainty	Emission factor uncertainty	Emission data uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	CO_2	8 034	1	8	0	8	1,01
1A1b	Petroleum Refining	CO_2	1 921	9	4	0	10	0,29
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CO_2	328	4	14	0	15	0,07
1A2a	Iron and Steel	CO_2	1 215	3	4	0	5	0,09
1A2b	Non-Ferrous Metals	CO_2	96	2	2	0	3	0,00
1A2c	Chemicals	CO_2	1 590	6	7	0	10	0,23
1A2d	Pulp, Paper and Print	CO_2	1 650	2	2	0	3	0,07
1A2e	Food Processing, Beverages and Tobacco	CO_2	662	3	2	0	4	0,04
1A2f	Other Manufacturing Industries and Construction, stationary	CO_2	3 207	7	4	0	7	0,37
1A	Mobile combustion	CO_2	24 073	13	7	0	14	5,28
1A4a	Commercial/Institutional	CO_2	839	9	2	0	9	0,12
1A4b	Residential, Stationary	CO_2	1 170	17	1	0	17	0,30
1A4c	Agriculture/Forestry/Fisheries, Stationary	CO_2	386	15	1	0	15	0,09
1A5a	Other non-specified combustion	CO_2	8	55	5	0	55	0,01
1B1	Solid fuels	CO_2	615	39	15	0	42	0,39
1B2	Oil and Natural Gas	CO_2	627	16	9	0	19	0,18
2A	Mineral Products	CO_2	2 180	1	3	7	4	0,13
2B	Chemical Industry	CO_2	47	5	5	0	7	0,01
2C	Metal Production	CO_2	2 706	5	5	3	5	0,22
3	Solvent and other product use	CO_2	163	15	20	0	25	0,06
6C	Waste Incineration	CO_2	103	0	0	20	20	0,03
	Total CO_2		**51 621**					**5,43**

Table 17 cont. Tier 1 uncertainty assessment for national total emissions of CO_2 equivalents in 2007 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 2007	Activity data uncertainty	Emission factor uncertainty	Emission data uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	CH_4	74	2	32	0	32	0,04
1A1b	Petroleum Refining	CH_4	1	8	84	0	85	0,00
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CH_4	0	4	16	0	17	0,00
1A2a	Iron and Steel	CH_4	1	3	18	0	19	0,00
1A2b	Non-Ferrous Metals	CH_4	0	2	12	0	12	0,00
1A2c	Chemicals	CH_4	1	6	14	0	15	0,00
1A2d	Pulp, Paper and Print	CH_4	28	2	38	0	38	0,02
1A2e	Food Processing, Beverages and Tobacco	CH_4	1	3	29	0	30	0,00
1A2f	Other Manufacturing Industries and Construction, stationary	CH_4	15	9	87	0	88	0,02
1A	Mobile combustion	CH_4	40	33	36	38	31	0,02
1A4a	Commercial/Institutional	CH_4	12	10	97	0	98	0,02
1A4b	Residential, Stationary	CH_4	265	10	100	0	100	0,41
1A4c	Agriculture/Forestry/Fisheries, Stationary	CH_4	24	10	99	0	100	0,04
1A5a	Other non-specified combustion	CH_4	0	55	20	0	59	0,00
1B1	Solid fuels	CH_4	0	34	14	0	37	0,00
1B2	Oil and Natural Gas	CH_4	5	8	20	400	385	0,03
2B	Chemical Industry	CH_4	1	0	0	100	100	0,00
2C	Metal Production	CH_4	0	5	20	0	21	0,00
2D	Other, pulp and paper production	CH_4	7	5	20	0	21	0,00
4A	Enteric Fermentation	CH_4	2 736	5	25	0	25	1,08
4B	Manure Management	CH_4	472	20	50	0	54	0,39
6A	Solid Waste Disposal on Land	CH_4	1 675	30	50	0	58	1,51
	Total CH4		5 357					1,94

