

**NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME
NATIONAL EMISSION CENTRE**

Poland's National Inventory Report 1999

Submission under
the United Nations Framework
Convention on Climate Change

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Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1999. The inventory covers the following GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF₄), perfluoroethane (C₂F₆), perfluorobutane (C₄F₁₀), and sulfur hexafluoride (SF₆). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides (NO + NO₂) - NO_x, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO₂.

The national inventory and accompanying tables of Common Reporting Format (CRF), have been prepared in accordance with the UN FCCC Reporting Guidelines on Annual Inventories. Methodologies used to calculate emissions and sinks of GHGs, are in accordance with methods recommended in two basic publications of Intergovernmental Panel on Climate Change - IPCC, namely *Revised 1996 Guidelines for National Greenhouse Gas Inventories*, and *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. According to these guidelines country specific methods have been used where appropriate and give more accurate emission data. Although, national inventory reports in Polish have been compiled since early 1990s, the first Polish NIR, in English, was submitted to UN FCCC Secretariat in 2003. Here, we present and discuss the results of the GHG national inventory for the year 1999. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1999, expressed as CO₂ equivalents, are presented in table ES.1 In 1999 the total national emission of GHG were about 418.89 million tones of CO₂-eq., excluding GHG emissions and sinks from category 5. (Land use change and forestry). Compared to the base year (1988/1995), the 1999 emissions have decreased by 28.6%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1999. [Gg CO₂ eq.]

Pollutant	Base year	1999	(1999-base)/base
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	315 162.18	-0.32
CO ₂ – without LUCF	494 885.88	345 007.89	-0.30
CH ₄	49 256.41	42 028.13	-0.15
N ₂ O	42 478.82	31 388.84	-0.26
HFCs	26.44	206.44	6.81
PFCs	250.18	239.79	-0.04
SF ₆	13.15	14.39	0.09
TOTAL without CO ₂ from LUCF	586 910.88	418 885.46	-0.29
TOTAL with LUCF	553 976.16	389 039.75	-0.30

* 1995 is the base year for HFCs, PFCs and SF₆

Carbon dioxide emissions

The CO₂ emissions in 1999 were estimated as 345.01 million tones. This is 30.3% lower than in the base year. CO₂ emission was accounted for 82.4% of total GHG emissions in Poland in 1999. The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.41% in 1999. The shares of the main

subcategories were as follows: *Energy industries* – 51.8%, *Manufacture Industries and Construction* – 16.0%, *Transport* – 9.5% and *Other Sectors* – 17.3%. *Industrial Processes* contributed to the total CO₂ emission by 4.3% in 1999. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO₂ removal in LUCF sector in 1999, was calculated to be approximately 29.8 million tonnes. It means that app. 7.7% of the total CO₂ emissions are offset by CO₂ uptake by forests.

Methane emissions

The CH₄ emission amounted to 2 001.34 Gg in 1999 i.e. 42.03 million tonnes of CO₂ equivalents. The contribution of CH₄ to the national total GHG emission was 10.0% in 1999. Three of main CH₄ emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture and Waste*. They contributed 37.8%, 33.4% and 27.4% to the national methane emission in 1999, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (28.5% of total CH₄ emission) and Oil and Natural Gas system (9.2% of total CH₄ emission). Waste disposal sites contributed to 14.8% of the methane emission from total CH₄ emission and Wastewater Handling contributed to 12.6% of total CH₄ emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.9% of total CH₄ emission in 1999.

Nitrous oxide emissions

The nitrous oxide emissions in 1999 were 101.25 Gg i.e. 31.39 million tonnes of CO₂ equivalents. The emission was app. 26.1% lower than the respective figure for the base year. The contribution of N₂O to the national total GHG emission was 7.5% in 1999. The main N₂O emission sources and its shares in total N₂O emission in 1999 are as follow: *Agricultural Soils* – 54.5%, *Manure Management* – 22.0%, *Chemical Industry* – 11.1% and *Fuel Combustion* – 8.4%.

Hydrofluorocarbons (HFCs) emissions

The total emission of HFCs in 1999 was 0.21 million tonnes CO₂ equivalents. The contribution of HFCs to the national total GHG emission in 1999 was relatively low and has been estimated at 0.05%. The emissions of HFCs-gases had increased 8 times between the base year (1995) and 1999. This significant growth in HFCs emission is mainly due to the increase of emission from refrigeration and air conditioning equipment.

Perfluorocarbons (PFCs) emissions

The total emission of PFCs in 1999 was 0.24 million tonnes of CO₂ equivalents. The contribution of PFCs to the national total GHG emission in 1999 was 0.06%. The emission of PFCs had fluctuated to a limited extend, and followed the trends in aluminium production-its main source. The emission changes between 1999 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C4F10 in fire extinguishers

Sulfur hexafluoride emissions

The total emission of SF₆ in 1999 was 0.01 million tonnes of CO₂ equivalents. The contribution of SF₆ to the national total GHG emission is insignificant, and in 1999 amounted to app. 0.003%. SF₆ emissions in 1999 were by 1.1 times higher than in 1995. Leakage from electrical equipment during its use and production is the main SF₆ emission source.

1. Introduction

1.1 Background information on greenhouse gas inventories and climate change

The report and underlying CRF tables have been prepared according to updated reporting guidelines on annual inventories of the following GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF₄), perfluoroethane (C₂F₆), perfluorobutane (C₄F₁₀), and sulfur hexafluoride (SF₆). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides (NO + NO₂) - NO_x, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO₂ (according to document FCCC/SBSTA/2006/9 published on 18.08.2006 following the decision 14/CP.11)

The ultimate goal of the United Nations Framework Convention on Climate Change (UNFCCC) is "...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system...". The basic evidence for fulfilling UNFCCC obligations is annual inventory made by Parties to the Convention.

1.2 A description of institutional arrangement for inventory preparation

GHG inventory presented below has been compiled by the National Emission Centre (NEC) established in 2000 at the Institute of Environmental Protection in Warsaw. NEC has been commissioned by the Polish Ministry of Environment to carry out inventories for the GHGs and other air pollutants. Since 2006 NEC is located within the National Administrator of Emission Trading Scheme established also in the Institute of Environmental Protection.

When compiling the inventory, NEC have been collaborating with a number of individual experts as well as institutions. Among the latter are: Central Statistical Office (GUS), Agency of Energy Market (ARE), Institute of Ecology of Industrial Areas in Katowice (IETU), Institute of Automobile Transport (ITS) as well as Office for Forest Planning and Management (BULGiL).

1.3 Brief description of the process for inventory preparation

The GHG emission estimates are based on methodologies elaborated by the Intergovernmental Panel on Climate Change (IPCC) and recommended by the UNFCCC, while emissions of indirect gases according to methodology elaborated by UN ECE/EMEP [IPCC 1997, IPCC 2000, IPCC 2003, EEA 2004]. Wherever necessary and possible, domestic methodologies and emission factors have been developed to reflect specific national conditions. The most important features of the inventory preparation and archiving can be briefly summarized in the following way:

- activity data are mostly taken from official public statistics (GUS) or when required data are not directly available, (commissioned) research reports or expert estimates are used instead,
- emission factors for the main emission categories are mostly taken from reports on domestic research; IPCC default data are used in cases where the emission factors are highly uncertain (e.g. N₂O emissions from animal waste in agriculture, and CH₄ and N₂O emission from stationary combustion), or when particular source category contribution to national total is insignificant,

- all activity data, emission factors and resulting emission data are stored at NEC database, which is constantly updated and extended to meet the ever changing requirements for emission reporting, with respect to UNFCCC and LTRAP as well as their protocols.

1.4 General description of methodologies and data sources used

The GHG emissions and removals inventory presented in this report follow the recommended Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [IPCC 1997], and the IPCC Good Practice Guidance and Uncertainty Management [GPG 2000]. According to these guidelines country specific methods have been used where appropriate giving more accurate emission data especially in case of key categories. For categories where emissions do not occur or are not estimated the abbreviation NE was used in tables. More detail description of methodologies used in Polish GHG inventory are given in sections 3–8.

The calculated emissions can be presented by various combinations of fuels, sources and sectors. The emissions from fuel combustion are calculated by combining the fuel consumption distributed among emission sources and economy sectors with fuel, source, sector and pollutant specific emission factors. The non-combustion emissions are estimated by combining activity data with emission factors. The emission factors are either estimated from measurements or taken from special investigations. If not available domestically, emission factors are taken first of all from IPCC guidelines or other international publications. The emissions of non-CO₂ gases are expressed in units of CO₂ equivalents, based on Global Warming Potentials (GWP), calculated for a time horizon of 100 years [IPCC 1995].

One of the main steps of emission inventorying from the 1.A. *Energy* category, is preparation of energy budgets for each energy carrier. These budgets are prepared based on the national energy balances published by Central Statistical Office and Agency of Energy Market. The tables of the national energy balance include detailed information on the ins and outs of all the energy carriers used in Poland, as well as information on their conversions to other energy carriers and on their direct consumption. The data for international bunker are also assessed.

The example of evaluation of hard coal consumption is given in table 1.1. The examples of the fuel budgets for: coking coal, brown coal (lignite), fuel oil and high-methane and nitrified natural gas are presented in Annex 2. For each fuel, balance data are given both in natural units and in common (energy) units.

Table 1.1 Steam coal consumption

Evaluation of fuel consumption in national combustion processes	Steam coal	
	10 ³ Mg	TJ
In	102 864	2 428 065
From national sources	100 535	2 365 534
1) Indigenous production	100 087	2 355 333
2) Transformation output or return	0	0
3) Stock decrease	448	10 200
Import	2 329	62 531
Out	102 864	2 428 065
National consumption	82 303	1 932 230
1) Transformation input	65 526	1 520 590
a) input for secondary fuel production	13 585	401 497
b) fuel combustion	51 941	1 119 094
2) Direct consumption	16 777	411 640
Non-energy use	1	30
Combusted directly	16 776	411 610
Combusted in Poland	68 716	1 530 704
Stock increase	407	11 963
Export	19 684	532 681
Losses and Statistical differences	471	-48 809
Net Calorific Value	MJ/kg	22.28
CO ₂ Emission Factor	kg/GJ	96.60

The data on quantity of the fuel combusted in whole country in a given year are used for calculation of the average net calorific value of the fuel. This calculated net calorific value provides then the basis for the estimation of country specific CO₂ emission factor for the given fuel. The calculations of these CO₂ emission factors for main fuels are based on empirical formulas that apply the relationship between net calorific values and elemental carbon content. The maximum (potential) CO₂ emission from combustion of a given fuel is, in turn, calculated based on the estimated emission factor. It is one of the way of checking the CO₂ emission value, estimated according to sectoral approach.

Basic information on activity data regarding IPCC categories, are usually published in various GUS statistical yearbooks. The activity data that are not available in GUS publications, have been worked out by experts based on studies commissioned by the Ministry of Environment specifically for the GHG emission inventory purposes.

Energy Statistics published by Central Statistical Office is the main source of activity data for *Energy* sector. The data on fuel consumption in *Transport* subcategory, including the fuel consumption data for various types of vehicles, are worked out routinely by experts from the Institute of Automobile Transport, as well as the emission factors for road transport.

1.5 Brief description of key source methodologies

The source categories in all sectors, are identified to be *key sources* on the basis of their contribution to the total level and/or trend uncertainty in accordance with IPCC Good Practice Guidance [IPCC 2000]. The complete tables with level and trend assessment are given in Annex 1.

1.6 Information on the QA/QC plan including verification

Comprehensive QA/QC system in Poland is still under development but general procedures are in place to ensure appropriate quality of national inventories. Activities underlying the Quality Control procedures within Polish GHG inventory system contain routine and consistent checks to ensure data integrity within entire time series, correctness as well as completeness. Potential errors and omissions are addressed through routinely checks. An extended QC procedure is carried out for higher tier methods including reviews of activity and emission factor data, and methods. Quality Assurance consisting activities aiming at external reviews are performed occasionally under the auspices of Ministry of Environment.

Generally the first draft of the inventory in form of IPCC tables and draft CRF, is usually produced 12-14 months after the end of the given year depending primarily on the availability of required activity data. The most of activity data comes from national statistics undergoing internal revision and checking process before using it in the inventory. But still extensive checks are done in form of consultations with data providers. The consultations cover both correctness of data and their proper interpretation. The most important institutional sources include: Central Statistical Office, Agency of Energy Market, and a number of collaborating individual experts and institutions. Wherever possible various different datasets are used for comparison purposes. All activity data, parameters and factors used for emission estimates for a given year are examined in comparison to entire time series to detect doubtful figures. Outliers are scrutinized in more detail. After the checking period is completed, the final CRF is prepared together with the accompanying report. The CRF Reporter is also used as one of the checking tool for detecting potential errors and omissions within domestic inventory.

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

Uncertainty evaluation made for 1999 is based on calculations and national experts judgements/estimations prepared in 2006 as well as opinions expressed by international experts under UNFCCC Secretariat during in-depth review made in 2005. Calculations includes simplified method for sector 5 and for fluorinated gases.

In Annex 5, the estimate of emission uncertainty for the year 1999 using *Tier 1* approach is given. The uncertainty figures varied significantly among various source categories. More details are included in Annexes 5.

1.8 General assessment of the completeness

The Polish GHG emission inventory includes calculation of emissions from all relevant sources that we are aware of. However, there is a number of exceptions. All of them are expected to have a minor effect on the total national GHG emissions. These exceptions are:

in *Energy* sector (*Fugitive Emission from Fuels* only):

- CO₂ and CH₄ from *Solid Fuel Transformation*
- CO₂ from *Coal Mining and Handling*
- some individual processes in *Oil and Natural Gas* systems

in *Industrial Processes*:

- CO₂ from *Asphalt Roofing*
- CO₂ from *Road Paving with Asphalt*
- CH₄ from *Ferroalloys Production*
- CH₄ from *Aluminium Production*

- CO₂ from *Food and Drink Production*
- CH₄ from *Sinter*
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF₆

in *Agriculture*

- CH₄ from *Agriculture Soils*

in *LULUCF*

- N₂O from *Forest and Grassland Conversion*
- CO₂ from *Decay*

in *Waste*

- N₂O from *Industrial Wastewater*
- N₂O from *Domestic and Commercial Wastewater except Humane Sewage*
- CH₄ from *Waste Incineration*.

2. Greenhouse gas emissions and removals in 1999

2.1 GHG aggregated emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO₂ emission and removals from category 5. (Land Use Change and Forestry - LUCF). According to IPCC methodology, CO₂ emissions are given with and without contributions from category 5. Also following IPCC, emission of CO₂ from biomass, is not included in the national total.

For non-CO₂ gases, the inventory results can also be presented (table 2.1) in units of CO₂ equivalents by applying values of the so called Global Warming Potentials - GWP. GWP for methane is 21, and for nitrous oxide 310. Carbon dioxide is the main GHG in Poland with the 82.4% share (in 1999), while the methane contributes with 10.0% to the national total. Nitrous oxide contribution is 7.5% and all industrial GHG together contribute 0.1%.

Table 2.1 Greenhouse gas emissions in 1999 in CO₂ eq.

Pollutant	1999	
	Emission in CO ₂ eq. [Gg]	Share [%]
CO ₂ – net emission (with LUCF)	315 162.18	
CO ₂ – without LUCF.	345 007.89	82.36
CH ₄	42 028.13	10.03
N ₂ O	31 388.84	7.49
HFCs	206.44	0.05
PFCs	239.79	0.06
SF ₆	14.39	0.003
TOTAL without CO ₂ from LUCF	418 885.46	100.0
TOTAL with LUCF	389 039.75	

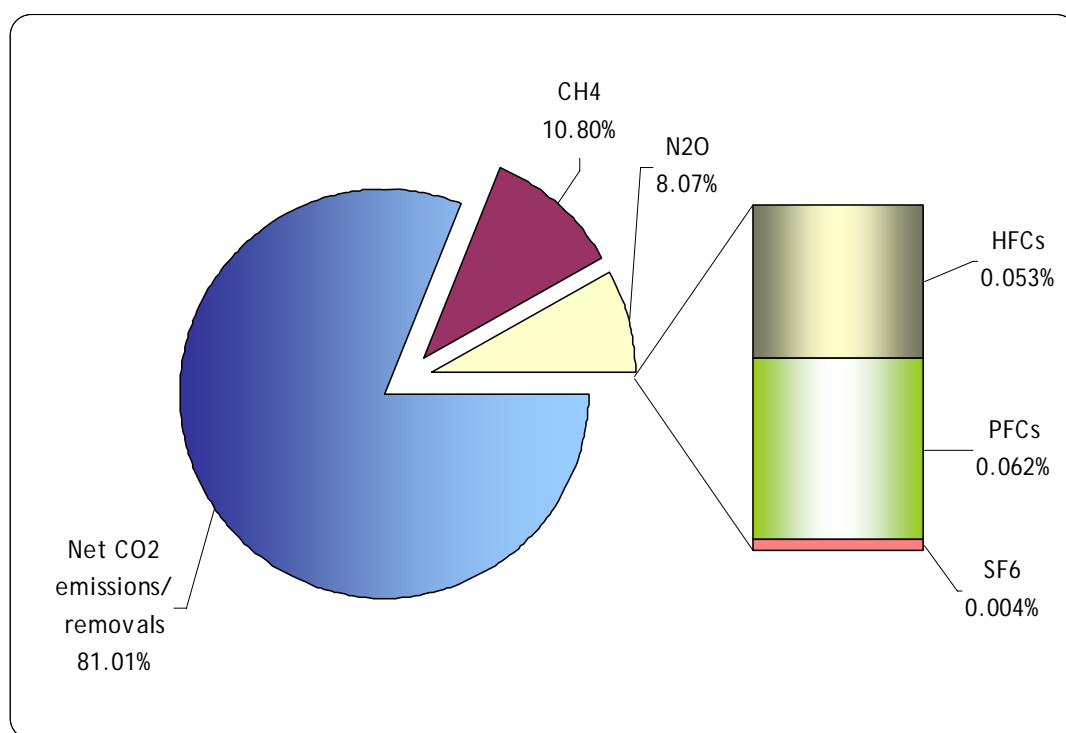


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1999

Emissions of main GHGs in 1999, disaggregated into main source sub-sectors, are given in table 2.2. Respective values for the industrial gases are presented in table 2.3. Discussion of these results is given in the following section

Table 2.2 Emissions of CO₂, CH₄ and N₂O in 1999 [Gg]

[Gg]	CO ₂	CH ₄	N ₂ O
TOTAL without CO ₂ from LUCF	345 007.89	2 001.34	101.25
1. Energy	329 312.28	772.72	8.51
A. Fuel Combustion	329 187.66	17.12	8.51
1. Energy Industries	178 820.55	2.03	2.60
2. Manufacturing Industries and Construction	55 135.76	2.32	0.85
3. Transport	32 656.75	6.79	3.33
4. Other Sectors	59 660.87	4.81	1.70
5. Other	2 913.74	1.18	0.03
B. Fugitive Emissions from Fuels	124.62	755.60	NE
1. Solid Fuels	0.66	570.67	NE
2. Oil and Natural Gas	123.96	184.93	NE
2. Industrial Processes	14 928.07	11.09	11.24
A. Mineral Products	8 250.74	NE	NE
B. Chemical Industry	2 736.11	8.93	11.24
C. Metal Production	3 941.21	2.15	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	411.04	NE	0.40
4. Agriculture	NE	668.96	77.51
A. Enteric Fermentation	NE	497.58	NE
B. Manure Management	NE	170.17	22.28
D. Agricultural Soils	NE	NE	55.17
F. Field Burning of Agricultural Residues	NE	1.22	0.06
5. Land Use, Land-Use Change and Forestry	-29 845.71	0.11	0.0007
A. Forest Land	-36 635.03	NE	NE
B. Cropland	6 977.65	NE	NE
C. Grassland	3 871.72	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-4 060.05	0.11	0.0007
F. Other Land	NE	NE	NE
6. Waste	356.51	548.46	3.60
A. Solid Waste Disposal on Land	NE	297.12	NE
B. Wastewater Handling	NE	251.34	3.53
C. Waste Incineration	356.51	NE	0.07

Table 2.3 Emissions of industrial gases: HFCs, PFCs and SF₆ in 1999 [eq. Gg]

1999	HFCs	PFCs	SF ₆	Total in eq. CO ₂
Total Industrial gases [Gg eq. CO ₂]	206.44	239.79	14.39	460.61
C. Metal Production	NE	230.76	NE	230.76
3. Aluminium Production	NE	230.76	NE	230.76
F. Consumption of Halocarbons and SF ₆	206.44	9.02	14.39	229.85
1. Refrigeration and Air Conditioning Equipment	96.85	NE	NE	96.85
2. Foam Blowing	10.40	NE	NE	10.40
3. Fire Extinguishers	1.27	9.02	NE	10.29
4. Aerosols	97.92	NE	NE	97.92
8. Electrical Equipment	NE	NE	14.39	14.39

As a supplement to the tables 2.2 and 2.3, table 2.4 includes percentage contributions of main source sectors to the national totals in 1999 for CO₂, CH₄ and N₂O.

Table 2.4 Percentage shares of individual source sectors in 1999 emissions

Percentage share of source sectors in biezacy emissions	Share [%]		
	CO ₂ without LUCF	CH ₄	N ₂ O
TOTAL	100.00	100.00	100.00
1. Energy	95.45	38.61	8.40
A. Fuel Combustion	95.41	0.86	8.40
1. Energy Industries	51.83	0.10	2.56
2. Manufacturing Industries and Construction	15.98	0.12	0.84
3. Transport	9.47	0.34	3.29
4. Other Sectors	17.29	0.24	1.68
5. Other	0.84	0.06	0.03
B. Fugitive Emissions from Fuels	0.04	37.75	NE
1. Solid Fuels	0.0002	28.51	NE
2. Oil and Natural Gas	0.04	9.24	NE
2. Industrial Processes	4.33	0.55	11.10
A. Mineral Products	2.39	NE	NE
B. Chemical Industry	0.79	0.45	11.10
C. Metal Production	1.14	0.11	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.12	NE	0.40
4. Agriculture	NE	33.43	76.55
A. Enteric Fermentation	NE	24.86	NE
B. Manure Management	NE	8.50	22.00
D. Agricultural Soils	NE	NE	54.49
F. Field Burning of Agricultural Residues	NE	0.06	0.06
5. Land Use, Land-Use Change and Forestry	NE	0.01	0.0007
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	NE	0.01	0.0007
F. Other Land	NE	NE	NE
6. Waste	0.10	27.40	3.55
A. Solid Waste Disposal on Land	NE	14.85	NE
B. Wastewater Handling	NE	12.56	3.49
C. Waste Incineration	0.10	NE	0.07

2.2 GHG emissions by gas

Carbon dioxide (CO₂)

In 1999, the net CO₂ emissions (with LULUCF) were estimated as 315.16 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 345.01 million tones (table 2.2). The main CO₂ emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO₂ emission by 95.41% in 1999. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 51.8%, *Manufacture Industries and Construction* – 16.0%, *Transport* – 9.5% and *Other Sectors* – 17.3%. Sector 2. *Industrial Processes* contributed to the total CO₂ emission by 4.3% in 1999. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO₂ emission/removal in LULUCF sector in 1999, was calculated to be approximately 29.8 million tonnes. It means that app. 7.7% of the total CO₂ emissions are offset by CO₂ uptake by forests.

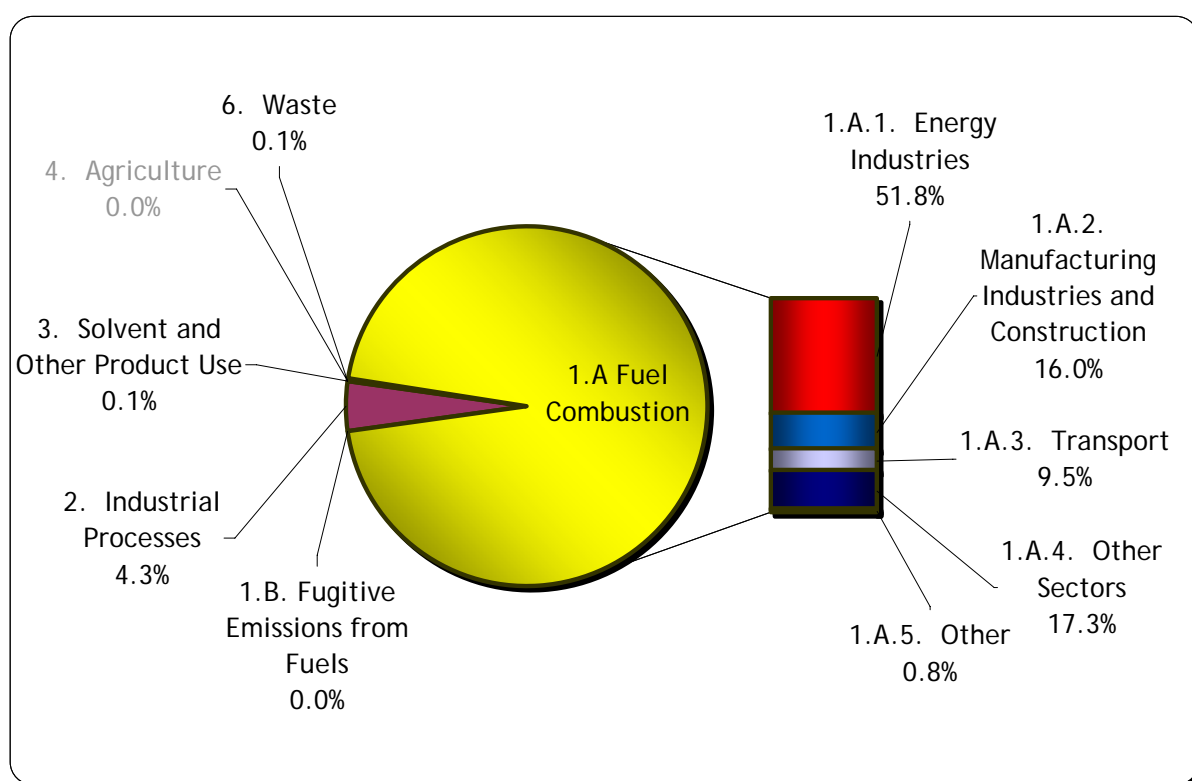


Figure 2.2 Carbon dioxide emission in 1999 by sector

Methane (CH₄)

The CH₄ emission amounted to 2 001.34 Gg in 1999 i.e. 42.03 million tones of CO₂ equivalents (table 2.2). Three of main CH₄ emission sources include the following categories: *Fugitive Emissions from Fuels*, *Agriculture* and *Waste*. They contributed to 37.8%, 33.4% and 27.4% of the national methane emission in 1999 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 28.5% of total CH₄ emission) and *Oil and Natural Gas* system (about 9.2% of total emission), *Disposal sites* contributed to 14.85% of the methane emission and *Wastewater Handling* contributed to 12.56%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.9% of total methane emission in 1999.

