NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME
NATIONAL EMISSION CENTRE

Poland's

National Inventory Report 1996

Submission under

the United Nations Framework

Convention on Climate Change

Krzysztof Olendrzyński, Iwona Kargulewicz, Jacek Skośkiewicz, Bogusław Dębski, Joanna Cieślińska, Anna Olecka, Monika Kanafa, Katarzyna Kania

December 2006

Table of contents

Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1996. The inventory covers the following GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF_4), perfluoroethane (C_2F_6), perfluorobutane (C_4F_{10}), and sulfur hexafluoride (SF_6). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides ($NO + NO_2$) - NO_X, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO_2.

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 1996. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1996, expressed as CO_2 equivalents, are presented in table ES.1 In 1996 the total national emission of GHG were about 474.01 million tones of CO_2-eq., excluding GHG emissions and sinks from category 5. (Land use change and forestry). Compared to the base year (1988/1995), the 1996 emissions have decreased by 19.2%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1996. [Gg CO_2 eq.]

Pollutant	Base year	1996	(1996-base)/base
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO_2 – net emission (with LUCF)	461 951.16	364 869.10	-0.21
CO_2 – without LUCF.	494 885.88	398 762.79	-0.19
CH_4	49 256.41	42 657.66	-0.13
N_2O	42 478.82	32 254.09	-0.24
HFCs	26.44	96.82	2.66
PFCs	250.18	235.68	-0.06
SF_6	13.15	7.55	-0.43
TOTAL without CO_2 from LUCF	586 910.88	474 014.60	-0.19
TOTAL with LUCF	553 976.16	440 120.90	-0.21

* 1995 is the base year for HFCs, PFCs and SF_6

Carbon dioxide emissions

The CO_2 emissions in 1996 were estimated as 398.76 million tones. This is 19.4% lower than in the base year. CO_2 emission was accounted for 84.1% of total GHG emissions in Poland in 1996. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 95.79% in 1996. The shares of the main subcategories were as follows: *Energy industries* – 49.1%, *Manufacture Industries and Construction* – 20.7%, *Transport* – 8.3% and *Other Sectors* – 16.9%. *Industrial Processes* contributed to the total CO_2 emission by 4.0% in 1996. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 removal in LUCF sector in 1996, was calculated to be approximately 33.9 million tones. It means that app. 7.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

Methane emissions

The CH_4 emission amounted to 2 031.32 Gg in 1996 i.e. 42.66 million tones of CO_2 equivalents. The contribution of CH_4 to the national total GHG emission was 9.0% in 1996. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed 40.3%, 32.3% and 25.7% to the national methane emission in 1996, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (30.9% of total CH_4 emission) and Oil and Natural Gas system (9.5% of total CH_4 emission). Waste disposal sites contributed to 13.4% of the methane emission from total CH_4 emission and Wastewater Handling contributed to 12.3% of total CH_4 emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.5% of total CH_4 emission in 1996.

Nitrous oxide emissions

The nitrous oxide emissions in 1996 were 104.05 Gg i.e. 32.25 million tonnes of CO_2 equivalents. The emission was app. 24.1% lower than the respective figure for the base year. The contribution of N_2O to the national total GHG emission was 6.8% in 1996. The main N_2O emission sources and its shares in total N_2O emission in 1996 are as follow: *Agricultural Soils* – 53.4%, *Manure Management* – 22.0%, *Chemical Industry* – 12.6% and *Fuel Combustion* – 8.1%.

Hydrofluorocarbons (HFCs) emissions

The total emission of HFCs in 1996 was 0.10 million tones CO_2 equivalents. The contribution of HFCs to the national total GHG emission in 1996 was relatively low and has been estimated at 0.02%. The emissions of HFCs-gases had increased 4 times between the base year (1995) and 1996. 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 1996 was 0.24 million tonnes of CO_2 equivalents. The contribution of PFCs to the national total GHG emission in 1996 was 0.05%. The emission of PFCs had fluctuated to a limited extend, and followed the trends in aluminium production-its main source. The emission changes between 1996 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 SF_6 in 1996 was 0.01 million tones of CO_2 equivalents. The contribution of SF_6 to the national total GHG emission is insignificant, and in 1996 amounted to app. 0.002%. SF_6 emissions in 1996 were by 0.6 times lower than in 1995. Leakage from electrical equipment during its use and production is the main SF_6 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 (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF_4), perfluoroethane (C_2F_6), perfluorobutane (C_4F_{10}), and sulfur hexafluoride (SF_6). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides ($NO + NO_2$) - NO_X, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO_2 (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. N_2O emissions from animal waste in agriculture, and CH_4 and N_2O 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-CO_2 gases are expressed in units of CO_2 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 CO_2 emission factor for the given fuel. The calculations of these CO_2 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) CO_2 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 CO_2 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 1996 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 1996 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):

- CO_2 and CH_4 from *Solid Fuel Transformation*
- CO_2 from *Coal Mining and Handling*
- some individual processes in *Oil and Natural Gas* systems

in *Industrial Processes*:

- CO_2 from *Asphalt Roofing*
- CO_2 from *Road Paving with Asphalt*
- CH_4 from *Ferroalloys Production*
- CH_4 from *Aluminium Production*

- CO_2 from *Food and Drink Production*
- CH_4 from *Sinter*
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF_6

in *Agriculture*

- CH_4 from *Agriculture Soils*

in *LULUCF*

- N_2O from *Forest and Grassland Conversion*
- CO_2 from *Decay*

in *Waste*

- N_2O from *Industrial Wastewater*
- N_2O from *Domestic and Commercial Wastewater except Humane Sewage*
- CH_4 from *Waste Incineration.*

2. Greenhouse gas emissions and removals in 1996

2.1 GHG aggregated emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO_2 emission and removals from category 5. (Land Use Change and Forestry - LUCF). According to IPCC methodology, CO_2 emissions are given with and without contributions from category 5. Also following IPCC, emission of CO_2 from biomass, is not included in the national total.

For non-CO_2 gases, the inventory results can also be presented (table 2.1) in units of CO_2 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 84.1% share (in 1996), while the methane contributes with 9.0% to the national total. Nitrous oxide contribution is 6.8% and all industrial GHG together contribute 0.1%.

Table 2.1 Greenhouse gas emissions in 1996 in CO_2 eq.

Pollutant	1996	
	Emission in CO_2 eq. [Gg]	Share [%]
CO_2 – net emission (with LUCF)	364 869.10	
CO_2 – without LUCF.	398 762.79	84.12
CH_4	42 657.66	9.00
N_2O	32 254.09	6.80
HFCs	96.82	0.02
PFCs	235.68	0.05
SF_6	7.55	0.002
TOTAL without CO_2 from LUCF	474 014.60	100.0
TOTAL with LUCF	440 120.90	

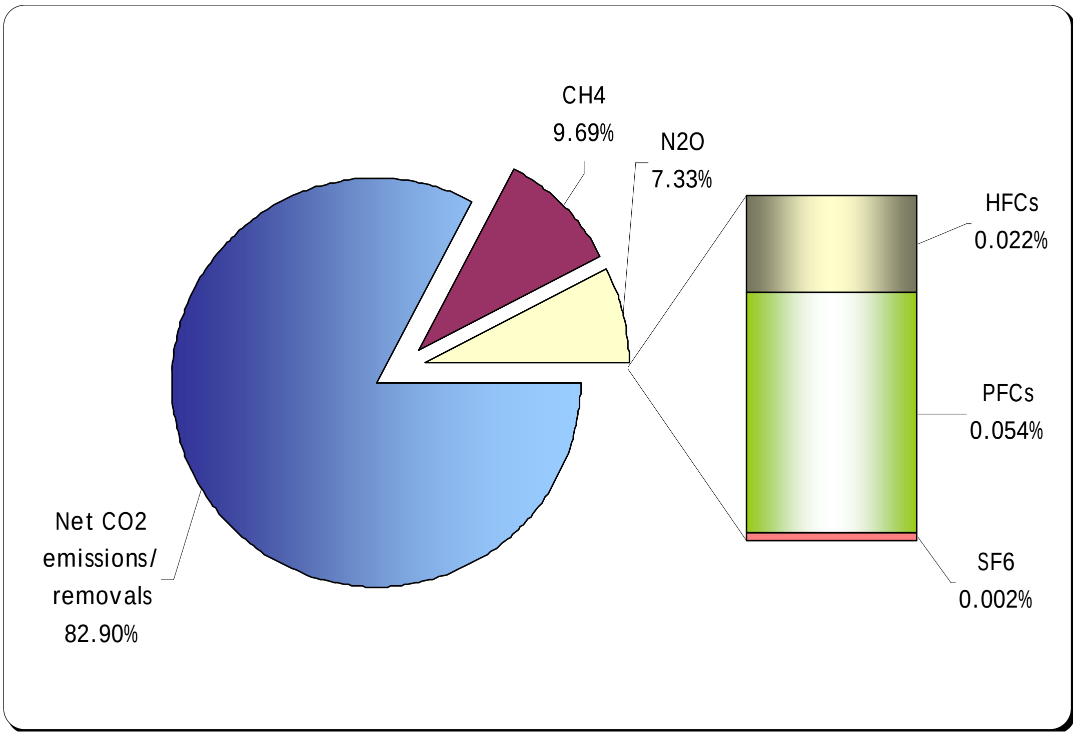


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1996

Emissions of main GHGs in 1996, 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 CO_2, CH_4 and N_2O in 1996 [Gg]

[Gg]	CO_2	CH_4	N_2O
TOTAL without CO_2 from LUCF	398 762.79	2 031.32	104.05
1. Energy	382 081.46	838.73	8.47
A. Fuel Combustion	381 987.49	19.14	8.47
1. Energy Industries	195 660.96	2.20	2.82
2. Manufacturing Industries and Construction	82 702.86	3.03	1.34
3. Transport	32 960.02	8.84	2.15
4. Other Sectors	67 438.48	4.97	1.79
5. Other	3 225.17	0.10	0.36
B. Fugitive Emissions from Fuels	93.97	819.58	NE
1. Solid Fuels	0.75	627.52	NE
2. Oil and Natural Gas	93.22	192.06	NE
2. Industrial Processes	15 857.10	13.45	13.09
A. Mineral Products	8 501.69	NE	NE
B. Chemical Industry	3 437.39	10.96	13.09
C. Metal Production	3 918.03	2.49	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	423.11	NE	0.40
4. Agriculture	NE	656.98	78.53
A. Enteric Fermentation	NE	496.66	NE
B. Manure Management	NE	159.06	22.94
D. Agricultural Soils	NE	NE	55.53
F. Field Burning of Agricultural Residues	NE	1.27	0.06
5. Land Use, Land-Use Change and Forestry	-33 893.69	0.11	0.0008
A. Forest Land	-39 673.32	NE	NE
B. Cropland	5 031.73	NE	NE
C. Grassland	2 791.98	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-2 044.09	0.11	0.0008
F. Other Land	NE	NE	NE
6. Waste	401.11	522.04	3.56
A. Solid Waste Disposal on Land	NE	273.20	NE
B. Wastewater Handling	NE	248.84	3.51
C. Waste Incineration	401.11	NE	0.05

Table 2.3 Emissions of industrial gases: HFCs, PFCs and SF_6 in 1996 [eq. Gg]

1996	HFCs	PFCs	SF_6	Total in eq. CO_2
Total Industrial gases [Gg eq. CO_2]	96.82	235.68	7.55	340.06
C. Metal Production	NE	235.02	NE	235.02
3. Aluminium Production	NE	235.02	NE	235.02
F. Consumption of Halocarbons and SF_6	96.82	0.67	7.55	105.04
1. Refrigeration and Air Conditioning Equipment	21.71	NE	NE	21.71
3. Fire Extinguishers	0.04	0.67	NE	0.70
4. Aerosols	75.08	NE	NE	75.08
8. Electrical Equipment	NE	NE	7.55	7.55

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 1996 for CO_2, CH_4 and N_2O.

Table 2.4 Percentage shares of individual source sectors in 1996 emissions

Percentage share of source sectors in biezacy emissions	Share [%]		
	CO_2 without LUCF	CH_4	N_2O
TOTAL	100.00	100.00	100.00
1. Energy	95.82	41.29	8.14
A. Fuel Combustion	95.79	0.94	8.14
1. Energy Industries	49.07	0.11	2.71
2. Manufacturing Industries and Construction	20.74	0.15	1.29
3. Transport	8.27	0.44	2.07
4. Other Sectors	16.91	0.24	1.72
5. Other	0.81	0.00	0.35
B. Fugitive Emissions from Fuels	0.02	40.35	NE
1. Solid Fuels	0.0002	30.89	NE
2. Oil and Natural Gas	0.02	9.46	NE
2. Industrial Processes	3.98	0.66	12.58
A. Mineral Products	2.13	NE	NE
B. Chemical Industry	0.86	0.54	12.58
C. Metal Production	0.98	0.12	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.11	NE	0.38
4. Agriculture	NE	32.34	75.48
A. Enteric Fermentation	NE	24.45	NE
B. Manure Management	NE	7.83	22.04
D. Agricultural Soils	NE	NE	53.37
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	25.70	3.42
A. Solid Waste Disposal on Land	NE	13.45	NE
B. Wastewater Handling	NE	12.25	3.38
C. Waste Incineration	0.10	NE	0.04

2.2 GHG emissions by gas

Carbon dioxide (CO_2)

In 1996, the net CO_2 emissions (with LULUCF) were estimated as 364.87 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 398.76 million tones (table 2.2). The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 95.79% in 1996. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 49.1%, *Manufacture Industries and Construction* – 20.7%, *Transport* – 8.3% and *Other Sectors* – 16.9%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission by 4.0% in 1996. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 1996, was calculated to be approximately 33.9 million tones. It means that app. 7.7% of the total CO_2 emissions are offset by CO_2 uptake by forests.

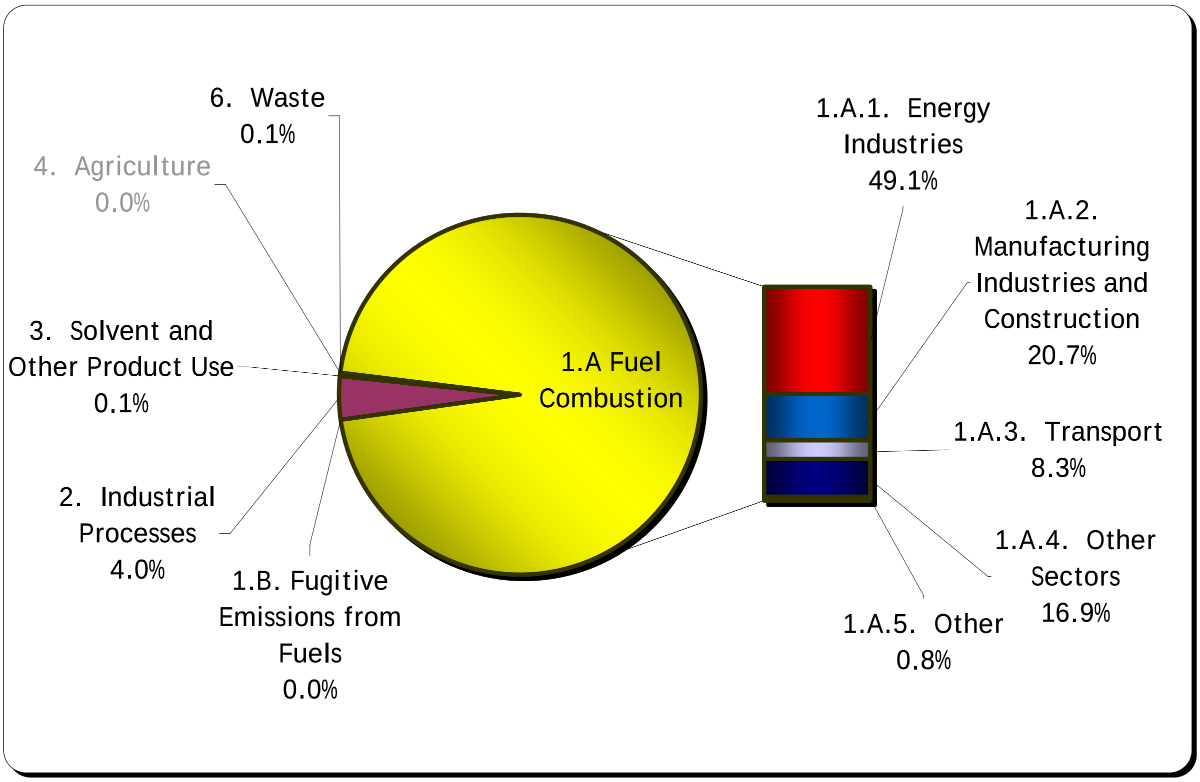


Figure 2.2 Carbon dioxide emission in 1996 by sector

Methane (CH_4)

The CH_4 emission amounted to 2 031.32 Gg in 1996 i.e. 42.66 million tones of CO_2 equivalents (table 2.2). Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed to 40.3%, 32.3% and 25.7% of the national methane emission in 1996 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 30.9% of total CH_4 emission) and *Oil and Natural Gas* system (about 9.5% of total emission), *Disposal sites* contributed to 13.45% of the methane emission and *Wastewater Handling* contributed to 12.25%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.5% of total methane emission in 1996.