Table 17 cont. Tier 1 uncertainty assessment for national total emissions of CO_2 equivalents in 2007 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 2007	Activity data uncertainty	Emission factor uncertainty	Emission data uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	N_2O	382	1	21	0	21	0,13
1A1b	Petroleum Refining	N_2O	21	8	82	0	83	0,03
1A1c	Manufacture of Solid Fuels and Other Energy Industries	N_2O	3	4	18	0	18	0,00
1A2a	Iron and Steel	N_2O	16	3	20	0	20	0,01
1A2b	Non-Ferrous Metals	N_2O	2	3	24	0	24	0,00
1A2c	Chemicals	N_2O	19	6	14	0	15	0,00
1A2d	Pulp, Paper and Print	N_2O	108	1	27	0	27	0,05
1A2e	Food Processing, Beverages and Tobacco	N_2O	10	2	15	0	15	0,00
1A2f	Other Manufacturing Industries and Construction, stationary	N_2O	139	6	29	0	30	0,06
1A	Mobile combustion	N_2O	523	19	30	46	29	0,24
1A4a	Commercial/Institutional	N_2O	11	7	33	0	34	0,01
1A4b	Residential, Stationary	N_2O	88	9	89	0	89	0,12
1A4c	Agriculture/Forestry/Fisheries, Stationary	N_2O	11	8	66	0	67	0,01
1A5a	Other non-specified combustion	1A5a	0	55	20	0	59	0,00
1B1	Solid fuels	N_2O	2	34	14	0	37	0,00
1B2	Oil and Natural Gas	N_2O	15	3	32	0	32	0,01
2B	Chemical Industry	N_2O	252	2	5	125	7	0,03
2D	Other, pulp and paper production	N_2O	86	5	20	0	21	0,03
3	Solvent and other product use	N_2O	131	10	10	0	14	0,03
4B	Manure Management	N_2O	478	20	50	0	54	0,40
4D	Agricultural Soils	N_2O	4 744	16	69	0	71	5,18
6B	Wastewater Handling	N_2O	139	10	50	0	51	0,11
	Total N2O		7 181					5,20
2C	Metal Production	PFC	246	2	30	0	30	0,11
2C	Metal Production	SF6	113	0	0	40	40	0,07
2F	Consumption of Halocarbons and SF6	HFC	855	11	26	0	28	0,37
2F	Consumption of Halocarbons and SF6	PFC	2	25	50	0	56	0,00
2F	Consumption of Halocarbons and SF6	SF6	37	12	16	0	20	0,01
	Total F-gases		894					0,37
	Total Sweden (CO_2-eqvivalents)		65 053					7,73

Table 17 cont. Tier 1 uncertainty assessment for national total emissions of CO2 equivalents in 1990 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 1990	Activity data uncertainty	Emission factor uncertainty	Emission data uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 1990
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	CO_2	7 691	1	5	0	5	0,55
1A1b	Petroleum Refining	CO_2	1 778	9	4	0	10	0,24
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CO_2	361	4	14	0	15	0,07
1A2a	Iron and Steel	CO_2	1 057	3	4	0	5	0,07
1A2b	Non-Ferrous Metals	CO_2	142	2	5	0	5	0,01
1A2c	Chemicals	CO_2	1 146	5	5	0	8	0,12
1A2d	Pulp, Paper and Print	CO_2	2 186	1	3	0	3	0,11
1A2e	Food Processing, Beverages and Tobacco	CO_2	949	3	2	0	3	0,04
1A2f	Other Manufacturing Industries and Construction, stationary	CO_2	4 095	8	1	0	8	0,47
1A	Mobile combustion	CO_2	21 987	15	7	0	16	5,02
1A4a	Commercial/Institutional	CO_2	2 541	14	1	0	14	0,51
1A4b	Residential, Stationary	CO_2	6 056	18	1	0	18	1,55
1A4c	Agriculture/Forestry/Fisheries, Stationary	CO_2	481	9	1	0	9	0,06
1B1	Solid fuels	CO_2	789	49	15	0	51	0,56
1B2	Oil and Natural Gas	CO_2	311	4	5	0	6	0,03
2A	Mineral Products	CO_2	1 919	2	4	7	4	0,11
2B	Chemical Industry	CO_2	69	5	7	0	9	0,01
2C	Metal Production	CO_2	2 413	4	4	3	5	0,17
3	Solvent and other product use	CO_2	242	15	20	0	25	0,08
6C	Waste Incineration	CO_2	44	0	0	20	20	0,01
	Total CO_2		56 257					5,37