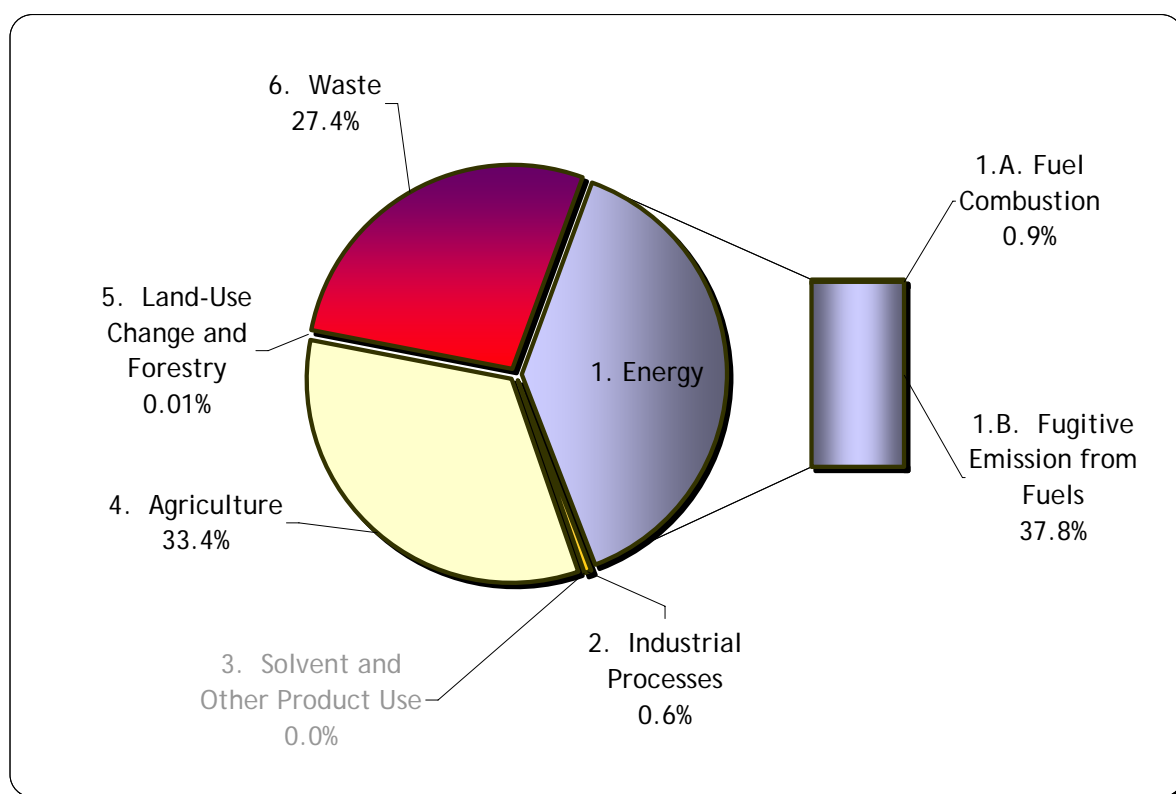


Figure 2.3 Methane emission in 1999 by sector

Nitrous oxide (N₂O)

The nitrous oxide emissions in 1999 were 101.25 Gg i.e. 31.39 million tonnes of CO₂ equivalents (table 2.2). The main N₂O emission sources and its shares in total N₂O emission in 1999 are: *Agricultural Soils* – 54.5%, *Manure Management* – 22.0%, *Chemical Industry* – 11.1% and *Fuel Combustion* – 8.4%.

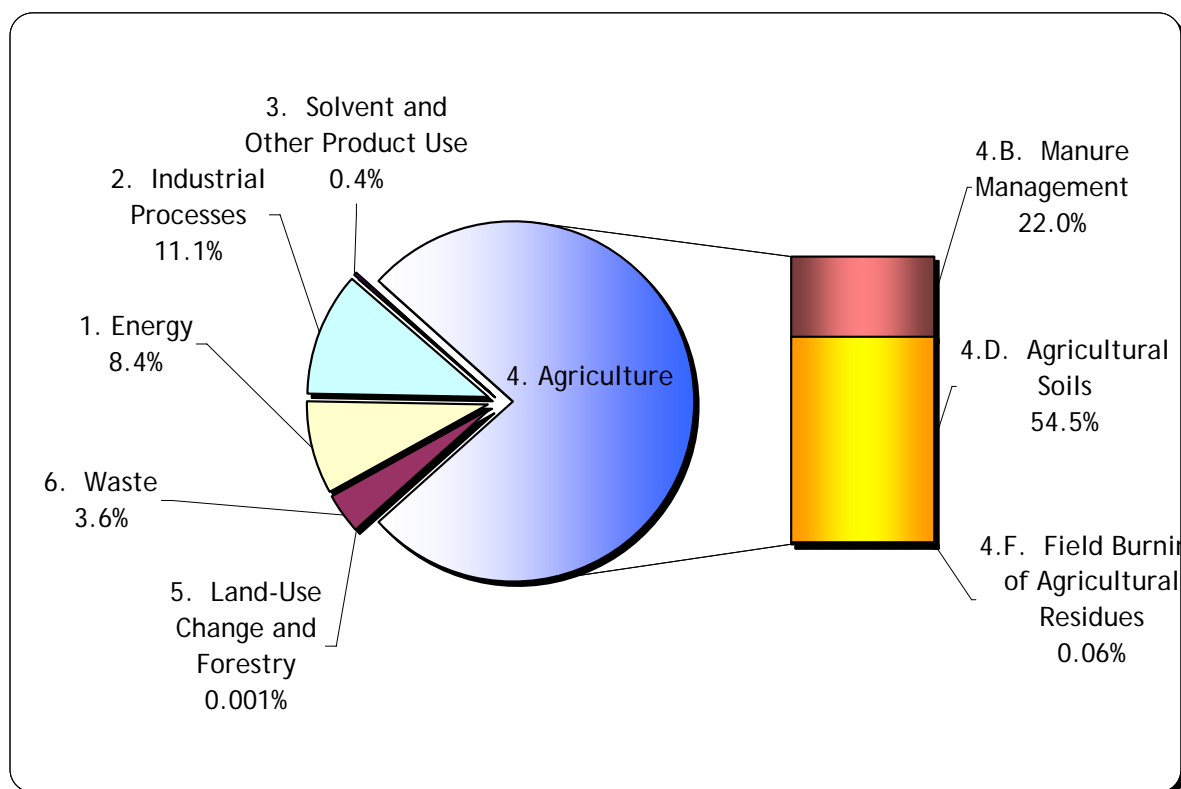


Figure 2.4 Nitrous oxide emission in 1999 by sector

Industrial gases

The total emission of HFCs in 1999 was 0.21 million tonnes of CO₂ equivalents. The emissions of HFCs-gases had increased 8 times between the base year (1995) and 1999. This significant growth of HFCs emission in recent years is mainly due to the increase of emission from refrigeration and air conditioning equipment.

The total emission of PFCs in 1999 was 0.24 million tonnes of CO₂ equivalents. The emissions of PFCs-gases had decreased by 4.2% between the base year (1995) and 1999. It is due to the growth in aluminium production and in the use of C₄H₁₀ for manufacturing of fire extinguishers. The emission of PFCs had fluctuated to a limited extend in recent years, and basically followed the trends in aluminium production - its main source.

The total emission of SF₆ in 1999 was 0.01 million tonnes of CO₂ equivalents. SF₆ emissions in 1999 were by 1.1 time higher than in 1995. Leakage from electrical equipment, is the main SF₆ emission source. Insignificant emission of SF₆ occurs during production of soundproof windows.

Large percentage increase of industrial F-gas emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contributed merely 0.1% to national total in 1999.

2.3 GHG emissions by category

Here emissions of greenhouse gases are presented from all categories except sector 5. LULUCF described in section 7.

Table 2.5. GHG emissions according to main sectors in base year (1988/1995) and 1999

	Total [Gg eq. CO ₂]		(1999-base)/base
	Base year	1999	
TOTAL with LUCF	553 976.2	389 039.75	-0.30
TOTAL without LUCF	586 902.6	418 882.96	-0.29
1. Energy	497 964.7	348 176.97	-0.30
2. Industrial Processes	27 356.2	19 106.95	-0.30
3. Solvent and Other Product Use	1 006.5	535.04	-0.47
4. Agriculture	52 378.1	38 075.23	-0.27
5. Land-Use Change and Forestry	-32 926.5	-29 843.20	-0.09
6. Waste	8 197.2	12 988.77	0.58

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1999 was 348.2 million tons of CO₂ equivalent. CO₂ emission share exceeded 94.6% of the total GHG emissions within 1. *Energy* category (table 2.6). The most emission intensive category was 1.A.1. *Fuel combustion activities* related mostly to heavy industry sector, highly energy consuming.

Table 2.6. GHG emissions from sub-sectors in category *Energy* in 1999

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Energy	% Share in total GHG emission from a given sub-sector		
			CO ₂	CH ₄	N ₂ O
Total Energy	348 176.97	100.0	94.6	4.7	0.8
A. Fuel Combustion	332 184.79	95.4	94.5	0.1	0.8
1. Energy Industries	179 667.91	51.6	51.4	0.0	0.2
2. Manufacturing Industries and Construction	55 447.50	15.9	15.8	0.0	0.1
3. Transport	33 832.98	9.7	9.4	0.0	0.3
4. Other Sectors	60 288.02	17.3	17.1	0.0	0.2
5. Other	2 948.37	0.8	0.8	0.0	0.0
B. Fugitive Emissions from Fuels	15 992.17	4.6	0.0	4.6	0.0
1. Solid Fuels	11 984.67	3.4	0.0	3.4	0.0
2. Oil and Natural Gas	4 007.50	1.2	0.0	1.1	0.0

2.3.2 Industrial Processes and Solvent and Other Use (IPCC categories 2 and 3)

Table 2.7 shows detailed information on emissions of CO₂, CH₄ and N₂O in *Industrial Processes* sector and in *Solvent and Other Use* sector in 1999. CO₂ is dominating among GHGs – its contribution exceeds 78.1%. The main GHG emission sources in this category were: production processes of cement, nitric acid and ammonia.

The emissions of GHG from *Solvent and Other Use* sector includes N₂O emissions from anaesthesia (23.2%) and CO₂ emissions (recalculated from NMVOC) (76.8%).

Table 2.7. The emissions of CO₂, CH₄ and N₂O from sub-sectors in category *Industrial Processes* and in category *Solvents and Other Product Use* in 1999

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Industrial Processes	% Share in total GHG emission from a given sub-sector			
			CO ₂	CH ₄	N ₂ O	HFC, PFC and SF ₆
Total Industrial Processes	19 106.95	100.0	78.1	1.2	18.2	2.4
A. Mineral Products	8 250.74	43.2	43.2	0.0	0.0	
B. Chemical Industry	6 409.15	33.5	14.3	1.0	18.2	
C. Metal Production	4 217.21	22.1	20.6	0.2	0.0	1.2
D. Other Production	NE	NE				
F. Consumption of Halocarbons and SF ₆	229.85	1.2				1.2
G. Other	0.00	0.0				
Total Solvent and Other Product Use	535.04	100	76.8	0.0	23.2	

2.3.3 Agriculture (IPCC category 4)

The main sources of GHG in category 4 *Agriculture* were: 4.D. *Agricultural Soils*, 4.B. *Enteric Fermentation* and 4.A. *Manure Management* (table 2.8). N₂O emission share was largest in total GHG emission from *Agriculture* in 1999 and came from both – direct (mineral and organic fertilisation) and indirect (volatilisation, leaching and runoff from applied synthetic fertiliser and animal manure) N₂O emissions from soils.

Table 2.8. GHG emissions from sub-sectors in category 4 *Agriculture* in 1999

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Agriculture	% Share in total GHG emission from a given sub-sector	
			CH ₄	N ₂ O
Total Agriculture	38 075.23	100.0	36.9	63.1
A. Enteric Fermentation	10 449.08	27.4	27.4	0.0
B. Manure Management	10 479.52	27.5	9.4	18.1
D. Agricultural Soils	17 103.75	44.9	0.0	44.9
F. Field Burning of Agricultural Residues	42.88	0.1	0.1	0.0

2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.9, the emission of CH₄ dominated in this sector in 1999 (almost 88.7%). The main part of GHG emissions came from *solid waste disposal on land* and *wastewater handling*.

Table 2.9. GHG emissions from sub-sectors in category 6 *Waste* in 1999

GHG emission categories	GHG Emission [Tg CO ₂ -eq]	% share in the total emission from Waste	% Share in total GHG emission from a given sub-sector		
			CO ₂	CH ₄	N ₂ O
Total Waste	12 988.77	100	2.7	88.7	8.6
A. Solid Waste Disposal on Land	6 239.42	48.0	0.0	48.0	0.0
B. Wastewater Handling	6 372.44	49.1	0.0	40.6	8.4
C. Waste Incineration	376.91	2.9	2.7	0.0	0.2

2.4 Comparison to base year (1988/1995)

The data for the GHGs and for the national total GHG emission are given in table 2.10.

Table 2.10 Changes of greenhouse gas emissions in 1999 with respect to base year 1988/1995

Pollutant	Base year	1999	1999/base year [%]
	Emission in CO ₂ eq. [Gg]	Emission in CO ₂ eq. [Gg]	
CO ₂ – net emission (with LUCF)	461 951.16	315 162.18	68.22
CO ₂ – without LUCF.	494 885.88	345 007.89	69.71
CH ₄	49 256.41	42 028.13	85.33
N ₂ O	42 478.82	31 388.84	73.89
HFCs	26.44	206.44	780.75
PFCs	250.18	239.79	95.84
SF ₆	13.15	14.39	109.45
TOTAL without CO ₂ from LUCF	586 910.88	418 885.46	71.37
TOTAL with LUCF	553 976.16	389 039.75	70.23

* for industrial gases: HFC, PFC and SF₆ the base year is 1995

Carbon dioxide

CO₂ emission had decreased by app. 30.3% from the base year to 1999.

The following changes took place in the structure of fuel use:

- share in of solid fuels decreased from 85.3% in 1988 to 76.1% in 1999
- share of liquid fuels increased from 11.4% (1988) to 18.8% (1999)
- share of gaseous fuels increased from 3.3% (1988) to 5.1% (1999).

Methane

CH₄ emission had decreased by app. 14.7% from the base year to 1999. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 34.5%
- the decrease in *Fugitive Emission* by 30.1%
- the increase in emission from *Waste* by 78.4%.

Nitrous oxide

The nitrous oxide emissions in 1999 were app. 26.1% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 22.0% in 1999, in *Agricultural Soils* decreased from 55.6% (1988) to 54.5% (1999) and in *Chemical Industry* decreased from 11.8% in 1988 to 11.1% in 1999.

Industrial gases: HFCs, PFCs and SF₆

HFCs emissions in 1999 were 8 times higher than in 1995. This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment.

PFCs emissions in 1999 were 4.2% lower than in base year (1995). The PFCs emission changes between 1999 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C4F10 in fire extinguishers.

SF₆ emissions in 1999 were about 1.1 times higher than in 1995. Leakage from electrical equipment during its use and production is the main SF₆ emission. Large percentage increase of industrial gases emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contribute merely app. 0.1% to the national total in 1999.

Emissions of greenhouse gases in base year (1988/1995) in CO₂ equivalent

Shares of individual GHGs to national total in base year (1988/1995) are presented in Table 2.11 and Figure 2.5 Compared to 1988/1995, the percentage share of CO₂ in 1999 decreased from 84.3% to 82.4%.

Table 2.11 Emissions of greenhouse gases in base year (1988/1995) in CO₂ equivalent

Pollutant	base year 1988 (1995)	
	Emission in CO ₂ eq. [Gg]	Share [%]
CO ₂ – net emission (with LUCF)	461 951.16	
CO ₂ – without LUCF.	494 885.88	84.3
CH ₄	49 256.41	8.4
N ₂ O	42 478.82	7.2
HFCs	26.44	0.0045
PFCs	250.18	0.0426
SF ₆	13.15	0.0022
TOTAL without CO ₂ from LUCF	586 910.88	100.0
TOTAL with LUCF	553 976.16	

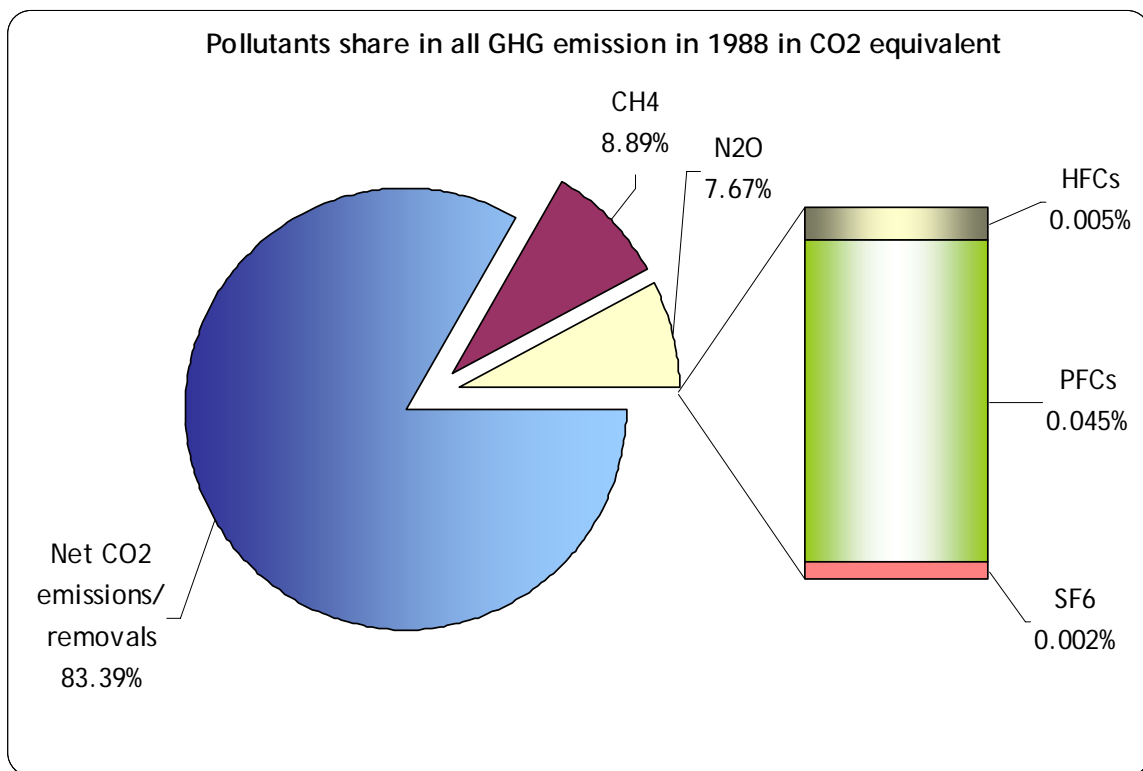


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 1999 and 1998

Changes of national emissions and sinks of GHGs in 1999 compared to 1998 were:

CO ₂	- net emission fall to	96.27%
CH ₄	- emission fall to	98.05%
N ₂ O	- emission fall to	97.30%
HFC [eq. CO ₂]	- actual emission rise to	123.60%
PFC [eq. CO ₂]	- actual emission fall to	95.45%
SF ₆ [eq. CO ₂]	- actual emission rise to	115.55%

Below results are discussed separately for each greenhouse gas with respect to 1999 emissions and change between 1999 and 1998.

Carbon dioxide (CO₂)

In 1999, the net CO₂ emissions (with LULUCF) was 3.7% lower than in 1998. The CO₂ emission in 1999 from category *Energy* was lower by 3.2% and from category *Industrial Processes* was lower by 7.8% than in 1998. In comparison to 1998 the CO₂ emission from category *Waste* in 1999 fall by 16.0%.

Table 2.12. Comparison of carbon dioxide emission in 1998 and 1999

Year	CO ₂ [Gg]		1999/1998 [%]
	1998	1999	
TOTAL without LUCF	357 125.5	345 007.9	96.6
1. Energy	340 094.1	329 312.3	96.8
A. Fuel Combustion	339 988.7	329 187.7	96.8
1. Energy Industries	183 924.3	178 820.5	97.2
2. Manufacturing Industries and Construction	64 751.9	55 135.8	85.1
3. Transport	31 880.0	32 656.8	102.4
4. Other Sectors	57 076.5	59 660.9	104.5
5. Other	2 356.1	2 913.7	123.7
B. Fugitive Emissions from Fuels	105.4	124.6	118.3
1. Solid Fuels	0.7	0.7	91.1
2. Oil and Natural Gas	104.6	124.0	118.5
2. Industrial Processes	16 187.6	14 928.1	92.2
A. Mineral Products	8 502.8	8 250.7	97.0
B. Chemical Industry	3 148.5	2 736.1	86.9
C. Metal Production	4 536.3	3 941.2	86.9
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	419.4	411.0	98.0
4. Agriculture	NE	NE	NE
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	NE	NE	NE
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	-29 737.3	-29 845.7	100.4
A. Forest Land	-36 313.8	-36 635.0	100.9
B. Cropland	6 537.2	6 977.7	106.7
C. Grassland	3 627.3	3 871.7	106.7
D. Wetlands	NE	NE	NE
E. Settlements	-3 588.1	-4 060.1	113.2
F. Other Land	NE	NE	NE
6. Waste	424.4	356.5	84.0
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	424.4	356.5	84.0

Methane (CH₄)

The emission in 1999 was lower than in 1998 by 1.9%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was higher by 2.9% in 1999 and from *Waste* sector was lower by 0.8% than in 1998. *Fugitive emission* in *Energy* sector was lower by 1.3% in 1999 compared to 1998.

Table 2.13 Comparison of methane emission in 1998 and 1999

Year	CH ₄ [Gg]		1999/1998 [%]
	1998	1999	
TOTAL	2 041.13	2 001.34	98.1
1. Energy	782.28	772.72	98.8
A. Fuel Combustion	16.69	17.12	102.6
1. Energy Industries	2.08	2.03	97.6
2. Manufacturing Industries and Construction	2.61	2.32	89.1
3. Transport	7.03	6.79	96.5
4. Other Sectors	4.92	4.81	97.8
5. Other	0.06	1.18	2023.3
B. Fugitive Emissions from Fuels	765.59	755.60	98.7
1. Solid Fuels	571.93	570.67	99.8
2. Oil and Natural Gas	193.66	184.93	95.5
2. Industrial Processes	12.73	11.09	87.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	10.26	8.93	87.1
C. Metal Production	2.47	2.15	87.2
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	693.28	668.96	96.5
A. Enteric Fermentation	526.52	497.58	94.5
B. Manure Management	165.40	170.17	102.9
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.36	1.22	89.3
5. Land Use, Land-Use Change and Forestry	0.13	0.11	82.7
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.13	0.11	82.7
F. Other Land	NE	NE	NE
6. Waste	552.70	548.46	99.2
A. Solid Waste Disposal on Land	289.14	297.12	102.8
B. Wastewater Handling	263.56	251.34	95.4
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N₂O)

The emission was lower than in 1998 (by 2.7%). The main sources of N₂O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 5.0% in 1999 and from *Agricultural Soils* was lower by 2.4% than in 1998.

Table 2.14. Comparison of nitrous oxide emission in 1998 and 1999

Year	N ₂ O [Gg]		1999/1998 [%]
	1998	1999	
TOTAL	104.06	101.25	97.3
1. Energy	8.54	8.51	99.6
A. Fuel Combustion	8.54	8.51	99.6
1. Energy Industries	2.68	2.60	97.0
2. Manufacturing Industries and Construction	1.02	0.85	82.9
3. Transport	3.07	3.33	108.6
4. Other Sectors	1.64	1.70	103.4
5. Other	0.13	0.03	25.0
B. Fugitive Emissions from Fuels	NE	NE	NE
1. Solid Fuels	NE	NE	NE
2. Oil and Natural Gas	NE	NE	NE
2. Industrial Processes	11.43	11.24	98.3
A. Mineral Products	NE	NE	NE
B. Chemical Industry	11.43	11.24	98.3
C. Metal Production	NE	NE	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.40	0.40	100.0
4. Agriculture	80.07	77.51	96.8
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	23.45	22.28	95.0
D. Agricultural Soils	56.56	55.17	97.6
F. Field Burning of Agricultural Residues	0.07	0.06	85.1
5. Land Use, Land-Use Change and Forestry	0.0009	0.0007	82.7
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0009	0.0007	82.7
F. Other Land	NE	NE	NE
6. Waste	3.62	3.60	99.4
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.54	3.53	99.8
C. Waste Incineration	0.08	0.07	80.4

Industrial gases

The total emission of HFCs in 1999 by 23.6% higher than in 1998. PFCs emissions in 1999 were by app. 4.5% lower than in 1998. SF₆ emissions in 1999 were by 15.5% higher than in 1998.

2.6 Emission trends for indirect greenhouse gases (CO, NO_x and NMVOC) and SO₂

Precursors of greenhouse gases e.g. NO_x, CO and non-methane volatile organic compounds - NMVOC, through their influence on the greenhouse gases, have an indirect effect on climate. The presence of SO₂ in the atmosphere influences the climate by increasing the number of secondary aerosols, which have been found to have a cooling effect. Figures 2.6-2.9 shows trends of emissions of SO₂, NO_x, NMVOC (1980-2005) and CO (1990-2005). Emissions of SO₂ decreased by 70% between 1980 and 2005, and 62% between 1990 and 2005. Most of the reductions were caused by the decline of the heavy industry in the late 1980s and early 1990s. In late 1990s the emissions declined because of the diminished share of coal (hard and brown) among fuels used for power and heat generation.