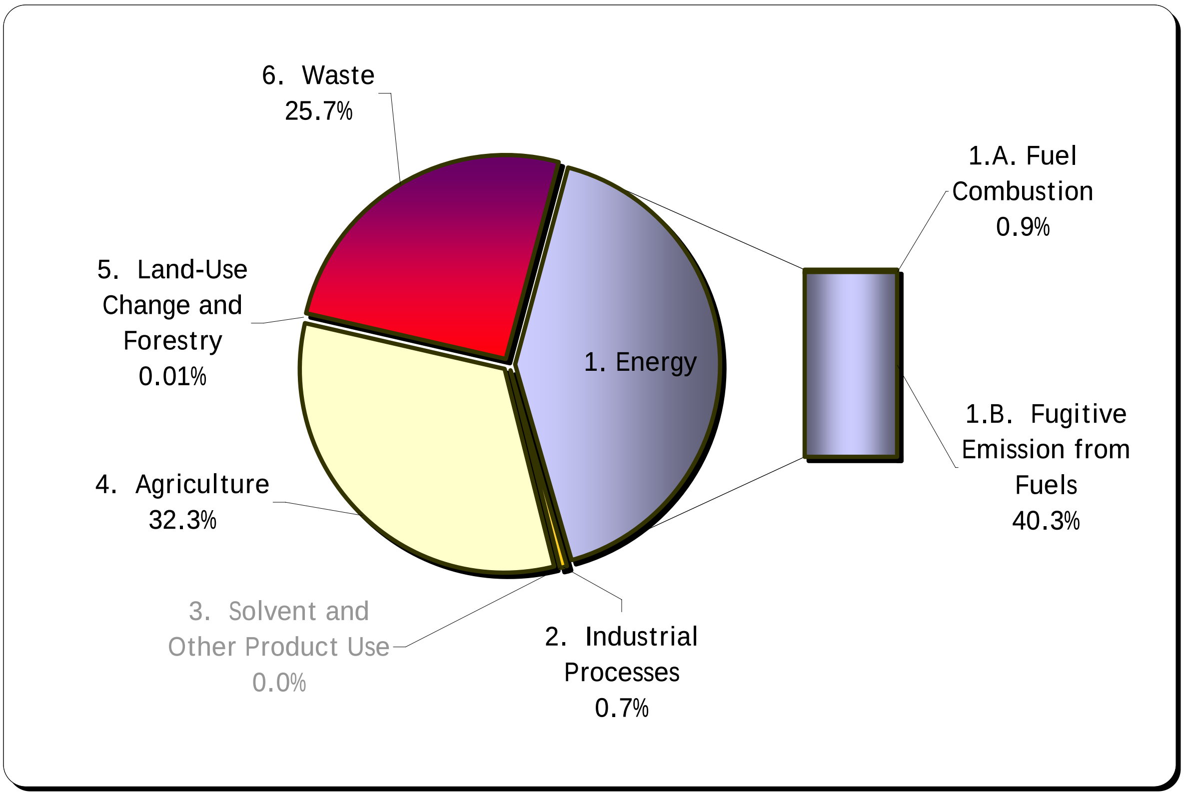


Figure 2.3 Methane emission in 1996 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions in 1996 were 104.05 Gg i.e. 32.25 million tonnes of CO_2 equivalents (table 2.2). The main N_2O emission sources and its shares in total N_2O emission in 1996 are: *Agricultural Soils* – 53.4%, *Manure Management* – 22.0%, *Chemical Industry* – 12.6% and *Fuel Combustion* – 8.1%.

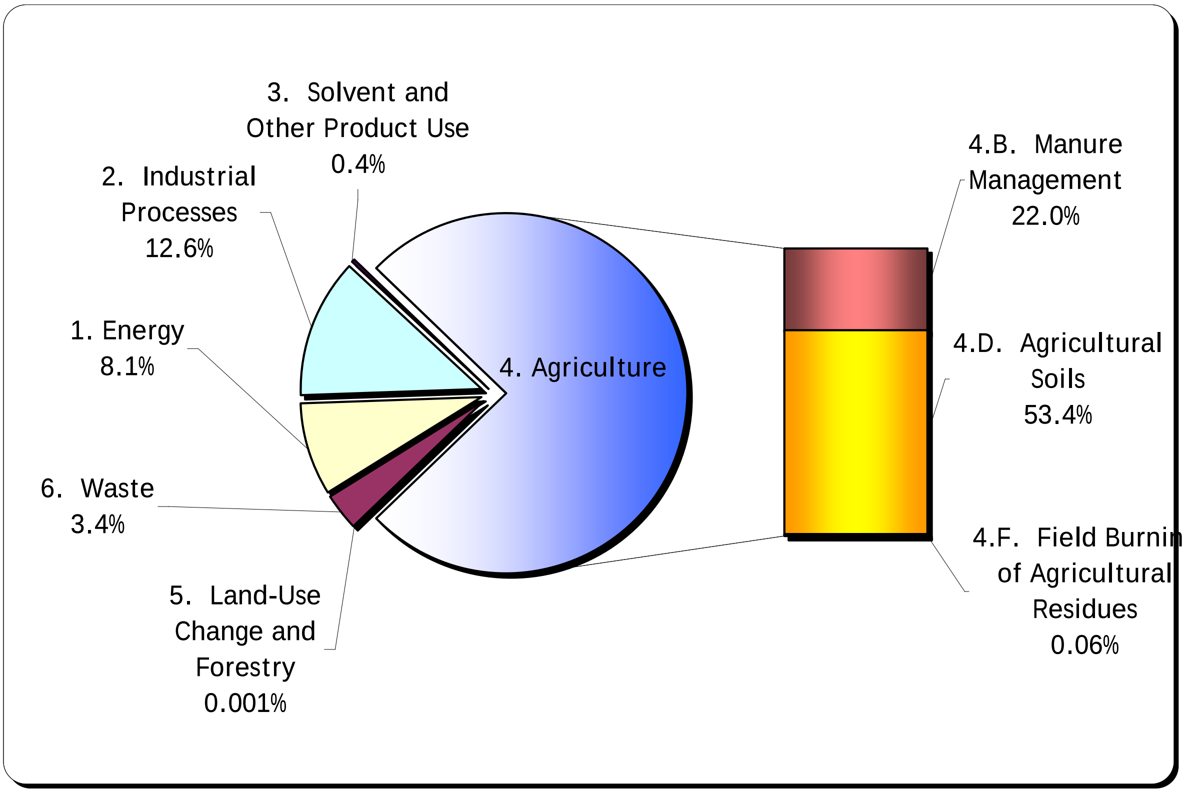


Figure 2.4 Nitrous oxide emission in 1996 by sector

Industrial gases

The total emission of HFCs in 1996 was 0.10 million tones of CO_2 equivalents. The emissions of HFCs-gases had increased 4 times between the base year (1995) and 1996. 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 1996 was 0.24 million tonnes of CO_2 equivalents. The emissions of PFCs-gases had decreased by 5.8% between the base year (1995) and 1996. It is due to the growth in aluminium production and in the use of C_4H_{10} 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 SF_6 in 1996 was 0.01 million tones of CO_2 equivalents. SF_6 emissions in 1996 were by 0.6 time lower than in 1995. Leakage from electrical equipment, is the main SF_6 emission source. Insignificant emission of SF_6 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 1996.

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 1996

	Total [Gg eq. CO_2]		(1996-base)/base
	Base year	1996	
TOTAL with LUCF	553 976.2	440 120.90	-0.21
TOTAL without LUCF	586 902.6	474 011.99	-0.19
1. Energy	497 964.7	402 319.16	-0.19
2. Industrial Processes	27 356.2	20 536.53	-0.25
3. Solvent and Other Product Use	1 006.5	547.11	-0.46
4. Agriculture	52 378.1	38 142.13	-0.27
5. Land-Use Chpole and Forestry	-32 926.5	-33 891.09	0.03
6. Waste	8 197.2	12 467.06	0.52

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1996 was 402.3 million tons of CO_2 equivalent. CO_2 emission share exceeded 95.0% 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 1996

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Energy	% Share in total GHG emission from a given sub-sector		
			CO_2	CH_4	N_2O
Total Energy	402 319.16	100.0	95.0	4.4	0.7
A. Fuel Combustion	385 013.93	95.7	94.9	0.1	0.7
1. Energy Industries	196 582.26	48.9	48.6	0.0	0.2
2. Manufacturing Industries and Construction	83 182.94	20.7	20.6	0.0	0.1
3. Transport	33 812.90	8.4	8.2	0.0	0.2
4. Other Sectors	68 096.46	16.9	16.8	0.0	0.1
5. Other	3 339.37	0.8	0.8	0.0	0.0
B. Fugitive Emissions from Fuels	17 305.23	4.3	0.0	4.3	0.0
1. Solid Fuels	13 178.67	3.3	0.0	3.3	0.0
2. Oil and Natural Gas	4 126.56	1.0	0.0	1.0	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 CO_2, CH_4 and N_2O in *Industrial Processes* sector and in *Solvent and Other Use* sector in 1996. CO_2 is dominating among GHGs – it's contribution exceeds 77.2%. 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 N_2O emissions from anaesthesia (22.7%) and CO_2 emissions (recalculated from NMVOC) (77.3%).

Table 2.7. The emissions of CO_2, CH_4 and N_2O from sub-sectors in category *Industrial Processes* and in category *Solvents and Other Product Use* in 1996

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Industrial Processes	% Share in total GHG emission from a given sub-sector			
			CO_2	CH_4	N_2O	HFC, PFC and SF6
Total Industrial Processes	20 536.53	100.0	77.2	1.4	19.8	1.7
A. Mineral Products	8 501.69	41.4	41.4	0.0	0.0	
B. Chemical Industry	7 724.39	37.6	16.7	1.1	19.8	
C. Metal Production	4 205.41	20.5	19.1	0.3	0.0	1.1
D. Other Production	NE	NE				
F. Consumption of Halocarbons and SF6	105.04	0.5				0.5
G. Other	0.00	0.0				
Total Solvent and Other Product Use	547.11	100	77.3	0.0	22.7	

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). N_2O emission share was largest in total GHG emission from *Agriculture* in 1996 and came from both – direct (mineral and organic fertilisation) and indirect (volatilisation, leaching and runoff from applied synthetic fertiliser and animal manure) N_2O emissions from soils.

Table 2.8. GHG emissions from sub-sectors in category 4.*Agriculture* in 1996

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Agriculture	% Share in total GHG emission from a given sub sector	
			CH_4	N_2O
Total Agriculture	38 142.13	100.0	36.2	63.8
A. Enteric Fermentation	10 429.89	27.3	27.3	0.0
B. Manure Management	10 450.27	27.4	8.8	18.6
D. Agricultural Soils	17 215.25	45.1	0.0	45.1
F. Field Burning of Agricultural Residues	46.72	0.1	0.1	0.1

2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.9, the emission of CH_4 dominated in this sector in 1996 (almost 87.9%). The main part of GHG emissions came from s*olid waste disposal on land* and *wastewater handling*.

Table 2.9. GHG emissions from sub-sectors in category 6.*Waste* in 1996

GHG emission categories	GHG Emission [Tg CO2-eq]	% share in the total emission from Waste	% Share in total GHG emission from a given sub-sector		
			CO_2	CH_4	N_2O
Total Waste	12 467.06	100	3.2	87.9	8.8
A. Solid Waste Disposal on Land	5 737.18	46.0	0.0	46.0	0.0
B. Wastewater Handling	6 314.63	50.7	0.0	41.9	8.7
C. Waste Incineration	415.25	3.3	3.2	0.0	0.1

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 1996 with respect to base year 1988/1995

Pollutant	Base year Emission in CO_2 eq. [Gg]	1996 Emission in CO_2 eq. [Gg]	1996/base year [%]
CO_2 – net emission (with LUCF)	461 951.16	364 869.10	78.98
CO_2 – without LUCF.	494 885.88	398 762.79	80.58
CH_4	49 256.41	42 657.66	86.60
N_2O	42 478.82	32 254.09	75.93
HFCs	26.44	96.82	366.17
PFCs	250.18	235.68	94.20
SF_6	13.15	7.55	57.45
TOTAL without CO_2 from LUCF	586 910.88	474 014.60	80.76
TOTAL with LUCF	553 976.16	440 120.90	79.45

* for industrial gases: HFC, PFC and SF_6 the base year is 1995

Carbon dioxide

CO_2 emission had decreased by app. 19.4% from the base year to 1996.
The following changes took place in the structure of fuel use:

- share in of solid fuels decreased from 85.3% in 1988 to 80.2% in 1996
- share of liquid fuels increased from 11.4% (1988) to 15.5% (1996)
- share of gaseous fuels increased from 3.3% (1988) to 4.3% (1996).

Methane

CH_4 emission had decreased by app. 13.4% from the base year to 1996. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 34.6%,
- the decrease in *Fugitive Emission* by 24.2%,
- the increase in emission from *Waste* by 69.8%.

Nitrous oxide

The nitrous oxide emissions in 1996 were app. 24.1% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 22.0% in 1996, in *Agricultural Soils* decreased from 55.6% (1988) to 53.4% (1996) and in *Chemical Industry* increased from 11.8% in 1988 to 12.6% in 1996.

Industrial gases: HFCs, PFCs and SF_6

HFCs emissions in 1996 were 4 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 1996 were 5.8% lower than in base year (1995). The PFCs emission changes between 1996 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C4F10 in fire extinguishers.

SF_6 emissions in 1996 were about than 0.6 times lower than in 1995. Leakage from electrical equipment during its use and production is the main SF_6 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 1996.

Emissions of greenhouse gases in base year (1988/1995) in CO_2 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 CO_2 in 1996 decreased from 84.3% to 84.1%.

Table 2.11 Emissions of greenhouse gases in base year (1988/1995) in CO_2 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_2O	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	

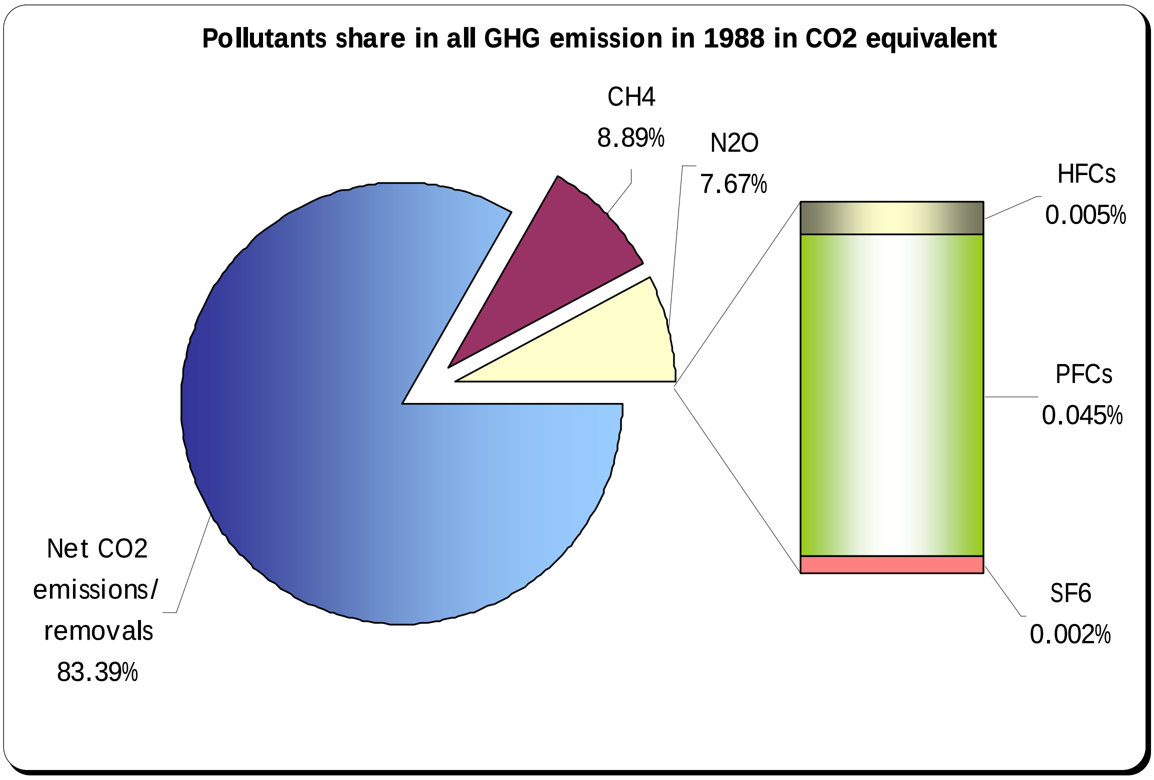


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 1996 and 1995

Changes of national emissions and sinks of GHGs in 1996 compared to 1995 were:

CO_2	- net emission rise to	105.86%
CH_4	- emission fall to	99.46%
N_2O	- emission fall to	99.10%
HFC [eq. CO_2]	- actual emission rise to	366.17%
PFC [eq. CO_2]	- actual emission fall to	94.20%
SF_6 [eq. CO_2]	- actual emission fall to	57.45%

Below results are discussed separately for each greenhouse gas with respect to 1996 emissions and change between 1996 and 1995.