Table 17 cont. Tier 1 uncertainty assessment for national total emissions of CO_2 equivalents in 1990 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 1990	Activity data uncer-tainty	Emission factor uncertainty	Emission data uncer-tainty	Combined uncertainty	Combined uncertainty as % of total na-tional emissions in 1990
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	CH_4	21	2	21	0	21	0,01
1A1b	Petroleum Refining	CH_4	1	8	80	0	81	0,00
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CH_4	0	4	17	0	18	0,00
1A2a	Iron and Steel	CH_4	0	3	20	0	20	0,00
1A2b	Non-Ferrous Metals	CH_4	0	3	18	0	18	0,00
1A2c	Chemicals	CH_4	1	4	19	0	20	0,00
1A2d	Pulp, Paper and Print	CH_4	25	2	38	0	38	0,01
1A2e	Food Processing, Beverages and Tobacco	CH_4	1	3	20	0	20	0,00
1A2f	Other Manufacturing Industries and Construction, stationary	CH_4	17	9	89	0	90	0,02
1A	Mobile combustion	CH_4	112	30	48	39	36	0,06
1A4a	Commercial/Institutional	CH_4	5	8	71	0	71	0,01
1A4b	Residential, Stationary	CH_4	232	10	99	0	99	0,32
1A4c	Agriculture/Forestry/Fisheries, Stationary	CH_4	1	8	76	0	76	0,00
1B1	Solid fuels	CH_4	0	40	13	0	42	0,00
1B2	Oil and Natural Gas	CH_4	5	4	23	400	390	0,03
2B	Chemical Industry	CH_4	1	0	0	100	100	0,00
2C	Metal Production	CH_4	0	5	20	0	21	0,00
2D	Other, pulp and paper production	CH_4	5	5	20	0	21	0,00
4A	Enteric Fermentation	CH_4	3 058	5	25	0	25	1,08
4B	Manure Management	CH_4	349	20	50	0	54	0,26
6A	Solid Waste Disposal on Land	CH_4	2 874	40	50	0	64	2,56
	Total CH_4		6 709					2,81

Table 17 cont. Tier 1 uncertainty assessment for national total emissions of CO_2 equivalents in 1990 without adjustment for correlation between gases.

CRF	IPCC category	GHG	Emissions 1990	Activity data uncer-tainty	Emission factor uncertainty	Emission data uncer-tainty	Combined uncer-tainty	Combined uncer-tainty as % of total national emissions in 1990
			Gg CO_2 eq	%	%	%	%	%
1A1a	Public electricity and Heat production	N_2O	305	2	26	0	27	0,11
1A1b	Petroleum Refining	N_2O	21	8	77	0	77	0,02
1A1c	Manufacture of Solid Fuels and Other Energy Industries	N_2O	3	4	17	0	18	0,00
1A2a	Iron and Steel	N_2O	15	3	21	0	21	0,00
1A2b	Non-Ferrous Metals	N_2O	3	3	19	0	20	0,00
1A2c	Chemicals	N_2O	19	4	15	0	16	0,00
1A2d	Pulp, Paper and Print	N_2O	118	1	24	0	24	0,04
1A2e	Food Processing, Beverages and Tobacco	N_2O	19	3	20	0	20	0,01
1A2f	Other Manufacturing Industries and Construction, stationary	N_2O	156	6	30	0	31	0,07
1A	Mobile combustion	N_2O	485	18	31	50	30	0,20
1A4a	Commercial/Institutional	N_2O	31	13	26	0	29	0,01
1A4b	Residential, Stationary	N_2O	115	10	55	0	56	0,09
1A4c	Agriculture/Forestry/Fisheries, Stationary	N_2O	15	8	28	0	29	0,01
1B1	Solid fuels	N_2O	2	40	13	0	42	0,00
1B2	Oil and Natural Gas	N_2O	15	2	38	0	38	0,01
2B	Chemical Industry	N_2O	832	2	5	125	6	0,07
2D	Other, pulp and paper production	N_2O	66	5	20	0	21	0,02
3	Solvent and other product use	N_2O	90	10	10	0	14	0,02
4B	Manure Management	N_2O	728	20	50	0	54	0,55
4D	Agricultural Soils	N_2O	5 248	16	70	0	72	5,25
6B	Wastewater Handling	N_2O	195	10	50	0	51	0,14
	Total N_2O		8 480					5,29
2C	Metal Production	PFC	377	2	30	0	30	0,16
2C	Metal Production	SF_6	24	0	0	40	40	0,01
2F	Consumption of Halocarbons and SF_6	HFC	4	22	29	0	37	0,00
2F	Consumption of Halocarbons and SF_6	SF_6	84	3	9	0	10	0,01
	Total F-gases		87					0,01
	Total Sweden (CO_2-eqvivalents)		71 534					8,05

References

Gustafsson, T. 2005. Improved structures for uncertainty analysis. SMED report 2005.