Emissions of NO_x decreased by 33% between 1980 and 2005, and 36% between 1990 and 2005. Similar to sulphur dioxide, most of the reductions were caused by the decline of the heavy industry and lower share of coal in the late 1980s and early 1990s. Increasing emissions from road traffic contribute to the national total, and cause comparatively lower emission reductions than in case of SO₂. Emissions of NMVOC decreased by 44% between 1980 and 2002, and 30% between 1990 and 2005. In 1981, there was a drop of NMVOC emission compared to 1980, but already in 1983 emissions began to grow and reached the maximum in 1988 - 1989. In 1990, there was a significant decrease of emissions, followed by a period of fairly stable emissions until 1997. Then the emissions began to fall again until the year 2001. From 1990 to 2005 the emissions of CO have decreased by 55%, mainly because of the same reasons as the described above decline in emissions of SO₂ and NO_x.

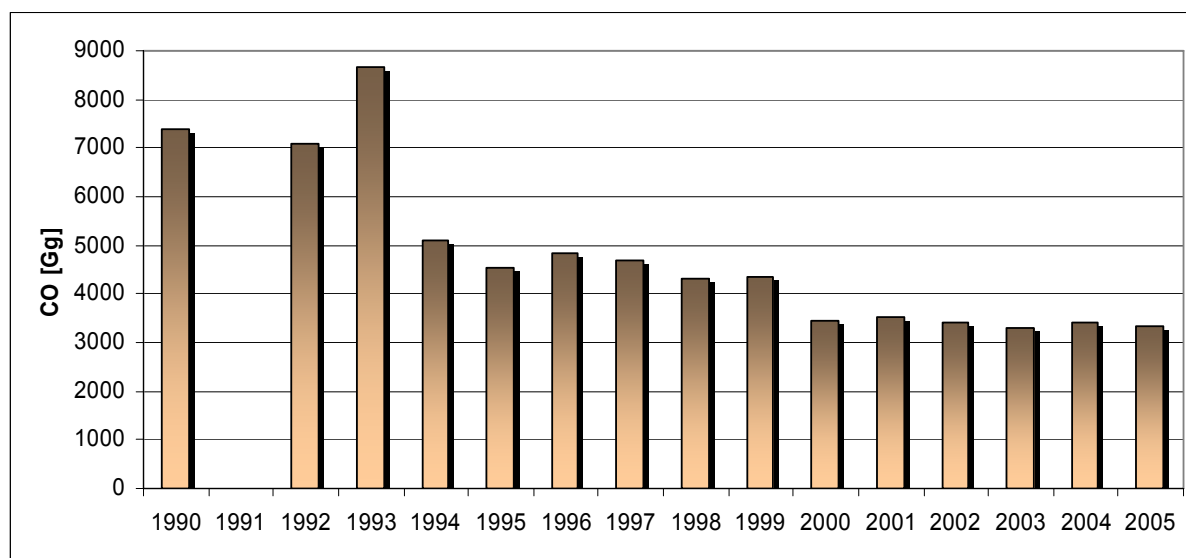


Figure 2.6 Emissions of CO (1990-2005).

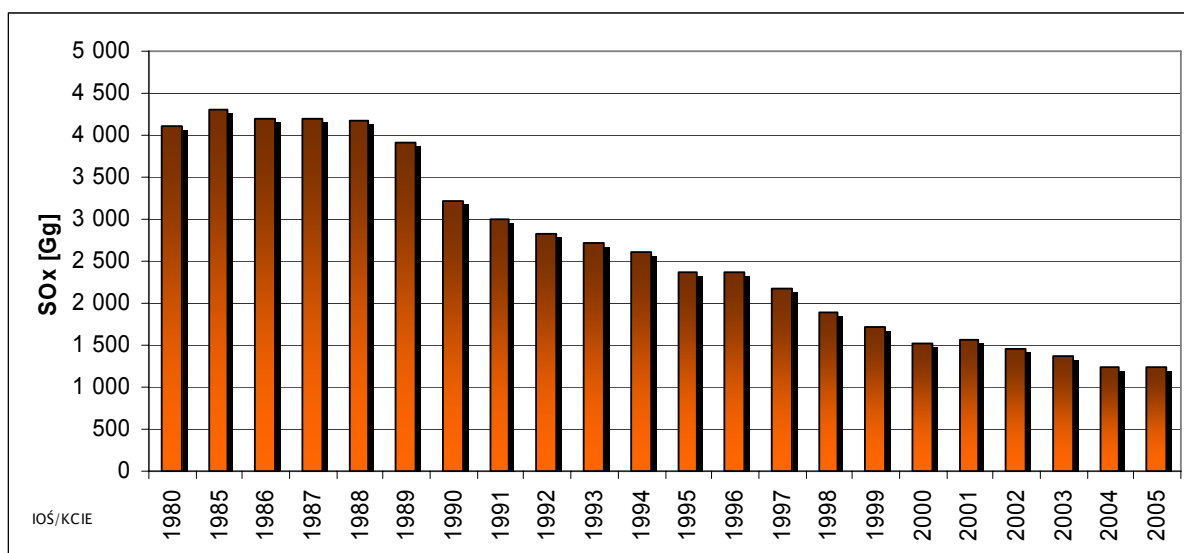


Figure 2.7 Emissions of SO_x, (1980-2005).

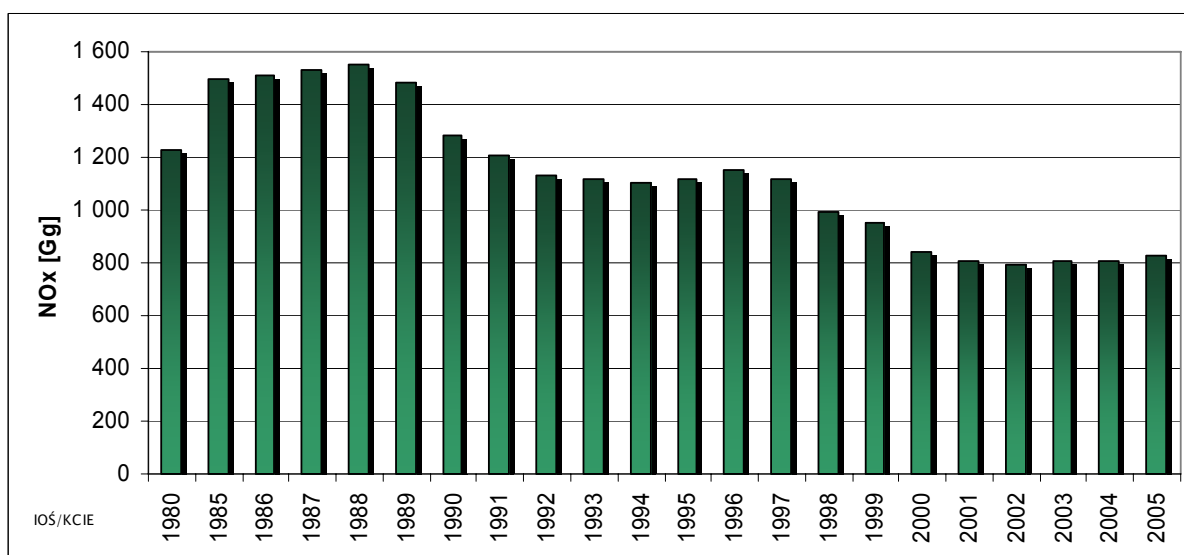


Figure 2.8 Emissions of NO_x (1980-2005).

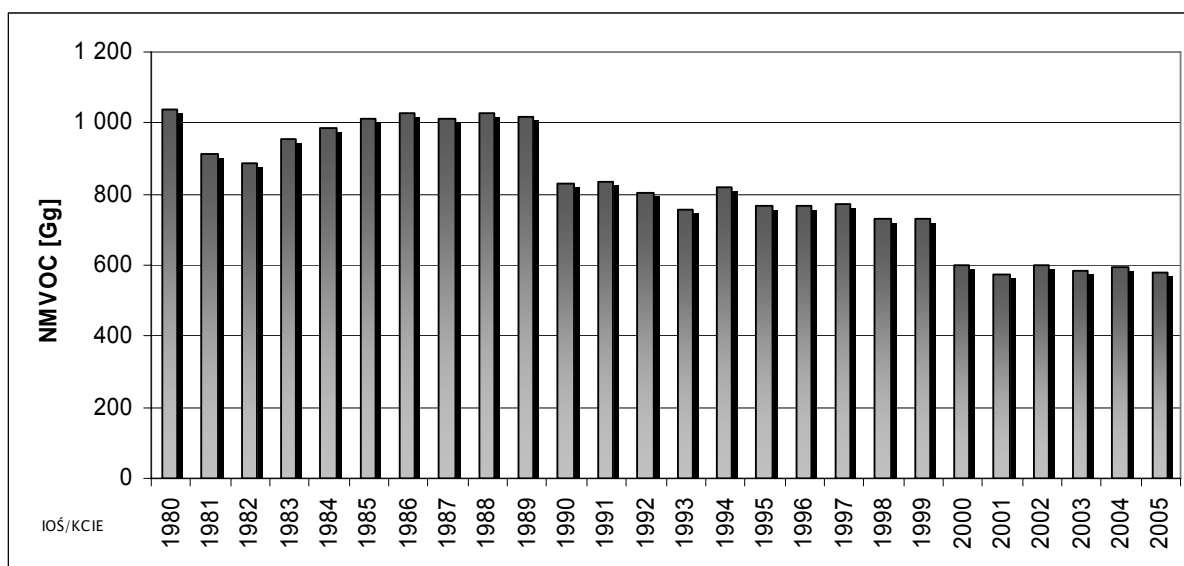


Figure 2.9 Emissions of NMVOC (1980-2005).

3. Energy (CRF sector 1)

3.1 Key categories

Following categories from sector 1 have been identified as key sources:

- 1.A.1, 1.A.2, 1.A.4, 1.A.5.a Stationary combustion of solid, liquid and gaseous fuels (CO₂ emission), share in total GHG emission 70.6%
- 1.A.3.b Transport Road Transportation (CO₂ emission), share in total GHG emission 7.2%
- 1.B.1.a. Coal Mining and Handling (CH₄ emission), share in total GHG emission 2.9%
- 1.B.2.b. Natural Gas (CH₄ emission), share in total GHG emission 0.9%

Share of these categories in total Poland's GHG emissions is 81.6%.

3.2 Methodological issues

3.2.1. Fuel combustion (CRF 1.A)

3.2.1.1. Fuel combustion – Sectoral Approach (CRF 1.A.a)

Combustion as a source of GHG emission occurs in the following category groups:

- 1.A.1. Energy industries
- 1.A.2. Manufacturing industries and construction
- 1.A.3. Transport
- 1.A.4. Other sectors:
 - a. commercial/institutional
 - b. residential
 - c. agriculture/forestry/fishing
- 1.A.5. Other:
 - a. stationary
 - b. mobile

Inventory methodology for **all stationary sources** assumes GHG emission estimation from fuel combustion on the level determined as *Tier 2* and is based on the simple formula:

$$E = \sum (EF_{abc} * A_{abc})$$

where: E - emission

EF - emission factor

A - fuel consumption

a - fuel type, b - sector, c - combustion technology

The national methodology as a primary step introduces preparation of balance spreadsheets, for each fuel. In the spreadsheet, the final calculation leads to the estimation of country specific average net calorific value (NCV) and calculation of elemental C content in the fuel - C_{max}, the maximum emission factor for CO₂. Description and examples of balance spreadsheets are given in chapter 1.4 and Annex 2.

Fraction of oxidised carbon

- gas – 0.995
- oil and oil products – 0.99
- coal – depending on technology of combustion:
 - pulverised coal - 0.984
 - travelling grate stocker – 0.946 – 0.973
 - underfeed stocker – 0.934 - 0.960
 - domestic open fire – 0.988 - 0.994
 - shallow bed AFBC (Advanced Fluidised Bed Combustion) - 0.960
 - Circulating Fluidised Bed Combustion – 0.970
 - Pressurised Fluidised Bed Combustion – 0.970

Fraction of carbon oxidised for hard coal – values for individual sub-sectors (these value have been selected basing on the estimation of share of combustion technology mentioned above):

- 0.984 for *Public thermal plants* and *Public heat plants*
- 0.973 for: *Autoproducing thermal plants*, *Non-public heat plants*, *Boilers in public thermal plants* and for fuel combustion in industry sectors
- 0.988 for *Commercial / Institutional*, *Residential*, *Agriculture / Forestry* sectors

Fraction of carbon oxidised for coke and lignite – like in the case of hard coal

Emission factors for fuel combustion in stationary sources

Maximum emission factors for elemental carbon were determined for major fuels in the form of formulas dependent on net calorific values - NCV, obtained with regression analysis of the results of country measurements. The following formulas were obtained:
the emission factor for elemental carbon from hard coal:

$$C_{hc} = 10(2.4858 \cdot NCV + 3.3132) / NCV$$

where: C_{hc} emission factor for hard coal [kg C/GJ],
NCV- net calorific value of hard coal [MJ/kg],

the emission factor for elemental carbon from brown coal (lignite):

$$C_{bc} \text{ [kg C/GJ]} = 10(1.9328 \cdot NCV + 10.067) / NCV$$

where: C_{bc} emission factor for brown coal [kg C/GJ],
NCV- net calorific value of brown coal [MJ/kg],

the emission factor for elemental carbon from coke and semi-coke:

$$C_c \text{ [kg C/GJ]} = 53.139 - 0.811 \cdot NCV$$

where: C_c emission factor for coke [kg C/GJ],
NCV- net calorific value of coke [MJ/kg],

the emission factor for elemental carbon from motor gasoline and diesel oil (this formula does not apply to mobile sources):

$$C_{gdo} [\text{kg C/GJ}] = 28.03333 - 0.192 * \text{NCV}$$

where: C_{gdo} emission factor for gasoline or diesel oil [kg C/GJ],
 NCV- net calorific value of gasoline or diesel oil [MJ/kg],

the emission factor for elemental carbon from fuel oil:

$$C_{fo} [\text{kg C/GJ}] = 39.7549 - 0.450 * \text{NCV}$$

where: C_{fo} emission factor for fuel oil [kg C/GJ],
 NCV- net calorific value of fuel oil [MJ/kg],

the emission factor for high-methane natural gas:

$$C_{hmng} [\text{kg C/GJ}] = 24.9018 - 0.2843 * \text{NCV}$$

where: C_{hmng} emission factor for high-methane natural gas [kg C/GJ],
 NCV- net calorific value of fuel oil [MJ/m³],

the emission factor for nitrified natural gas:

$$C_{nng} = 15.0 [\text{kg C/GJ}]$$

The following formula was derived for the emission factor for elemental carbon from city gas:

$$C_{cg} [\text{kg C/GJ}] = 10.678 - 0.029 * \text{NCV}$$

where: C_{cg} emission factor for city gas [kg C/GJ],
 NCV- net calorific value of city gas [MJ/m³].

Finally, following formula was derived for the emission factor for elemental carbon from blast furnace gas:

$$C_{bfg} [\text{kg C/GJ}] = 115.5 - 13.43 * \text{NCV}$$

where: C_{bfg} emission factor for blast furnace gas [kg C/GJ]
 NCV- net calorific value of blast furnace gas [MJ/m³].

Calculation of the CO₂ emission factor, when the C_{max} [kg C/GJ] is already known is done with the following formula:

$$EF_{abc} = C_{max} * 44/12 * FO_{abc} [\text{kgCO}_2/\text{GJ}]$$

where: C_{max} - maximum content of elemental carbon in fuel [kg C/GJ]
 FO_{abc} - carbon oxidation factor in combustion processes dependent on fuel type and combustion technology

CO₂ emission factors for main fuels are calculated for each sub-category basing on formulas given above. NCV of fuel, which is applied in formula, is calculated basing on statistical data for this fuel consumption expressed in TJ and in natural units. Suitable carbon oxidation

factor value for individual sub-category is selected according to information given above. In some cases aggregation of estimated emission data from detailed sub-sectors is necessary for full-filling of relevant CRF tables. For example, aggregation is needed in 1.A.1.a sub-category where emissions are calculated for each type of energy production plants separately, according to applied national methodology of inventory.

For CH₄ and N₂O applied emission factors are default factors taken from [IPCC 1997, 2006]. The emission factors for other pollutants (e.g. NO_x, CO and NMVOC) were selected from existing sets by taking into account industrial technologies and combustion conditions.

Emissions in 1.A.1 *Energy Industries* category are estimated for each fuel according to data on the year consumption value given in *Energy Statistics* published by Central Statistical Office (GUS). Calculation of emissions are carried out for detailed sub-categories as follows:

a) 1.A.1.a *Public Electricity and Heat Production*

- *Public thermal plants* – electricity generation (PKD¹ 40.1),
- *Public thermal plants* – heat generation (PKD 40.1)
- *Autoproducing thermal plants* – electricity generation (PKD 40.1)
- *Autoproducing thermal plants* – heat generation (PKD 40.1)
- *Public heat plants* (PKD 40.3)
- *Non-public heat plants* (PKD 40.3)
- *Boilers in public thermal plants* (PKD 40.3)

b) 1.A.1.b *Petroleum Refining* (PKD 23.2)

- *Manufacture of refined petroleum products* (PKD 40.3)

c) 1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries*

- *Manufacture of coke oven products* (PKD 23.1)
- *other energy industries* (PKD 10.1, 10.2, 11.1, 40.1 and 40.3 – only direct consumption of fuels included)

Emissions in 1.A.2 *Energy Industries* category are estimated for each fuel in detailed sub-categories as follows:

a) *Iron and Steel* - 1.A.2.a (PKD 27 excluding activities connected with 1.A.2.b *Non-Ferrous Metals* sub-category given below)

b) *Non-Ferrous Metals* - 1.A.2.b (PKD 27.4, 27.53, 27.54)

c) *Chemicals* - 1.A.2.c (PKD 24 i 25)

d) *Pulp, Paper and Print* - 1.A.2.d (PKD 21 i 22)

e) *Food Processing, Beverages and Tobacco* - 1.A.2.e (PKD 15 and 16)

f) *Other* - 1.A.2.f:

- *construction* (PKD – section F) and *other industry branches not included elsewhere*: (PKD 13-14, 17-20, 26, 28-37, 40.2, 41)
- *off-road and other mobile machinery in industry and construction sectors*

Estimation of emissions in 1.A.3 *Transport* are carried out for each fuel in sub-categories listed below:

a) *Civil Aviation* (1.A.3.a)

b) *Road Transportation* (1.A.3.b)

c) *Railways* (1.A.3.c)

d) *Navigation* (1.A.3.d)

e) *Other Transportation* (1.A.3.e)

¹ PKD – (Polska Klasyfikacja Działalności) – Polish Classification of Economic Activities

Emissions in 1.A.4 *Other Sectors* are estimated for each fuel in detailed sub-categories given below:

a) *Commercial/Institutional* (1.A.4.a) (PKD sections excluding sections connected with categories included elsewhere, it means excluding sections A-F and I)

b) *Residential* (1.A.4.b)

c) *Agriculture/Forestry/Fisheries* (1.A.4.c) (PKD – sections A and B)

- agriculture – stationary sources,
- agriculture – mobile sources
- fisheries.

Emissions in 1.A.5 *Other* are estimated for each fuel in detailed sub-categories as follows:

a) *stationary* (1.A.5.a) – (PKD – section I – only stationary sources from this)

b) *mobile* (1.A.4.b)

- other national aviation (not included in 1.A.3.a)
- emission from the use of motor gasoline, diesel oils and liquid gas calculated in the inventory as statistical difference between total direct consumption of these fuels given in statistic and summary results of consumption in categories 1.A.1, 1.A.2, 1.A.3 and 1.A.4.

List of fuels for which GHG emissions are estimated is as follow:

- liquid fuels: fuel oil, liquid petroleum gas (LPG), crude oil, refinery gas, non-energy products, feedstocks, other energy sources, gaseous waste fuels
- gas fuels: high – methane natural gas, coal-bed methane, nitrified natural gas
- solid fuels: hard coal, lignite, coke, coke oven gas, blast furnace gas, town gas, gas manufactured from coal, industrial wastes, municipal wastes - (non-biomass fraction)
- biomass: fuel wood, solid biomass and animal products, biogas, municipal wastes - (biomass fraction).

Sources of information

The correct inventory of GHG emissions for stationary sources, carried out by:

- precise determination of activities for categories: 1.A.1, 1.A.2, 1.A.4 and 1.A.5 and
- correct calculation or selection of emission factors for CO₂, CH₄ and N₂O

is supported by data found in the following periodic publications (annual or less frequent) or statistical yearbooks for some economy sectors:

- Electrical Power Statistics [GUS 2001a]
- Energy Balance Poland – OECD [ARE 2000]

Emission factors for stationary combustion in the sectors 1.A.1, 1.A.2, 1.A.4 and 1.A.5 are presented in the tables 3.1-3.4. Empty cells for CO₂ emission factors mean that EF is calculated based on the functions described above. Country specific EFs are estimated based on measurements or based on literature and expert opinion (not calculated based on functions connected with NCV) are marked by italic. The other factors are default values taken from [IPCC 2006].

Table 3.1. Applied EFs [kg/GJ] for 1.A.1. category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Crude Oil	73.30	0.0030	0.0006
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	73.30	0.0030	0.0006
Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Biogas	54.60	0.0010	0.0001
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

Table 3.2. Applied EFs [kg/GJ] for 1.A.2 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	73.30	0.0030	0.0006
Other Energy Sources	77.22	0.0029	0.0006
Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0100	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Biogas	54.60	0.0010	0.0001
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

Table 3.3. Applied EFs [kg/GJ] for 1.A.4 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	73.30	0.0030	0.0006
Other Energy Sources	77.22	0.0029	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

Table 3.4. Applied EFs [kg/GJ] for 1.A.5 category

Fuel	EF CO ₂	EF CH ₄	EF N ₂ O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	57.27	0.0015	0.0006
Other Energy Sources	77.22	0.0029	0.0006
Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Solid Biomass and Animal Products	100.00	0.0300	0.0040

As concerns sector 1.A.3 *Transport*, activity data for road transport were taken from [ITS 2000]. CO₂ emissions factors for road transport come also from [ITS 2000]. All other emission factors are default values from [IPCC 1997, 2006]. Applied emission factors are presented in the table 3.5.

Other activity data sources are as follows:

- ♦ OECD Energy Balance for Poland, [ARE 2000],
- ♦ Questionnaire/Report G-03, [GUS 2000e],
- ♦ Statistical Yearbook of The Republic of Poland [GUS 2001],
- ♦ Non-published data from Energy Market Agency

Table 3.5 Emission factors [kg/GJ] for transport in 1999

Type of transport	Category code	EF CO ₂	EF CH ₄	EF N ₂ O
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	70.69	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.69	0.0005	0.0022
1.A.5.b. Other Aviation	1.ii.BL.	72.10	0.060	0.0009
	1.ii.PL.	72.80	0.002	0.0002
1.A.3.b.i Passenger Cars without catalysts	2.i.a.BS	70.75	0.030	0.002
	2.i.a.LG	63.13	0.020	0.0002
	2.i.a.ON	73.18	0.002	0.004
	2.i.b.BS	70.75	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	70.31	0.007	0.0200
	2.i.g.LG	63.13	0.020	0.0002
	2.i.g.ON	73.18	0.002	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	70.75	0.020	0.001
	2.ii.a.LG	63.13	0.030	0.0002
	2.ii.a.ON	73.18	0.001	0.0040
	2.ii.b.BS	70.75	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	70.31	0.020	0.001
	2.ii.g.LG	63.13	0.010	0.0002
	2.ii.g.ON	73.16	0.001	0.004
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	70.75	0.020	0.001
	2.iii.a.ON	73.18	0.006	0.003
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. with catalysts	2.iii.g.ON	73.18	0.006	0.003
1.A.3.b.iii Autobusy	2.iii.a.ON	73.18	0.0039	0.0013
	2.iii.g.ON	73.18	0.0039	0.0013
1.A.3.b.iv Motorcycles	2.iv.BS	70.75	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	70.75	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.18	0.004	0.0039
1.A.3.c. Railways	3.ON	73.00	0.004	0.030
	3.WK	75.00	0.006	0.002
1.A.3.d.ii Domestic Navigation - inland	4.ON	73.00	0.004	0.030
1.A.3.d.ii Domestic Navigation - marine	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.3.d.i Domestic Navigation - bunker	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.4.c.iii Fishery	5.ii.ON	74.10	0.007	0.002
	5.ii.OP	77.60	0.007	0.002
1.A.4.c.ii Agriculture - Off-Road Vehicles	6.i.ON	73.00	0.004	0.0039
1.A.4.c.ii Agriculture - Machines	6.ii.ON	73.00	0.004	0.030
1.A.2. Off-Road Vehicles in Industry na Other	7.i.ON	73.00	0.004	0.030
1.A.3.e.ii Other Off-Road Transport	7.ii.BS	71.00	0.120	0.002
	7.ii.LG	63.10	0.062	0.0002
	7.ii.ON	73.00	0.004	0.0300

Abbreviation explanations to table 3.5:

catal - catalytic converter

BS - motor gasoline

ON - diesel oil

LG – liquid gas

OP - fuel oil

PL - jet fuel

BL - aviation gasoline.

3.2.1.2. *Fuel combustion – Reference Approach* (CRF 1.A.b)

The CO₂ emissions from fuel combustion category was estimated also by use of reference approach characterising “top–down” approach to GHG emissions estimations. The difference between reference and sectoral approaches in CO₂ emissions is 5.27% in favour of reference approach [Radwański 2006a]. More data on energy consumption and CO₂ emissions for both approaches are given in annex 6, in CRF table 1.A(c).