Carbon dioxide (CO_2)

In 1996, the net CO_2 emissions (with LULUCF) was 5.9% higher than in 1995. The CO_2 emission in 1996 from category *Energy* was higher by 6.3% and from category *Industrial Processes* was lower by 7.3% than in 1995. In comparison to 1995 the CO_2 emission from category *Waste* in 1996 rise by 1.3%.

Table 2.12. Comparison of carbon dioxide emission in 1995 and 1996

Year	CO_2 [Gg]		1996/1995 [%]
	1995	1996	
TOTAL without LUCF	377 448.3	398 762.8	105.6
1. Energy	359 542.8	382 081.5	106.3
A. Fuel Combustion	359 457.5	381 987.5	106.3
1. Energy Industries	192 904.7	195 661.0	101.4
2. Manufacturing Industries and Construction	73 556.8	82 702.9	112.4
3. Transport	29 831.8	32 960.0	110.5
4. Other Sectors	61 213.2	67 438.5	110.2
5. Other	1 951.0	3 225.2	165.3
B. Fugitive Emissions from Fuels	85.3	94.0	110.1
1. Solid Fuels	0.7	0.8	113.4
2. Oil and Natural Gas	84.6	93.2	110.1
2. Industrial Processes	17 108.7	15 857.1	92.7
A. Mineral Products	9 027.2	8 501.7	94.2
B. Chemical Industry	3 568.3	3 437.4	96.3
C. Metal Production	4 513.2	3 918.0	86.8
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	400.8	423.1	105.6
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	-32 784.2	-33 893.7	103.4
A. Forest Land	-38 793.9	-39 673.3	102.3
B. Cropland	4 800.3	5 031.7	104.8
C. Grassland	2 663.5	2 792.0	104.8
D. Wetlands	NE	NE	NE
E. Settlements	-1 454.1	-2 044.1	140.6
F. Other Land	NE	NE	NE
6. Waste	396.0	401.1	101.3
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	396.0	401.1	101.3

Methane (CH_4)

The emission in 1996 was lower than in 1995 by 0.5%. The main sources are *Agriculture*, *Energy* and *Waste.* Emission from *Manure Management* in the *Agriculture* sector was lower by 6.3% in 1996 and from *Waste* sector was higher by 1.8% than in 1995. *Fugitive emission* in *Energy* sector was higher by 0.8% in 1996 compared to 1995.

Table 2.13 Comparison of methane emission in 1995 and 1996

Year	CH_4 [Gg]		1996/1995 [%]
	1995	1996	
TOTAL	2 042.29	2 031.32	99.5
1. Energy	830.46	838.73	101.0
A. Fuel Combustion	17.66	19.14	108.4
1. Energy Industries	2.18	2.20	100.9
2. Manufacturing Industries and Construction	2.63	3.03	115.3
3. Transport	7.70	8.84	114.8
4. Other Sectors	5.10	4.97	97.6
5. Other	0.05	0.10	209.2
B. Fugitive Emissions from Fuels	812.81	819.58	100.8
1. Solid Fuels	629.14	627.52	99.7
2. Oil and Natural Gas	183.66	192.06	104.6
2. Industrial Processes	14.02	13.45	95.9
A. Mineral Products	NE	NE	NE
B. Chemical Industry	11.25	10.96	97.4
C. Metal Production	2.77	2.49	90.1
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	684.86	656.98	95.9
A. Enteric Fermentation	513.73	496.66	96.7
B. Manure Management	169.79	159.06	93.7
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.34	1.27	94.6
5. Land Use, Land-Use Change and Forestry	0.11	0.11	103.7
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.11	0.11	103.7
F. Other Land	NE	NE	NE
6. Waste	512.84	522.04	101.8
A. Solid Waste Disposal on Land	266.46	273.20	102.5
B. Wastewater Handling	246.37	248.84	101.0
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N_2O)

The emission was lower than in 1995 (by 0.9%). The main sources of N_2O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 5.5% in 1996 and from *Agricultural Soils* was lower by 1.3% than in 1995.

Table 2.14. Comparison of nitrous oxide emission in 1995 and 1996

Year	N_2O [Gg]		1996/1995 [%]
	1995	1996	
TOTAL	104.99	104.05	99.1
1. Energy	7.37	8.47	114.9
A. Fuel Combustion	7.37	8.47	114.9
1. Energy Industries	2.77	2.82	101.9
2. Manufacturing Industries and Construction	1.14	1.34	118.0
3. Transport	1.72	2.15	124.8
4. Other Sectors	1.72	1.79	104.1
5. Other	0.02	0.36	1652.5
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	13.09	13.09	100.0
A. Mineral Products	NE	NE	NE
B. Chemical Industry	13.09	13.09	100.0
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	80.62	78.53	97.4
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	24.26	22.94	94.5
D. Agricultural Soils	56.29	55.53	98.7
F. Field Burning of Agricultural Residues	0.06	0.06	103.8
5. Land Use, Land-Use Change and Forestry	0.0007	0.0008	103.7
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0007	0.0008	103.7
F. Other Land	NE	NE	NE
6. Waste	3.51	3.56	101.3
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.47	3.51	101.3
C. Waste Incineration	0.04	0.05	101.5

Industrial gases

The total emission of HFCs in 1996 by % 266.2 than in 1995. PFCs emissions in 1996 were by app. % -5.8 than in 1995. SF_6 emissions in 1996 were by % -42.5 than in 1995.

2.6 Emission trends for indirect greenhouse gases (CO, NO_x and NMVOC) and SO_2

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 SO_2 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 SO_2, NO_x, NMVOC (1980-2005) and CO (1990-2005). Emissions of SO_2 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 SO_2. 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 SO_2 and NO_x.

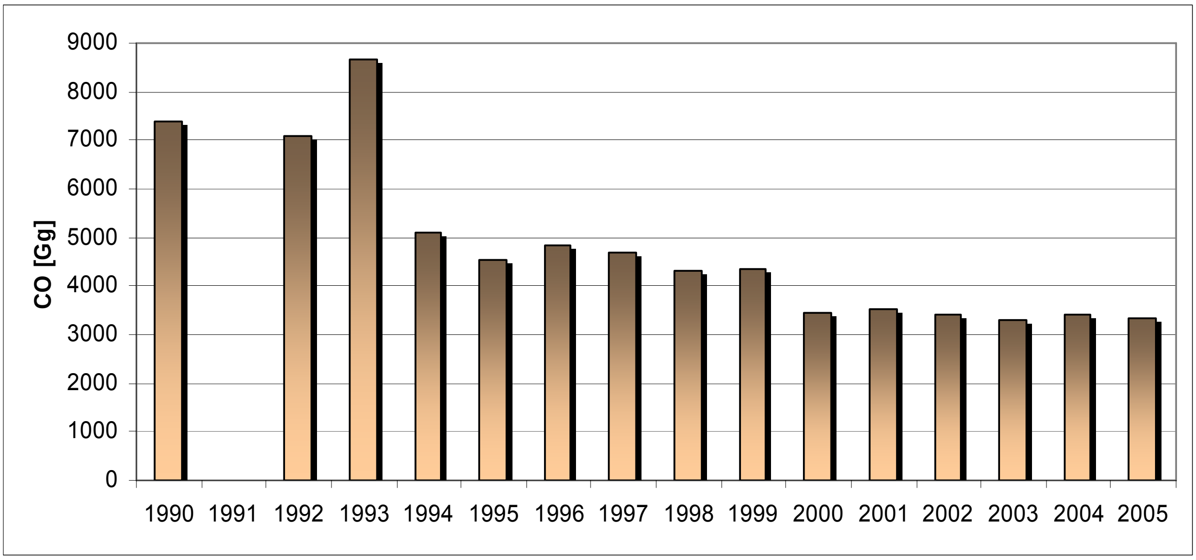


Figure 2.6 Emissions of CO (1990-2005).

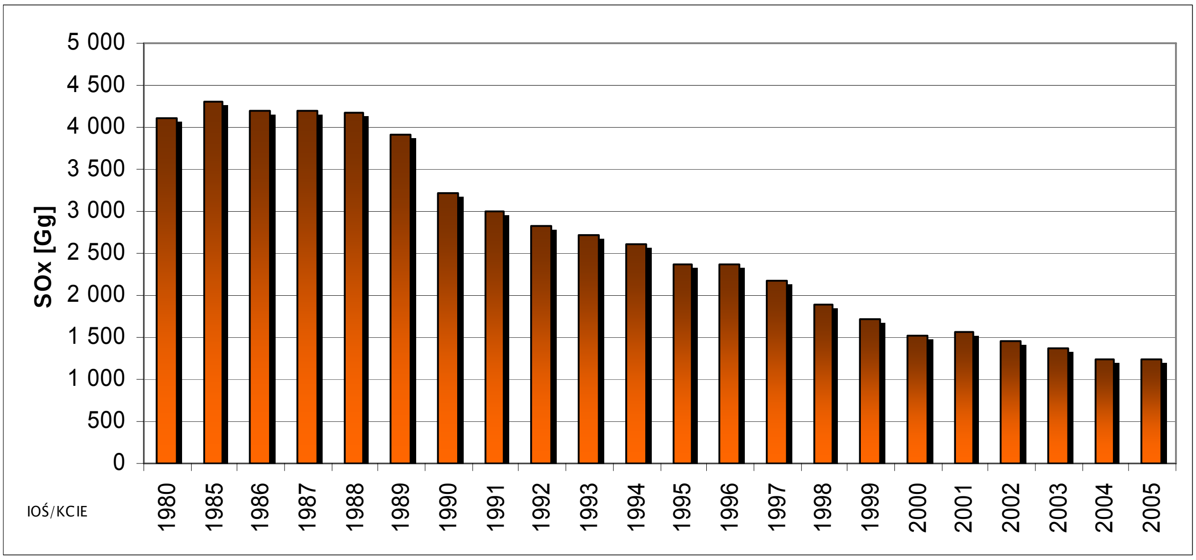


Figure 2.7 Emissions of SO_x, (1980-2005).

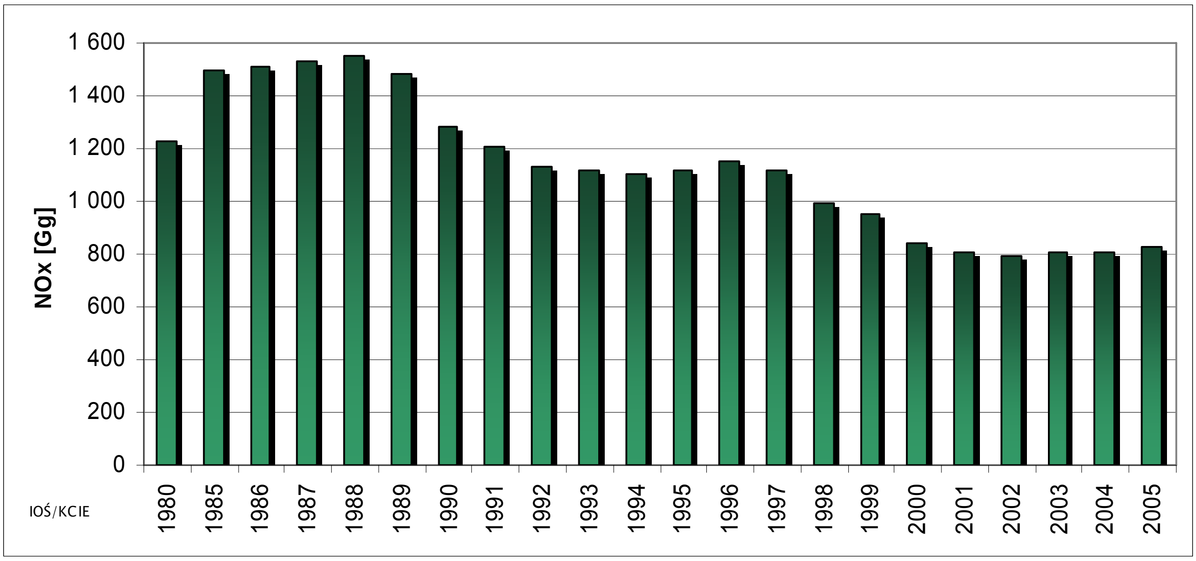


Figure 2.8 Emissions of NO_x (1980-2005).

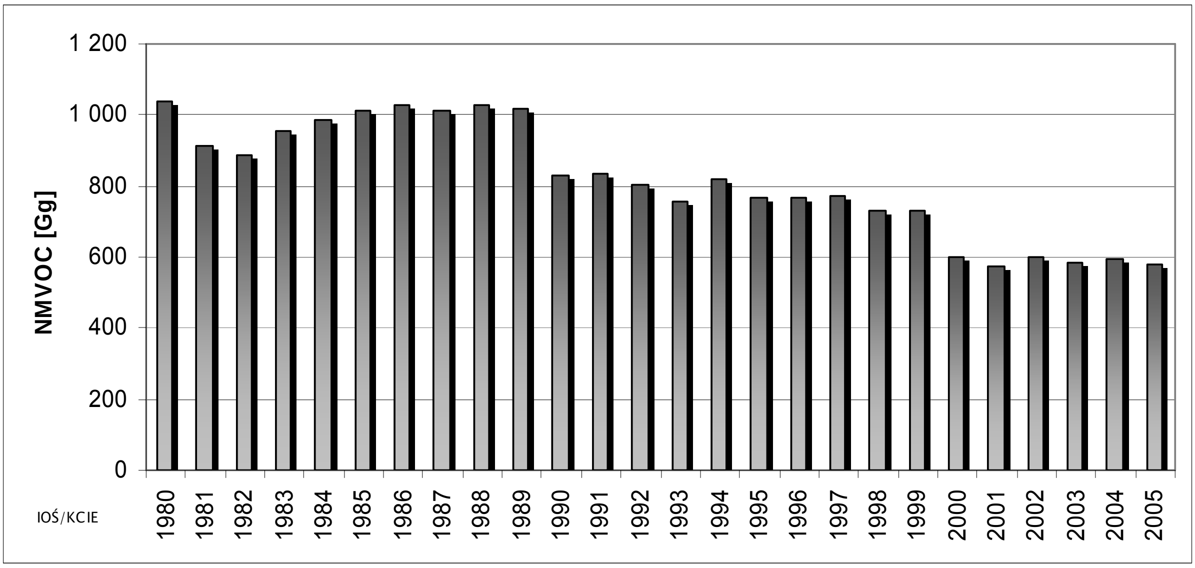


Figure 2.9 Emissions of NMVOC (1980-2005).

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 (CO_2 emission), share in total GHG emission 73.5%
- 1.A.3.b Transport Road Transportation (CO2 emission), share in total GHG emission 6.2%
- 1.B.1.a. Coal Mining and Handling (CH4 emission), share in total GHG emission 2.8%
- 1.B.2.b. Natural Gas (CH4 emission), share in total GHG emission 0.8%

Share of these categories in total Poland's GHG emissions is 83.2%.

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 CO_2. 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:

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

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):

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

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:

$$C_{c}\ [kg\ C/GJ] = 53.139 - 0.811*NCV$$

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):

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

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:

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

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:

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

where: C_{hmng} emission factor for high-methane natural gas [kg C/GJ],
NCV- net calorific value of fuel oil [MJ/m^3],

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:

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

where: C_{cg} emission factor for city gas [kg C/GJ],
NCV- net calorific value of city gas [MJ/m^3].

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

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

where: C_{bfg} emission factor for blast furnace gas [kg C/GJ]
NCV- net calorific value of blast furnace gas [MJ/m^3].

Calculation of the CO_2 emission factor, when the Cmax [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

CO_2 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 CH_4 and N_2O 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 (PKD[1] 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 CO_2, CH_4 and N_2O

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 1998a]
- Energy Balance Poland – OECD [ARE 1997]

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 CO_2 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_2O
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
Liquide and 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
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Biogas	54.60	0.0010	0.0001

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

Fuel	EF CO_2	EF CH_4	EF N_2O
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
Liquide and 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
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	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_2O
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
Liquide and 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
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	*116*	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	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_2O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Crude Oil	73.30	0.0030	0.0006
Non-energy Products	*76.50*	0.0030	0.0006
Liquide and 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
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

As concerns sector 1.A.3 *Transport,* activity data for road transport were taken from [ITS 1997]. CO_2 emissions factors for road transport come also from [ITS 1997]. 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 1997],
- Questionnaire/Report G-03, [GUS 1997e],
- Statistical Yearbook of The Republic of Poland [GUS 1998],
- Non-published data from Energy Market Agency

Table 3.5 Emission factors [kg/GJ] for transport in 1996

Type of transport	Category code	EF CO_2	EF CH_4	EF N_2O
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	72.63	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	72.63	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	70.77	0.030	0.002
	2.i.a.LG	63.11	0.020	0.0002
	2.i.a.ON	72.78	0.002	0.004
	2.i.b.BS	70.77	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	70.32	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	70.77	0.020	0.001
	2.ii.a.LG	63.11	0.030	0.0002
	2.ii.a.ON	72.78	0.001	0.0040
	2.ii.b.BS	70.77	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	70.32	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	70.77	0.020	0.001
	2.iii.a.ON	72.78	0.006	0.003
	2.iii.b.ON	72.78	0.006	0.003
1.A.3.b.iv Motorcycles	2.iv.BS	70.77	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	70.77	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	72.78	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 CO_2 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 CO_2 emissions is 1.00% in favour of sectoral approach [Radwański 2006a]. More data on energy consumption and CO_2 emissions for both approaches are given in annex 6, in CRF table 1.A(c).