Annex 8

Other Annexes

Annex 8:1

Description of Sweden's Emission Trading Scheme and comparison to the national inventory

The EU Emissions Trading Scheme (EU ETS) was launched on the 1st of January 2005 and covers approximately 740 installations in Sweden. Installations include combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, ceramics, pulp and paper.

The system is divided into different sectors, depending on the main activity at the installation. An installation is defined as a stationary technical unit where a listed Main Activity is carried out. All installations have a permit to emit carbon dioxide. An installation can be all or part of a plant or industry. If several different operators are situated in one plant, it may be divided into several installations.

THE MAIN ACTIVITIES IN THE EU ETS ARE:

Energy activities

The definition includes combustion installations with a rated thermal input exceeding 20 MW, mineral oil refineries and coke ovens. Sweden has an opt-in of small combustion installations that includes all combustion installations connected to a district heating grid with an aggregated installed capacity exceeding 20 MW.

Installations which incinerate municipal waste and/or hazardous waste are not included in the scheme. During the first trading period (2005-2007) Sweden has interpreted this in the following way: If an installation, or a certain boiler in an installation, mainly incinerate municipal waste or hazardous waste, they are excluded. But from 2008 and onwards (2nd trading period) all installations, or boilers at an installation, with a permit to the Environmental Code to incinerate municipal waste and/or hazardous waste will be excluded. Incineration of other kinds of waste, such as industrial waste, are included in the scheme.

Sweden has used a semi broad definition of combustion installation which means that an installation producing electricity, hot water, hot oil and steam were included but not kilns and ovens. For the second trading period (2008-2012) Sweden has followed the recommendation from the EU Commission to broaden the definition. From 2008 all combustion installations irrespective of fuel and irrespective of the purpose of the combustion will be included.

Production and processing of ferrous metals

The definition includes metal ore roasting or sintering installations, installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting.

In the production and processing of ferrous metals, the works are included in the process until the continuous casting. The rolling mill is not included in the EU ETS as part of an iron and steel plant, but from 2008 and onwards part of it can be included as a combustion installation if the requirements for an Energy activity are met.

Mineral industry

Installations for the production of cement clinker in rotary kilns or lime in rotary kilns or other furnaces are included. Also included are installations for the manufacture of glass including glass fibre and installations for the manufacture of ceramic products by firing.

Other activities

Industrial plants for the production of pulp from timber or other fibrous materials, or for the production of paper and board.

MONITORING AND REPORTING

The emissions are reported yearly to the competent authority, the Swedish Environmental Protection Agency. The deadline for reporting is March the year following the year when the emissions took place. Carbon dioxide is the only greenhouse gas included in the scheme in the first trading period. From 2008 some Member States has included N2O in their national scheme.

In the ETS, the yearly emission report is verified by an independent accredited verification body. The verifier controls the emissions report, and secures that the correct tiers, according to the ETS guidelines and the operators permit, are used and that the total emissions figure is accurate.

Comparisons of data in the GHG inventory and EU ETS in Sweden

Ever since the Swedish national allocation plan was prepared in 2004, Sweden has performed a number of studies to compare data in the both systems and improve the greenhouse gas (GHG) inventory.[85] One result of the studies is that for a number of plants in the Energy and Industrial process sectors, data from the ETS is used in the GHG inventory since it is convenient and since the quality is considered higher than that from data sources used in earlier submissions.

In Sweden, emissions from the systems needs to be compared on plant level and not on a total or sector based level, since the ETS does not cover all plants in the GHG inventory.

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[85] Nyström, A-K (2007). Study of differences in plant data between the Energy Statistics and the EU Emission Trading Scheme

Backman, H. and Gustafsson, T. (2006). Verification of activity data within the energy sector for the reporting to the UNFCCC, EU Monitoring Mechanism, CLRTAP and the EU NEC Directive using data from the EU Emission Trading Scheme. SMED-report.

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Gustafsson, T., Lidén, M. and Nyström, A-K., (2005).