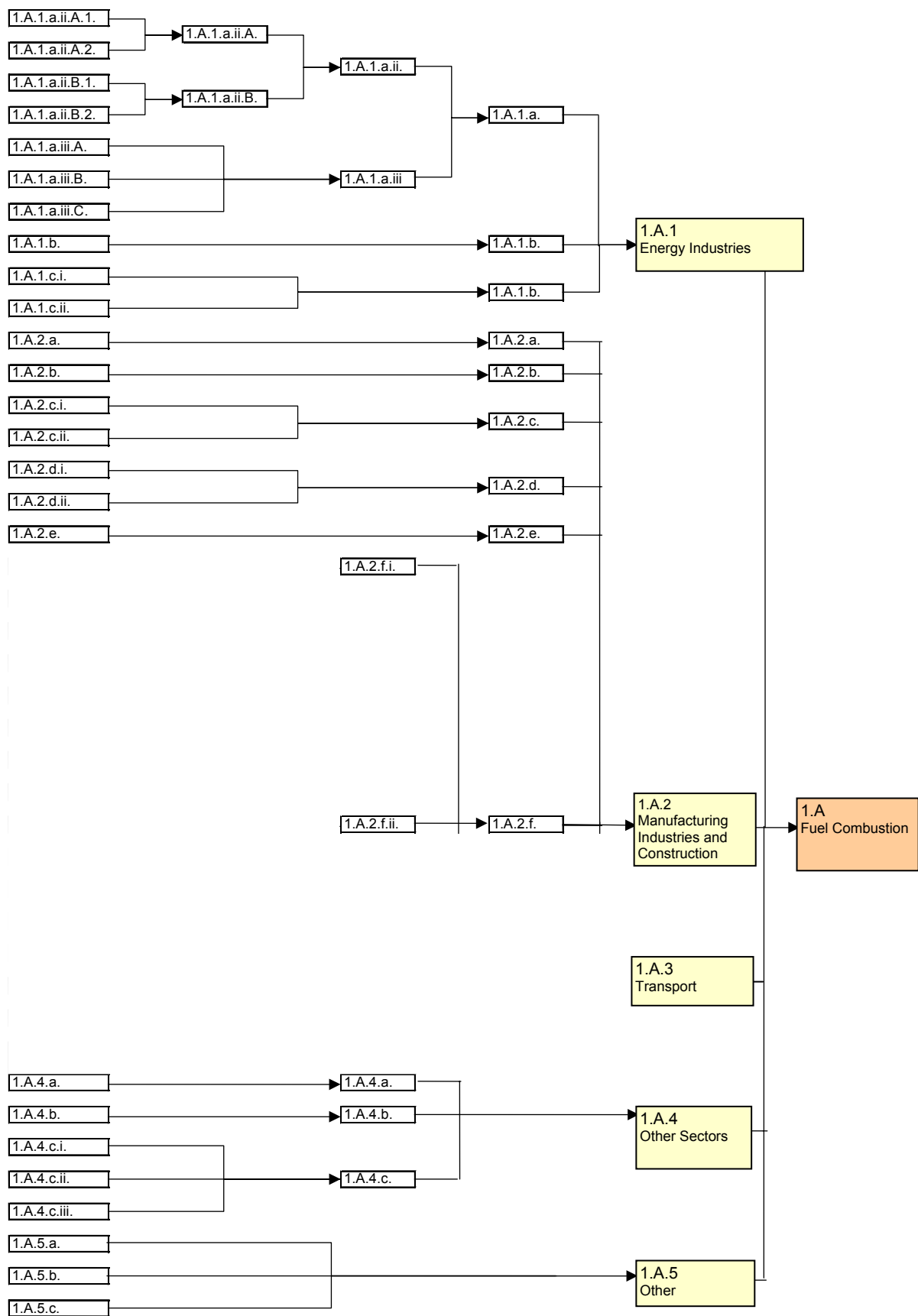


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

3.2.2 Fugitive emissions from fuels (CRF 1.B)

3.2.2.1 Fugitive emissions from fuels – coal mining (CRF 1.B.1.a)

Coal Mining and Handling – underground mines (CRF 1.B.1.a.i)

Based on country study [Gawlik 1994, Gawlik, 2001] domestic emission factors were estimated for the following emission sources in mines: venting systems, methane capture systems, post-mining processes and production waste. The newest emission factors were estimated by [Kwarciński 2005] based on detail data and measurements for entire period 1988–2003. For the domestic inventory purposes emissions factors were calculated for 1 tone coal mined. The set of emissions factors are presented in table 3.6.

Table 3.6. Methane emission factors analysis

Emissions sources	[Gawlik 1994]		[Gawlik 2001]		[Kwarciński 2005]	
	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal	Nm ³ CH ₄ /Mg Coal
Venting systems	6.0050	4.0234	6.4430	4.3168	5.8011	3.8868
De-methane systems			0.5962	0.3994	0.9927	0.6651
Post-mining processes	1.4810	0.9923	1.0200	0.6834	0.4288	0.2873
Production waste	0.0649	0.0435	0.0630	0.0422	0.0289	0.0194
Closed mines			0.0489	0.0328		0.0000

The following data and references for estimating emission factors for 1999 were used:

- venting processes – [Gawlik 2001]
- methane capture systems – direct data
- post-mining processes – [Kwarciński 2005]
- dumping grounds – [Kwarciński 2005]
- closed mines – [Gawlik 2001]

Table 3.7 contains the data on coal mining as well as methane captured and used for 1999. Emission from de-methane systems stands as a difference between methane capture and use.

Table 3.7. Data relating to coal mining and methane captured and used for 1999

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
			mln m ³	mln Nm ³	Gg CH ₄
110.0	218.0	131.7	86.3	83.45	55.91

Coal Mining and Handling – surface mines (CRF 1.B.1.a.ii)

Fugitive emission of CH₄ from surface mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG, 2000] and country specific emission factor, which was taken from the study [Radwański 1995]. The value of these emission factors are as follow:

- Ventilation emission from coal seam – 0.007 m³ CH₄ / t of extracted coal
- Ventilation emission from surrounding rocks - 0.012 m³ CH₄ / t of extracted coal.

The conversion factor applied for recalculation of emitted methane volume upto mass of CH₄ is 0.67 kg/m³.

3.2.2.2 Fugitive emissions from fuels – coke oven gas (CRF 1.B.1.c)

Tier 1 method has been used for calculation of fugitive emissions from coke oven gas system [GPG 2000], while emission factors presented in table 3.8 have been taken from domestic case study [Steczko 1994]. Activity data come from energy statistics [GUS 2001a].

Table. 3.8. Emission factors for CO₂ and CH₄ from coke oven gas system

CO ₂ emission factors	[Gg/PJ]
gas processing	0.000194
gas transmission	0.020629
gas distribution	0.038056
CH ₄ emission factors	
gas processing	0.000546
gas transmission	0.057977
gas distribution	0.106954

3.2.2.3 Fugitive emissions from fuels – oil (CRF 1.B.2.a)

Tier 1 method has been used for calculation of fugitive emissions from oil system [GPG 2000]. Activity data come from energy statistics [GUS 2001a]:

production	PJ	18.451
distribution	Gg	16456

CO₂ and CH₄ factors used for estimation of emissions from oil production have been taken from country study [Żebrowski 1994] while for oil transmission default factors were used from [GPG 2000] (tab. 3.9).

Table 3.9. Emission factors for CO₂ and CH₄ from oil production and transmission

CO ₂ emission factors		
production	EF CO ₂ [Gg/PJ]	6.3150
transmission	EF CO ₂ [Gg/m ³]	0.0054
CH ₄ emission factors		
production	EF CH ₄ [Gg/PJ]	0.0618
transmission	EF CH ₄ [Gg/m ³]	0.00049

3.2.2.4 Fugitive emissions from fuels – natural gas (CRF 1.B.2.b)

Estimation of CO₂ and CH₄ emissions from systems of high-methane and nitrified natural gases was carried out based on *Tier 1* method [GPG 2000]. Activity data come from energy statistics [GUS 2001a] and are given in table 3.10.

Table 3.10. Activities for high-methane and nitrified natural gas systems.

Highmethane gas system		
Gas production	Gas production [PJ]	66.569
Gas processing	Gas use [PJ]	348.964
Gas transmission	Gas use [PJ]	348.964
Underground gas storage	Gas use [PJ]	348.964
Gas distribution	Gas use [PJ]	348.964
Nitrified natural gas system		
Gas production	Gas production [PJ]	63.314
Gas processing	Gas use [PJ]	31.9032
Gas transmission	Gas use [PJ]	31.9032
Gas distribution	Gas use [PJ]	31.9032

Emission factors for both gas systems were taken from country study [Steczko K. 1994] and are listed in tables 3.11 and 3.12.

Table 3.11. Emission factors for CO₂ and CH₄ from high-methane gas system.

CO ₂ emission factors	[Gg/PJ]
Gas production	0.000402
Gas processing	0.014368
Gas transmission	0.000558
Underground gas storage	0.000011
Gas distribution	0.001234
CH ₄ emission factors	
Gas production	0.100848
Gas processing	0.000004
Gas transmission	0.140189
Underground gas storage	0.002742
Gas distribution	0.309945

Table 3.12. Emission factors for CO₂ and CH₄ from nitrified natural gas system.

CO ₂ emission factors	[Gg/PJ]
Gas production	0.000060
Gas processing	0.051321
Gas transmission	0.000192
Gas distribution	0.000558
CH ₄ emission factors	
Gas production	0.034307
Gas processing	0.101227
Gas transmission	0.109475
Gas distribution	0.317671

4. Industrial Processes (CRF sector 2)

4.1 Key categories

Following categories from sector 2 have been identified as key sources:

- 2.A.1 Cement Production (CO₂ emission), share in total GHG emission 1.5%
- 2.C.1. Iron and Steel Production (CO₂ emission), share in total GHG emission 0.9%

Share of these categories in total Poland's GHG emissions is 2.3%.

4.2 Methodological issues

4.2.1. *Mineral Products* (CRF 2.A)

4.2.1.1. *Cement Production* (CRF 2.A.1)

CO₂ emission from cement production was estimated based on data on clinker production from [GUS 2000b]. The applied emission factor is equal 525 kg / Mg clinker. This country specific emission factor is taken from [IMMB 2006]

4.2.1.2. *Lime Production* (CRF 2.A.2)

Emission of CO₂ from lime production was calculated based on data on lime production from [GUS 2000b]. The applied emission factor is equal 785 kg / Mg lime. This is default value given for quicklime (high calcium lime) production in [IPCC 1997].

4.2.1.3. *Soda Ash Production and Use* (CRF 2.A.4)

Soda Ash is produced in Poland in the Solvay Process. Emission of CO₂ from this process was assumed as 0. CO₂ emission from soda ash use was estimated based on assumption that amount of used soda ash is equal soda ash production. Data on soda ash production was taken from [GUS 2000e]. Value of emission factor taken for inventory calculation it is 415 kg CO₂/Mg of soda ash used. This emission factor is recommended in [IPCC 1997].

4.2.2. *Chemical Industry* (CRF 2.B)

4.2.2.1. *Ammonia Production* (CRF 2.B.1)

CO₂ and CH₄ emissions for ammonia production are estimated based on the data on gas and liquid ammonia production from [Radwański 2005]. The CO₂ emission factor (1.5 Mg CO₂/Mg NH₃) was taken from [IPCC 1997]. Methane emission factor is 4.9 kg CH₄ /Mg NH₃ produced was taken from [CITEPA 1992]. Emission N₂O was estimated as 0, according to the study [Kozłowski 2001].

4.2.2.2. *Nitric Acid Production* (CRF 2.B.2)

Estimation of N₂O emission from nitric acid production was based on the annual HNO₃ production data from [GUS 2000b]. The applied country specific emission factor, which is equal 6.47 kg/Mg nitric acid [Kozłowski 2001].

4.2.2.3. *Carbide Production* (CRF 2.B.4)

Activity data concerning calcium carbide production are published in [GUS 2000b]. CO₂ emission factor for this category, which is equal 1.100 Mg CO₂/ Mg carbide, was taken from [IPCC 1997].

4.2.2.4. *Other* (CRF 2.B.5)

- *Carbon Black Production*

CH₄ emission from production of black carbon was estimated based on annual black carbon production from [GUS 2000b]. The emission factor, which is equal 10 kg CH₄ /Mg black carbon, was taken from [CITEPA 1992].

- *Ethylene Production*

Emission of CO₂ from ethylene production was calculated based on ethylene annual production from [GUS 2000b]. Emission factor was taken from [CITEPA 1992]. Its value is 0.3 kg CO₂ / Mg ethylene produced.

- *Caprolactam Production*

Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 2000b]. Applied country specific emission factor of N₂O, which value is 4.74 kg N₂O / Mg caprolactam produced, was assessed based on the Polish study [Kozłowski 2001].

4.2.3. Metal Production (CRF 2.C)

4.2.3.1. Iron and Steel Production (CRF 2.C.1)

4.2.3.1.1. Iron Ore Sintering (CRF 2.C.1.a)

The value of annual iron ore sinter production was taken from [GUS 2000e]. Country specific emission factor of CO₂, which is equal 80.60 kg CO₂ / Mg iron ore sinter, was taken from [KASHUE 2006].

4.2.3.1.2. Steel Cast Production (CRF 2.C.1.c)

The data on steel cast production for CO₂ emission calculation was taken from [GUS 2000b]. Country specific emission factor applied for CO₂ emission estimation is from [FEWE 1994]. Its value is 62 kg CO₂ / Mg steel cast produced.

4.2.3.1.3. Iron Cast Production (2.C.1.d)

Annual iron cast production for CO₂ emission estimation was taken from [GUS 2000b]. Country specific emission factor applied for CO₂ emission calculation is from [FEWE 1994]. Its value is 61 kg CO₂ / Mg iron cast produced. Applied CH₄ emission factor is 0.20 kg CH₄ / Mg iron cast produced. It was taken from [Radwański 1995].

4.2.3.1.4. Blast Furnaces Process (CRF 2.C.1.e)

Processing emission of CO₂ from blast furnaces was estimated based on elementary carbon budget in Blast Furnaces Process.

4.2.3.1.5. Basic Oxygen Furnace Steel (CRF 2.C.1.f)

Basic oxygen furnace steel production was taken from [GUS 2000b]. Country specific CO₂ emission factor used for inventory report, which value is 11.26 kg CO₂ / Mg steel produced, was calculated in [FEWE 1994] based on composition of gases from basic oxygen furnaces in Polish plants.

4.2.3.1.6. Electric Furnace Steel (2.C.1.g)

Annual electric furnace steel production was taken from [GUS 2000b]. Applied CO₂ country specific emission factor is equal 4.30 kg CO₂ / Mg steel produced and it was calculated in [FEWE 1994] based on composition of gases from electric furnaces in Polish plants. CH₄ emission factor, which value is 0.12 kg CO₂ / Mg steel produced, is country specific as well [FEWE 1994]. Results of measurements carried out in Polish steel plants were the sources of this emission factor [Olczak 1993].

4.2.3.1.7. Coke production (CRF 2.C.1.j)

Processing emission of CO₂ from coking plants was estimated based on elementary carbon budget in coking plants process. CH₄ emission was estimated based on coke production volume from [GUS 2000b] and emission factor is 0.2 kg CH₄ / Mg coke produced [EEA 1996].

4.2.3.2. Ferroalloys production (CRF 2.C.2)

Emission of CO₂ concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 2000b]. Applied emission factor, which value is 3900 kg CO₂ / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

4.2.3.3. Aluminium Production (CRF 2.C.3)

Calculation of CO₂ emission from primary aluminium production is based on the data on aluminium production published in [GUS 2000b]. The emission factor, which is equal 1.8 Mg CO₂ / Mg primary aluminium, was taken from [IPCC 1997] as value recommended for Soderberg Process.

4.2.4. Consumption of Halocarbons and SF₆ (CRF 2.F)

Emissions of HFC, PFCs and SF₆ are based on activity data available at public statistics data and data collected by surveys among importers and exporters of CFCs and F-gases. In case of refrigeration and air-conditioning equipment containing HFCs, some information concerning e.g. amounts of gas used, are collected by experts among main domestic producers and importers/exporters. The emission factors for HFC-134a [IPCC 2000] are given in table 4.1.

Table 4.1. HFC-134a emission factors

Emission sources	Emission factor
Devices used In households (refrigerators and freezers) - use	0.5 %
Commercial devices (window refrigerators and chamber freezers) – devices production	3 %
Commercial devices (window refrigerators and chamber freezers) – devices use	20 %

Activity data applied to estimate the PFC and SF₆ emissions in 1999 are presented in table 4.2. The main source of emission of PFC gases in Poland is aluminium production (table 4.2, marked as bold). Activities on aluminium production were taken from [GUS 2001b]. *Tier 1* method and the following emission factors as in [IPCC 2000] were used for estimation of PFC emissions:

for CF₄ EF = 0.61 kg/Mg aluminium produced

for C₂F₆ EF = 0.061 kg/Mg aluminium produced

As concerns SF₆ – the only sources estimated in Poland are electrical equipment and sound-proof windows. Because of lack of activity data in import of this gas for 1999 the interpolation method was used based on data from neighboring available years presented in table 4.2 as *Italic* (values marked as underlined were estimated based on mass analysis for 2000–2003). The following emission factors [IPCC 2000] were used for calculation of SF₆ emission:

Equipment manufacturing – EF = 0.06 Mg/Mg

Equipment use – EF = 0.02 Mg/Mg.

Table 4.2 Activities used for estimation of emissions of PFC and SF₆

Activity according to subsector	1995	1996	1997	1998	1999	2000	2001	2002	2003
2.C. Metal production									
3. Aluminium production [Gg]	55.278	51.924	53.614	54.168	50.981	46.941	54.606	58.777	57.237
2.F. HFC, PFC i SF ₆ use									
7. Electrical equipment and sound-proof windows – SF ₆ in use [Mg]	10.000	25.000	40.000	55.000	70.000	<u>71.120</u>	<u>72.841</u>	<u>75.346</u>	<u>76.090</u>
7. Electrical equipment and sound-proof windows – SF ₆ imported [Mg]	0.000	0.600	0.600	2.000	2.330	2.660	3.303	4.160	2.500

5. Solvent and Other Product Use (CRF sector 3)

5.1 Key categories

There are no sources from sector 3, which are identified as key sources.

5.2 Methodological issues

Calculations of CO₂ emissions within Sector 3, using the common methodology, were carried out on the basis of results of NMVOC emissions [IETU 2001]. from the following activities:

- Paint application (CRF 3.A)
- Degreasing and dry cleaning (CRF 3.B)
- Other solvents use (CRF 3.D)

CO₂ emission factor was determined assuming, that carbon content in NMVOC is 85%. Then carbon content has been calculated in a stoichiometric way to CO₂. Calculations were made in accordance with formula:

$$\text{CO}_2 = 0.85 * 44/12 * \text{NMVOC}$$

where:

CO₂ – carbon dioxide emission from particular subsectors,

NMVOC – NMVOC emission from particular subsectors.

N₂O emission from anaesthesiology was taken from the case study [IOŚ 2001].

6. Agriculture (CRF sector 4)

6.1 Key categories

Following categories from sector 4 have been identified as key sources:

- 4.A. Enteric Fermentation (CH ₄ emission), share in total GHG emission	2.5%
- 4.B. Manure Management (N ₂ O emission), share in total GHG emission	1.6%
- 4.D.1. Direct Soil Emissions (N ₂ O emission), share in total GHG emission	3.0%
- 4.D.3. Indirect Soil Emissions (N ₂ O emission), share in total GHG emission	0.9%

Share of these categories in total Poland's GHG emissions is 8.1%.

6.2 Methodological issues

6.2.1. Methane from Enteric Fermentation (CRF 4.A)

The emission factors for estimation of CH₄ emission from enteric fermentation were calculated based on IPCC Guidelines [IPCC 1997] as well as the national case study [Myczko 2001] and updated data on animal breeding [Walczak 2003, 2006]. The CH₄ emission factors were estimated for each livestock subcategory within cattle: dairy cows and non-dairy cattle disaggregated for: calves under 1 year, young cattle 1-2 years and other matured cattle (over 2 years). Also domestic emission factor for sheep was estimated based on disaggregating this

livestock group for lambs under one year and mature sheep above one year. The emission factors for other livestock like goats, horses and swine come from [IPCC 1997].

CH₄ emissions for category 4.A Enteric fermentation for cattle and sheep were calculated using the IPCC *Tier 2* methodology. The emissions for goats, horses and swine were calculated using *Tier 1* methodology and default factors [IPCC 1997]. Activity data were obtained from national statistics [GUS 2001].

The calculated Gross Energy Intake (GE) values and applied emission factors expressed in kg CH₄ per head per year, including the weighted mean for all non-dairy cattle subcategories, are given in Table 6.1.

Table 6.1. Livestock population, daily Gross Energy Intake (GE) and CH₄ emissions factors in 1999

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH ₄ / animal / year]
4.A Enteric Fermentation	26.217	---	---
1 Cattle	6.555	---	---
a. Dairy cattle	3.418	228.232	89.816
b Non-dairy cattle	3.137	120.4799	47.413
3 Sheep	0.392	18.544	8.212
4 Goats	0.181	---	5.000
6 Horses	0.551	---	18.000
8 Swine	18.538	---	1.500

6.2.2. Methane from Manure Management (CRF 4.B)

The IPCC *Tier 2* methodology was used to establish domestic CH₄ emission factors for cattle, sheep and swine. The *Tier 1* methodology was used for estimation of default emission factors for goats, horses and poultry [IPCC 1997]. Animal population was taken from [GUS 2001].

Table 6.2. Livestock population, volatile solids excreted (Vs) and CH₄ emissions factors

Livestock	Population [millions]	Vs Volatile Solids Excreted [kg dm /animal/ day]	EF Emission Factor [kg CH ₄ / animal / year]
4.B Manure Management	229.121	---	---
1 Cattle	6.555	---	---
a. Dairy cattle	3.418	4.413	5.847
b Non-dairy cattle	3.137	2.070	3.930
3 Sheep	0.392	0.370	0.172
4 Goats	0.181	0.280	0.120
6 Horses	0.551	1.720	1.390
8 Swine	18.538	0.500	6.536
9 Poultry	202.904	0.100	0.078

The factors recommended for cool climate were used. The country specific CH₄ emission factors for dairy and non-dairy cattle, sheep and swine were calculated based on:

- country specific data on the fraction of manure managed in given AWMS from [Walczak 2003, 2006] (see Table 6.3),
- B₀ (methane-producing potential) factors were taken from [IPCC 1997],
- VS (average daily volatile excreted solids) for dairy, non-dairy cattle and sheep were estimated based on country specific GE (average feed intake); VS for swine was the default value from [IPCC 1997]

- MCFs (methane conversion factors) for individual manure management systems concerning cool climate are from [IPCC 2000].

6.2.3. Nitrous oxide from Manure Management (CRF 4.B)

Livestock population for N₂O emission calculation from manure management was taken from [GUS 2001]. The fractions of manure managed in given AWMS for each type of animals, taken from [Myczko 2001] and [Walczak 2003, 2006], are presented in the table 6.3.

Table 6.3. Fractions of manure managed in given AWMS for each type of animals

Livestock	Type of AWSM		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0331	0.8202	0.1467
Non-dairy cattle	0.0939	0.7861	0.1200
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2863	0.7137	---
Poultry	0.2000	0.8000	---

The default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997] were used for emission calculation. Default values of N₂O emission factors for management systems from [IPCC 1997] were applied (Tables 6.4.a, 6.4.b. and 6.5).

Table 6.4.a. Emissions of nitrogen excreted in livestock manure in:

a) liquid system

Livestock	Nitrogen excreted in manure Nex [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.0331	7919.506
1.b. Non-dairy cattle	50.0	0.0939	14728.215
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2863	106148.588
9 Poultry	0.6	0.2000	24348.481

b) solid storage and drylot

Livestock	Nitrogen excreted in manure Nex [kg/animal/year]	AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]
1.a. Dairy cattle	70.0	0.8202	196249.027
1.b. Non-dairy cattle	50.0	0.7861	123299.785
3 Sheep	16.0	0.5000	3136.000
4 Goats	25.0	0.9000	4074.750
6 Horses	25.0	0.9000	12397.500
8 Swine	20.0	0.7137	264611.412
9 Poultry	0.6	0.8000	97393.925

Table 6.5. Factors of N₂O–N emission for various manure management systems

Animal Waste Management Systems	EF Emission Factor [kg N ₂ O-N/ kg N]
10. Anaerobic lagoons	0.001
11. Liquid systems	0.001
12. Solid storage and drylot	0.020
13. Other	0.005

6.2.4. Agricultural Soils (CRF 4.D)

6.2.4.1. *Direct Soil Emission* (CRF 4.D.1)

6.2.4.1.1. *N₂O from synthetic fertilisers* (CRF 4.D.1.1)

N₂O emission from synthetic fertilisers was estimated based on the amount of synthetic fertiliser nitrogen applied to agricultural fields published in [GUS 2001]. The nitrogen fraction converted to N₂O was estimated as 0.9 (1–0.1 Frac_{gasf} – see 4.D.3) and this is default value from [IPCC 1997]. The country specific emission factor (0.008 kg N₂O-N / kg N applied) taken from [Mercik 2001] was corrected for 0.009 kg N₂O-N / kg N as the previous one included the fraction of nitrogen that is emitted as NO_x + NH₃.

6.2.4.1.2. *N₂O from animal manure applied to soils* (CRF 4.D.1.2.)

Manure nitrogen use as fertiliser was estimated according to IPCC guidelines. The total amount of nitrogen in animal excreta was calculated based on animal population taken from [GUS 2001] and the default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997]. The data on fraction of manure managed in each AWMS applied in Poland are the country specific data taken from Polish studies [Myczko 2001] and [Walczak 2003, 2006]. The fractions of manure managed in given AWMS for each type of animals are given in table 6.3.

N₂O emission factors for all listed AWMS were taken from [IPCC 1997]. The fraction of nitrogen excreted during grazing was calculated based on data estimated for 4.D.2 *Pasture, range and paddock manure*. The value of the total nitrogen excretion fraction that is emitted as NO_x and NH₃ (0.2 kg NH₃-N + NO_x-N / kg of nitrogen excreted by livestock) was taken from [IPCC 1997]. The fraction of livestock nitrogen excretion contained in excrements burned was assumed as 0 in calculations.

6.2.4.1.3. *N₂O from N-fixing crops* (CRF 4.D.1.3)

N₂O emission from N-fixing crops was calculated based on the data on sown area of N-fixing crops, published in [GUS 2001]. According to study [Mercik 2001] 1% of nitrogen fixed by papilionaceous plants is denitrificated to N₂O and in this connection the used emission factor value is 0,010 N₂O-N/ kg N contained in papilionaceous plants. Most above ground plant parts is removed from fields in Poland, so only plant residues were taken into account in N₂O emission calculation. Based on the data from the study mentioned above was assumed, that nitrogen amount in plant residues is 90 kg N/ha.