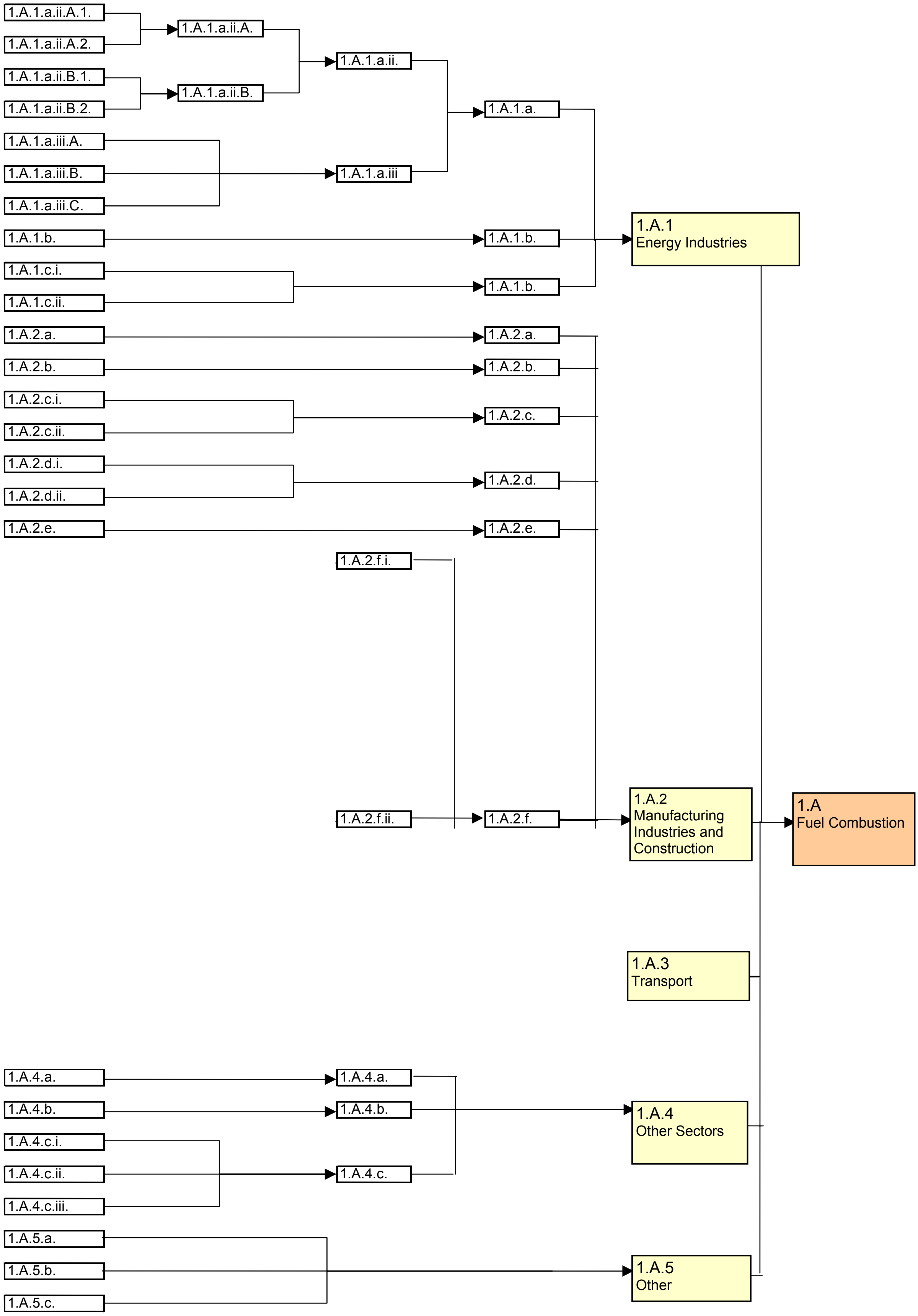


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

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	Nm3 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 1996 were used:

- venting processes – [Gawlik 1994]
- methane capture systems – direct data
- post-mining processes – [Kwarciński 2005]
- dumping grounds – [Kwarciński 2005]
- closed mines – not estimated

Table 3.7 contains the data on coal mining as well as methane captured and used for 1996. 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 1996

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
mln Mg	mln m^3	mln m^3	mln m^3	mln Nm^3	Gg CH_4
136.3	195.9	142.6	53.3	51.54	34.53

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

Fugitive emission of CH_4 from surface mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG, 1997] 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 m^3 CH_4 / t of extracted coal
- Ventilation emission from surrounding rocks - 0.012 m^3 CH_4 / t of extracted coal.

The conversion factor applied for recalculation of emitted methane volume upto mass of CH_4 is 0.67 kg/m^3.

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 1998a].

Table. 3.8. Emission factors for CO_2 and CH_4 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 1998a]:

production	PJ	13.482
distribution	Gg	14343

CO_2 and CH_4 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 CO_2 and CH_4 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 CO_2 and CH_4 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 1998a] 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]	63.438
Gas processing	Gas use [PJ]	352.240
Gas transmission	Gas use [PJ]	352.240
Underground gas storage	Gas use [PJ]	352.240
Gas distribution	Gas use [PJ]	352.240
Nitrified natural gas system:		
Gas production	Gas production [PJ]	68.035
Gas processing	Gas use [PJ]	43.4699
Gas transmission	Gas use [PJ]	43.4699
Gas distribution	Gas use [PJ]	43.4699

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 CO_2 and CH_4 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 CO_2 and CH_4 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 1.3%
- 2.B.2. Nitric Acid Production (N2O emission), share in total GHG emission 0.8%

Share of these categories in total Poland's GHG emissions is 2.1%.

4.2 Methodological issues

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

4.2.1.1. *Cement Production* (CRF 2.A.1)
CO_2 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 CO_2 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 CO_2 from this process was assumed as 0. CO_2 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 1997e]. Value of emission factor taken for inventory calculation it is 415 kg CO_2/ 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)
CO_2 and CH_4 emissions for ammonia production are estimated based on the data on gas and liquid ammonia production from [Radwański 2005]. The CO_2 emission factor (1.5 Mg CO_2/Mg NH_3 was taken from [IPCC 1997]. Methane emission factor is 4.9 kg CH_4 /Mg NH_3 produced was taken from [CITEPA 1992]. Emission N_2O was estimated as 0, according to the study [Kozłowski 2001].

4.2.2.2. *Nitric Acid Product*ion (CRF 2.B.2)
Estimation of N_2O emission from nitric acid production was based on the annual HNO_3 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]. CO_2 emission factor for this category, which is equal 1.100 Mg CO_2/ Mg carbide, was taken from [IPCC 1997].

4.2.2.4. *Other* (CRF 2.B.5)
- *Carbon Black Production*
CH_4 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 CH_4 /Mg black carbon, was taken from [CITEPA 1992].

- *Ethylene Production*
Emission of CO_2 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 CO_2 / 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 N_2O, which value is 4.74 kg N_2O / 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 1997e]. Country specific emission factor of CO_2, which is equal 78.40 kg CO_2 / 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 CO_2 emission calculation was taken from [GUS 2000b]. Country specific emission factor applied for CO_2 emission estimation is from [FEWE 1994]. Its value is 62 kg CO_2 / Mg steel cast produced.

4.2.3.1.3. *Iron Cast Production* (2.C.1.d)
Annual iron cast production for CO_2 emission estimation was taken from [GUS 2000b]. Country specific emission factor applied for CO_2 emission calculation is from [FEWE 1994]. Its value is 61 kg CO_2 / Mg iron cast produced. Applied CH_4 emission factor is 0.20 kg CH_4 / 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 CO_2 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 CO_2 emission factor used for inventory report, which value is 11.26 kg CO_2 / 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 CO_2 country specific emission factor is equal 4.30 kg CO_2 / Mg steel produced and it was calculated in [FEWE 1994] based on composition of gases from electric furnaces in Polish plants. CH_4 emission factor, which value is 0.12 kg CO_2 / 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 CO_2 from coking plants was estimated based on elementary carbon budget in coking plants process. CH_4 emission was estimated based on coke production volume from [GUS 2000b] and emission factor is 0.2 kg CH_4 / Mg coke produced [EEA 1996].

4.2.3.2. *Ferroalloys production* (CRF 2.C.2)
Emission of CO_2 concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 2000b]. Applied emission factor, which value is 3900 kg CO_2 / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

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

Calculation of CO_2 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 CO_2 / Mg primary aluminium, was taken from [IPCC 1997] as value recommended for Soderberg Process.

4.2.4. *Consumption of Halocarbons and SF_6* (CRF 2.F)

Emissions of HFC, PFCs and SF_6 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 SF_6 emissions in 1996 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 2000b]. *Tier 1* method and the following emission factors as in [IPCC 2000] were used for estimation of PFC emissions:

for CF_4 EF = 0.61 kg/Mg aluminium produced

for C_2F_6 EF = 0.061 kg/Mg aluminium produced

As concerns SF_6 – the only sources estimated in Poland are electrical equipment and sound-proof windows. Because of lack of activity data in import and use of this gas for 1996 the interpolation/extrapolation 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 SF_6 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 SF_6

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 CO_2 emissions within Sector 3, using the common methodology, were carried out on the basis of results of NMVOC emissions [IETU 1998]. from the following activities:
- Paint application (CRF 3.A)
- Degreasing and dry cleaning (CRF 3.B)
- Other solvents use (CRF 3.D)

CO_2 emission factor was determined assuming, that carbon content in NMVOC is 85%. Then carbon content has been calculated in a stoichiometric way to CO_2. Calculations were made in accordance with formula:

$$CO_2 = 0.85 * 44/12 * NMVOC$$

where:
CO_2 – carbon dioxide emission from particular subsectors,
NMVOC – NMVOC emission from particular subsectors.

N_2O 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 (CH4 emission), share in total GHG emission	2.2%
- 4.B. Manure Management (N2O emission), share in total GHG emission	1.5%
- 4.D.1. Direct Soil Emissions (N2O emission), share in total GHG emission	2.7%
- 4.D.3. Indirect Soil Emissions (N2O emission), share in total GHG emission	0.8%

Share of these categories in total Poland's GHG emissions is 7.2%.

6.2 Methodological issues

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

The emission factors for estimation of CH_4 emission from enteric fermentation were calculated based on IPCC Guidelines [IPCC 2000] as well as the national case study [Myczko 2001] and updated data on animal breeding [Walczak 2003, 2006]. The CH_4 emission factors were estimated for each livestock subcategory within cattle: dairy cows and non-dairy cattle disaggregated for: calves (under 6 months), young cattle (6–12 months) and other cattle (1 year and over). 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].

CH_4 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 1998].

The calculated Gross Energy Intake (GE) values and applied emission factors expressed in kg CH_4 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 CH_4 emissions factors in 1996

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH_4 / animal / year]
4.A Enteric Fermentation	26.221	---	---
1 Cattle	7.136	---	---
a. Dairy cattle	3.461	227.937	89.700
b Non-dairy cattle	3.675	99.2794	39.070
3 Sheep	0.552	18.578	8.231
4 Goats	0.179	---	5.000
6 Horses	0.569	---	18.000
8 Swine	17.964	---	1.500

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

The IPCC *Tier 2* methodology was used to establish domestic CH_4 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 1998].

Table 6.2. Livestock population, volatile solids excreted (Vs) and CH_4 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	235.854	---	---
1 Cattle	7.136	---	---
a. Dairy cattle	3.461	4.511	4.781
b Non-dairy cattle	3.675	1.643	2.134
3 Sheep	0.552	0.371	0.172
4 Goats	0.179	0.280	0.120
6 Horses	0.569	1.720	1.390
8 Swine	17.964	0.500	6.536
9 Poultry	209.454	0.100	0.078

The factors recommended for cool climate were used. The country specific CH_4 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),
- B_o (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 N_2O emission calculation from manure management was taken from [GUS 1998]. For goats population activity was taken from 1996 because of lack of data from earlier years.

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	0.0212	0.8101	0.1687
Non-dairy cattle	0.0559	0.8061	0.1380
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 N_2O 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	0.0212	5136.124
1.b. Non-dairy cattle	50.0	0.0559	10271.625
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2863	102861.864
9 Poultry	0.6	0.2000	25134.449

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	0.8101	196271.003
1.b. Non-dairy cattle	50.0	0.8061	148120.875
3 Sheep	16.0	0.5000	4416.000
4 Goats	25.0	0.9000	4034.610
6 Horses	25.0	0.9000	12802.500
8 Swine	20.0	0.7137	256418.136
9 Poultry	0.6	0.8000	100537.796

Table 6.5. Factors of N_2O–N emission for various manure management systems

Animal Waste Management Systems	EF Emission Factor [kg N2O-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. *N_2O from synthetic fertilisers* (CRF 4.D.1.1)

N_2O emission from synthetic fertilisers was estimated based on the amount of synthetic fertiliser nitrogen applied to agricultural fields published in [GUS 1998]. The nitrogen fraction converted to N_2O 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 N_2O-N / kg N applied) taken from [Mercik 2001] was corrected for 0.009 kg N_2O-N / kg N as the previous one included the fraction of nitrogen that is emitted as $NO_x + NH_3$.

6.2.4.1.2. *N_2O 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 1998] 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.

N_2O 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 NH_3 (0.2 kg NH_3-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. *N_2O from N-fixing crops* (CRF 4.D.1.3)

N_2O emission from N-fixing crops was calculated based on the data on sown area of N-fixing crops, published in [GUS 1998]. According to study [Mercik 2001] 1% of nitrogen fixed by papilionaceous plants is denitrificated to N_2O and in this connection the used emission factor value is 0,010 N_2O-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 N_2O 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. *N_2O from crop residue* (CRF 4.D.1.4)

Emission of N_2O 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 N_2O-N/ kg N contained in residues. Data on sown area of other than N-fixing crops are published in [GUS 1998].

6.2.4.1.5. *N_2O 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. N_2O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N_2O-N /ha.

6.2.4.2. *N_2O from pasture, range and paddock manure* (CRF 4.D.2)

Animal population for calculation of N_2O emission from pasture range and paddock was taken from [GUS 1998]. 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]. N_2O 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 N_2O–N emission

Livestock	Nitrogen excretion Nex [kg/head/yr]	Fraction of manure nitrogen per AWMS [% / 100]	Nitrogen excreted in AWMS [kg N / year / 1000]	EF Emission factor for AWMS [kg N2O-N/ kg N]
1.a. Dairy cattle	70.0	0.17	40862.873	
1.b. Non-dairy cattle	50.0	0.14	25357.500	
3 Sheep	16.0	0.50	4416.000	
4 Goats	25.0	0.10	448.290	
6 Horses	25.0	0.10	1422.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	72507.163	0.020

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

The *Tier 1a* method was used for assessing indirect emissions of N_2O for 1996 in Poland. The basic equation for estimating a country's indirect N_2O emissions:

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

where:
$N_2O_{indirect} \rightarrow N$ – emissions of N_2O in units of nitrogen,

$N_2O_{(G)} \rightarrow N$ – N_2O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds (kg N/year),

$N_2O_{(L)} \rightarrow N$ –N_2O produced form 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 N_2O 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:

$$N_2O_{(G)} \rightarrow N = [(N_{FERT} * Frac_{GASF}) + (Nex/1000 * Frac_{GASM})] * EF,$$

where:

$N_2O_{(G)} \rightarrow N$ – N_2O 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 1998],

Nex – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

$Frac_{GASF}$ – fraction of synthetic N fertiliser that volatilises to nitrogen compounds, default value,

$Frac_{GASM}$ – fraction of animal manure N that volatilises to nitrogen compounds, default value,

EF– emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of N_20–N from atmospheric deposition

N_{fert} [Gg/year]	$Frac_{GASF}$ [kg N/kgN]	N_{ex} [kgN/year/1000]	$Frac_{GASM}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(G)} \rightarrow N$ [GgN_2O-N]
852	0.1	72 507.16	0.2	0.01	1.00

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, an d gets to the groundwater, rivers and wetlands. It results in biogenic production of N_2O. 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:

$N_2O_{(L)} \rightarrow N = (N_{FERT} + Nex/1000) * Frac_{LEACH} * EF$,

where:
$N_2O_{(L)} \rightarrow N$ – N_2O produced form 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 1998],
Nex – 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 N_2O emissions for leaching/runoff, default value.

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

Table 6.8. Estimation of indirect emissions of N_20–N from nitrogen leaching and run-off

N_{fert} [Gg/year]	N_{ex} [kgN/year /1000]	$Frac_{LEACH}$ [kg N/kg N]	EF [kgN_2O-N/kg N]	$N_2O_{(L)} \rightarrow N$ [GgN_2O-N]
852	72 507.16	0.3	0.025	6.934

The following equation is a conversion of $N_2O \rightarrow N$ emissions to N_2O emissions:

$N_2O = N_2O \rightarrow N * 44/28$

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

CH_4 and N_2O 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 *at al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 1998]. 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 CH_4 and N_2O 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_2O
							[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 1996 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 easy inferred.