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In 2006, a study on plants in the ETS Energy sector was performed based on data from 2005. The 63 plants with the largest emissions in the ETS in 2005, which accounted for 75% of the CO_2 emissions from all plants within the ETS were included in the study. Activity data, thermal values and CO_2 emission factors from the plants were compared with the energy statistics and analyzed. The results show that for one third of the plants, accounting for about 50% of the CO_2 emissions of the 63 plants investigated, no significant difference between the two data sources were identified. That is, the difference between the energy consumption in the ETS and QS were lower than the reported uncertainty limits in the GHG inventory.

For about 20 of the remaining plants other explanations were possible that still made the quarterly fuels statistics appropriate to use, such as that the fossil fuel activity data in the quarterly fuel statistics was consistent with the time series, while the data from the ETS showed large discrepancies. For the remaining plants closer studies were made and for three plants (refineries) ETS data was recommended as data source for the GHG inventory. For the other remaining plants a number of reasons for the differences were identified, for instance the absence of waste fuel in ETS data.

In 2007, a new study was performed based on data from 2006. The study focused on plants with the highest differences in the previous study and where sufficient explanations for the differences were not found. Comparisons were made between the ETS and the quarterly fuel statistics and showed that energy amounts and emissions differed between the data sets in several cases. A difference of 17% between the datasets was found when the fossil energy consumption was compared for 19 plants included in the study. When waste was excluded the difference was smaller. In the following text, some main conclusions are summarized, which will explain differences between the data sets.

General differences

Not all of the plants in the GHG inventory are included in the ETS, due to the definitions used in ETS. For combustion plants for instance, only installations with a rated thermal input exceeding a certain limit are included in ETS, but in GHG inventories all plants are included.[86]

In the GHG inventory emissions are separated in Energy and Industrial process emissions and into different subsectors (CRF codes). In the ETS, there is a similar system but a number of plants that are reported in specific industrial CRF sectors in the GHG inventory are included as a combustion installation in the ETS and are hence included in the Energy sector. That is for instance the case for chemical producers and pulp and paper producers. Some technical units in food industry and engineering industry are also included in the ETS as combustion plants in the Energy sector.

[86] For further information of the completeness, see each sector chapter in the National Inventory Report.

Definitions of Energy and Industrial process emissions

When comparing data with emissions from the use of raw materials, the definitions and the interpretation of the IPCC Guidelines results in different categorization of energy and process related emissions in the both systems.

For instance emissions from catalytic cracking in oil refineries are reported as process related in the ETS, while in the GHG inventory they are reported in the Energy sector.

Primary iron and steel works calculate and report their emissions according to a mass balance approach in the ETS, whereas in the GHG inventory emissions are reported in several different sectors (CRF codes) in line with how the IPCC guidelines have been interpreted.

DIFFERENCES IN THE ENERGY SECTOR

Different certainty on plant level data

Data from Statistics Sweden's quarterly fuels statistics is used in the GHG inventory in the Energy sector. Data is reported quarterly from the plants and might have to be estimated if data is not available. ETS data on the other hand are reported after the year ends for all sectors and is in addition verified by an independent accredited verification body.

Different aggregations of micro data in the Energy sector

The basis for the quarterly fuel statistics survey, used for energy production plants (CRF 1A1a), is not by plant, but by company and municipality. Identifying energy consumption and emissions for specific plants in that sector is therefore in some cases not possible.

Only parts of plants included in the ETS

Combustion of municipal solid waste is not included in the ETS, while it is included in the GHG inventory. For instance, the plant with the largest emissions within the Chemical industries sector (CRF 1A1c) is only partly included in the ETS in the first trading period.

Emission factors and thermal values

In the ETS, the plants in some cases use plant specific emission factors and thermal values, while in the GHG inventory, thermal values and CO_2 emission factors are in many cases general and yield good estimates on national level. Hence, they are to some extent not representative on plant level.

Another smaller problem in the GHG inventory is that unconventional fuels are grouped together into for instance “other non specific fuels” which leads to high uncertainties on plant level since the emission factors are not specific for a certain fuel. Besides, some of those unconventional fuels are incorrectly classified. In the ETS some of these fuels are often partly biogenic and should hence be classified as "Other biomass" in GHG inventory.