6.2.4.1.4. *N₂O from crop residue* (CRF 4.D.1.4)

Emission of N₂O for non-N-fixing crop residues was calculated based on the information from [Mercik 2001], that quantity of dry residue from 1 ha of non-N-fixing crop harvested area is 2 Mg d.m. / ha and content of nitrogen in plant residues is 0.76%. The emission factor for inventory purpose was taken from this study as well. Its value is 0,010 kg N₂O-N/ kg N contained in residues. Data on sown area of other than N-fixing crops are published in [GUS 2001].

6.2.4.1.5. *N₂O from cultivation of histosols* (CRF 4.D.1.5)

The area of histosols in Poland is estimated as 1269 thousand ha [Mercik 2001] and this value was applied to entire inventory period from 1988. N₂O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N₂O-N /ha.

6.2.4.2. *N₂O from pasture, range and paddock manure* (CRF 4.D.2)

Animal population for calculation of N₂O emission from pasture range and paddock was taken from [GUS 2001]. Total amount of nitrogen in animal excreta was estimated based on the data presented in the table 6.6. The default values of nitrogen excretion per head of animal for each type of animals (values for Eastern Europe) from [IPCC 1997] were used. The data on fraction of manure related with grazing animal are the country specific data taken from Polish studies [Myczko 2001, Walczak 2006]. N₂O emission factor (0.02) for pasture range and paddock was taken from [IPCC 1997].

Table 6.6. Fraction of manure related with grazing animal, nitrogen excreted in AWMS systems and factor of N₂O–N emission

Livestock	Nitrogen excretion N _{ex} [kg/head/yr]	Fraction of manure nitrogen per AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]	EF Emission factor for AWMS [kg N ₂ O-N/ kg N]
1.a. Dairy cattle	70.0	0.15	35091.467	
1.b. Non-dairy cattle	50.0	0.12	18822.000	
3 Sheep	16.0	0.50	3136.000	
4 Goats	25.0	0.10	452.750	
6 Horses	25.0	0.10	1377.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	58879.717	0.020

6.2.4.3. Indirect emissions (CRF 4.D.3)

The *Tier 1a* method was used for assessing indirect emissions of N₂O for 1999 in Poland. The basic equation for estimating a country's indirect N₂O emissions:

$$N_2O_{\text{indirect} \rightarrow N} = N_2O_{(G) \rightarrow N} + N_2O_{(L) \rightarrow N},$$

where:

$N_2O_{\text{indirect} \rightarrow N}$ – emissions of N₂O in units of nitrogen,

$N_2O_{(G) \rightarrow N}$ – N₂O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds (kg N/year),

$N_2O_{(L) \rightarrow N}$ – N₂O produced from leaching and runoff of applied fertiliser and animal manure N (kg N/year).

6.2.4.3.1. Atmospheric deposition (CRF 4.D.3.1)

Atmospheric deposition of nitrogen compounds fertilises soils and surface waters. It results in enhanced biogenic N₂O formation. According to this methodology the amount of N applied to soils is equal to the total amount of synthetic fertiliser nitrogen applied to soils plus the total amount of animal manure nitrogen excreted in country. Those values have to be multiplied by appropriate volatilisation factors. This sum is then multiplied by an emission factor (table 6.7). Calculations were made according to the following equation:

$$N_2O_{(G) \rightarrow N} = [(N_{\text{FERT}} * \text{Frac}_{\text{GASF}}) + (N_{\text{ex}}/1000 * \text{Frac}_{\text{GASM}})] * \text{EF},$$

where:

$N_2O_{(G) \rightarrow N}$ – N₂O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds,

N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 2001],

N_{ex} – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

$\text{Frac}_{\text{GASF}}$ – fraction of synthetic N fertiliser that volatilises to nitrogen compounds, default value,

$\text{Frac}_{\text{GASM}}$ – fraction of animal manure N that volatilises to nitrogen compounds, default value,

EF – emission factor for N₂O emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of N₂O–N from atmospheric deposition

N_{fert} [Gg/year]	$\text{Frac}_{\text{GASF}}$ [kg N/kg N]	N_{ex} [kgN/year/1000]	$\text{Frac}_{\text{GASM}}$ [kg N/kg N]	EF [kgN ₂ O-N/kg N]	$N_2O_{(G) \rightarrow N}$ [GgN ₂ O-N]
862	0.1	58 879.72	0.2	0.01	0.98

6.2.4.3.2. Nitrogen leaching and run-off (CRF 4.D.3.2)

Part of the nitrogen is lost from agricultural soils through leaching and runoff, and gets to the groundwater, rivers and wetlands. It results in biogenic production of N₂O. To estimate the amount of applied N that leaches or runs off, the total amount of synthetic fertiliser nitrogen and the total amount of animal N excretion must be summed and then multiplied by a fraction of N input, that is lost through leaching and runoff. Then it must be multiplied by an appropriate emission factor (table 6.8). Calculations were made according to the following equation:

$$N_{2O(L) \rightarrow N} = (N_{FERT} + N_{ex}/1000) * \text{Frac}_{LEACH} * EF,$$

where:

N_{2O(L)→N} – N₂O produced from leaching and runoff of applied fertiliser and animal manure N,

N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 2001],

N_{ex} – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

Frac_{LEACH} – fraction nitrogen input to soil that is lost through leaching and runoff, default value,

EF – emission factor for N₂O emissions for leaching/runoff, default value.

The values, that were taken to calculations and emissions, are presented in table 6.8.

Table 6.8. Estimation of indirect emissions of N₂O–N from nitrogen leaching and run-off

N _{fert} [Gg/year]	N _{ex} [kgN/year /1000]	Frac _{LEACH} [kg N/kg N]	EF [kgN ₂ O-N/kg N]	N _{2O(L)→N} [GgN ₂ O-N]
862	58 879.72	0.3	0.025	6.907

The following equation is a conversion of N₂O→N emissions to N₂O emissions:

$$N_{2O} = N_{2O \rightarrow N} * 44/28$$

6.2.5. Field Burning of Agricultural Residues (CRF 4.F)

CH₄ and N₂O emissions from burning of agricultural residues in fields were estimated based on methodology described in [IPCC 1997]. For domestic purposes there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits [Łoboda *et al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 2001]. Factors applied for emissions calculation were taken from country study [Łoboda 1994] where experimental and literature data as well as default emission factors were used. These values are presented in the table 6.9.

Table 6.9. Factors applied for CH₄ and N₂O emission estimation from field burning of agriculture residues

Crops	Residue to crop ratio	Dry matter fraction	Fraction burned in fields	Fraction oxidised	Carbon fraction of residue	N / C	Aggregated emission factors	
							CH ₄	N ₂ O
							[Gg/Gg]	[Gg/Gg]
wheat	1.45	0.86	0.005	0.90	0.4853	0.014	0.0032	0.0001
rye	1.60	0.87	0.005	0.90	0.4800	0.011	0.0032	0.0001
barley	1.25	0.86	0.005	0.90	0.4567	0.015	0.0030	0.0001
oats	1.50	0.89	0.004	0.90	0.4700	0.016	0.0031	0.0001
triticale	1.50	0.86	0.005	0.90	0.4853	0.013	0.0032	0.0001
cereal mixed	1.40	0.87	0.004	0.90	0.4730	0.015	0.0032	0.0001
buckwheat & millet	1.70	0.86	0.002	0.90	0.4500	0.020	0.0030	0.0001
maize	1.30	0.50	0.002	0.90	0.4709	0.020	0.0031	0.0001
edible pulses	1.50	0.88	0.001	0.90	0.4500	0.040	0.0030	0.0002
feed pulses	2.00	0.85	0.001	0.90	0.4500	0.045	0.0030	0.0002
potatoes	0.30	0.25	0.100	0.85	0.4226	0.048	0.0028	0.0002
rape	2.35	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
other oil-bearing crops	3.50	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
flax straw	0.25	0.86	0.001	0.90	0.4500	0.016	0.0030	0.0001
tobacco	1.28	0.50	0.002	0.85	0.4500	0.040	0.0030	0.0002
hop	4.00	0.25	0.020	0.90	0.4500	0.035	0.0030	0.0002
hay from greenland	0.05	0.23	0.001	0.90	0.4500	0.044	0.0030	0.0002
hay from pulses	0.05	0.23	0.001	0.90	0.4500	0.045	0.0030	0.0002
hay from legumes	0.05	0.23	0.001	0.90	0.4500	0.061	0.0030	0.0003
tomatoes	0.60	0.15	0.050	0.85	0.4500	0.050	0.0030	0.0002
other ground veget.	0.35	0.15	0.010	0.90	0.4500	0.055	0.0030	0.0003
veget. cult. under cover	0.40	0.35	0.010	0.90	0.4500	0.060	0.0030	0.0003
apples	1.50	0.35	0.050	0.90	0.4500	0.033	0.0030	0.0002
pears & other	1.50	0.35	0.070	0.90	0.4500	0.033	0.0030	0.0002
plums	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
sweet cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
strawberries	0.50	0.18	0.010	0.90	0.4500	0.033	0.0030	0.0002
raspberries	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
currants	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
gooseberries & other	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002

7. Land Use Change and Forestry (CRF sector 5)

7.1 Key categories

Sector 5 is not analyzed in key source analyses.

7.2 Methodological issues

All calculations within the GHG inventory for LUCF in Poland in 1999 were prepared using the [IPCC 1997] methodology. The land use transition matrix was not available during the inventory preparation hence the methodology suggested by GPG LULUCF could not be applied. The obtained GHG estimates were first inserted into the old CRF file, and then translated into the CRF required by GPG LULUCF. Majority of cells in the new CRF could

not be filled in and those filled in were calculated by means of the transition matrix presented in table 7.2.

Reporting under the GPG LULUCF requires significant improvements in data collection and access to data on changes in land uses. The current calculations are based on net land use changes (with exception to afforestation/reforestation and deforestation for which gross data are available). This most likely underestimates the actual emissions and removals in this category. The underestimation may bias GHG estimates but direction and degree of the bias can not be easily inferred.

The inventory results for 1999 (and comparing to 1998) for LULUCF sector are presented in the following tables according to new [IPCC 2003] and previous [IPCC 1997] methodologies.

Table 7.1. Total CO₂ emissions and removals from Land Use Change and Forestry in 1998 and 1999 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1998			1999		
	Net CO ₂ emissions/ removals	CH ₄	N ₂ O	Net CO ₂ emissions/ removals	CH ₄	N ₂ O
	(Gg)			(Gg)		
5. Total Land-Use Categories	-29 737.34	0.131	0.001	-29 845.71	0.108	0.001
5A. Forest Land	-36 313.85			-36 635.03		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	6 537.24			6 977.65		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	3 627.34			3 871.72		
1. Grassland remaining Grassland	IE			IE		
2. Land converted to Grassland	IE			IE		
5D. Wetlands	IE			IE		
1. Wetlands remaining Wetlands	IE			IE		
2. Land converted to Wetlands	IE			IE		
5E. Settlements	-3 588.07	0.131	0.001	-4 060.05	0.108	0.001
1. Settlements remaining Settlements	IE			IE		
2. Land converted to Settlements	IE			IE		
5F. Other Land	IE			IE		
1. Other Land remaining Other Land	IE			IE		
2. Land converted to Other Land	IE			IE		
5G. Other(please specify)	NE	NE	NE	NE	NE	NE
Harvested Wood Products	NE	NE	NE	NE	NE	NE

* IE – included elsewhere

* NE – not estimated

Table 7.2. Transition matrix from [IPCC 1997] to [IPCC 2003] LULUCF categories

Sector 5 - Land Use Change and Forestry		New CRF data																				
		Land Use Change and Forestry	A. Forest Land	1. Forest Land remaining Forest Land	2. Land converted to Forest Land	B. Cropland	1. Cropland remaining Cropland	2. Land converted to Cropland	C. Grassland	1. Grassland remaining Grassland	2. Land converted to Grassland	D. Wetlands	1. Wetlands remaining Wetlands	2. Land converted to Wetlands	E. Settlements	1. Settlements remaining Settlements	2. Land converted to Settlements	F. Other Land	1. Other Land remaining Other Land	2. Land converted to Other Land	G. Other (please specify)	Harvested Wood Products
Old IPCC data	Total Land-Use Change and Forestry	1																				
	A. Changes in Forest and Other Woody Biomass Stocks																					
	1. Tropical Forests																					
	2. Temperate Forests		1	Inc. in A	Inc. in A																	
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other (please specify)																					
	Harvested Wood																					
	B. Forest and Grassland Conversion																					
	1. Tropical Forests																					
	2. Temperate Forests														1	Inc. in E	Inc. in E					
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other (please specify)																					
	C. Abandonment of Managed Lands																					
	1. Tropical Forests																					
	2. Temperate Forests																					
	3. Boreal Forests																					
	4. Grasslands/Tundra																					
	5. Other (please specify)																					
	D. CO2 Emissions and Removals from Soil																					
	1. Cultivation of Mineral Soils					0.64	Inc. in B	Inc. in B	0.36	Inc. in C	Inc. in C	Inc. in C										
	2. Cultivation of Organic Soils																					
	3. Liming of Agricultural Soils					0.64			0.36													
	4. Forest Soils		1	Inc. in A	Inc. in A																	
	5. Other Land (please specify)															1	Inc. in E	Inc. in E				
	E. Other (please specify)																					

Table 7.3. Total CO₂ emissions and removals from sector 5. Land Use Change and Forestry in 1998 and 1999 [IPCC 1997]

Greenhouse gas source and sink categories	1998					1999				
	CO ₂ emissions	CO ₂ removals	Net CO ₂ emissions/removals	CH ₄	N ₂ O	CO ₂ emissions	CO ₂ removals	Net CO ₂ emissions/removals	CH ₄	N ₂ O
	Gg					Gg				
5. Total Land-Use Change and Forestry	52 358.18	-82 095.52	-29 737.34	0.131	0.001	55 161.13	-85 006.84	-29 845.71	0.108	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	43 602.68	-63 494.17	-19 891.50			45 440.06	-65 287.23	-19 847.17		
1. Tropical Forests										
2. Temperate Forests	43 602.68	-63 494.17	-19 891.50			45 440.06	-65 287.23	-19 847.17		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	43.66		43.66			36.34		36.34		
1. Tropical Forests										
2. Temperate Forests	43.7			0.131	0.001	36.3			0.108	0.001
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00	0.00	0.00		
1. Tropical Forests										
2. Temperate Forests										
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
5D. CO ₂ Emissions and Removals from Soil	8 711.84	-18 601.34	-9 889.50			9 684.74	-19 719.62	-10 034.87		
Cultivation of Mineral Soils	8 711.84		8 711.84			9 684.74		9 684.74		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 452.7	1 452.74				1 164.6	1 164.63		
Forest Soils		-16 422.35	-16 422.35				-16 787.86	-16 787.86		
Other Land (please specify)		-3 631.73	-3 631.73				-4 096.39	-4 096.39		
5E. Other (please specify)										

According to calculation for 1999, Sector 5. Land-Use Change and Forestry, was net CO₂ sink. Removals/emissions balance increased from 29 737 Gg CO₂ in 1998 to 29 846 Gg CO₂ in 1999 and included results from groups given below.

7.2.1. Changes in Forest and Other Woody Biomass Stocks (old CRF 5.A)

GHG balance in this group is a net sink. In 1999 net CO₂ removals decreased to 19 847 Gg CO₂ from about 19 891 Gg CO₂ in 1998.

Increase in forest

Increase of woody biomass in forest of all owners forms was estimated based on data published in Statistical Year Book for Forestry. Source data contains also area–volume tables with age classes prepared by Forest Management and Geodesy Bureau in order of Directorate General of State Forests published in annual reports “Results of updated estimates of forestry areas and resources in state owned forests”.

Data published in statistical yearbooks are of synthetic character – (apply to all types together or separately for conifers and broadleaves only).

Estimation of actual increase (m³/ha/year) for all forests is based on data of increment in growing stock and harvest of thick. Data of harvest of thick are given as net volume of thick wood (without bark). For calculation of harvest of thick it is necessary to add estimated volume of thick bark to net harvest of thick (assume that thick bark is about 25% of thick wood without bark [Czuraj, 1991]. Increase is determined by forest type, age class and quality of forest habitats.

Harvest of thick and growing stock were converted into mass of biomass separately, using expansion ratio for timber removals and conversion for growing stocks.

Calculations were based on average values, regarded as approximation of real values. Methodology for biomass annual increase calculations should be still improved, among others for better show long and short term trends. For calculations there were used default factor describing fraction of elementary carbon in dry matter 0.5 [IPCC 1997].

7.2.2. Forest and Grassland Conversion (old CRF 5.B)

In 1999 this category was a net CO₂ emissions and accounted for about 36 Gg CO₂. Net emission in year 1999 was lower than in 1998 and it was caused by lessening forest area transmitted into non-forest tasks.

Emissions ratios for calculation CH₄, N₂O, CO and NO_x emissions from biomass burning are presented in table below.

Table 7.4. Emissions ratios for calculation CH₄, N₂O, CO and NO_x emissions from biomass burning.

Compound	Ratio		
CH ₄	0.012	default	[IPCC 1997]
CO	0.060	default	[IPCC 1997]
N ₂ O	0.007	default	[IPCC 1997]
NO _x	0.121	default	[IPCC 1997]

Ratio of carbon to nitrogen in burning biomass was taken as 0.001 and default factor of carbon fraction in aboveground biomass is equal 0.5 [IPCC 1997]. Both default factors for fraction of carbon oxidized on and off site are equal to 0.9 [IPCC 1997].

In this category emission of other than CO₂ GHGs is reported from forest fires only. Assumption is made that woody biomass is not burnt entirely during fires (only canopies and underwood are damaged) so if there is a need for moving out damaged or dead woods it is included into total wood harvest. Controlled burning of forests is not practiced in Poland.

7.2.3. Abandonment of Managed Lands (old CRF 5.C)

According to [IPCC 1997] definition, there is no anthropogenic activity on abandonment lands in Poland, so such category is not considered here. Generally agriculture lands are converted to forests or come under municipal management.

7.2.4. CO₂ Emissions and Removals from Soil (old CRF 5.D)

GHG balance in this category is a net sink. It is mainly caused by afforestation of agriculture lands. In 1999 net CO₂ sink was about 10 035 Gg CO₂ and was higher by about 145 Gg CO₂ than in previous year.

In order to calculate carbon emissions and removals in soils, area of country was divided into forestland, cropland and other lands. Other lands are used for balance country area.

Soil types occurring in Poland are as follow.

Forests soils

Estimation of different soil types area (high activity soils, low activity soils, sandy and wetland) is based on area of forest habitat types (Table 7.5). Next the percentage fractions of all soil types in forest management were calculated (Table 7.7).

Table 7.5. Forest soils type occur in Poland.

Soil type	Forest habitat types
High Activity Soils	Fresh mixed forest, moist mixed forest, mixed upland forest, mountain mixed forest, fresh broadleaved forest, moist broadleaved forest upland forest, mountain forest
Low Activity Soils	Moist coniferous forest, mountain coniferous forest, high- mountain coniferous forest, 0,5*fresh mixed coniferous forest, moist mixed coniferous forest, upland mixed coniferous forest, mountain mixed coniferous forest
Sandy	Dry coniferous forest, fresh coniferous forest, 0,5* fresh mixed coniferous forest
Wetland	Marshy coniferous forest, boggy mountain coniferous forest, boggy mixed coniferous forest, boggy mixed forest, alder forest, ash- alder swamp forest, mountain alder forest, floodplain forest, mountain floodplain forest

Agriculture soils

Estimation of area of different soil types (high activity soils, low activity soils, sandy and wetland) is based on area of soil valuation classes (Table 7.6). Then percentage fraction of all soil types in croplands, grasslands and other lands were calculated (Table 7.7).

Table 7.6. Agricultural land by soil valuation classes

Soil type	Soil Valuation classes
High Activity Soils	I, II, III
Low Activity Soils	IV
Sandy	V
Wetland	other

Table 7.7. Percentage fraction of soil type by land use system (for time t and t–20)

Climate	Land use	Soil type (t)			
	Land-use/ management system	High Activity Soils	Low Activity Soils	Sandy	Wetland
		(%)			
Temperate	Forest management	39.6	19.0	37.2	4.2
	Grassland/Rangeland	14.6	43.1	31.5	10.7
	Agricultural crops	29.1	39.0	20.1	11.7
	Rest land	21.9	41.1	25.8	11.2
Climate	Land use	Soil type (t-20)			
	Land-use/ management system	High Activity Soils	Low Activity Soils	Sandy	Wetland
		(%)			
Temperate	Forest management	31.4	19.8	45.1	3.7
	Grassland/Rangeland	14.7	41.0	32.1	12.2
	Agricultural crops	27.8	39.3	20.6	12.3
	Rest land	21.3	40.1	26.3	12.3

Table 7.8. Area of soil type by land use system in 1999

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.583
	Low Activity Soils	70.0	1.719
	Sandy	30.0	3.365
	Wetland	230.0	0.380
Sum			9.047
Grassland/Rangeland	High Activity Soils	90.0	0.556
	Low Activity Soils	60.0	1.641
	Sandy	25.0	1.200
	Wetland	120.0	0.407
Sum			3.805
Agricultural crops	High Activity Soils	70.0	3.956
	Low Activity Soils	60.0	5.301
	Sandy	25.0	2.733
	Wetland	120.0	1.592
Sum			13.582
Other land	High Activity Soils	56.0	1.057
	Low Activity Soils	48.0	1.986
	Sandy	20.0	1.249
	Wetland	96.0	0.542
Sum			4.835
Total			31.2685

Carbon stock rates in soils were taken as default factors from [IPCC 1997] and corrected to domestic conditions by experts.

Estimation of CO₂ emissions and removals by soils is approximate and will be corrected by new methodology presented in [IPCC 2003]. Emissions and removals from soils were calculated separately, then the net emission/removal balance was estimated.

7.2.5. Carbon emissions from agricultural lime application (old CRF 5.D)

The reported annual carbon emission from agricultural lime application is calculated as:

$$C = M_{\text{limestone}} * EF_{\text{limestone}} + M_{\text{dolomite}} * EF_{\text{dolomite}}$$

where:

M_{limestone} - annual amount of sold calcic limestone [Mg/yr],

M_{dolomite} - annual amount of sold calcic dolomite [Mg/yr],

EF_{limestone} - emission factor for limestone – 0.120 [Mg C/ Mg limestone],

EF_{dolomite} - emission factor for dolomite – 0.122 [Mg C/ Mg dolomite].

Domestic statistic publications contain only data of use of lime fertilizers in pure nutrient (CaO), that it was necessary to convert these data into actual use of fertilizers [Radwański 2006b]. It was assumed that lime – magnesium fertilizers (CaMg(CO₃)₂) contains 89.1% of CaCO₃ and 10.9% of MgCO₃. Carbon (C) is converted to carbon-dioxide (CO₂) by the conversion factor 44/12.

8. Waste (CRF sector 6)

8.1 Key categories

Following categories from sector 6 have been identified as key sources:

- 6.A. Solid Waste Disposal on Land (CH₄ emission), share in total GHG emission 1.5%
- 6.B. Wastewater Handling (CH₄ emission), share in total GHG emission 1.3%

Share of these categories in total Poland's GHG emissions is 2.7%.

8.2 Methodological issues

8.2.1 Solid Waste Disposal on Land (CRF 6.A)

The methane emissions from solid waste disposals in 1999 were calculated using the IPCC Waste Model published in [IPCC 2006]. The model establish multiyear series when methane is generated from organic matter decomposition in anaerobic conditions. The emission of CH₄ is diminished by recapturing of this gas.

The following indicators were used for estimation of CH₄ emissions:

- DOC – degradable organic carbon in the year of deposition (table 8.1, default value [IPCC 2006])

- DOC_f – fraction of DOC that can decompose (fraction) (table 8.1, default value [IPCC 2006])
- MCF – CH_4 correction factor for aerobic decomposition in the year of deposition (table 8.2, default value [IPCC 2006])
- OX – Oxidation Factor reflecting the amount of CH_4 from solid waste disposal sites that is oxidised in the soil or other material covering the waste (table 8.3, default value [IPCC 2006])
- k – reaction constant [Steczko 2001] (table 8.3)
- F – fraction of CH_4 by volume, in generated landfill gas (fraction) [Steczko 2001] (table 8.3).
- R – methane recovery assumed as 0.

Table 8.1. DOC and DOC_f indicators

DOC (Degradable Organic Carbon)	Range	Default	Adopted Value
Food waste	0.08-0.20	0.15	0.15
Garden	0.16-0.19	0.2	0.2
Paper	0.36-0.45	0.4	0.4
Wood and straw	0.39-0.46	0.43	0.43
Textiles	0.20-0.40	0.24	0.24
Disposable nappies	0.18-0.32	0.24	0.24
Sewage sludge	0.04-0.05	0.05	0.05
Industrial waste	0-0.54	0.15	0.15
DOC_f		0.5	0.5

Table 8.2. MCF indicators of organic carbon in disposed waste

Unmanaged, shallow	Unmanaged, deep	Managed	Managed, semiaerobic	Uncategorised
0.4	0.8	1	0.5	0.6

Table 8.3. Indicators k , F and OX assumed for calculations

Methane generation rate constant (k)	Range	Default	Value
Food waste	0.1–0.2	0.185	0.086
Garden	0.06–0.1	0.1	0.069
Paper	0.05–0.07	0.06	0.039
Wood and straw	0.02–0.04	0.03	0.023
Textiles	0.05–0.07	0.06	0.039
Disposable nappies	0.06–0.1	0.1	0.1
Sewage sludge	0.1–0.2	0.185	0.185
Industrial waste	0.08–0.1	0.09	0.09
Delay time (months)		6	6
Fraction of methane (F) in developed gas		0.5	0.618
Oxidation factor (OX)		0	0

Activities used for estimation of CH_4 emissions from solid waste disposals contain:

- Population – number of population was taken from [GUS 2001]
- Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. The same method was used for 1976. In domestic statistics data were given in dm^3 . To recalculate data into Gg a conversion factor was used. According to GUS this conversion factor is $0.25 t/m^3$.