The inventory results for 1996 (and comparing to 1995) for LULUCF sector are presented in the following tables according to new [IPCC 2003] and previous [IPCC 1997] methodologies.

Table 7.1. Total CO_2 emissions and removals from Land Use Change and Forestry in 1995 and 1996 [IPCC 2003]

	1995			1996		
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	Net CO_2 emissions/ removals	CH_4	N_2O
	(Gg)			(Gg)		
5. Total Land-Use Categories	-32 784.19	0.109	0.001	-33 893.69	0.113	0.001
5A. Forest Land	-38 793.92			-39 673.32		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	4 800.27			5 031.73		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	2 663.55			2 791.98		
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	-1 454.09	0.109	0.001	-2 044.09	0.113	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 CO_2 emissions and removals from sector 5. Land Use Change and Forestry in 1995and 1996 [IPCC 1997]

Greenhouse gas source and sink categories	1995					1996				
	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O
	Gg					Gg				
5. Total Land-Use Change and Forestry	45 521.98	-78 306.17	-32 784.19	0.109	0.001	45 197.00	-79 090.69	-33 893.69	0.113	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	39 481.15	-62 035.82	-22 554.67			38 707.67	-62 072.35	-23 364.68		
I. Tropical Forests										
2. Temperate Forests	39 481.15	-62 035.82	-22 554.67			38 707.67	-62 072.35	-23 364.68		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	45.93		45.93			44.63		44.63		
1. Tropical Forests										
2. Temperate Forests	45.9			0.109	0.001	44.6			0.113	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	5 994.90	-16 270.36	-10 275.46			6 444.69	-17 018.34	-10 573.64		
Cultivation of Mineral Soils	5 994.90		5 994.90			6 444.69		6 444.69		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 468.9	1 468.92				1 379.0	1 379.02		
Forest Soils		-16 239.26	-16 239.26				-16 308.63	-16 308.63		
Other Land (please specify)		-1 500.02	-1 500.02				-2 088.72	-2 088.72		
5E. Other *(please specify)*										

According to calculation for 1996, Sector 5. Land-Use Change and Forestry, was net CO_2 sink. Removals/emissions balance increased from 32 784 Gg CO_2 in 1995 to 33 894 Gg CO_2 in 1996 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 1996 net CO_2 removals increased to 23 365 Gg CO_2 from about 22 555 Gg CO_2 in 1995. This change was caused by harvest of thick decrease (about 0.45 million m^3 of wood).

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 (m^3/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 1996 this category was a net CO_2 emissions and accounted for about 45 Gg CO_2. Net emission in year 1996 was similar to previous year.

Emissions ratios for calculation CH_4, N_2O, CO and NO_x emissions from biomass burning are presented in table below.

Table 7.4. Emissions ratios for calculation CH_4, N_2O, CO and NO_x emissions from biomass burning.

Compound	Ratio		
CH_4	0.012	default	[IPCC 1997]
CO	0.060	default	[IPCC 1997]
N_2O	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 CO_2 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. *CO_2 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 1996 net CO_2 sink was about 10 573 Gg CO_2 and was higher by about 298 Gg CO_2 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 tape 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 1996

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.553
	Low Activity Soils	70.0	1.705
	Sandy	30.0	3.338
	Wetland	230.0	0.377
Sum			8.972
Grassland/Rangeland	High Activity Soils	90.0	0.583
	Low Activity Soils	60.0	1.722
	Sandy	25.0	1.259
	Wetland	120.0	0.427
Sum			3.991
Agricultural crops	High Activity Soils	70.0	4.044
	Low Activity Soils	60.0	5.418
	Sandy	25.0	2.794
	Wetland	120.0	1.627
Sum			13.883
Other land	High Activity Soils	56.0	0.967
	Low Activity Soils	48.0	1.817
	Sandy	20.0	1.143
	Wetland	96.0	0.496
Sum			4.423
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 CO_2 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:

$$C = M_{limestone} * EF_{limestone} + Md_{olomite} * EF_{dolomite}$$

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 ($CaMg(CO_3)_2$) contains 89.1% of $CaCO_3$ and 10.9% of $MgCO_3$. Carbon (C) is converted to carbon-dioxide (CO_2) 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	1.2%
- 6.B. Wastewater Handling (CH4 emission), share in total GHG emission	1.1%

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

8.2 Methodological issues

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

The methane emissions from solid waste disposals in 1995 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 CH_4 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
DOCf		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 1998]
– Municipial 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 dam^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]

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 1997d] 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)

CH_4 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 1997d]. 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 0.732 (for this estimation the country specific value of BOD = 357 g O_2/m^3 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 CH_4 / kg BOD
- for sewage sludge: 0.394 kg CH_4 / kg BOD.

The default value (0.6 kg CH_4 / kg BOD) of maximum methane producing capacity was applied for estimation of sludge and wastewater emission factors. Fractions of wastewater and sludge anareobically treated with and without methane recovery are estimated according to [Bernacka 2003]. These value are as follows: percentage of wastewater anareobically treated – 5%, fractions of sludge anareobically degraded – 65.6% of which with methane recovery – 31.5%.

N_2O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 1998]. Value of protein consumption per capita per year comes from [FAOSTAT 2006]. Default values were used for fraction of nitrogen in protein and for N_2O 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 1996 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1997d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1997] as well as on annual mean use of hospital bed [GUS 1997]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

References

ARE (1997). Fuel balance according to OECD structure. Agency of Energy Market, Warsaw, 1997.

Bernacka (2003). Bernacka J., Pawłowska L. Elaboration and analysis of data regarding GHG emissions from municipal wastewater management. Institute of Environmental Protection, 2003 (in Polish).

BULiGL (1992). Results of updating forest area and woody biomass in State Forests At 1 January 1992. Office for Forest Planning and Management. Warsaw. 1992. (in Polish)

CITEPA (1992). Default Emission Factors Handbook, CORINAIR INVENTORY, CITEPA, Paris, 1992.

Czuraj M. (1991). Tables of log volume of butt end and standing trees. PWRiL. Warsaw. 1991 (in Polish).

EEA (1996). EMEP/CORINAIR The Atmospheric Emission Inventory Guidebook. 1996.

EEA (2002). EMEP/CORINAR. The Atmospheric Emission Inventory Guidebook. 3rd Ed., European Environmental Agency. 2002.

EEA (2004). EMEP/CORINAIR Emission Inventory Guidebook. 2004.

FAOSTAT (2006). FAOSTAT data base, 2006, http://faostat.fao.org/site/502/DesktopDefault.asp1990?PageID=502.

FEWE (1994). Determination of GHG emission factors from fuel combustion in industrial technology processes. Foundation on Effective Energy Use – FEWE, 1994. (in Polish).

Fudała (1994). Fudała J., Hławiczka S., Cenowski M., Butniewicz K. Establishment of a list of sources of the emission of greenhouse gases (in surface industrial activities). determination of emission factors for these sources and calculation of emission for the last year, as well as submission of a methodology for the updating of information. 1994. (in Polish).

Gawlik (1994). Gawlik L. et al. (1994). Establishment of GHG sources related to handling of coal (hard and brown coal) system and estimation of emission factors in emission system sources; emission calculation for the last year applying OECD/IPCC methodology and current methodology information actualisation. Cracow 1994. (in Polish).

Gawlik (2001). Gawlik. L., Grzybek I. Study on GHG fugitive emission from the hard coal system. 2001. (in Polish).

Górka (1991). Górka W., Zajączkowski K., Zajączkowska B. Estimation of wood stock in stand density in Poland. Forest Research Institute. 1991. (in Polish).

GUS (1974). Statistical Yearbook of The Republic of Poland 1974. GUS, 1974.

GUS (1978). Statistical Yearbook of The Republic of Poland 1978. GUS. Warsaw, 1978.

GUS (1985). Statistical Yearbook of The Republic of Poland 1985. GUS. Warsaw, 1985.

GUS (1986d). Environmental Protection. GUS, Warsaw 1986.

GUS (1987). Statistical Yearbook of The Republic of Poland 1987. GUS. Warsaw, 1987.

GUS (1989d). Environmental Protection. GUS, Warsaw 1989.

GUS (1990d). Environmental Protection. GUS, Warsaw 1990.

GUS (1996). Statistical Yearbook of The Republic of Poland 1996. GUS. Warsaw, 1996.

GUS (1996z). Use of mineral and lime fertilisers in 1995/1996. Warsaw 1996.

GUS (1997). Statistical Yearbook of The Republic of Poland 1997. GUS, Warsaw 1997.

GUS (1997a). Energy Statistics 1995-1996, GUS, Warsaw 1997.

GUS (1997c). Forestry. GUS. Warsaw, 1997.

GUS (1997d). Environmental Protection. 1997. GUS. Warsaw, 1997.

GUS (1997e). Questionnaire/Report G-03. Selected data from energy statistic system. GUS 1997.

GUS (1998). Statistical Yearbook of The Republic of Poland 1998. GUS, Warsaw 1998.
GUS (1998). Statistical Yearbook of The Republic of Poland 1998. GUS, Warsaw 1998.
GUS (1998a): Energy Statistics 1996-1997, GUS, Warsaw 1998.

GUS (2000b). Production of industrial products. GUS, Warsaw 2000.

GUS (2000c). Forestry 2000. GUS. Warsaw, 2000.

GUS (2000d). Environmental Protection. GUS, Warsaw 2000.

GUS (2001r). Statistical Yearbook of The Republic of Poland Rolnictwa w 2001. GUS, Warsaw 2001.

GUS (2004d). Environmental Protection. GUS, Warsaw 2004.

GUS (2005c). Forestry. GUS. Warsaw, 2005.

GUS (2005d). Environmental Protection. 2005. GUS. Warsaw, 2005.

Gworek (2003). Gworek B., Barański A., Czarnomski K., Bojanowicz A. GHG emission from waste disposal sites, Institute of Environmental Protection, 2003.

IETU (1998). Emission inventory for 1996 connected with LRTAP Convention. NMVOC and heavy metals emission, 1998. (in Polish).

IMMB (2006). Cement sector in Poland. Allocation plan of CO2 allowances in frames of NAP for 2008-20012. Institute for Mineral Building Materials, Opole, 2006.

IOŚ (2001). Strategy of reduction of GHG emission until 2020 in the division into separate gases (N2O, HFCs, PFCs i SF6) and sectors. IOŚ, 2001 (in Polish)

IOŚ (2002). Emission Inventory of SO2, N2O, NH3, CO, PMs, HMs, MNVOCs and POPs in Poland in 2000, IOŚ, 2002

IPCC (1995). Third Assessment Report. IPCC 1995.

IPCC (1997). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories - Vol. 1. Reporting Instructions, Vol. 2. Workbook, Vol. 3. Reference Manual. Intergovernmental Panel on Climate Change - IPCC, 1997.

IPCC (2000). Good Practice Guidance and Uncertainty Management in National GHG Inventories, Intergovernmental Panel on Climate Change -IPCC, 2000.

IPCC (2006). Draft IPCC Guidelines for National Greenhouse Gas Inventories, Intergovernmental Panel on Climate Change -IPCC 2006.

ITS (1997). GHG emission inventory for transport in Poland for 1996 according to IPCC Revised 1996 methodology. Motor Transport Institute. Warsaw, 1996.

KASHUE (2006). Database of National Administration of Emission Trading Scheme. Institute of Environmental Protection. Warsaw, 2006.

Kozłowski (2001). Kozłowski K. Strategy of reduction of N2O emission in industry processes. (Part of the report: Radwański E. et al. - Strategy of reduction of GHG emission until 2020 in the division into separate gases (N2O, HFCs, PFCs i SF6) and sectors up to 2020. (in Polish) 2001.

Krzysik (1975). Krzysik S. Wood science (in Polish). PWN Warsaw 1975.

Kwarciński (2005). Kwarciński et al. Estimation of actual methane emissions caused by coal production. Polish Geological Institute, Sosnowiec, 2005.

Łoboda (1994). Łoboda T., Pietkiewicz S. Estimation of amount of CH4, CO, N2O and NOx released to atmosphere from agricultural residues burning in 1992, Warsaw Agricultural University, 1994 (in Polish).

Mercik (2001). Mercik S., Moskal S., Study on GHG emission and sinks from arable land soils (in Polish). 2001.

Myczko (2001). Myczko A., Karłowski J., Szulc R. Study on GHG emissions from enteric fermentation and animal manure in 1999 (in Polish). 2001.

Olczak (1993). Olczak Cz. et al. Elaboration of quantitative and qualitative measurement profile for voletail organic compounds emitted from iron and steel production processes. (in Polish). Opole, 1993.

Ordinance of Council of Ministers No. 219 from 29 October 2002 - Ordinance of Council of Ministers No. 219 from 29 October 2002 on National Plan on Waste Management.

PIG (1997): Balance of mineral resources and underground water in Poland. Polish Geological Institute. Warsaw, 1997 (in Polish)

Radwański (1995). Radwański E. National Study on sources and sinks of GHG. National Foundation of Environmental Protection, 1995 (in Polish).

Radwański E. (1998). Radwanski E., Szkudlarski S., Kozakiewicz J., Mąkosa J.(1998) Inventory of emission and sinks of GHG: CO2, CH4, N2O, HFCs, PFCs and SF6 in Poland in 1995. Warsaw, FEWE 1998.

Radwański (2005). Radwański E. Proposal of the ammonia production value for verification of CO2 emission in 2 IPCC category in GHG emission inventory for 1988-2003, Warsaw, 2005 (in Polish)

Radwański E. 2006a. Estimation of emissions of C–CO2 according to Reference Approach. Warsaw, 2006. (in Polish).

Radwański E. 2006b. Estimation of carbon content in liming of agricultural and forest soils. Warsaw, 2006. (in Polish).

Steczko (1994). Steczko K. i in. „Establishment of emission sources of GHG associated with the operation of the (high-methane and nitrified) natural gas system and the system involving other network gases, together with the determination of emission factors for emission sources in the system, the calculation of emission for the last year using the OECD/IPCC methodology for the continuous updating of information". Cracow, 1994.

Steczko (2001). Steczko K. Studies on GHG emissions and removals for 1999 within solid waste disposals sector. (in Polish). IGNiG, Cracow, 2001.

Walczak (2003). Walczak J. Correction of N2O emissions in agriculture, in: Realization of tasks of National Emission Centre in the emission inventory. Institute of Environmental Protection, (in Polish) 2003.

Walczak (2006). Walczak J. Elaboration of activity data and GHG emission factors in Polish agriculture. National Research Institute of Animal Production, Cracow, 2006.

Wielgosiński (2003). Wielgosiński G. Estimation of data and update of methodology for pollutants emissions inventory from waste combustion. Łódź, 2003.

Żebrowski M. 1994. Emission inventory of GHG from crude oil system. Cracow, 1994

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 identify 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 76.2% of the total GHG emissions in Poland expressed in units of CO_2 equivalents. Combustion of solid, gaseous and liquid fuels in stationary sources, made up 73.45% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 64.6% 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 76.17%.