Annex 8:2

Normal-year corrected emissions

Normal-year correction of green-house gas emissions

In the UNFCCC Reporting Guidelines on Annual Inventories, Parties are encouraged to give information on application of adjustments as it is regarded as important information in relation to the monitoring of emission and removal trends and the performance of national policies and measures. Information on fossil CO_2-emissions adjusted for climatic conditions in Sweden was included in the Third National Communication on Climate Change due in November 2001 and up-dated in the Fourth National Communication in 2005.

The Swedish climate varies a great deal from year to year. Temperature, solar radiation and wind influence the amount of energy needed to heat buildings in order to maintain normal indoor temperatures. Precipitation affects the quantity of water flowing in watercourses and hence the potential for generating electric energy using hydropower.

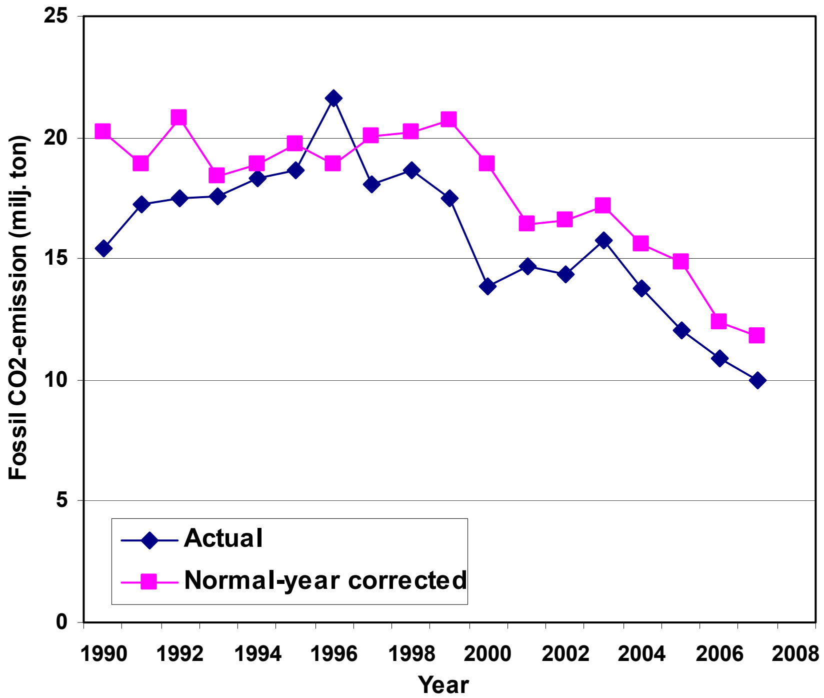

Figure 16. Actual and normal-year corrected fossil CO_2-emissions for heating of buildings and electricity production for the years 1990-2007. For 2007 preliminary data is used for the fossil fuel consumption.

Sweden has developed a normal-year correction method for adjusting fossil CO_2-emissions for climatic conditions in Sweden to be able to compare the actual emissions with a climatic "normal" year. Normal-year correction includes emissions from heating of buildings (but not cooling) and from electricity generation. The model used to calculate the need, depending of weather, for heating of buildings is described in more detail in Appendix 19 in Sweden's Third National Communication on Climate Change, also in [1] and later further elaborated in details. The model for normal-year corrections of CO_2-emissions from electricity production is described in [2]. Actual and normal-year corrected fossil CO_2-emissions caused by heating of buildings plus electricity production are shown for 1990-2007 (preliminary data for fossil fuel consumption in 2007) in Figure 16. In Table 18 the normal-year corrections of fossil CO_2-emissions (1000 ton CO_2/year) in total and separated for electricity production (including electric heating) and heating of buildings (except electric heating) are shown. The correction shall be added to the actual emission to obtain the normal-year emission.

	Normal-year corrections of fossil CO2 [1000 ton CO2/year]		
Year	Electricity production & heating	Heating buildings excl. el-heating	Total normal-year correction
1990	2827	1943	4770
1991	933	765	1698
1992	1905	1425	3330
1993	303	502	805
1994	132	496	628
1995	706	342	1048
1996	-1938	-757	-2695
1997	1257	680	1937
1998	1184	325	1509
1999	2108	1065	3173
2000	3436	1619	5055
2001	1265	487	1752
2002	1364	901	2265
2003	757	662	1418
2004	1170	642	1813
2005	1965	859	2824
2006	482	1048	1530
2007P	723	1064	1786

Table 18. Annual 1990-2007 (2007 preliminary data) calculated normal-year corrections of fossil CO_2-emissions (1000 ton CO_2/year). Values are given for the total correction as well as separated into heating of buildings (excluding electric heating) and electricity production (including electric heating). The correction shall be added to the actual emission to obtain the normal-year emission.