Table 8.4. Data sources for amount of municipal waste

1970	4113.98	[GUS 1987]
1971	4624.65	interpolacja
1972	5135.31	interpolacja
1973	5645.98	interpolacja
1974	6156.64	[GUS 1974d]
1975	6788.96	[GUS 1986d]
1976	7397.99	interpolacja
1977	8007.03	[GUS 1981d]
1978	8702.83	[GUS 1981d]
1979	9052.63	[GUS 1981d]
1980	9868.72	[GUS 1986d]
1981	10014.42	[GUS 1986d]
1982	10329.07	[GUS 1986d]
1983	10541.91	[GUS 1986d]
1984	10864.54	[GUS 1986d]
1985	11086.95	[GUS 1986d]
1986	11546.86	[GUS 1987]
1987	11877.45	[GUS 1989d]
1988	12084.18	[GUS 1989d]
1989	12000.95	[GUS 1990d]
1990	11098.28	[GUS 1996]
1991	10637.98	[GUS 1996]
1992	10621.00	[GUS 1996]
1993	10644.66	[GUS 1996]
1994	11014.64	[GUS 1996]
1995	10985.00	[GUS 2005d]
1996	11621.22	[GUS 1997d]
1997	12183.44	[GUS 1998d]
1998	12275.77	[GUS 1999d]
1999	12316.90	[GUS 2000d]

The percentage of waste generated, which goes to solid waste disposal sites – according to the GUS Statistical Yearbook, Environment 1990, in 1982-1990 there was no combustion of waste and the composting was on level of 0.1% (the same in 1981 – GUS 1987). Because of the lack of data, for other years this value was assumed on level of 0.1%. Distribution of solid waste disposal sites for managed and unmanaged ones was made in accordance to elaboration [Gworek 2003].

Composition of waste (according to IPCC) was assumed on a basis of National Plan on Waste Management (table 8.5)

Table 8.5. Composition of waste

Food	Garden	Paper	Wood	Textile	Plastics, other inert
18%	2%	16%	3%	3%	57%

8.2.2 Waste Water Handling (CRF 6.B)

8.2.2.1. Industrial wastewater (CRF 6.B.1)

Methane emission from industrial wastewater was estimated based on activity data from particular industrial sectors [GUS 2000d] and fraction of treated wastewater using default factors of Biochemical Oxygen Demand (BOD). Also the default values of maximum methane producing capacity were used [IPCC 2006]. Share of anaerobic treatment of wastewater was taken from [Radwański 1995] (table 8.6).

Table 8.6. Data for CH₄ emission estimation from Industrial Wastewater Handling

Industry sectors		Degradable organic component (BOD) [kg / dm ³]	Fraction of wastewater treated by anaerobically method	Maximum methane producing capacity [Gg CH ₄ / Gg BOD]
Mining and quarrying		0.001	0.15	0.6
Iron and steel		0.001	0.15	0.6
Non-ferrous metals		0.001	0.15	0.6
Fertilizer		0.004	0.15	0.6
Food products	meat and poultry	0.003	0.15	0.6
	fish processing	0.0015	0.15	0.6
	vegetable & fruit processing	0.002	0.15	0.6
	oil & grease	0.0008	0.15	0.6
	dairy products	0.003	0.15	0.6
	sugar	0.008	0.15	0.6
	soft drinks	0.001	0.15	0.6
	beer	0.004	0.15	0.6
	other	0.004	0.15	0.6
Textiles		0.0008	0.15	0.6
Leather		0.001	0.15	0.6
Wood, wood products and pulp & paper		0.004	0.15	0.6
Energy transformation sector		0.004	0.15	0.6
Chemicals		0.002	0.15	0.6
Rubber and plastic products		0.001	0.15	0.6
Non-metallic minerals		0.001	0.15	0.6
Machinery and transportation equipment		0.001	0.15	0.6
Other		0.002	0.15	0.6

8.2.2.2. Domestic and Commercial Wastewater (6.B.2)

CH₄ emission from domestic and commercial wastewater was based on methodology [IPCC 1997]. Amounts of degradable organic components for wastewater and for sludge were estimated basing on the data on population connected to sewage treatment plants and on the rate of the each type of sewage treatment plants in municipal wastewater treatment. These data were taken from [GUS 2000d]. Default value of organic load in biochemical oxygen demand per person, which is equal to 60 g BOD/person/day [IPCC 2000], was taken for the calculations. Fraction of BOD that readily settles and is removed as sludge was estimated basing on the report [Bernacka 2003] and its value was 0.786 (for this estimation the country

specific value of BOD = 357 g O₂/m³ was used). The emission factors calculated on the basis of the study mentioned above and applied in inventory report are:

- for wastewater: 0.030 kg CH₄ / kg BOD
- for sewage sludge: 0.394 kg CH₄ / kg BOD.

The default value (0.6 kg CH₄ / kg BOD) of maximum methane producing capacity was applied for estimation of sludge and wastewater emission factors. Fractions of wastewater and sludge anaerobically treated with and without methane recovery are estimated according to [Bernacka 2003]. These value are as follows: percentage of wastewater anaerobically treated – 5%, fractions of sludge anaerobically degraded – 65.6% of which with methane recovery – 31.5%.

N₂O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 2001]. Value of protein consumption per capita per year comes from [FAOSTAT 2006]. Default values were used for fraction of nitrogen in protein and for N₂O emission factor [IPCC 2000].

8.2.3. Waste Incineration (CRF 6.C)

Waste incineration was estimated based on IPCC methodology [IPCC 2000] and domestic case study [Wielgosiński 2003]. Emission factors as default were taken from [IPCC 2000]. For 1999 no data on municipal waste incineration was available. Data on incineration of sewage sludge waste was taken from [GUS 2000d]. Activity data on the amount of industrial waste was calculated based on [GUS 2000d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 2000] as well as on annual mean use of hospital bed [GUS 2000]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

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ANNEXES

Annex 1. Key sources

The source categories in all sectors, are identified to be *key sources* on the basis of their contribution to the total level and/or trend uncertainty in accordance with IPCC Good Practice Guidance (IPCC 2000).

From source categories which have been identified as key sources in level assessment, the most important are:

- Stationary combustion Solid Fuels,
- 1.A.3.b Transport Road Transportation,
- Stationary combustion Liquid Fuels.

Emission from these sources made up 73.9% of the total GHG emissions in Poland expressed in units of CO₂ equivalents. Combustion of solid, gaseous and liquid fuels in stationary sources, made up 70.63% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 59.8% of the total GHG emissions.

The most important source categories in level assessment are:

- Stationary combustion Solid Fuels,
- 1.A.3.b Transport Road Transportation,
- Stationary combustion Liquid Fuels.

Share of these sources in national total made up 73.85%.

7.A1 - 7.A3 IPCC Good Practice Guidance tables, concerning level and trend assessment are listed below.

Level Assessment

		IPCC Source Categories	Direct GHG	Current Year Estimate	Level Assessment	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO ₂	250519.94	0.5981	0.60
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO ₂	30307.18	0.0724	0.67
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO ₂	28521.30	0.0681	0.74
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO ₂	16799.87	0.0401	0.78
5	4.D.1	4.D.1. Direct Soil Emissions	N ₂ O	12688.31	0.0303	0.81
6	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH ₄	11945.03	0.0285	0.84
7	4.A	4.A. Enteric Fermentation	CH ₄	10449.08	0.0249	0.86
8	4.B	4.B. Manure Management	N ₂ O	6905.93	0.0165	0.88
9	6.A	6.A. Solid Waste Disposal on Land	CH ₄	6239.42	0.0149	0.89
10	2.A.1	2.A.1 Cement Production	CO ₂	6130.95	0.0146	0.91
11	6.B	6.B. Wastewater Handling	CH ₄	5278.16	0.0126	0.92
12	1.B.2.b.	1.B.2.b. Natural Gas	CH ₄	3859.40	0.0092	0.93
13	4.D.3	4.D.3. Indirect Soil Emissions	N ₂ O	3841.78	0.0092	0.94
14	2.C1	2.C.1. Iron and Steel Production	CO ₂	3605.71	0.0086	0.95

Trend Assessment

		IPCC Source Categories	Direct GHG	Base Year Estimate	Current Year Estimate	Level Assessment	Trend Assessment	Contribution to Trend [%]	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO2	400745.92	250519.94	0.5981	0.1187	36.9472	0.37
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	30307.18	0.0724	0.0630	19.6072	0.57
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	28521.30	0.0681	0.0314	9.7588	0.66
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	16799.87	0.0401	0.0190	5.9250	0.72
5	6.B	6.B. Wastewater Handling	CH4	2170.23	5278.16	0.0126	0.0125	3.8813	0.76
6	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	6239.42	0.0149	0.0106	3.3114	0.79
7	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	689.80	0.0016	0.0097	3.0333	0.82
8	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	568.03	0.0014	0.0061	1.9013	0.84
9	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	12688.31	0.0303	0.0048	1.5084	0.86
10	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	11945.03	0.0285	0.0041	1.2773	0.87
11	4.B	4.B. Manure Management	CH4	3435.39	3573.60	0.0085	0.0038	1.1674	0.88
12	2.A.1	2.A.1 Cement Production	CO2	7028.18	6130.95	0.0146	0.0037	1.1603	0.89
13	2.C1	2.C.1. Iron and Steel Production	CO2	6556.09	3605.71	0.0086	0.0036	1.1173	0.91
14	4.A	4.A. Enteric Fermentation	CH4	15954.36	10449.08	0.0249	0.0031	0.9761	0.92
15	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4111.13	3859.40	0.0092	0.0031	0.9629	0.93
16	1.A.3.b	1.A.3.b Transport Road Transportation	N2O	153.15	909.71	0.0022	0.0027	0.8330	0.93
17	2.A.2	2.A.2. Lime Production	CO2	3477.55	1804.72	0.0043	0.0023	0.7049	0.94
18	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	3841.78	0.0092	0.0021	0.6638	0.95
19	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	1061.57	0.0025	0.0020	0.6289	0.95

Annex 2. 1999 Energy balance data for main fuels

Energy balances in 1999 for several main fuels: brown coal, diesel oil, fuel oil, high-methane and nitrified natural gas and coke, are given below. Similar balance data for hard coal are presented in Chapter 1.4.

Brown coal consumption

Evaluation of fuel consumption In national combustion processes	Brown coal	
	10 ³ Mg	TJ
In	60 839	521 471
From national sources	60 839	521 471
1) Indigenous production	60 839	521 467
2) Transformation output or return	0	0
3) Stock decrease	0	4
Import	0	0
Out	60 839	521 471
National consumption	60 826	525 727
1) Transformation input	60 448	521 984
a) input for secondary fuel production	98	912
b) fuel combustion	60 350	521 072
2) Direct consumption	378	3 743
Non-energy use	0	0
Combusted directly	378	3 743
Combusted in Poland	60 728	524 815
Stock increase	0	0
Export	13	116
Losses and statistical differences		-4 372
Net calorific value	MJ/kg	8.64
CO ₂ Emission Factor	kg/GJ	113.58

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10 ³ Mg	TJ
In	6 832	295 921
From national sources	5 971	258 656
1) Indigenous production	0	0
2) Transformation output or return	5 971	258 656
3) Stock decrease	0	0
Import	861	37 265
Out	6 831	295 921
National consumption	6 746	292 214
1) Transformation input	727	31 502
a) input for secondary fuel production	725	31 422
b) fuel combustion	2	80
2) Direct consumption	6 019	260 712
Non-energy use	0	0
Combusted directly	6 019	260 712
Combusted in Poland	6 021	260 792
Stock increase	63	2 720
Export	61	2 673
Losses and statistical differences	-39	-1 686
Net calorific value	MJ/kg	43.32
CO ₂ Emission Factor	kg/GJ	72.29

Fuel oil consumption

Evaluation of fuel consumption In national combustion processes	Fuel oil	
	10 ³ Mg	TJ
In	5 399	225 255
From national sources	5 309	221 518
1) Indigenous production	0	0
2) Transformation output or return	5 309	221 518
3) Stock decrease	0	0
Import	90	3 737
Out	5 400	225 256
National consumption	4 205	175 954
1) Transformation input	853	35 160
a) input for secondary fuel production	162	6 650
b) fuel combustion	691	28 510
2) Direct consumption	3 352	140 794
Non-energy use	0	0
Combusted directly	3 352	140 794
Combusted in Poland	4 043	169 304
Stock increase	78	3 284
Export	1 692	69 184
Losses and statistical differences	-575	-23 166
Net calorific value	MJ/kg	41.88
CO ₂ Emission Factor	kg/GJ	76.67

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10 ⁶ m ³	TJ
In	9 755	347 820
From national sources	2 499	85 878
1) Indigenous production	1 788	61 433
2) Transformation output or return	711	24 445
3) Stock decrease	0	0
Import	7 256	261 942
Out	9 754	347 819
National consumption	9 257	333 992
1) Transformation input	864	30 880
a) input for secondary fuel production	642	23 012
b) fuel combustion	222	7 868
2) Direct consumption	8 393	303 112
Non-energy use	1 787	63 271
Combusted directly	6 606	239 841
Combusted in Poland	6 829	247 708
Stock increase	72	2 606
Export	39	1 385
Losses and statistical differences	386	9 836
Net calorific value	MJ/m ³	36.28
CO ₂ Emission Factor	kg/GJ	53.49

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10 ⁶ m ³	TJ
In	2 957	72 028
From national sources	2 957	72 028
1) Indigenous production	2 712	63 314
2) Transformation output or return	245	8 714
3) Stock decrease	0	0
Import	0	0
Out	2 956	72 027
National consumption	2 905	70 799
1) Transformation input	1 450	36 568
a) input for secondary fuel production	1 208	31 411
b) fuel combustion	242	5 157
2) Direct consumption	1 455	34 231
Non-energy use	1	34
Combusted directly	1 454	34 197
Combusted in Poland	1 696	39 354
Stock increase	0	0
Export	0	0
Losses and statistical differences	51	1 228
Net calorific value	MJ/m ³	23.21
CO ₂ Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10 ³ Mg	TJ
In	8 386	237 572
From national sources	8 368	237 078
1) Indigenous production	0	0
2) Transformation output or return	8 368	237 078
3) Stock decrease	0	0
Import	18	494
Out	8 387	237 573
National consumption	5 473	156 002
1) Transformation input	1 250	35 166
a) input for secondary fuel production	1 150	32 437
b) fuel combustion	100	2 729
2) Direct consumption	4 223	120 836
Non-energy use	92	2 541
Combusted directly	4 131	118 295
Combusted in Poland	4 231	121 024
Stock increase	39	1 087
Export	2 875	80 488
Losses and statistical differences	0	-4
Net calorific value	MJ/kg	28.60
CO ₂ Emission Factor	kg/GJ	109.78

Annex 3. National energy balance 1999 [GUS, 2001a]

CZĘŚĆ II. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII

PART II. BASIC ENERGY SUPPLY AND USE BALANCE

TABL. 1(4). SYNTETYCZNY BILANS ENERGII

TABLE 1(4). BASIC (SYNTHETIC) ENERGY BALANCE

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
#	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
1	ENERGIA OGÓŁEM TOTAL ENERGY	1999	TJ	3506368	1228570	4192	846998	-15315
		2000		3330679	1254833	9184	868684	-36650
2	ENERGIA PIERWOTNA PRIMARY ENERGY	1999	TJ	3506368	1013077	-	641843	-16977
		2000		3330679	1085140	-	629026	-25591
3	WĘGIEL KAMIENNY ENERGETYCZNY STEAM COAL	1999	tys.ton	88844	408	-	17467	143
		2000	10 ³ ton	86127	189	-	17955	-1696
		1999	TJ	2039684	10440	-	446989	3170
		2000		1972768	4920	-	465817	-38873
4	WĘGIEL KAMIENNY KOKSOWY COKING COAL	1999	tys.ton	21380	1953	-	6635	-700
		2000	10 ³ ton	17222	1263	-	5290	-137
		1999	TJ	623109	56913	-	193353	-20727
		2000		505281	37307	-	156246	-4019
5	WĘGIEL BRUNATNY BROWN COAL	1999	tys.ton	60839	0	-	13	0
		2000	10 ³ ton	59487	-	-	9	-13
		1999	TJ	521467	0	-	116	-4
		2000		507525	-	-	81	-106
6	ROPA NAFTOWA CRUDE OIL	1999	tys.ton	434	16022	-	0	-47
		2000	10 ³ ton	653	18002	-	129	445
		1999	TJ	18451	682217	-	0	-1985
		2000		27674	764888	-	5477	18583
7	GAZ ZIEMNY WYSOKOMETANOWY HIGH - METHANE NATURAL GAS	1999	mln m ³	2004	7256	-	39	72
		2000	10 ⁶ m ³	2021	7676	-	39	-46
		1999	TJ	66569	261942	-	1385	2606
		2000		66640	278025	-	1406	-1649
8	GAZ ZIEMNY ZAAZOTOWANY NITRIFIED NATURAL GAS	1999	mln m ³	2712	-	-	-	-
		2000	10 ⁶ m ³	2917	-	-	-	-
		1999	TJ	63314	-	-	-	-
		2000		71812	-	-	-	-
9	TORF I DREWNO PEAT AND WOOD	1999	tys. m ³	12859	-	-	-	-13
		2000	10 ³ m ³	13000	-	-	-	10
		1999	TJ	122163	-	-	-	-121
		2000		123503	-	-	-	98
10	ENERGIA WODY I WIATRU HYDRO AND WOOD ENERGY	1999	TJ	7770	-	-	-	-
		2000		7599	-	-	-	-
11	ENERGIA GEOTERMALNA GEOTHERMAL ENERGY	1999	TJ	104	-	-	-	-
		2000		124	-	-	-	-
12	GAZ GNILNY (BIOGAZ) BIOGAS	1999	TJ	1054	-	-	-	-
		2000		1234	-	-	-	-
13	PALIWA ODPADOWE STAŁE ROŚLINNE I ZWIERZĘCE SOLID BIOMASS AND ANIMAL PRODUCTS	1999	TJ	25063	-	-	-	302
		2000		26985	-	-	-	194
14	ODPADY PRZEMYSŁOWE STAŁE I CIEKŁE INDUSTRIAL WASTES	1999	TJ	13970	-	-	-	-218
		2000		15061	-	-	-	29

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETYCZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	#
3903255	2080689	x	2964600	2999705	111240	19640	1
3753478	2130716	x	3050669	2829505	136929	4019	
3894579	33159	x	2782158	1147595	67704	-2015	2
3812383	35720	x	2861545	1008742	81118	-22184	
71642	-	71642	51498	25264	11	-5121	3
70058	-	70058	51628	20770	12	-2341	
1599965	-	1599965	1119367	647013	344	-166415	
1550744	-	1550744	1111979	484834	375	-46069	
17398	-	17398	11395	194	-	5809	4
13332	-	13332	12314	178	-	839	
507395	-	507395	335912	5837	-	165646	
390362	-	390362	364777	5393	-	20191	
60826	-	60826	60448	378	-	-	5
59490	-	59490	58839	651	-	-	
521355	-	521355	521984	3743	-	-4372	
507551	-	507551	502745	5840	-	-1035	
16503	-	16503	16719	2	-	-218	6
18080	-	18080	18274	1	-	-194	
702652	-	702652	710501	89	-	-7937	
768502	-	768502	776570	32	-	-8100	
9149	711	9859	970	8503	1787	386	7
9704	791	10495	1182	8974	2142	339	
324519	24445	348964	34064	305064	63271	9836	
344908	28693	373601	41839	320442	76837	11320	
2712	245	2956	1450	1455	1	51	8
2917	197	3114	1583	1445	-	85	
63314	8714	72028	36568	34231	34	1228	
71812	7027	78839	40219	37111	-	1509	
12872	-	12872	25	12847	-	-	9
12990	-	12990	25	12965	-	-	
122284	-	122284	240	122044	-	-	
123405	-	123405	234	123171	-	-	
7770	-	7770	7770	-	-	-	10
7599	-	7599	7599	-	-	-	
104	-	104	-	104	-	-	11
124	-	124	-	124	-	-	
1054	-	1054	349	704	-	-	12
1234	-	1234	444	790	-	-	
24761	-	24761	3158	21603	-	-	13
26791	-	26791	3227	23564	-	-	
14188	-	14188	7275	6913	4052	-	14
15032	-	15032	8032	7000	3900	-	

TABL. 1(4). SYNTETYCZNY BILANS ENERGII (c.d.)

TABLE 1(4). BASIC (SYNTHETIC) ENERGY BALANCE (cont.)

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
#	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
15	ODPADY KOMUNALNE MUNICIPAL WASTES	1999	TJ	12	-	-	-	0
		2000		64	-	-	-	-8
16	PALIWA CIEKŁE Z BIOMASY LIQUID FUELS FROM BIOMASS	1999	TJ	-	-	-	-	-
		2000		70	-	-	-	-
17	INNE SUROWCE ENERGETYCZNE OTHER ENERGY SOURCES	1999	TJ	3641	1566	-	-	-
		2000		4338	-	-	-	161
18	ENERGIA POCHODNA DERIVED ENERGY	1999	TJ	-	215493	4192	205155	1662
		2000		-	169694	9184	239658	-11059
19	BRYKIETY Z WĘGLA KAMIENNEGO HARD COAL BRIQUETTES	1999	tys. ton	-	0	-	1	-1
		2000	10 ³ ton	-	-	-	-	-2
		1999	TJ	-	0	-	15	-21
		2000	TJ	-	-	-	-	-35
20	BRYKIETY Z WĘGLA BRUNATNEGO BROWN COAL BRIQUETTES (BKB)	1999	tys. ton	-	0	-	20	0
		2000	10 ³ ton	-	-	-	-	-1
		1999	TJ	-	3	-	358	6
		2000	TJ	-	-	-	-	-22
21	KOKS I PÓLKOKS COKE AND SEMI-COKE	1999	tys. ton	-	18	-	2875	39
		2000	10 ³ ton	-	16	-	3691	-465
		1999	TJ	-	494	-	80488	1087
		2000	TJ	-	446	-	103349	-12557
22	GAZ CIEKŁY LIQUEFIED PETROLEUM GAS (LPG)	1999	tys. ton	-	797	-	24	0
		2000	10 ³ ton	-	933	-	47	20
		1999	TJ	-	37682	-	1113	-11
		2000	TJ	-	44144	-	2218	946
23	BENZYNY SILNIKOWE MOTOR GASOLINE	1999	tys. ton	-	1670	-	-	53
		2000	10 ³ ton	-	898	-	75	61
		1999	TJ	-	74811	-	-	2366
		2000	TJ	-	40226	-	3363	2732
24	BENZYNY LOTNICZE AVIATION GASOLINE	1999	tys. ton	-	4	3	-	1
		2000	10 ³ ton	-	3	3	0	1
		1999	TJ	-	178	154	-	41
		2000	TJ	-	137	137	9	45
25	PALIWA ODRZUTOWE JET FUEL	1999	tys. ton	-	34	33	12	7
		2000	10 ³ ton	-	144	114	191	7
		1999	TJ	-	1515	1493	520	318
		2000	TJ	-	6403	5082	8496	312
26	OLEJ NAPĘDOWY I AUTOMOTIVE DIESEL OIL	1999	tys. ton	-	858	1	61	60
		2000	10 ³ ton	-	707	26	70	192
		1999	TJ	-	37157	46	2660	2580
		2000	TJ	-	30615	1136	3026	8298
27	OLEJE NAPĘDOWE POZOSTAŁE OTHER DIESEL OIL	1999	tys. ton	-	3	3	0	3
		2000	10 ³ ton	-	0	0	-	-12
		1999	TJ	-	108	108	13	140
		2000	TJ	-	12	12	-	-496
28	LEKKI OLEJ OPAŁOWY LIGHT FUEL OIL	1999	tys. ton	-	-	-	-	31
		2000	10 ³ ton	-	15	-	75	65
		1999	TJ	-	-	-	-	1345
		2000	TJ	-	641	-	3290	2844

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETYCZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	#
12	-	12	-	12	-	-	15
72	-	72	-	72	-	-	
-	-	-	-	-	-	-	16
70	-	70	-	70	-	-	
5207	-	5207	4970	237	1	-	17
4177	-	4177	3880	298	7	-	
8677	2047531	x	179934	1854618	39808	21655	18
-58905	2094996	x	186734	1823154	48551	26204	
0	-	0	0	0	-	-	19
2	-	2	0	1	-	-	
6	-	6	3	3	-	-	
35	-	35	2	33	-	-	
-21	49	28	0	28	-	-	20
1	21	23	0	23	-	-	
-361	879	518	1	517	-	-	
22	383	405	0	405	-	-	
-2896	8368	5473	1250	4223	92	-	21
-3210	8972	5762	1570	4193	102	-	
-81080	237078	155998	35166	120836	2541	-4	
-90346	254378	164031	44561	115104	2831	4367	
773	290	1063	9	1055	-	-	22
866	291	1158	58	1100	-	-	
36580	13720	50300	418	49882	-	-	
40980	13787	54767	2723	52044	-	-	
1617	4287	5905	162	5743	-	-	23
762	4412	5174	175	4999	-	-	
72445	192027	264472	7252	257220	-	-	
34131	197624	231756	7839	223917	-	-	
3	-	3	0	3	-	-	24
2	-	2	0	2	-	-	
138	-	138	7	131	-	-	
84	-	84	7	76	-	-	
15	259	274	26	248	-	-	25
-54	442	388	26	361	-	-	
677	11534	12211	1151	11060	-	-	
-2405	19697	17292	1179	16113	-	-	
737	5606	6343	712	5631	-	-	26
445	5555	6000	829	5171	-	-	
31918	242927	274845	30843	244002	-	-	
19292	240709	260000	35930	224070	-	-	
-1	365	364	15	388	-	-39	27
12	57	69	11	113	-	-55	
-45	15729	15683	659	16710	-	-1686	
508	2472	2980	464	4886	-	-2371	
-31	1532	1501	75	1409	-	17	28
-126	2232	2107	61	2046	-	-	
-1345	67000	65655	3275	61638	-	742	
-5492	97635	92143	2659	89484	-	-	

TABL. 1(4). SYNTETYCZNY BILANS ENERGII (dok.)