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	CO2	306293.90	0.6462	0.65
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	29276.16	0.0618	0.71
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	25488.19	0.0538	0.76
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	16390.73	0.0346	0.80
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	13133.63	0.0277	0.82
6	4.D.1	4.D.1. Direct Soil Emissions	N2O	12645.38	0.0267	0.85
7	4.A	4.A. Enteric Fermentation	CH4	10429.89	0.0220	0.87
8	4.B	4.B. Manure Management	N2O	7110.06	0.0150	0.89
9	2.A.1	2.A.1 Cement Production	CO2	6171.90	0.0130	0.90
10	6.A	6.A. Solid Waste Disposal on Land	CH4	5737.18	0.0121	0.91
11	6.B	6.B. Wastewater Handling	CH4	5225.72	0.0110	0.92
12	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4015.67	0.0085	0.93
13	2.B.2	2.B.2. Nitric Acid Production	N2O	3869.20	0.0082	0.94
14	4.D.3	4.D.3. Indirect Soil Emissions	N2O	3863.44	0.0082	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	306293.90	0.6462	0.0454	25.8255	0.26
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	29276.16	0.0618	0.0426	24.2345	0.50
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	25488.19	0.0538	0.0100	5.6855	0.56
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	16390.73	0.0346	0.0100	5.6829	0.61
5	6.B	6.B. Wastewater Handling	CH4	2170.23	5225.72	0.0110	0.0091	5.1639	0.67
6	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	854.66	0.0018	0.0084	4.7937	0.71
7	4.A	4.A. Enteric Fermentation	CH4	15954.36	10429.89	0.0220	0.0064	3.6513	0.75
8	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	5737.18	0.0121	0.0059	3.3856	0.78
9	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	723.75	0.0015	0.0052	2.9535	0.81
10	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	13133.63	0.0277	0.0046	2.6351	0.84
11	2.C1	2.C.1. Iron and Steel Production	CO2	6556.09	3544.55	0.0075	0.0046	2.6028	0.87
12	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	3863.44	0.0082	0.0031	1.7928	0.88
13	2.A.2	2.A.2. Lime Production	CO2	3477.55	1931.89	0.0041	0.0023	1.3037	0.90
14	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4111.13	4015.67	0.0085	0.0018	1.0339	0.91
15	4.D.2	4.D.2. Animal Production	N2O	1575.89	706.43	0.0015	0.0015	0.8421	0.92
16	4.B	4.B. Manure Management	CH4	3435.39	3340.21	0.0070	0.0015	0.8410	0.92
17	2.A.1	2.A.1 Cement Production	CO2	7028.18	6171.90	0.0130	0.0013	0.7369	0.93
18	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	1421.99	0.0030	0.0012	0.6886	0.94
19	2.B.1.	2.B.1. Ammonia Production	CO2	3516.60	3277.80	0.0069	0.0011	0.6507	0.95
20	4.B	4.B. Manure Management	N2O	9335.10	7110.06	0.0150	0.0011	0.6385	0.95

Annex 2. 1996 Energy balance data for main fuels

Energy balances in 1996 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	**63 909**	**553 363**
From national sources	63 870	553 030
1) Indigenous production	63 845	552 820
2) Transformation output or return	0	0
3) Stock decrease	25	210
Import	39	333
Out	**63 910**	**553 365**
National consumption	63 808	541 221
1) Transformation input	63 063	534 759
a) input for secondary fuel production	176	1 719
b) fuel combustion	62 887	533 040
2) Direct consumption	745	6 462
Non-energy use	0	1
Combusted directly	745	6 461
Combusted in Poland	**63 632**	**539 501**
Stock increase	0	0
Export	45	387
Losses and statistical differences	57	11 757
Net calorific value	MJ/kg	8.48
CO_2 Emission Factor	kg/GJ	114.41

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10^3 Mg	TJ
In	**6 621**	**286 817**
From national sources	5 294	229 353
1) Indigenous production	0	0
2) Transformation output or return	5 294	229 353
3) Stock decrease	0	0
Import	1 327	57 464
Out	**6 621**	**286 816**
National consumption	6 509	281 991
1) Transformation input	496	21 497
a) input for secondary fuel production	491	21 263
b) fuel combustion	5	234
2) Direct consumption	6 013	260 494
Non-energy use	0	0
Combusted directly	6 013	260 494
Combusted in Poland	**6 018**	**260 728**
Stock increase	70	3 031
Export	6	252
Losses and statistical differences	36	1 542
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	**4 515**	**184 283**
From national sources	3 929	160 661
1) Indigenous production	0	0
2) Transformation output or return	3 929	160 661
3) Stock decrease	0	0
Import	586	23 622
Out	**4 517**	**184 282**
National consumption	3 279	133 585
1) Transformation input	586	23 987
a) input for secondary fuel production	1	48
b) fuel combustion	585	23 939
2) Direct consumption	2 693	109 598
Non-energy use	0	17
Combusted directly	2 693	109 581
Combusted in Poland	**3 278**	**133 520**
Stock increase	36	1 459
Export	1 029	42 007
Losses and statistical differences	173	7 231
Net calorific value	MJ/kg	40.73
CO_2 Emission Factor	kg/GJ	78.56

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10^6 m^3	TJ
In	**9 820**	**348 621**
From national sources	2 462	83 512
1) Indigenous production	1 732	58 420
2) Transformation output or return	722	24 821
3) Stock decrease	8	271
Import	7 358	265 109
Out	**9 819**	**348 620**
National consumption	9 477	341 476
1) Transformation input	326	11 415
a) input for secondary fuel production	205	7 255
b) fuel combustion	120	4 160
2) Direct consumption	9 151	330 061
Non-energy use	2 211	78 791
Combusted directly	6 940	251 270
Combusted in Poland	**7 061**	**255 430**
Stock increase	0	0
Export	40	1 399
Losses and statistical differences	302	5 745
Net calorific value	MJ/m^3	36.18
CO_2 Emission Factor	kg/GJ	53.60

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10^6 m^3	TJ
In	**2 956**	**73 447**
From national sources	2 956	73 447
1) Indigenous production	2 802	68 035
2) Transformation output or return	154	5 412
3) Stock decrease	0	0
Import	0	0
Out	**2 956**	**73 447**
National consumption	2 833	69 887
1) Transformation input	1 236	30 790
a) input for secondary fuel production	1 207	29 977
b) fuel combustion	29	813
2) Direct consumption	1 597	39 097
Non-energy use	2	49
Combusted directly	1 595	39 048
Combusted in Poland	**1 624**	**39 861**
Stock increase	0	0
Export	0	0
Losses and statistical differences	123	3 560
Net calorific value	MJ/m^3	24.55
CO_2 Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10^3 Mg	TJ
In	**10 382**	**289 454**
From national sources	10 340	288 287
1) Indigenous production	0	0
2) Transformation output or return	10 340	288 287
3) Stock decrease	0	0
Import	42	1 167
Out	**10 381**	**289 454**
National consumption	7 873	218 626
1) Transformation input	1 806	51 375
a) input for secondary fuel production	1 562	44 864
b) fuel combustion	244	6 511
2) Direct consumption	6 067	167 251
Non-energy use	160	4 294
Combusted directly	5 907	162 957
Combusted in Poland	**6 151**	**169 468**
Stock increase	289	8 010
Export	2 205	61 740
Losses and statistical differences	14	1 078
Net calorific value	MJ/kg	27.55
CO_2 Emission Factor	kg/GJ	112.91

Annex 3. National energy balance 1996 [GUS, 1998a]

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 *SPECIFICATION*	ROK *YEAR*	JEDNOSTKA MIARY *UNIT OF MEASURE*	POZYSKANIE *INDIGENOUS PRODUCTION*	IMPORT *IMPORT*	- W TYM BUNKIER *AMONG WHICH BUNKER*	EKSPORT *EXPORT*	ZMIANA ZAPASÓW *STOCK CHANGE*
1	***ENERGIA OGÓŁEM***	1996	*TJ*	***4309143***	***1160932***	***25604***	***909336***	***17884***
	TOTAL ENERGY	1997		***4205564***	***1264959***	***29750***	***927128***	***167167***
2	***ENERGIA PIERWOTNA***	1996	*TJ*	***4309143***	***920450***	-	***754368***	***6529***
	PRIMARY ENERGY	1997		***4205564***	***998164***	-	***732794***	***178976***
3	WĘGIEL KAMIENNY ENERGETYCZNY	1996	tys.ton	112372	255	-	19034	1090
	STEAM COAL	1997	10^3 ton	111235	327	-	20328	6295
		1996	TJ	2693347	6178	-	460437	26362
		1997		2530607	7911	-	462466	150893
4	WĘGIEL KAMIENNY KOKSOWY	1996	tys.ton	25499	1721	-	9886	-294
	COKING COAL	1997	10^3 ton	26520	2917	-	9138	274
		1996	TJ	709343	50851	-	292121	-8697
		1997		779674	86186	-	268667	7627
5	WĘGIEL BRUNATNY	1996	tys.ton	63845	39	-	45	-25
	BROWN COAL	1997	10^3 ton	63169	10	-	37	-1
		1996	TJ	552820	333	-	387	-210
		1997		543899	89	-	319	-7
6	ROPA NAFTOWA	1996	tys.ton	317	14026	-	1	-255
	CRUDE OIL	1997	10^3 ton	289	14713	-	0	116
		1996	TJ	13482	595982	-	24	-10837
		1997		12286	625149	-	7	4913
7	GAZ ZIEMNY WYSOKOMETANOWY	1996	mln m^3	1952	7358	-	40	-8
	HIGH - METHANE NATURAL GAS	1997	10^6 m^3	1988	7682	-	38	433
		1996	TJ	63438	265109	-	1399	-271
		1997		65096	276947	-	1335	15473
8	GAZ ZIEMNY ZAAZOTOWANY	1996	mln m^3	2802	-	-	-	-
	NITRIFIED NATURAL GAS	1997	10^6 m^3	2848	-	-	-	-
		1996	TJ	68035	-	-	-	-
		1997		69054	-	-	-	-
9	TORF I DREWNO	1996	tys. m^3	14303	-	-	-	62
	PEAT AND WOOD	1997	10^3 m^3	13451	-	-	-	30
		1996	TJ	135877	-	-	-	590
		1997		127789	-	-	-	282
10	ENERGIA WODY I WIATRU	1996	TJ	6967	-	-	-	0
	HYDRO AND WOOD ENERGY	1997		7476	-	-	-	0
11	PALIWA ODPAD. STAŁE I INNE SUROWCE	1996	TJ	65834	1997	-	-	-407
	SOLID WASTE FUELS	1997		69685	1883	-	-	-205
12	***ENERGIA POCHODNA***	1996	*TJ*	-	***240481***	***25604***	***154968***	***11355***
	DERIVED ENERGY	1997		-	***266795***	***29750***	***194333***	***-11809***
13	BRYKIETY Z WĘGLA KAMIENNEGO	1996	tys.ton	-	0	-	6	-7
	HARD COAL BRIQUETTES	1997	10^3 ton	-	0	-	7	-9
		1996	TJ	-	10	-	128	-174
		1997		-	2	-	162	-219
14	BRYKIETY Z WĘGLA BRUNATNEGO	1996	tys.ton	-	2	-	79	0
	BROWN COAL BRIQUETTES (BKB)	1997	10^3 ton	-	1	-	49	0
		1996	TJ	-	34	-	1425	4
		1997		-	9	-	896	-5
15	KOKS I PÓŁKOKS	1996	tys.ton	-	42	-	2205	289
	COKE AND SEMI-COKE	1997	10^3 ton	-	55	-	3234	-362
		1996	TJ	-	1167	-	61740	8010
		1997		-	1590	-	91981	-10128
16	GAZ CIEKŁY	1996	tys.ton	-	597	-	1	1
	LIQUEFIED PETROLEUM GAS (LPG)	1997	10^3 ton	-	738	-	4	4
		1996	TJ	-	28224	-	63	48
		1997		-	34908	-	172	180

ZUŻYCIE GLOBALNE LUB SALDO WYM. *GLOBAL CONSUMPTION OR EXCHANGE BALANCES*	UZYSK Z PRZEMIAN LUB ODZYSK *TRANSFORMATIONS OUTPUT OR RETURNS*	ZUŻYCIE OGÓŁEM *TOTAL CONSUMPTION*	ZUŻYCIE NA WSAD PRZEMIAN *TRANSFORMATIONS INPUT*	ZUŻYCIE BEZPOŚREDNIE *DIRECT CONSUMPTION*	- W TYM ZUŻYCIE NIEENERGETYCZNE *AMONG WHICH NON-ENERGY USE*	STRATY I RÓŻNICE BILANSOWE *LOSSES AND STATISTICAL DIFFERENCE*	LP #
4542855	***2181223***	***x***	***3138595***	***3466511***	***142923***	***118972***	***1***
4376229	***2401747***	***x***	***3403516***	***3385844***	***142479***	***-11384***	
4468697	***30234***	***x***	***2879966***	***1525909***	***84191***	***93056***	***2***
4291958	***30023***	***x***	***2864571***	***1416134***	***81977***	***41276***	
92503	-	92503	58532	37562	17	-3591	3
84939	-	84939	56208	33123	9	-4391	
2212726	-	2212726	1262520	947320	497	2886	
1925159	-	1925159	1213607	832287	280	-120735	
17628	-	17628	13768	115	-	3745	4
20024	-	20024	14337	433	1	5254	
476770	-	476770	404243	3419	-	69108	
589565	-	589565	422237	12888	16	154439	
63865	-	63865	63063	745	0	57	5
63144	-	63144	62519	625	-	-	
552977	-	552977	534759	6462	1	11757	
543676	-	543676	531963	5491	-	6221	
14598	-	14598	14597	2	-	-	6
14886	-	14886	14885	2	-	-	
620278	-	620278	620214	64	-	0	
632514	-	632514	632442	72	-	-	
9278	722	9999	394	9303	2211	302	7
9200	737	9938	442	9355	2238	140	
327419	24821	352240	13599	332895	78791	5745	
325235	25354	350588	15241	334145	79872	1203	
2802	154	2956	1236	1597	2	123	8
2848	134	2982	1281	1676	2	25	
68035	5412	73447	30790	39097	49	3560	
69054	4669	73724	33115	40461	44	148	
14241	-	14241	16	14225	-	-	9
13422	-	13422	53	13369	-	-	
135287	-	135287	150	135137	-	-	
127507	-	127507	503	127004	-	-	
6967	-	6967	6967	-	-	-	10
7476	-	7476	7476	-	-	-	
68238	0	68238	6724	61514	4853	0	11
71772	-	71772	7987	63786	1765	0	
74158	***2150990***	***x***	***252250***	***1946981***	***45495***	***25916***	***12***
84271	***2371724***	***x***	***536046***	***1972609***	***48356***	***-52660***	
2	-	2	0	2	-	-	13
3	-	3	2	0	-	-	
56	-	56	1	56	-	-	
59	-	59	54	5	-	-	
-77	93	16	0	16	-	0	14
-49	79	31	0	31	-	-	
-1395	1680	285	3	279	-	3	
-881	1413	532	0	532	-	-	
-2452	10340	7888	1806	6067	160	14	15
-2817	10536	7719	1826	6371	142	-478	
-68583	288287	219704	51375	167251	4294	1078	
-80262	298048	217786	52072	177337	3912	-11623	
594	165	760	6	754	-	-	16
731	181	911	6	905	-	-	
28113	7822	35935	270	35683	-	-18	
34556	8539	43096	294	42802	-	-	

TABL. 1(4). SYNTETYCZNY BILANS ENERGII (DOK)
TABLE 1(4). BASIC (SYNTHETIC) ENERGY BALANCE (END)

LP *#*	NAZWA NOŚNIKA ENERGII *SPECIFICATION*	ROK *YEAR*	JEDNOSTKA MIARY *UNIT OF MEASURE*	POZYSKANIE *INDIGENOUS PRODUCTION*	IMPORT *IMPORT*	- W TYM BUNKIER *AMONG WHICH BUNKER*	EKSPORT *EXPORT*	ZMIANA ZAPASÓW *STOCK CHANGE*
17	BENZYNY SILNIKOWE	1996	tys. ton	-	1337	-	0	-18
	MOTOR GASOLINE	1997	10^3 ton	-	1725	-	0	53
		1996	TJ	-	59886	-	1	-822
		1997		-	77285	-	0	2392
18	BENZYNY LOTNICZE	1996	tys. ton	-	3	-	0	-2
	AVIATION GASOLINE	1997	10^3 ton	-	5	-	0	-2
		1996	TJ	-	125	-	4	-67
		1997		-	205	-	5	-73
19	PALIWA ODRZUTOWE	1996	tys. ton	-	256	88	26	-12
	JET FUEL	1997	10^3 ton	-	241	110	22	5
		1996	TJ	-	11418	3924	1146	-546
		1997		-	10722	4906	960	212
20	OLEJE NAPĘDOWE	1996	tys. ton	-	1327	101	6	70
	DIESEL OIL	1997	10^3 ton	-	1181	111	14	-99
		1996	TJ	-	57464	4352	252	3031
		1997		-	51146	4795	611	-4289
21	OLEJE OPAŁOWE	1996	tys. ton	-	586	430	1029	36
	FUEL OIL	1997	10^3 ton	-	1114	498	1334	47
		1996	TJ	-	23622	17329	42007	1459
		1997		-	46544	20049	54338	1979
22	PRODUKTY NIEENERGETYCZNE I PÓŁ-PRODUKTY Z PRZEROBU ROPY NAFT. *NON-ENERGY PRODUCTS AND FEEDSTOCKS*	1996	TJ	-	41247	-	19672	414
		1997		-	25099	-	18057	-1858
23	GAZ RAFINERYJNY	1996	tys. ton	-	-	-	-	-
	REFINERY GAS	1997	10^3 ton	-	-	-	-	-
		1996	TJ	-	-	-	-	-
		1997		-	-	-	-	-
24	GAZ KOKSOWNICZY	1996	mln m^3	-	-	-	-	-
	COKE OVEN GAS	1997	10^6 m^3	-	-	-	-	-
		1996	TJ	-	-	-	-	-
		1997		-	-	-	-	-
25	GAZ WIELKOPIECOWY	1996	mln m^3	-	-	-	-	-
	GAS MANUFACTURED FROM COAL	1997	10^6 m^3	-	-	-	-	-
		1996	TJ	-	-	-	-	-
		1997		-	-	-	-	-
26	GAZ MIEJSKI	1996	mln m^3	-	-	-	-	-
	TOWN GAS	1997	10^6 m^3	-	-	-	-	-
		1996	TJ	-	-	-	-	-
		1997		-	-	-	-	-
27	GAZ CZADNICOWY I WYTLEWNY	1996	mln m^3	-	-	-	-	0
	BLAST FURNACE GAS	1997	10^6 m^3	-	-	-	-	-
		1996	TJ	-	-	-	-	-2
		1997		-	-	-	-	-
28	ENERGIA ELEKTRYCZNA	1996	GWh	-	4801	-	7925	-
	ELECTRICITY	1997		-	5357	-	7542	-
		1996	TJ	-	17284	-	28530	-
		1997		-	19285	-	27152	-
29	CIEPŁO *)	1996	TJ	-	-	-	-	-
	HEAT *)	1997		-	-	-	-	-
30	***ENERGIA Z ODZYSKU***	1996	TJ	-	-	-	-	-
	ENERGY FROM RETURNS	1997		-	-	-	-	-
31	PALIWA ODPAD. CIEKŁE I GAZOWE	1996	TJ	-	-	-	-	-
	LIQUID AND GASEOUS WASTE FUELS	1997		-	-	-	-	-
32	CIEPŁO Z ODZYSKU	1996	TJ	-	-	-	-	-
	HEAT FROM RETURNS	1997		-	-	-	-	-