REFERENCES

[1] Persson C. Normalårskorrigering av Sveriges utsläpp av fossil CO_2 från uppvärmning. Summary in English. Rapportserie SMED och SMED&SLU, Nr 1. 2004

[2] Holmberg J. & Axelsson J. Kortfattad metodbeskrivning – Normalårskorrigering av el. SwedPower. 2006

Annex 8:3
Units and Abbreviations

t	1 (metric) tonne = 1 megagram (Mg) = 10^6 g
toe	tonne oil equivalent 1 toe = 41.87 GJ
Mg	1 megagram = 10^6 g = 1 tonne
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
TJ	1 terajoule
ARTEMIS	Assessment and Reliability of Transport Emission Models and Inventory Systems
AWMS	Animal Waste Management System
C	Carbon or Confidential
CH_4	Methane
EMIR	Emissions database of the county administrative boards
CFCs	Freons
CKD	Cement kiln dust
CO	Carbon monoxide
CO_2	Carbon dioxide
COP	Conference Of the Parties
CORINAIR	EMEP/CORINAIR Emission Inventory Guidebook
CRF	Common Reporting Format
EC	Environmental Class
EAA	European Aluminium Association
EEA	European Environment Agency
EF	Emission Factors
EU	European Union
EMV	Emission Model for Road Traffic
ETS	European Union Emission Trading Scheme
FAME	Fatty Acid Methyl Ester (earlier called RME)
F-gases	Fluorinated gases (HFCs, PFCs, SF_6)
FMV	Swedish Defence Material Administration
FOD model	IPCC First Order Decay model
FOI	Swedish Defence Research Agency
FORTV	Swedish Fortification Department
FRA	National Defence Radio Institute
FTP	Federal Test Procedure
GHG	Greenhouse gases
Good Practice Guidance	IPCC Good Practice Guidance and Uncertainty Managment in National Greenhouse Gas Inventories IPCC NGGIP
GWP	Global Warming Potential
Halocarbons	Organic compunds containing one or more halogens
HFCs	Hydrofluorcarbons
IE	Included Elsewhere

IEF	Implied Emission Factors
Industrial statistics	Industrial energy statistics
IPCC	Intergovernmental Panel on Climate Change
IPCC Guidelines	Revised 1996 Guidelines for National Greenhouse Gas Inventories
IVL	IVL Swedish Environmental Research Institute AB
Jernkontoret	Swedish Steel Producers' Association
KemI	The Swedish Chemicals Inspectorate
LPG	Liquified Petroleum Gas
LTO	Landing and Take-Off
LUCF	Land-use change and forestry
LULUCF	Land-use, land-use change and forestry
MSW	Municipal solid waste
N_2O	Nitrous oxide
NAP	Swedish national allocation plan
NA	Not Applicable
NBF	National Board of Forestry
NE	Not Estimated
NFI	National Forest Inventory
NIR	National Inventory Report
NMVOC	Non Methane Volatile Organic Compounds
NO	Not Occuring
NO_X	Nitrogen oxides
NSFSV	National Survey of Forest Soils and Vegetation
MTC	Motor Test Center
O_3	Ozone
PFCs	Perfluorocarbons
QA/QC	Quality assurance and Quality control
Quarterly statistics	Quarterly fuel statistics
RME	Rapeseed Methyl Ester fuel
RVF	Swedish Association of Waste Management
SCAA	Swedish Civil Aviation Authority
SF_6	Sulphur hexafluoride
SGU	Geological Survey of Sweden
SJV	Swedish Board of Agriculture
SLU	Swedish University of Agricultural Sciences
SMED	Swedish Environmental Emissions Data
SMHI	Swedish Meteorological and Hydrological Institute
SNRA	Swedish National Road Administration
SO_2	Sulphur dioxide
SPI	Swedish Petroleum Institute
Swedish EPA	Swedish Environmental Protection Agency
UNFCCC	United Nations Convention on Climate Change
VETO	Mechanistic model for simulations on road traffic
VTI	Swedish Road- and Transport Research Institute
WBCSD	World Business Council for Sustainable Development
WRI	World Resource Institut