TABLE 1(4). BASIC (SYNTHETIC) ENERGY BALANCE (end)

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
#	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
29	CIĘŻKI OLEJ OPALOWY HEAVY FUEL OIL	1999	tys. ton	-	90	58	1692	47
		2000	10 ³ ton	-	182	69	1546	12
		1999	TJ	-	3737	2392	69184	1939
		2000		-	7473	2816	63376	477
30	PÓŁPRODUKTY Z PRZEROBU ROPY NAFTOWEJ FEEDSTOCKS	1999	tys. ton	-	566	-	87	-
		2000	10 ³ ton	-	221	-	-	-306
		1999	TJ	-	22729	-	3493	-
		2000		-	8895	-	-	-12291
31	PRODUKTY NIEENERGETYCZNE NON-ENERGY PRODUCTS	1999	TJ	-	24510	-	16975	-8125
		2000		-	18856	-	17744	-1313
32	GAZ RAFINERYJNY REFINERY GAS	1999	tys. ton	-	-	-	-	-
		2000	10 ³ ton	-	-	-	-	-
		1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
33	GAZ KOKSOWNICZY COKE OVEN GAS	1999	mln m ³	-	-	-	-	-
		2000	10 ⁶ m ³	-	-	-	-	-
		1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
34	GAZ WIELKOPIECOWY GAS MANUFACTURED FROM COAL	1999	mln m ³	-	-	-	-	-
		2000	10 ⁶ m ³	-	-	-	-	-
		1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
35	GAZ MIEJSKI TOWN GAS	1999	mln m ³	-	-	-	-	-
		2000	10 ⁶ m ³	-	-	-	-	-
		1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
36	GAZ CZADNICOWY I WYTLEWNY BLAST FURNACE GAS	1999	mln m ³	-	-	-	-	-
		2000	10 ⁶ m ³	-	-	-	-	-
		1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
37	ENERGIA ELEKTRYCZNA ELECTRICITY	1999	GWh	-	3491	-	8426	-
		2000		-	3290	-	9663	-
		1999	TJ	-	12569	-	30335	-
		2000		-	11844	-	34787	-
38	CIEPŁO *) HEAT *)	1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
39	ENERGIA Z ODZYSKU ENERGY FROM RETURNS	1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
40	PALIWA ODPAD. GAZOWE GASEOUS WASTE FUELS	1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-
41	CIEPŁO Z ODZYSKU HEAT FROM RETURNS	1999	TJ	-	-	-	-	-
		2000		-	-	-	-	-

*) Patrz 'Uwagi metodyczne'

*) See the 'Methodology remarks'

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	#
-1649	3777	2128	778	1943	-	-592	29
-1376	3690	2315	676	1796	-	-157	
-67386	154518	87132	31885	79156	-	-23908	
-56380	151484	95105	27892	73512	-	-6300	
479	308	786	567	220	147	-	30
527	-	527	300	227	226	-	
19236	12371	31607	22775	8831	5913	-	
21186	-	21186	12066	9121	9098	-	
15660	99082	114742	12895	88517	31354	13330	31
2425	115462	117887	14675	107616	36622	-4403	
-	537	537	-	537	-	-	32
-	664	664	-	664	-	-	
-	25834	25834	-	25834	-	-	
-	31950	31950	-	31950	-	-	
-	3579	3579	875	2694	-	9	33
-	3905	3905	935	2910	-	60	
-	62990	62990	16076	46739	-	174	
-	68849	68849	17093	50744	-	1011	
-	8681	8681	1032	7648	-	-	34
-	11346	11346	1334	10012	-	-	
-	28179	28179	3364	24814	-	-	
-	37053	37053	4376	32677	-	-	
-	7	7	-	7	-	0	35
-	7	7	-	7	-	-	
-	185	185	-	176	-	9	
-	168	168	-	168	-	-	
-	52	52	-	52	-	-	36
-	-	-	-	-	-	-	
-	304	304	-	304	-	-	
-	-	-	-	-	-	-	
-4935	142128	137193	2965	119655	-	14572	37
-6373	145183	138810	2789	121354	-	14667	
-17766	511659	493893	10675	430758	-	52460	
-22943	522660	499717	10040	436876	-	52801	
-	371515	371515	3489	387488	-	-19461	38
-	340684	340684	5227	354358	-	-18901	
-	54860	x	2508	52352	3728	-	39
-	65908	x	2391	63517	7260	-	
-	16430	16430	2508	13922	3728	-	40
-	18479	18479	2391	16088	7260	-	
-	38430	38430	-	38430	-	-	41
-	47429	47429	-	47429	-	-	

Poland : 1999

SUPPLY AND CONSUMPTION	Coal (TJ)						Oil (TJ)		
	Coking Coal	Other Bit. Coal	Lignite	Peat	Oven and Gas Coke	Patent Fuel	BKB	Crude Oil	Feed-stocks
Production	623108.5	2019997.1	521467.2		237078.4		878.9	18450.5	
From Other Sources		19687.1							7133.8
Import	56912.7	10439.5	0.0		494.5	0.0	3.3	682216.8	24033.6
Export	-193353.3	-446989.0	-115.6		-80488.1	-15.1	-357.8	-0.1	
International Marine Bunkers									
Stock Changes	20727.0	-3169.9	3.6		-1086.5	21.1	-6.2	-1761.8	
DOMESTIC SUPPLY	507395.0	1599964.8	521355.1		155998.3	6.0	518.2	698905.4	31167.4
Transfers									14903.4
Statistical Differences	-165645.9	166415.0	4372.3		4.3			11684.4	
TRANSFORMATION	335911.7	1119366.8	521984.3		35166.3	2.6	0.8	710500.8	46070.8
Electricity Plants									
CHP Plants		936690.9	520615.1		4.3				
Heat Plants	1329.8	182271.5	457.5		2724.7	2.6	0.8		
Blast Furnaces					30996.5				
Gas Works		404.5							
Coke Ovens	334581.9				1440.8				
Patent Fuel Plants									
BKB Plants			911.8						
Petroleum Refineries								710500.8	46070.8
Petrochemical Industry									
Other Transform. Sector									
ENERGY SECTOR	5530.4	47011.1	265.3		47.1		24.0	89.0	
Coal Mines	1831.1	44013.2	256.2		9.9		24.0		
Oil and Gas Extraction		4.8			3.7			89.0	
Petroleum Refineries		549.7			2.0				
Electr., CHP + Heat Plants									
Patent Fuel Plants									
Coke Ovens	3686.5	20.7			11.3				
Gas Works		3.1			0.7				
BKB									
Pumped Storage (Elec.)									
Other Energy Sector	12.7	2419.5	9.1		19.6				
Distribution Losses									
FINAL CONSUMPTION	307.0	600001.9	3477.9		120789.2	3.5	493.5		0.0
INDUSTRY SECTOR	276.0	246252.2	695.4		79650.0	3.0	28.8		
Iron and Steel	125.4	19470.8			60023.3				
Chemical and Petrochemical		47117.3	143.0		1570.1				
of which: Feedstocks		16.4			2.0				
Non-Ferrous Metals		2903.2			5787.2				
Non-Metallic Minerals	123.2	62753.6	63.6		7637.7		28.8		
Transport Equipment		5861.8			378.8				
Machinery		12481.7			1100.5				
Mining and Quarrying		5405.2			379.3				
Food and Tobacco		47990.2	223.6		1686.5				
Paper, Pulp and Print		17203.3			1.8				
Wood and Wood Products		6425.9			18.0				
Construction	4.9	1245.4	0.7		165.9	2.6			
Textile and Leather		10519.4	253.8		181.7				
Non-specified (Industry)	22.5	6874.5	10.7		719.3	0.5			
TRANSPORT SECTOR									
Air Transport									
Road									
Rail									
Pipeline Transport									
Internal Navigation									
Non-specified (Transport)									
OTHER SECTORS	31.0	353405.4	2782.5		38598.4	0.4	464.7		0.0
Agriculture	21.3	60498.9	1277.3		5586.3	0.4	464.7		
Commerce and Public Services	9.8	17911.7	5.2		12839.2				
Residential		274994.8	1500.0		20172.8				
Non-specified (Other)	0.0	0.0	0.0		0.0				0.0
NON-ENERGY USE		344.2			2540.8				
in Industry/Transf/Energy		344.2			2540.8				
in Transport									
in Other Sectors									

Poland : 1999

SUPPLY AND CONSUMPTION	Oil (TJ)											
	Additives	Refinery Gas	LPG + Ethane	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/ Diesel	Light Fuel Oil	Heavy Fuel Oil	Naphtha	Other Prod.
Production	3403.9	25838.1	13723.0	183083.6		11536.6	144.8	236504.5	64695.6	146854.2	31746.0	53237.6
From Other Sources												
Import	1566.4		37691.1	74825.6	178.3	1514.7	12018.7	37114.6	0.1	1311.9		11354.2
Export			-1113.2			-520.4	-11.8	-2673.2		-62966.4		-8645.6
International Marine Bunkers								-4797.4		-17679.8		
Stock Changes			-462.1	-288.7	-40.8	-197.1	38.1	996.7	866.7	5506.5	7492.5	807.5
DOMESTIC SUPPLY	4970.3	25838.1	49838.8	257620.4	137.5	12333.9	12189.8	267145.1	65562.4	73026.4	39238.5	56753.7
Transfers			-5.2	2249.3	-6.7	-1097.5	-1021.4	-9171.9			-323.6	-5378.3
Statistical Differences			473.1	-2077.8			-10810.3	-2036.7	-3421.2	15998.9	-7500.1	3169.2
TRANSFORMATION	4970.3		413.5					81.0	1563.0	26299.3		
Electricity Plants												
CHP Plants								58.5	135.2	20067.7		
Heat Plants			211.0					22.5	1427.8	6231.6		
Blast Furnaces												
Gas Works			202.5									
Coke Ovens												
Patent Fuel Plants												
BKB Plants												
Petroleum Refineries	4970.3											
Petrochemical Industry												
Other Transform. Sector												
ENERGY SECTOR		6185.9	223.3	151.0			30.6	1824.5	89.7	25938.7	0.5	1466.7
Coal Mines			1.4	22.8			11.4	1131.9	27.7			66.3
Oil and Gas Extraction				0.4			0.4	278.2	7.8			
Petroleum Refineries		6185.9	192.6	99.0				68.2	21.2	25785.6		1395.9
Electr., CHP + Heat Plants												
Patent Fuel Plants												
Coke Ovens							0.4	10.8				
Gas Works			5.7	7.6			0.4	22.5	2.6		0.5	
BKB												
Pumped Storage (Elec.)												
Other Energy Sector			23.7	21.1			17.9	312.9	30.3	153.1		4.4
Distribution Losses												
FINAL CONSUMPTION	19652.2	49669.9	257641.0	130.8	11236.4	327.5	254031.0	60488.4	36787.3	31414.3	53078.0	
INDUSTRY SECTOR	19652.2	3902.7	609.7	14.3	67.3	305.0	7276.8	16155.6	31300.9	31413.9	9310.0	
Iron and Steel		27.9	2.7			8.8	225.3	116.6	1796.6		0.8	
Chemical and Petrochemical	19652.2	2133.7	155.5			183.8	452.3	857.1	15770.2	31413.9	8548.7	
of which: Feedstocks	19652.2	2088.3	142.5				15.9	42.5	6180.5	31413.9	5584.9	
Non-Ferrous Metals		0.9	0.4			2.6	112.2	36.8	566.7		1.2	
Non-Metallic Minerals		344.4	15.2			18.8	616.6	1112.8	5961.5		395.9	
Transport Equipment		41.2	25.1	14.3	67.3	23.2	657.8	240.1	234.3		6.8	
Machinery		376.6	106.2			34.1	523.9	911.3	45.0		29.7	
Mining and Quarrying		9.0	9.9			0.9	1917.5	540.8	651.1		0.8	
Food and Tobacco		483.0	63.2			2.2	402.1	7166.0	2284.6			
Paper, Pulp and Print		114.5	5.4			6.1	47.2	766.6	1309.5		0.4	
Wood and Wood Products		18.5	21.5			1.3	110.1	462.4	2560.3		4.8	
Construction		41.6	141.6			14.4	1908.8	2153.7	73.2		14.5	
Textile and Leather		175.5	18.4			0.9	29.5	857.1	47.8		2.4	
Non-specified (Industry)		135.8	44.8			7.9	273.4	934.3			303.9	
TRANSPORT SECTOR		22094.2	255687.3	116.5	11169.1	21.9	146220.7	6.1				
Air Transport				116.5	11169.1		2.2					
Road		22094.2	255686.4			13.1	137476.9					
Rail						8.8	7781.4					
Pipeline Transport			0.9				9.1	6.1				
Internal Navigation							951.2					
Non-specified (Transport)												
OTHER SECTORS		0.0	23673.0	1344.0	0.0	0.0	0.7	100533.4	44326.8	5486.4	0.5	632.2
Agriculture			1655.9	1344.0				100533.4	28166.7	5486.4		
Commerce and Public Services			2146.5				0.7		7060.1		0.5	632.2
Residential			19870.6						9100.0			
Non-specified (Other)		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
NON-ENERGY USE												43135.8
in Industry/Transf/Energy												33998.3
in Transport												580.4
in Other Sectors												

SUPPLY AND CONSUMPTION	Gas (TJ)				Comb.Renew.& Waste (TJ)				(TJ)	(TJ)
	Natural Gas	Gas Works	Coke Ovens	Blast Furnaces	Solid Biomass	Gas/Liquids from Biomass	Municipal Waste	Industrial Waste	Electricity	Heat
Production	144314.1	337.9	69988.4	28178.6	147224.1	1053.6	12.2	7278.5	511659.3	371515.2
From Other Sources		205.1						16429.9		
Import	291046.2								12569.0	
Export	-1539.2								-30334.8	
International Marine Bunkers										
Stock Changes	-2895.8				-180.2		-0.1	217.8		
DOMESTIC SUPPLY	430925.3	543.0	69988.4	28178.6	147043.9	1053.6	12.1	23926.2	493893.4	371515.2
Transfers										
Statistical Differences	85.6	0.0	366.5							
TRANSFORMATION	33897.3		17862.6	3364.3	3397.9	349.5		3091.4		3489.1
Electricity Plants						299.7				
CHP Plants	9052.4		16848.1	3035.6	2869.9			2772.5		3489.1
Heat Plants	8958.1		1014.6	250.2	528.0	49.8		310.7		
Blast Furnaces										
Gas Works										
Coke Ovens	822.6			78.6				8.3		
Patent Fuel Plants										
BKB Plants										
Petroleum Refineries	15064.3									
Petrochemical Industry										
Other Transform. Sector										
ENERGY SECTOR	35510.4	13.5	33247.4	768.4	4.6	21.8		465.8	101602.7	49093.5
Coal Mines	1255.4		255.2		1.9				25841.3	8182.1
Oil and Gas Extraction	9941.2								90.4	5.8
Petroleum Refineries	1511.6		57.2					310.4	1590.7	7593.6
Electr., CHP + Heat Plants									49042.5	11392.7
Patent Fuel Plants										
Coke Ovens	599.7		32935.0	768.4				155.4	2254.6	9836.9
Gas Works	22122.7	11.5							592.6	116.2
BKB									11.2	160.1
Pumped Storage (Elec.)									10675.1	
Other Energy Sector	79.8	2.0	0.1		2.7	21.8			11504.3	11806.1
Distribution Losses	12379.0	10.1	559.9						52460.0	
FINAL CONSUMPTION	349224.2	519.4	18685.0	24045.9	143641.5	682.3	12.1	20369.0	339830.8	318932.6
INDUSTRY SECTOR	165679.7	337.9	18541.6	24045.9	22988.2	19.7		10306.7	141898.7	56787.4
Iron and Steel	22999.0		17639.1	24034.2	4.1			7.8	24282.3	4886.5
Chemical and Petrochemical	80247.2		2.4	7.1	0.0			6080.9	29048.7	27401.8
of which: Feedstocks								2803.9	4830.4	9739.5
Non-Ferrous Metals	6288.7				10.0			2069.9	13283.6	539.3
Non-Metallic Minerals	26573.8	337.9	893.5	4.6	2.0			528.8	11830.6	1804.0
Transport Equipment	2593.7				0.3			0.2	5481.2	3749.4
Machinery	8053.3		6.7		1.7			34.4	12477.0	5176.0
Mining and Quarrying	1412.7				0.1			1.4	5181.4	2333.0
Food and Tobacco	10282.5				69.1	19.7		0.1	13334.5	3220.6
Paper, Pulp and Print	1119.3				15443.0			102.1	9517.3	2275.2
Wood and Wood Products	880.5				5574.4			1144.0	4344.7	311.8
Construction	533.4				9.9				2023.9	639.4
Textile and Leather	1554.3		</							

Annex 5. Uncertainty estimation of the 1999 inventory

Uncertainty analysis for the year 1999 was performed with Tier1 methodology. This simplified methodology is based on the assumptions listed below:

- every value is independent (there is no correlation between values)
- probability distribution is symmetric (probability of underestimation and overestimation is the same)

Conclusions from the 2005 in-depth review of the Polish GHG emission inventory were taken into account and additional analyses were made in *Agriculture* sector. For sector 5. *LUFC* and *Industrial gases* (HFC, PFC, SF₆) due to lack of appropriate information, uncertainty estimates were made directly to emission values.

First step of the analysis was to assign uncertainty to each activity and emission factor. Next step was to estimate error propagation and its influence of total results. To estimate error propagation from activity and emission factor to emission values, formula (1) was used.

$$U_{\text{emission}} = \text{square root } (U_{\text{act}}^2 + U_{\text{EF}}^2) \quad (1)$$

where: U_{emission} – uncertainty of emission value
 U_{act} – uncertainty of activity value
 U_{ef} – uncertainty of emission factor value

To estimate error propagation from sectoral emissions to national total, formula (2) was used

$$U_{\text{emission}} = \text{square root } (\Sigma (\text{Emission} * U_{\text{emission}})^2) / \Sigma \text{Emission} \quad (2)$$

where: U_{emission} – uncertainty of emission value in sector
Emission – emission from sector

As the base bottom level of analysis the following sectors were chosen:

- sector 1: levels 1.A.1, 1.A.2, 1.A.3., 1.A.4, 1.A.5 with disaggregation by fuel type (liquid, solid, gaseous, biomass etc.)
- sector 2: levels 2.A.1, 2.A.2 2.C.3. (no estimates of emission from 2.D and 2.E)
- sector 4: 4.A.1, 4.A.2 4.F.5
- sector 6: 6.A.1, 6.A.2; 6.B with disaggregation according to wastewater types and 6.C with disaggregation according to waste types.

To estimate uncertainty of input data, the results of research made in 2000 for the 1998 GHG emission inventory were used. These data were assigned for emission factors for CH₄ and N₂O in sector 1. *Energy*, 4. *Agriculture* and partly in 6. *Waste*. Another source of data on uncertainties was analysis of 2002 GHG Inventory of Scandinavian countries. Conclusions were applied to activities in sector 1. *Energy* and for activities and emission factors in sector 2. *Industrial processes*. Other uncertainties for activities and factors were estimated with expert's opinion in National Emission Centre in Warsaw (CO₂ emission factors in sector 1. *Energy*; and activities and factors in 6.C Waste/Waste Incineration).

Results of analysis of error propagation of uncertainty of national totals are shown below:

CO ₂ – 6.4%	CH ₄ – 20.9%	N ₂ O – 50.1%
HFC – 35.4%	PFC – 20.0%	SF ₆ – 100.0%

Activities

Most uncertain values of activity were assigned in category *4.F Agriculture/Field Burning of Agricultural Residues* and in *6.B Waste/Domestic and Commercial Wastewater* (30%). Lowest uncertainty values were assigned to *1.B Fugitive emission from fuels* (2%) and in *1.A.1 Energy/ Fuel Combustion/ Energy Industries* (3%).

CO₂ emission factors

Most uncertain values for CO₂ emission factors were assigned in sector *6.C Waste incineration* (50%), *2.A. Cement Production* (15%) and *2.C Metal Production* (10%), the most precise values were in *1.A Fuel Combustion* (1-2%).

Low level of uncertainty of national total of CO₂ (6.4%) comes from the fact, that major part of emission comes from sector *1.A Fuel Combustion* where data for activities and factors are most precise (relatively 2-5% and 1-2%).

CH₄ emission factors

Most uncertain values for CH₄ emission factors were assigned in sector *6.A Solid Waste Disposal on Land* (100%), and *6.B. Wastewater Handling* (100%), *4.A. Enteric Fermentation* and *4.B Manure Management* (50%), *1.A.3 Transport* (50%), and for liquid fuels in *1.A Fuel Combustion* (41,8%), the most precise values were in *1.B.2 Fugitive emission from fuels/ Oil and natural gas* (8.1%).

Uncertainty of CH₄ emission is app. 20.9% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

N₂O emission factors

Most uncertain values for N₂O emission factors were assigned in sector *4.B.11* and *4.B.12 Manure management* (150%), *4.D Agricultural Soils* (150%) and in *4.F Agriculture/Field Burning of Agricultural Residues* (150%), most precise values were for Natural gas combustion in *1.A.3 Transport* (2.3%) and *1.A Fuel Combustion* (3.8%).

Highest value of uncertainty of national total occurred in N₂O (50.1%) and is a result of high uncertainty of the emission factors in sector of *Agriculture* (*4.B.11 Liquid systems*, *4.B.12 Solid Storage and Dry Lot*, *4.D Agricultural Soils* and *4.Field Burning of Agricultural residues* – 150%).

Industrial Gases

Simplified analysis were made for industrial gases HFC, PFC and SF₆ – uncertainty estimates were applied directly to emission values of each pollutant. Results are HFC – 35.4%, PFC – 20.0%, SF₆ – 100.0%. Due to lack of information, additional analysis need to be done for these gases.

The uncertainty assessment of GHG Inventory for 1999 was made on the basis of calculations and experts opinions made in 2006 (during compiling inventories for years 2000-2004) and recommendations of the UNFCCC expert review team. The calculations were extended to cover simplified approach for LULUCF sector and industrial gases.

Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small (411.04 Gg) compared to total CO₂ and high uncertainty have very little influence on uncertainty of values of total national CO₂ emission.