*) Patrz 'Uwagi metodyczne'

*) See the 'Methodology remarks'"

ZUŻYCIE GLOBALNE LUB SALDO WYM. *GLOBAL CONSUMPTION OR EXCHANGE BALANCES*	UZYSK Z PRZEMIAN LUB ODZYSK *TRANSFORMATIONS OUTPUT OR RETURNS*	ZUŻYCIE OGÓŁEM *TOTAL CONSUMPTION*	ZUŻYCIE NA WSAD PRZEMIAN *TRANSFORMATIONS INPUT*	ZUŻYCIE BEZPOŚREDNIE *DIRECT CONSUMPTION*	- W TYM ZUŻYCIE NIEENERGETYCZNE *AMONG WHICH NON-ENERGY USE*	STRATY I RÓŻNICE BILANSOWE *LOSSES AND STATISTICAL DIFFERENCE*	LP #
1355	3337	4692	218	4616	0	-141	17
1672	3413	5085	120	4966	0	0	
60707	149463	210170	9753	206726	0	-6309	
74893	152877	227770	5358	222412	0	-	
4	-	4	0	4	-	0	18
6	-	6	0	6	-	-	
188	-	188	3	185	-	0	
273	-	273	13	260	-	-	
243	230	473	100	373	-	0	19
214	226	440	77	364	-	-	
10817	10275	21092	4476	16617	-	0	
9550	10069	19619	3412	16207	-	-	
1251	5294	6545	496	6013	0	36	20
1266	5293	6559	659	6096	0	-196	
54180	229353	283534	21497	260494	0	1542	
54823	229314	284137	28530	264059	0	-8452	
-478	3929	3451	586	2693	0	173	21
-267	4427	4159	737	2772	-	651	
-19844	160661	140817	23987	109598	17	7231	
-9773	184992	175219	30299	114884	-	30036	
21161	211320	232481	110216	120730	40804	1535	22
8900	408195	417096	382976	109023	44273	-74903	
-	326	326	-	326	-	-	23
-	413	413	-	413	-	-	
-	15706	15706	-	15706	-	-	
-	19891	19891	-	19891	-	-	
-	4229	4229	771	3421	21	38	24
-	4501	4501	919	3524	9	58	
-	76035	76035	13975	61089	380	971	
-	79286	79286	16450	61886	170	950	
-	11713	11713	1022	10690	-	-	25
-	12264	12264	1018	11260	-	-14	
-	39062	39062	3418	35645	-	-	
-	41319	41319	3453	37915	-	-49	
-	10	10	-	12	-	-2	26
-	9	9	-	23	-	-14	
-	246	246	-	305	-	-60	
-	229	229	-	556	-	-326	
0	223	224	1	202	-	20	27
-	107	107	0	107	-	-	
2	1287	1288	4	1165	-	119	
-	613	613	2	611	-	-	
-3124	143173	140049	2745	119271	-	18033	28
-2185	142769	140584	2588	121311	-	16685	
-11246	515424	504178	9884	429376	-	64919	
-7867	513969	506102	9317	436719	-	60066	
-	444370	444370	3388	486077	-	-45096	29
-	422969	422969	3817	467510	-	-48358	
-	***69416***	*x*	***6379***	***63038***	***13237***	***0***	***30***
-	***63922***	*x*	***2899***	***61022***	***12146***	-	
-	27076	27076	6379	20697	13237	0	31
-	21614	21614	2899	18715	12146	-	
-	42341	42341	-	42341	-	-	32
-	42307	42307	-	42307	-	-	

Annex 4. National energy balance 1996 – OECD

POLAND 1996

PRODUCTION AND USES OF ENERGY	Coal (TJ)							Gas (TJ)	
	Hard Coal	Brown Coal	Oven Coke and Gas Coke	Patent Fuel	BKB	Fuel Wood	Other Non-commercial Fuels	Natural Gas	Gas Works Gas
Indigenous Production	3383068.7	552820.4	288287.3	0.0	1679.8	135859.5	62693.4	139372.2	1438.5
From Other Sources	19621.1	0.0	0.0	0.0	0.0	0.0	0.0	6709.1	264.1
Imports	57029.2	332.9	1167.1	10.5	33.8	0.0	0.0	294565.3	0.0
Exports	752558.4	386.5	61740.2	128.0	1424.7	0.0	0.0	1554.5	0.0
International Marine Bunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Changes	-17664.4	210.2	-8009.9	173.9	-4.0	-580.6	407.2	301.0	1.9
DOMESTIC SUPPLY	**2689496.2**	**552977.0**	**219704.4**	**56.4**	**284.8**	**135278.9**	**63100.5**	**439393.1**	**1704.5**
Returns to Supply	0.0	0.0	0.0	0.0	0.0	0.0	25032.8	0.0	0.0
Transfers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	0.0
TOTAL REQUIREMENTS	**2689496.2**	**552977.0**	**219704.4**	**56.4**	**284.8**	**135278.9**	**88133.3**	**439392.6**	**1704.5**
Statistical Difference	71994.2	11756.6	1078.4	0.0	2.6	0.0	0.0	-32054.4	43.8
TRANSFORMATION SECTOR	**1666762.9**	**534758.7**	**51375.1**	**0.5**	**3.2**	**142.4**	**5926.3**	**9999.4**	**4.8**
Patent Fuel Plants	0.0	1719.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	403899.8	0.0	1836.5	0.0	0.0	0.0	6.6	2047.1	0.0
Gas Works	1840.6	0.0	59.3	0.0	0.0	0.0	0.0	0.0	0.0
Blast Furnaces	0.0	0.0	42968.5	0.0	0.0	0.0	0.0	0.0	0.0
Oil Refineries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Autoproducers of Electricity	72043.5	489.7	0.1	0.0	0.0	0.0	4369.6	2066.8	0.0
Public Plants for CHP	924751.3	531825.7	0.0	0.0	0.0	0.0	1312.3	1845.1	0.0
Heating Plants	264227.6	724.2	6510.7	0.5	3.2	142.4	237.8	4040.5	4.8
Non-Specified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENERGY SECTOR	**67296.7**	**346.6**	**527.8**	**2.7**	**35.0**	**3.3**	**392.7**	**34870.6**	**68.0**
Coal Mines	60718.9	343.5	71.7	0.0	35.0	1.2	30.6	1608.3	28.0
Oil and Gas Extraction	59.0	0.0	7.6	0.0	0.0	0.0	0.0	8082.8	0.0
Patent Fuel Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	1745.2	0.0	311.9	0.0	0.0	0.0	0.0	442.4	0.0
Gas Works	326.9	0.0	24.6	0.0	0.0	0.0	0.0	22713.1	39.8
Oil Refineries	1375.7	0.0	0.1	0.0	0.0	0.0	350.5	1943.1	0.0
Electric Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumped Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	3071.0	3.1	111.9	2.7	0.0	2.1	11.6	80.9	0.2
Distribution Losses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42393.4	21.8
FINAL CONSUMPTION	**883442.3**	**6115.0**	**166723.1**	**53.2**	**243.9**	**135133.3**	**81814.4**	**384183.5**	**1566.0**
INDUSTRY SECTOR	**407407.6**	**1583.6**	**107469.9**	**49.8**	**38.4**	**6520.7**	**29894.3**	**116301.1**	**1303.2**
Iron and Steel	28595.6	0.0	78860.1	0.0	0.0	6.2	498.2	26728.0	89.1
Chemical	64508.2	503.1	2960.3	0.0	2.5	0.0	3352.5	6879.4	58.2
of which: Petrochemical	7.9	0.0	0.0	0.0	0.0	0.0	193.7	0.0	0.0
Non-Ferrous Metals	4091.2	0.0	6333.1	0.0	0.0	149.0	2411.5	11582.0	0.0
Non-Metallic Minerals	91608.9	137.6	10582.4	0.0	0.0	10.0	144.4	29610.6	1147.9
Transport Equipment	10144.8	0.0	607.2	0.0	0.0	0.7	53.8	4478.4	0.0
Machinery	27661.6	52.8	1910.0	0.0	0.0	10.0	76.3	7671.4	0.6
Mining and Quarrying	8813.2	11.3	725.1	0.0	35.7	2.0	21.4	2191.1	0.0
Food and Tobacco	93814.3	354.9	3090.9	24.7	0.0	84.0	10.5	16723.0	2.8
Paper, Pulp and Print	21390.0	0.0	235.2	0.0	0.0	8.1	16235.0	506.4	4.3
Wood and Wood Products	8767.6	0.9	56.2	0.0	0.0	5908.7	4669.1	429.5	0.0
Constructions	6641.6	17.1	1273.1	0.2	0.2	32.1	14.3	856.6	0.1
Textiles and Leather	25807.5	473.2	424.9	0.0	0.0	31.0	491.0	8049.4	0.3
Non-specified	15563.1	32.7	411.4	24.9	0.0	279.0	1916.3	595.3	0.0
TRANSPORT SECTOR	**179.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Air Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Road Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railways	179.7	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Internal Navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER SECTORS	**475358.1**	**4530.6**	**54959.1**	**3.3**	**205.5**	**128612.6**	**33830.3**	**180282.2**	**262.8**
Agriculture	71885.4	1236.2	3863.2	3.3	0.0	17566.9	103.8	475.3	0.0
Commerce and Public	0.0	0.0	0.0	0.0	0.0	0.0	33442.3	0.0	0.0
Residential	375072.6	3255.3	26398.7	0.0	0.0	101000.0	0.0	158951.8	246.5
Non-Specified	28400.1	39.2	24697.2	0.1	205.5	10045.7	284.2	20855.2	16.3
NON-ENERGY USE	**497.0**	**0.7**	**4294.2**	**0.0**	**0.0**	**0.0**	**18089.7**	**87600.2**	**0.0**
in Industry	430.6	0.7	4294.0	0.0	0.0	0.0	9846.0	87600.2	0.0

POLAND 1996

PRODUCTION AND USES OF ENERGY	Gas (TJ)		Electricity		Heat	Oil (TJ)				
	Coke Oven Gas	Blast Furnace Gas	Total	of which Hydro		Crude Oil + Feedstocks + Other Inputs	Crude Oil + NGL	Feed-stocks	Other Inputs	Rafinery Gas
Indigenous Production	84483.8	39062.3	508300.2	6950.5	441093.0	16571.1	13482.2	0.0	3088.9	15708.3
From Other Sources	0.0	0.0	7123.7	7123.7	3276.5	0.0	0.0	0.0	0.0	0.0
Imports	0.0	0.0	17284.0	0.0	0.0	636615.0	595982.2	38635.5	1997.3	0.0
Exports	0.0	0.0	28530.0	0.0	0.0	23.8	23.8	0.0	0.0	0.0
International Marine Bunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Changes	0.0	0.0	0.0	0.0	0.0	7325.4	10837.3	-3561.8	49.8	0.0
DOMESTIC SUPPLY	**84483.8**	**39062.3**	**504177.9**	**14074.2**	**444369.5**	**660487.8**	**620278.0**	**35073.7**	**5136.0**	**15708.3**
Returns to Supply	0.0	0.0	0.0	0.0	42340.7	2041.9	0.0	2041.9	0.0	0.0
Transfers	0.0	0.0	0.0	0.0	0.0	22959.5	0.0	22959.5	0.0	0.0
TOTAL REQUIREMENTS	**84483.8**	**39062.3**	**504177.9**	**14074.2**	**486710.2**	**685489.2**	**620278.0**	**60075.2**	**5136.0**	**15708.3**
Statistical Difference	-289.2	0.0	0.0	0.0	0.0	9963.3	0.0	9964.4	-1.1	0.0
TRANSFORMATION SECTOR	**15528.2**	**3417.6**	**0.0**	**0.0**	**3388.3**	**675462.0**	**620214.1**	**50110.7**	**5137.1**	**0.0**
Patent Fuel Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	0.0	199.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blast Furnaces	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil Refineries	0.0	0.0	0.0	0.0	0.0	675462.0	620214.1	50110.7	5137.1	0.0
Autoproducers of Electricity	8350.4	2976.4	0.0	0.0	3388.3	0.0	0.0	0.0	0.0	0.0
Public Plants for CHP	6190.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heating Plants	987.7	242.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENERGY SECTOR	**39005.8**	**1383.2**	**103356.2**	**0.0**	**71878.1**	**63.9**	**63.9**	**0.0**	**0.0**	**8740.7**
Coal Mines	476.9	0.0	29805.8	0.0	10011.7	0.0	0.0	0.0	0.0	0.0
Oil and Gas Extraction	0.0	0.0	622.0	0.0	0.0	63.9	63.9	0.0	0.0	0.0
Patent Fuel Plants	0.0	0.0	16.2	0.0	261.5	0.0	0.0	0.0	0.0	0.0
Coke Ovens	38526.3	1383.2	2462.7	0.0	11244.8	0.0	0.0	0.0	0.0	0.0
Gas Works	2.6	0.0	750.9	0.0	345.9	0.0	0.0	0.0	0.0	0.0
Oil Refineries	0.0	0.0	2141.0	0.0	10152.6	0.0	0.0	0.0	0.0	8740.7
Electric Plants	0.0	0.0	35145.5	0.0	5044.4	0.0	0.0	0.0	0.0	0.0
Pumped Storage	0.0	0.0	9883.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	0.0	0.0	22528.6	0.0	34817.3	0.0	0.0	0.0	0.0	0.0
Distribution Losses	1368.5	0.0	64918.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FINAL CONSUMPTION	**28870.5**	**34261.5**	**335902.9**		**411443.8**					**6967.5**
INDUSTRY SECTOR	**28158.0**	**34261.5**	**166334.8**	**0.0**	**72757.6**	**0.0**	**0.0**	**0.0**	**0.0**	**6967.5**
Iron and Steel	26692.5	34205.2	27431.3	0.0	7463.2	0.0	0.0	0.0	0.0	0.0
Chemical	870.9	3.6	34329.6	0.0	23891.1	0.0	0.0	0.0	0.0	6967.5
of which: Petrochemical	0.0	0.0	3612.9	0.0	2369.6	0.0	0.0	0.0	0.0	6967.5
Non-Ferrous Metals	0.0	0.0	10704.4	0.0	831.5	0.0	0.0	0.0	0.0	0.0
Non-Metallic Minerals	565.8	52.7	13064.7	0.0	2401.5	0.0	0.0	0.0	0.0	0.0
Transport Equipment	0.0	0.0	6256.8	0.0	7111.6	0.0	0.0	0.0	0.0	0.0
Machinery	15.3	0.0	15592.5	0.0	9164.4	0.0	0.0	0.0	0.0	0.0
Mining and Quarrying	8.7	0.0	8837.6	0.0	4340.2	0.0	0.0	0.0	0.0	0.0
Food and Tobacco	3.8	0.0	17837.7	0.0	5563.0	0.0	0.0	0.0	0.0	0.0
Paper, Pulp and Print	0.8	0.0	10579.6	0.0	2232.8	0.0	0.0	0.0	0.0	0.0
Wood and Wood Products	0.0	0.0	4634.7	0.0	321.5	0.0	0.0	0.0	0.0	0.0
Constructions	0.0	0.0	3554.4	0.0	1568.2	0.0	0.0	0.0	0.0	0.0
Textiles and Leather	0.1	0.0	6477.6	0.0	5721.7	0.0	0.0	0.0	0.0	0.0
Non-specified	0.0	0.0	7034.0	0.0	2147.0	0.0	0.0	0.0	0.0	0.0
TRANSPORT SECTOR	**0.0**	**0.0**	**17013.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Air Transport	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Road Transport	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Railways	0.0	0.0	17013.6	0.0		0.0	0.0	0.0	0.0	0.0
Internal Navigation	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
OTHER SECTORS	**289.7**	**0.0**	**152554.5**	**0.0**	**338686.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Agriculture	0.0	0.0	19774.8	0.0	1600.0	0.0	0.0	0.0	0.0	0.0
Commerce and Public	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	250.6	0.0	69206.4	0.0	291000.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	39.1	0.0	63573.3	0.0	46086.2	0.0	0.0	0.0	0.0	0.0
NON-ENERGY USE	**422.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
in Industry	422.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