GHG inventory 1999 – Uncertainty analysis, part 1, sectors 1-2

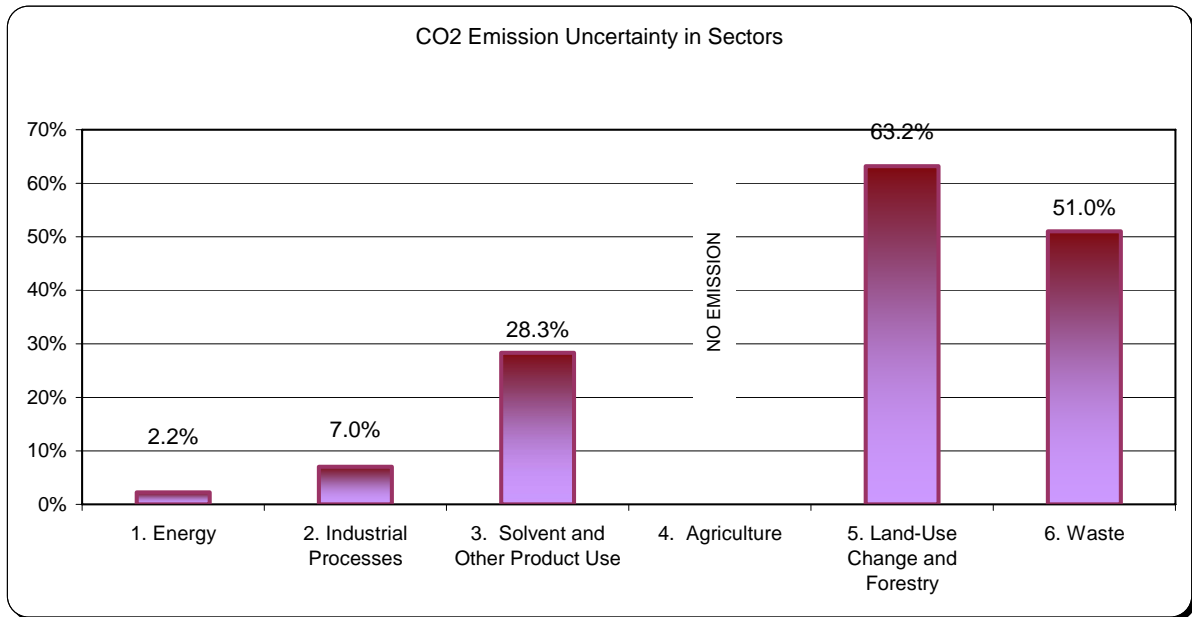
1999	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									315 162.18	2 001.34	101.25	6.4%	20.9%	50.1%	20 265.31	419.32	50.75
1. Energy									329 312.28	772.72	8.51	2.2%	14.8%	3.5%	7345.95	114.68	0.30
A. Fuel Combustion									329 187.66	17.12	8.51	2.2%	10.1%	3.5%	7345.95	1.72	0.30
1. Energy Industries									178 820.55	2.03	2.60	3.5%	12.4%	3.5%	6246.91	0.25	0.09
Liquid Fuels	68 287	3.0%	65.06	2.05	0.39	1.0%	41.8%	3.8%	4 443.92	0.14	0.03	3.2%	41.9%	3.2%	140.53	0.06	0.00
Solid Fuels	1 746 747	3.0%	99.16	1.01	1.46	2.0%	13.5%	11.7%	173 210.41	1.77	2.55	3.6%	13.8%	3.6%	6245.19	0.24	0.09
Gaseous Fuels	20 966	3.0%	55.62	1.00	0.10	2.0%	17.0%	20.0%	1 166.22	0.02	0.00	3.6%	17.3%	3.6%	42.05	0.00	0.00
Biomass	3 870	3.0%				0.0%	24.0%	37.0%	368.74	0.10	0.01	3.0%	24.2%	3.0%		0.02	0.00
2. Manufacturing Industries and Construction									55 135.76	2.32	0.85	4.0%	12.0%	8.8%	2208.90	0.28	0.07
Liquid Fuels	113 938.07	5.0%	74.32	2.92	2.06	1.0%	41.8%	3.8%	8 468.15	0.33	0.24	5.1%	42.1%	6.3%	431.79	0.14	0.01
Solid Fuels	373 668.98	5.0%	105.98	3.14	1.36	2.0%	13.5%	11.7%	39 601.52	1.17	0.51	5.4%	14.4%	12.7%	2132.61	0.17	0.06
Gaseous Fuels	127 897.72	5.0%	55.25	1.00	0.10	2.0%	17.0%	20.0%	7 066.09	0.13	0.01	5.4%	17.7%	20.6%	380.52	0.02	0.00
Biomass	23 674.34	5.0%	99.40	29.16	3.89	0.0%	24.0%	37.0%	2 353.12	0.69	0.09	5.0%	24.5%	37.3%		0.17	0.03
3. Transport									32 656.75	6.78	3.33	7.1%	11.4%	5.5%	2309.18	0.77	0.18
Liquid Fuels	457 180.37	5.0%	71.43	14.84	7.29	5.0%	10.2%	2.3%	32 656.75	6.78	3.33	7.1%	11.4%	5.5%	2309.18	0.77	0.18
Solid Fuels	0.00	5.0%	0.00	0.00	0.00	5.0%	13.5%	11.7%	0.00	0.00	0.00	7.1%	14.4%	12.7%	0.00	0.00	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	24.0%	37.0%	0.00	0.00	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
Other Fuels	NE	5.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	0.00	0.00	0.00	5.0%	50.2%	50.2%	0.00	0.00	0.00
4. Other Sectors									59 660.87	4.81	1.70	3.6%	19.3%	11.7%	2170.97	0.93	0.20
Liquid Fuels	192 963.37	5.0%	72.77	3.32	3.20	1.0%	41.8%	3.8%	14 041.70	0.64	0.62	5.1%	42.1%	6.3%	715.99	0.27	0.04
Solid Fuels	387 314.93	5.0%	95.76	1.00	1.50	2.0%	13.5%	11.7%	37 090.38	0.39	0.58	5.4%	14.4%	12.7%	1997.38	0.06	0.07
Gaseous Fuels	161 927.90	5.0%	52.67	1.00	0.10	2.0%	17.0%	20.0%	8 528.19	0.16	0.02	5.4%	17.7%	20.6%	459.29	0.03	0.00
Biomass	120 657.25	5.0%	112.00	30.00	4.00		24.0%	37.0%	13 513.52	3.62	0.48	5.0%	24.5%	37.3%		0.89	0.18
5. Other									2 913.74	1.18	0.03	4.1%	99.5%	5.8%	119.83	1.17	0.00
Liquid Fuels	34 092.14	5.0%	66.21	34.27	0.67	1.0%	100.0%	3.8%	2 257.33	1.17	0.02	5.1%	100.1%	6.3%	115.10	1.17	0.00
Solid Fuels	6 142.93	5.0%	100.54	1.00	1.50	2.0%	80.0%	11.7%	617.63	0.01	0.01	5.4%	80.2%	12.7%	33.26	0.00	0.00
Gaseous Fuels	704.98	5.0%	55.01	1.00	0.10	2.0%	90.0%	20.0%	38.78	0.00	0.00	5.4%	90.1%	20.6%	2.09	0.00	0.00
Biomass	0.65	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	0.07	0.00	0.00	5.0%	95.1%	37.3%		0.00	0.00
B. Fugitive Emissions from Fuels									124.62	755.60	0.00	6.2%	15.2%		7.73	114.67	0.00
1. Solid Fuels									0.66	570.67	0.00	6.6%	20.0%		0.04	114.17	0.00
1. B. 1. a. Coal Mining and Handling															0.00	0.00	0.00
i. Underground Mines (Activity in Mt, EF in kg/t)	109.99	2.0%		5.16462			20.0%						20.1%		0.00	114.17	0.00
ii. Surface Mines (Activity in Mt, EF in kg/t)	60.86	2.0%		0.01273			20.0%			0.77			20.1%		0.00	0.16	0.00
1. B. 1. c. Other (CO2 Emission from Coking Gas Subsystem)	0.32	2.0%	2 060 765	5 791 695.00			20.0%		0.66	1.86		6.6%	15.0%		0.04	0.28	0.00
2. Oil and Natural Gas									123.96	184.93	0.00	6.2%	5.7%		7.73	10.62	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
i. Production (Activity in PJ, EFs in kg/PJ)	18.45	0.5%	6 315 000	61 800.00		6.6%	8.1%		116.52	1.14		6.6%	8.1%		7.71	0.09	0.00
ii. Transport (Activity in Gg)	16 456.00	0.5%	NE	NE		6.6%	8.1%		0.10	0.01		6.6%	8.1%		0.01	0.00	0.00
1. B. 2. b. Natural Gas															0.00	0.00	0.00
i. Production / Processing (Activity in PJ, EFs in kg/PJ)	129.88	0.5%	51 444.60	93 286.46		6.6%	8.1%		6.68	12.12		6.6%	8.1%		0.44	0.98	0.00
ii. Transmission (Activity in PJ, EFs in kg/PJ)	380.87	0.5%	527.34	137 616.25		6.6%	8.1%		0.20	52.41		6.6%	8.1%		0.01	4.25	0.00
ii. Distribution (Activity in PJ, EFs in kg/PJ)	380.87	0.5%	1 187.45	313 104.48		6.6%	8.1%		0.45	119.25		6.6%	8.1%		0.03	9.68	0.00
2. Industrial Processes									149 288.07	11.09	11.24	7.0%	16.6%	28.3%	1049.51	1.84	3.18
A. Mineral Products									8250.74		0	12.2%			1002.92	0.00	0.00
1. Cement Production (Activity in kt, EF in t/t)	11 678.00	5.0%	0.525			15.0%			6130.95			15.8%			969.39	0.00	0.00
2. Lime Production (Activity in kt, EF in t/t)	2 299.00	10.0%	0.785			10.0%			1804.72			14.1%			255.23	0.00	0.00
4. Soda Ash (production) (Activity in kt, EF in t/t)	759.23	10.0%	0.415			0.0%			315.08			10.0%			31.51	0.00	0.00
7. Other (Limestone) (Activity in kt, EF in t/t)	0.00	5.0%	0			5.0%			0.00			7.1%			0.00	0.00	0.00
B. Chemical Industry									2736.11	8.93	11.24	6.9%	20.2%	28.3%	189.37	1.80	3.18
1. Ammonia Production (Activity in kt, EF in t/t)	1 785.00	5.0%	1.5	0.0049		5.0%	20.0%		2677.50	8.78		7.1%	20.6%		189.33	1.80	0.00
2. Nitric Acid Production (Activity in kt, EF in t/t)	1 635.50	2.0%			0.01			30.0%			10.58			30.1%	0.00	0.00	3.18
3. Adipic Acid Production (Activity in kt, EF in t/t)	NO	5.0%			0.00			10.0%	NO					11.2%		0.00	
4. Carbide Production (calcium carbide) (Activity in kt, EF in t/t)	53.20	5.0%	1.1			5.0%			58.52			7.1%			4.14	0.00	0.00
5. Other (Carbon Black) (Activity in kt, EF in t/t)	18.70	5.0%		0.01			20.0%			0.19			20.6%		0.00	0.04	0.00
5. Other (Ethylene) (Activity in kt, EF in t/t)	295.81	5.0%	0.0003			5.0%			0.09			7.1%			0.01	0.00	0.00
5. Other (N2O for Medical Use) (Activity in kt, EF in t/t)	IE	5.0%			IE			20.0%			IE				0.00	0.00	IE
5. Other (Urea production) (Activity in kt, EF in t/t)	580.70	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) (Activity in kt, EF in t/t)	139.58	5.0%			0.0047			20.0%			0.66			20.6%	0.00	0.00	0.14
C. Metal Production									3941.21	2.15	0	6.2%	16.6%		244.47	0.36	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter (Activity in kt, EF in t/t)	6 475.93	5.0%	0.08			10.0%			521.96			11.2%			58.36	0.00	0.00
Coke (Activity in kt, EF in t/t)	8 476.00	5.0%	0.15	0.000200		10.0%	20.0%		1251.07	1.70		11.2%	20.6%		139.87	0.35	0.00
Open-heart Steel (Activity in kt, EF in t/t)	378.00	5.0%	0.052			10.0%			19.66			11.2%		NE			
Electric Furnace Steel (Activity in kt, EF in t/t)	3 022.00	5.0%	0.00430	0.000120		10.0%	20.0%		12.99	0.36		11.2%	20.6%		1.45	0.07	0.00
Pig Iron (Activity in kt, EF in t/t)	5 282.26	5.0%	0.32301			10.0%			1706.21			11.2%			190.76	0.00	0.00
Iron Cast (Activity in kt, EF in t/t)	481.90	5.0%	0.061	0.000200		10.0%	20.0%		29.40	0.10		11.2%	20.6%		3.29	0.02	0.00
Steel Cast (Activity in kt, EF in t/t)	48.90	5.0%	0.062			10.0%			3.03			11.2%			0.34	0.00	0.00
Basic Oxygen Furnace Steel (Activity in kt, EF in t/t)	5 452.00	5.0%	0.01126			10.0%			61.39			11.2%			6.86	0.00	0.00
2. Ferroalloys Production (Activity in kt, EF in t/t)	62.50	5.0%	3.9			5.0%			243.75			7.1%			17.24	0.00	0.00
3. Aluminium Production (Activity in kt, EF in t/t)	50.97	5.0%	1.8			5.0%			91.75			7.1%			6.49	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 1999 – Uncertainty analysis, part 2, sector 3-6

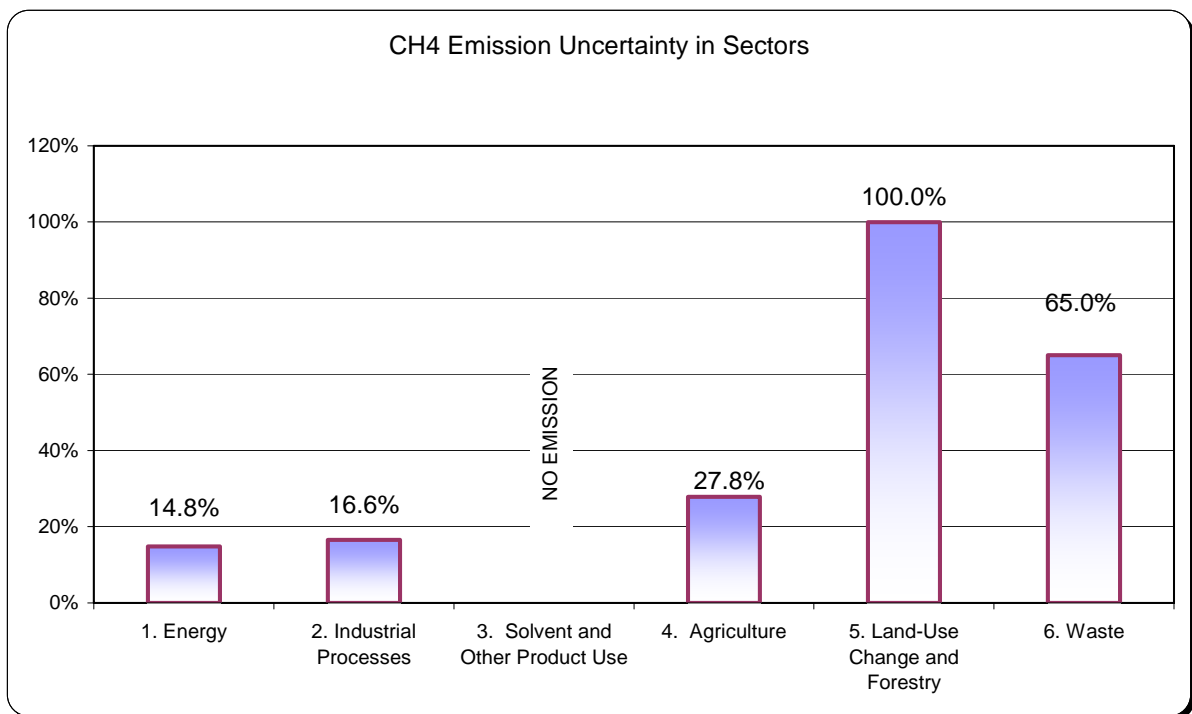
1999																		
	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]	
3. Solvent and Other Product Use	119.42		NA						411.04	668.96	77.51	28.3%						
4. Agriculture										497.58								
A. Enteric Fermentation																		
1. Cattle																		
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 418.0	5.0%		89.82			50.0%			306.99			50.2%		0.00	154.26	0.00	
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 137.0	5.0%		47.41			50.0%			148.73			50.2%		0.00	74.74	0.00	
3. Sheep [Activity in 1000 heads, EF in kg/head]	392.0	5.0%		8.21			50.0%			3.22			50.2%		0.00	1.62	0.00	
4. Goats [Activity in 1000 heads, EF in kg/head]	181.1	5.0%		5.00			50.0%			0.91			50.2%		0.00	0.46	0.00	
6. Horses [Activity in 1000 heads, EF in kg/head]	551.0	5.0%		18.00			50.0%			9.92			50.2%		0.00	4.98	0.00	
8. Swine [Activity in 1000 heads, EF in kg/head]	18 538.0	5.0%		1.50			50.0%			27.81			50.2%		0.00	13.97	0.00	
9. Poultry [Activity in 1000 heads, EF in kg/head]	202 904.0	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00	
B. Manure Management										170.17	22.28		41.6%	148.5%	0.00	70.85	33.08	
1. Cattle															0.00	0.00	0.00	
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 418.0	5.0%		5.85			50.0%			19.99			50.2%		0.00	10.04	0.00	
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 137.0	5.0%		3.93			50.0%			12.33			50.2%		0.00	6.20	0.00	
3. Sheep [Activity in 1000 heads, EF in kg/head]	392.0	5.0%		0.17			50.0%			0.07			50.2%		0.00	0.03	0.00	
4. Goats [Activity in 1000 heads, EF in kg/head]	181.1	5.0%		0.12			50.0%			0.02			50.2%		0.00	0.01	0.00	
6. Horses [Activity in 1000 heads, EF in kg/head]	551.0	5.0%		1.39			50.0%			0.77			50.2%		0.00	0.38	0.00	
8. Swine [Activity in 1000 heads, EF in kg/head]	18 538.0	5.0%		6.54			50.0%			121.17			50.2%		0.00	60.89	0.00	
9. Poultry [Activity in 1000 heads, EF in kg/head]	202 904.0	5.0%		0.08			50.0%			15.83			50.2%		0.00	7.95	0.00	
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.24			150.1%	0.00	0.00	0.36	
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			22.04			150.1%	0.00	0.00	33.07	
D. Agricultural Soils											55.17			69.4%	0.00	0.00	38.31	
1. Direct Soil Emissions															0.00	0.00	0.00	
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	775 800 000	5.0%		0.01				150.0%		10.84				150.1%	0.00	0.00	16.26	
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	671 669 809	5.0%		0.01				150.0%		10.55				150.1%	0.00	0.00	15.84	
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	44 370 000	5.0%		0.01				150.0%		0.70				150.1%	0.00	0.00	1.05	
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	183 798 400	5.0%		0.01				150.0%		2.89				150.1%	0.00	0.00	4.33	
Cultivation of Histosols [Activity in ha, EF in kg N2O-N/ha]	1 269 000	5.0%		8.00				150.0%		15.95				150.1%	0.00	0.00	23.94	
2. Animal Production [Activity in kg N, EF in kg N2O-N/kg N]	58 879 717	5.0%		0.02				150.0%		1.85				150.1%	0.00	0.00	2.78	
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	97 975 943	20.0%			1.26488674			150.0%		12.39				151.3%	0.00	0.00	18.75	
F. Field Burning of Agricultural Residues										1.22	0.06		20.4%	99.2%	0.00	0.25	0.06	
1. Cereals															0.00	0.00	0.00	
Wheat [Activity in t of crop production, EF in kg/t dm]	9 051 300	30.0%		0.1816	0.0004		20.0%	150.0%		0.16	0.00		36.1%	153.0%	0.00	0.06	0.01	
Barley [Activity in t of crop production, EF in kg/t dm]	3 401 000	30.0%		0.1473	0.0004		20.0%	150.0%		0.05	0.00		36.1%	153.0%	0.00	0.02	0.00	
Maize [Activity in t of crop production, EF in kg/t dm]	599 000	30.0%		0.0367	0.0001		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00	
Oats [Activity in t of crop production, EF in kg/t dm]	1 447 000	30.0%		0.1506	0.0004		20.0%	150.0%		0.02	0.00		36.1%	153.0%	0.00	0.01	0.00	
Rye [Activity in t of crop production, EF in kg/t dm]	5 181 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.10	0.00		36.1%	153.0%	0.00	0.04	0.00	
Other Cereals [Activity in t of crop production, EF in kg/t dm]	6 071 000	30.0%		0.1548	0.0004		20.0%	150.0%		0.09	0.00		36.1%	153.0%	0.00	0.03	0.00	
2. Pulses (Other non-specified)	317 000	30.0%		0.0427	0.0003		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00	
3. Tuber and Root															0.00	0.00	0.00	
Potatoes [Activity in t of crop production, EF in kg/t dm]	19 927 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.36	0.03		36.1%	153.0%	0.00	0.13	0.04	
Other Tuber and Root [Activity in t of crop production, EF in kg/t dm]	0	30.0%		0.0000	0.0000		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00	
5. Other															0.00	0.00	0.00	
Fruits, Veget., Rape, Tobacco, Hop, Hey [Activity in t of crop prod., EF in kg/t of crop]	24 450 500	30.0%		0.0173	0.0007		20.0%	150.0%		0.42	0.02		36.1%	153.0%	0.00	0.15	0.03	
5. Land-Use Change and Forestry									-29845.71	0.11	0.00		63.2%	100.0%	100.0%	-18856.61	0.11	0.00
A. Forest Land									-36635.03				50.0%			-18317.51	0.00	0.00
B. Cropland									6977.65				50.0%			3488.83	0.00	0.00
C. Grassland									3871.72				50.0%			1935.86	0.00	0.00
D. Wetlands									0.00				50.0%			0.00	0.00	0.00
E. Settlements									-4060.05	0.11	0.0007		50.0%	100.0%	100.0%	-2030.03	0.11	0.00
F. Other Land									0.00	0.00	0.0000		50.0%	100.0%	100.0%	0.00	0.00	0.00
6. Waste									356.51	548.46	3.60		51.0%	65.0%	51.2%	181.78	356.66	1.84
A. Solid Waste Disposal on Land															0.00	0.00	0.00	
1. Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%			297.12			102.6%			304.87	0.00	0.00
2. Unmanaged Waste Disposal Sites - deep (>5 m) [Activity in Gg, EF in t/t MSW]																0.00	0.00	0.00
3. Other - Total Waste Disposal on Land (Draft Guidelines 2006) [Activity in Gg, EF in t/t MSW]	12 035.00	23.0%					100.0%			297.12			102.6%			304.87	0.00	0.00
B. Wastewater Handling										251.34	3.53		73.6%	52.2%		0.00	185.10	1.84
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	1 735.24	30.0%		0.09			100.0%			156.17			100.0%			0.00	156.17	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	436.01	30.0%		0.218274598			100.0%			95.17			104.4%			0.00	99.36	0.00
N2O from human sewage [Activity in 1000s of population, EF in kg N2O-N/kg sewage N produced]	38 654.00	15.0%			0.0000913			50.0%			3.53		52.2%			0.00	0.00	1.84
C. Waste Incineration										356.51	0.07	51.0%		21.3%		181.78	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%					50.0%			130.80	0.03	51.0%		30.0%		66.69	0.00	0.01
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%					50.0%			356.51	0.04	51.0%		30.0%		181.78	0.00	0.01

Industrial gases inventory 1999 – Uncertainty analysis for HFC, PFC and SF₆.

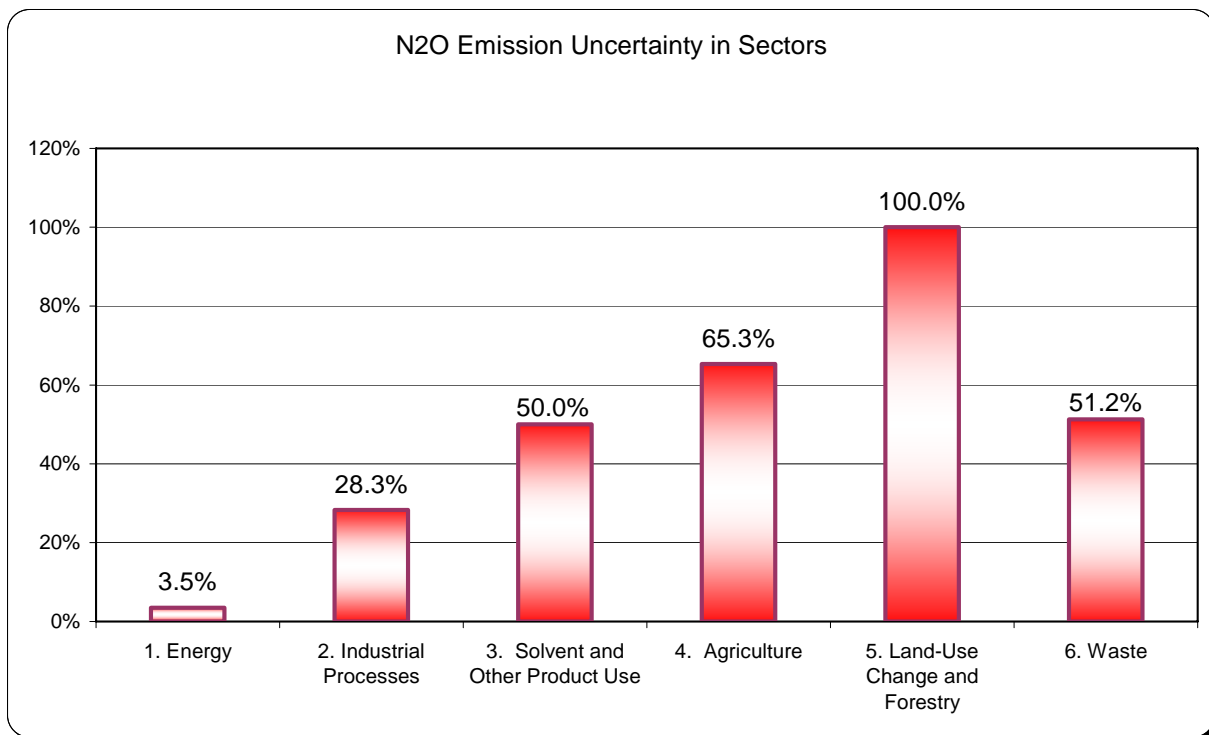
1999	HFC Emission [Gg of CO ₂ eq.]	PFC Emission [Gg of CO ₂ eq.]	SF ₆ Emission [Gg of CO ₂ eq.]	HFC Emission uncertainty [%]	PFC Emission uncertainty [%]	SF ₆ Emission uncertainty [%]	HFC Emission absolute uncertainty [Gg of CO ₂ eq.]	PFC Emission absolute uncertainty [Gg of CO ₂ eq.]	SF ₆ Emission absolute uncertainty [Gg of CO ₂ eq.]
TOTAL	206.44	239.79	14.39	35.4%	20.0%	100.0%	72.99	47.96	14.39
2. Industrial Processes	206.44	239.79	14.39	35.4%	20.0%	100.0%	72.99	46.15	14.39
C. Metal Production		230.76			20.0%			46.15	
3. Aluminium Production		230.76			20.0%			46.15	
F. Consumption of Halocarbons and SF ₆	206.44	9.02	14.39	35.4%		100.0%	72.99	0.00	14.39
1. Refrigeration and Air Conditioning Equipment	96.85			50.0%			48.43		
2. Foam Blowing	10.40			50.0%				0.00	
3. Fire Extinguishers	1.27	9.02		50.0%	20.0%				
4. Aerosols/ Metered Dose Inhalers	97.92			50.0%			48.96		
8. Electrical Equipment			14.39			100.0%			14.39



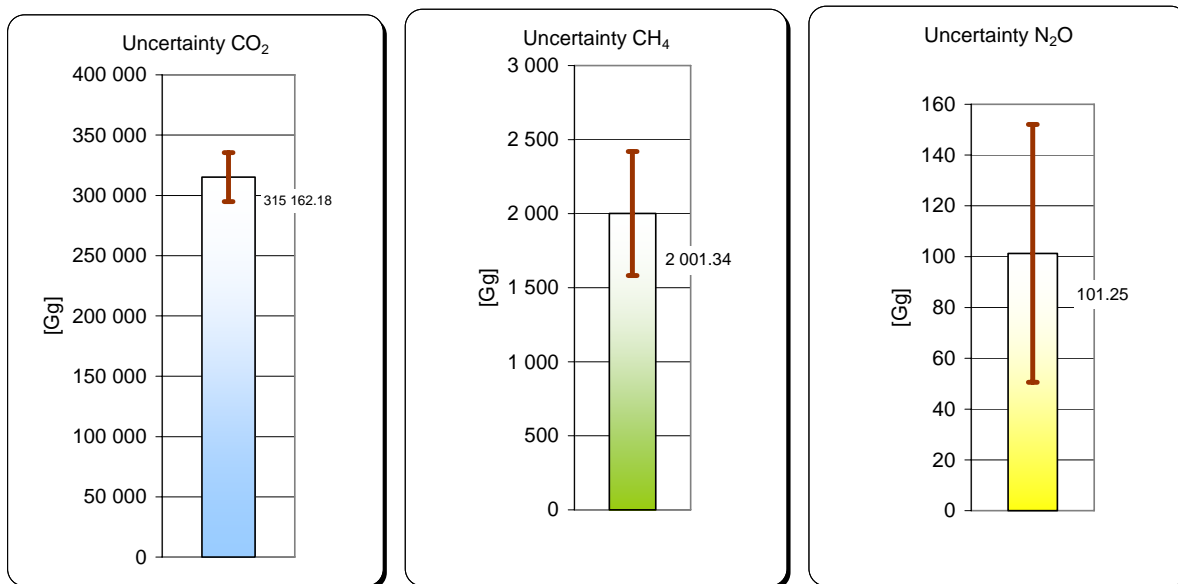
Results of uncertainty analysis in percents for CO₂ with sectoral split.



Results of uncertainty analysis in percents for CH₄ with sectoral split.



Results of uncertainty analysis in percents for N₂O with sectoral split



Emission results with uncertainties bars.