POLAND 1996

PRODUCTION AND USES OF ENERGY	Oil (TJ)		Petroleum Products (TJ)						
	Liquified Petroleum Gases	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/Diesel Oil	Residual Fuel Oil	Naphta	Other Petroleum Products
Indigenous Production	7823.5	133683.6	0.0	10180.4	252.5	225171.9	157915.5	32819.2	77145.6
From Other Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports	28230.6	59897.4	124.7	11420.3	682.9	53131.3	6276.8	0.0	3305.5
Exports	63.1	1.3	4.1	1146.5	53.2	252.0	41343.6	0.0	7407.8
International Marine Bunkers	0.0	0.0	0.0	0.0	0.0	1620.2	7576.4	0.0	0.0
Stock Changes	-47.5	822.6	67.2	545.9	494.6	-3029.7	-1427.0	946.2	1053.7
DOMESTIC SUPPLY	**35943.4**	**194402.2**	**187.8**	**21000.1**	**1376.8**	**273401.3**	**113845.3**	**33765.4**	**74096.9**
Returns to Supply	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transfers	0.0	5291.7	-3.1	-4379.8	-666.8	-17038.8	-25.5	0.0	-6070.1
TOTAL REQUIREMENTS	**35943.4**	**199694.0**	**184.7**	**16620.3**	**710.0**	**256362.4**	**113819.9**	**33765.4**	**68026.8**
Statistical Difference	-0.7	-6614.5	0.0	0.1	-726.5	1502.3	434.5	42.8	-7939.3
TRANSFORMATION SECTOR	**269.8**	**0.0**	**0.0**	**0.0**	**0.0**	**234.9**	**23501.7**	**0.0**	**5322.5**
Patent Fuel Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Works	267.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blast Furnaces	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil Refineries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Autoproducers of Electricity	0.0	0.0	0.0	0.0	0.0	21.4	4401.5	0.0	5322.5
Public Plants for CHP	0.0	0.0	0.0	0.0	0.0	51.3	6743.7	0.0	0.0
Heating Plants	2.8	0.0	0.0	0.0	0.0	162.2	12356.5	0.0	0.0
Non-Specified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENERGY SECTOR	**59.7**	**1743.5**	**0.0**	**0.0**	**26.1**	**3172.2**	**41083.9**	**0.1**	**1166.2**
Coal Mines	0.3	34.0	0.0	0.0	18.8	1522.3	20.8	0.1	438.1
Oil and Gas Extraction	0.0	0.8	0.0	0.0	0.4	419.8	11.7	0.0	7.3
Patent Fuel Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	0.2	1.5	0.0	0.0	0.0	6.7	0.0	0.0	10.6
Gas Works	21.3	26.7	0.0	0.0	2.0	804.0	4.5	0.0	51.7
Oil Refineries	20.1	1661.7	0.0	0.0	0.0	113.7	40752.4	0.0	434.6
Electric Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumped Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	17.7	18.8	0.0	0.0	4.9	305.7	294.4	0.0	224.0
Distribution Losses	0.7	299.8	1.1	1.3	1.0	60.7	1.4	0.0	9.6
FINAL CONSUMPTION	**35614.0**	**204265.1**	**183.6**	**16619.0**	**1409.4**	**251392.4**	**48798.3**	**33722.5**	**69467.8**
INDUSTRY SECTOR	**5110.0**	**1817.0**	**0.0**	**0.0**	**596.2**	**16446.9**	**35168.8**	**1.5**	**0.0**
Iron and Steel	5.4	19.3	0.0	0.0	15.3	804.6	1061.2	0.0	0.0
Chemical	4635.7	23.5	0.0	0.0	350.3	926.7	9887.7	0.0	0.0
of which: Petrochemical	4620.2	0.3	0.0	0.0	0.0	197.3	147.9	0.0	0.0
Non-Ferrous Metals	60.6	3.1	0.0	0.0	3.9	155.4	752.8	0.1	0.0
Non-Metallic Minerals	45.7	13.5	0.0	0.0	4.5	945.7	4583.3	0.1	0.0
Transport Equipment	35.9	144.5	0.0	0.0	42.4	885.5	363.2	0.1	0.0
Machinery	47.7	171.5	0.0	0.0	73.4	1650.9	874.8	1.1	0.0
Mining and Quarrying	0.2	59.2	0.0	0.0	2.2	3012.5	773.6	0.0	0.0
Food and Tobacco	161.0	177.8	0.0	0.0	8.1	942.0	8495.3	0.0	0.0
Paper, Pulp and Print	51.5	8.1	0.0	0.0	10.9	143.5	1488.9	0.0	0.0
Wood and Wood Products	1.2	19.0	0.0	0.0	8.6	376.5	2186.6	0.0	0.0
Constructions	37.3	1000.0	0.0	0.0	30.6	6059.6	3078.8	0.0	0.0
Textiles and Leather	10.2	8.9	0.0	0.0	21.7	145.0	802.9	0.0	0.0
Non-specified	17.6	168.7	0.0	0.0	24.3	399.1	819.7	0.1	0.0
TRANSPORT SECTOR	**11982.5**	**202448.0**	**183.6**	**16619.0**	**46.8**	**148278.3**	**631.1**	**0.1**	**0.0**
Air Transport	0.0	0.0	183.6	16619.0	0.0	12.2	0.0	0.0	0.0
Road Transport	11982.5	202445.9	0.0	0.0	23.7	137829.7	398.2	0.1	0.0
Railways	0.0	0.0	0.0	0.0	23.0	9729.9	210.4	0.0	0.0
Internal Navigation	0.0	2.1	0.0	0.0	0.0	706.5	22.5	0.0	0.0
OTHER SECTORS	**18521.5**	**0.0**	**0.0**	**0.0**	**8.5**	**86666.8**	**12982.4**	**0.0**	**0.0**
Agriculture	1182.8	0.0	0.0	0.0	0.0	86666.8	12058.0	0.0	0.0
Commerce and Public	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	16558.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Specified	779.9	0.0	0.0	0.0	8.5	0.0	924.4	0.0	0.0
NON-ENERGY USE	**0.0**	**0.1**	**0.0**	**0.0**	**758.0**	**0.5**	**16.0**	**33720.8**	**69467.8**
in Industry	0.0	0.1	0.0	0.0	754.6	0.2	16.0	33720.8	47615.7

Annex 5. Uncertainty estimation of the 1996 inventory

Uncertainty analysis for the year 1996 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. *LUCF* 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.

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

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

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

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 CH_4 and N_2O 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 (CO_2 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 – 6.0%	CH_4 – 20.0%	N_2O – 49.5%
HFC – 40.4%	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%).

CO_2 emission factors

Most uncertain values for CO_2 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 CO_2 (6.0%) 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%).

CH_4 emission factors

Most uncertain values for CH_4 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 CH_4 emission is app. 20.0% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

N_2O emission factors

Most uncertain values for N_4O 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 N_2O (49.5%) 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 – 40.4%, 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 1996 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 (423.11 Gg) compared to total CO_2 and high uncertainty have very little influence on uncertainty of values of total national CO_2 emission.

GHG inventory 1996 – Uncertainty analysis, part 1, sectors 1-2

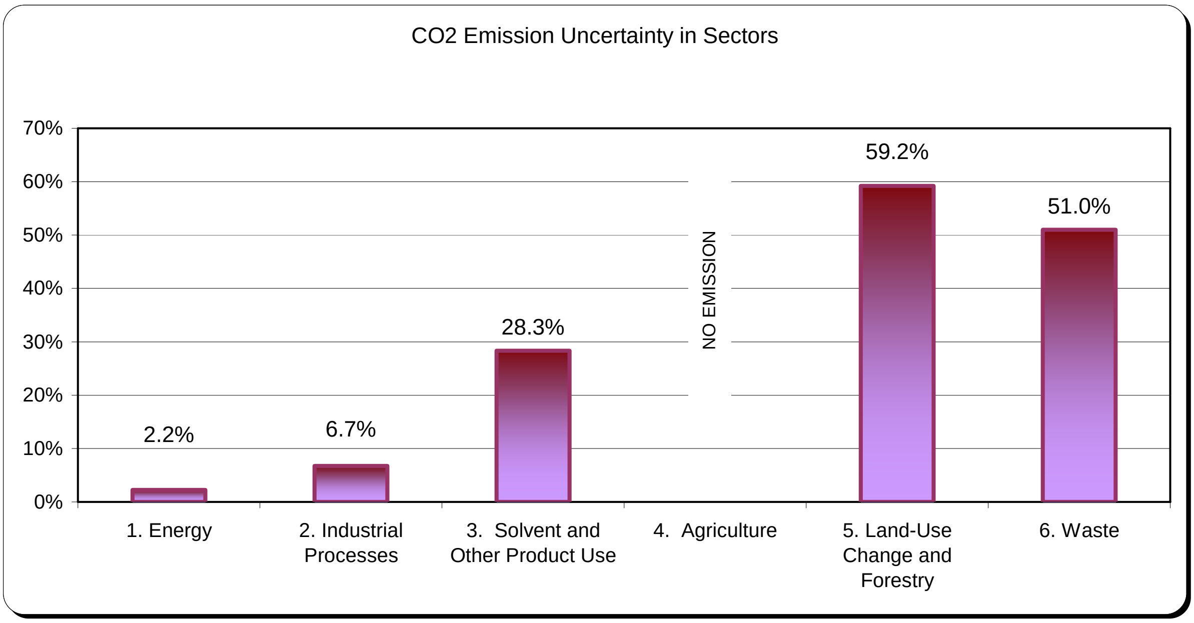
1996	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									364 869.10	2 031.32	104.05	6.0%	20.0%	49.5%	21 828.89	406.53	51.51
1. Energy									**382 081.46**	**838.73**	**8.47**	2.2%	15.0%	3.5%	**8514.15**	**126.04**	**0.29**
A. Fuel Combustion									**381 987.49**	**19.14**	**8.47**	2.2%	7.7%	3.5%	8514.15	1.47	0.29
1. Energy Industries									195 660.96	2.20	2.82	3.5%	13.0%	3.5%	6781.09	0.29	0.10
Liquid Fuels	97 439	3.0%	71.15	2.50	0.49	1.0%	41.8%	3.8%	6 932.90	0.24	0.05	3.2%	41.9%	3.2%	219.24	0.10	0.00
Solid Fuels	1 894 434	3.0%	99.22	1.02	1.46	2.0%	13.5%	11.7%	187 973.64	1.94	2.77	3.6%	13.8%	3.6%	6777.49	0.27	0.10
Gaseous Fuels	13 518	3.0%	55.81	1.00	0.10	2.0%	17.0%	20.0%	754.42	0.01	0.00	3.6%	17.3%	3.6%	27.20	0.00	0.00
Biomass	309	3.0%				0.0%	24.0%	37.0%	29.91	0.01	0.00	3.0%	24.2%	3.0%		0.00	0.00
2. Manufacturing Industries and Construction									82 702.86	3.03	1.34	4.4%	12.3%	9.1%	3666.92	0.37	0.12
Liquid Fuels	109 618.62	5.0%	75.73	2.99	3.34	1.0%	41.8%	3.8%	8 301.09	0.33	0.37	5.1%	42.1%	6.3%	423.27	0.14	0.02
Solid Fuels	640 010.93	5.0%	105.09	3.72	1.47	2.0%	13.5%	11.7%	67 259.78	2.38	0.94	5.4%	14.4%	12.7%	3622.05	0.34	0.12
Gaseous Fuels	129 342.42	5.0%	55.22	1.00	0.10	2.0%	17.0%	20.0%	7 142.00	0.13	0.01	5.4%	17.7%	20.6%	384.61	0.02	0.00
Biomass	6 463.11	5.0%	112.00	30.00	4.00	0.0%	24.0%	37.0%	723.87	0.19	0.03	5.0%	24.5%	37.3%		0.05	0.01
3. Transport									32 960.02	8.84	2.15	7.1%	11.4%	5.5%	2329.67	1.00	0.12
Liquid Fuels	435 897.27	5.0%	75.58	20.27	4.94	5.0%	10.2%	2.3%	32 946.55	8.84	2.15	7.1%	11.4%	5.5%	2329.67	1.00	0.12
Solid Fuels	179.60	5.0%	75.00	6.00	2.00	5.0%	13.5%	11.7%	13.47	0.00	0.00	7.1%	14.4%	12.7%	0.95	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									67 438.48	4.97	1.79	4.1%	19.4%	12.2%	2760.39	0.97	0.22
Liquid Fuels	126 679.13	5.0%	72.59	3.47	3.79	1.0%	41.8%	3.8%	9 195.74	0.44	0.48	5.1%	42.1%	6.3%	468.89	0.18	0.03
Solid Fuels	517 117.09	5.0%	96.31	1.00	1.50	2.0%	13.5%	11.7%	49 804.46	0.52	0.78	5.4%	14.4%	12.7%	2682.05	0.07	0.10
Gaseous Fuels	159 265.08	5.0%	52.98	1.00	0.10	2.0%	17.0%	20.0%	8 438.28	0.16	0.02	5.4%	17.7%	20.6%	454.42	0.03	0.00
Biomass	128 581.91	5.0%	112.00	30.00	4.00		24.0%	37.0%	14 401.17	3.86	0.51	5.0%	24.5%	37.3%		0.95	0.19
5. Other									3 225.17	0.10	0.36	3.7%	85.4%	6.0%	118.74	0.08	0.02
Liquid Fuels	27 543.40	5.0%	69.46	2.96	12.44	1.0%	100.0%	3.8%	1 913.11	0.08	0.34	5.1%	100.1%	6.3%	97.55	0.08	0.02
Solid Fuels	12 697.78	5.0%	98.92	1.05	1.50	2.0%	80.0%	11.7%	1 256.03	0.01	0.02	5.4%	80.2%	12.7%	67.64	0.01	0.00
Gaseous Fuels	1 017.28	5.0%	55.07	1.00	0.10	2.0%	90.0%	20.0%	56.03	0.00	0.00	5.4%	90.1%	20.6%	3.02	0.00	0.00
Biomass	14.34	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	1.61	0.00	0.00	5.0%	95.1%	37.3%		0.00	0.00
B. Fugitive Emissions from Fuels									**93.97**	**819.58**	**0.00**	6.0%	15.4%		5.66	126.03	0.00
1. Solid Fuels									0.75	627.52	0.00	6.6%	20.0%		0.05	125.54	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]	136.27	2.0%		4.58347			20.0%			624.60			20.1%		0.00	125.54	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	63.85	2.0%		0.01273			20.0%			0.81			20.1%		0.00	0.16	0.00
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	0.36	2.0%	2 060 765	5 791 695.00			20.0%		0.75	2.11		6.6%	15.0%		0.05	0.32	
2. Oil and Natural Gas									93.22	192.06	0.00	6.1%	5.7%		5.66	11.03	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	13.48	0.5%	6 315 000	61 800.00		6.6%	8.1%		85.14	0.83		6.6%	8.1%		5.64	0.07	0.00
iii. Transport [Activity in Gg]	14 343.00	0.5%	NE	NE		6.6%	8.1%		0.09	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]	131.47	0.5%	55 688.14	99 894.34		6.6%	8.1%		7.32	13.13		6.6%	8.1%		0.48	1.07	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	395.71	0.5%	517.79	136 814.98		6.6%	8.1%		0.20	54.14		6.6%	8.1%		0.01	4.39	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	395.71	0.5%	1 169.53	313 234.51		6.6%	8.1%		0.46	123.95		6.6%	8.1%		0.03	10.06	0.00
2. Industrial Processes									**15857.10**	**13.45**	**13.09**	6.7%	16.7%	28.7%	1066.53	2.25	3.75
A. Mineral Products									8501.69		0	11.9%			1014.17	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	11 756.00	5.0%	0.525			15.0%			6171.90			15.8%			975.86	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 461.00	10.0%	0.785			10.0%			1931.89			14.1%			273.21	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	958.80	10.0%	0.415			0.0%			397.90			10.0%			39.79	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									3437.39	10.96	13.09	6.8%	20.2%	28.7%	232.05	2.21	3.75
1. Ammonia Production [Activity in kt, EF in t/t]	2 185.20	5.0%	1.5	0.0049		5.0%	20.0%		3277.80	10.71		7.1%	20.6%		231.78	2.21	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 929.10	2.0%			0.01			30.0%			12.48			30.1%	0.00	0.00	3.75
3. Adipic Acid Production [Activity in kt, EF in t/t]	NO	5.0%			0.00			10.0%	NO					11.2%			
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	145.00	5.0%	1.1			5.0%			159.50			7.1%			11.28	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	24.80	5.0%		0.01			20.0%			0.25			20.6%		0.00	0.05	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	298.83	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]	800.80	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	127.77	5.0%			0.0047			20.0%			0.61			20.6%	0.00	0.00	0.12
C. Metal Production									3918.03	2.49	0	6.0%	17.3%		234.75	0.43	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	8 318.58	5.0%	0.08			10.0%			652.18			11.2%			72.92	0.00	0.00
Coke [Activity in kt, EF in t/t]	10 340.00	5.0%	0.09	0.000200		10.0%	20.0%		981.32	2.07		11.2%	20.6%		109.71	0.43	0.00
Open-heart Steel [Activity in kt, EF in t/t]	1 118.00	5.0%	0.052			10.0%			58.14			11.2%			NE		
Electric Furnace Steel [Activity in kt, EF in t/t]	2 554.00	5.0%	0.00430	0.000120		10.0%	20.0%		10.98	0.31		11.2%	20.6%		1.23	0.06	0.00
Pig Iron [Activity in kt, EF in t/t]	6 561.85	5.0%	0.26285			10.0%			1724.78			11.2%			192.84	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	594.90	5.0%	0.061	0.000200		10.0%	20.0%		36.29	0.12		11.2%	20.6%		4.06	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	77.20	5.0%	0.062			10.0%			4.79			11.2%			0.54	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	6 757.00	5.0%	0.01126			10.0%			76.08			11.2%			8.51	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	71.80	5.0%	3.9			5.0%			280.02			7.1%			19.80	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	51.92	5.0%	1.8			5.0%			93.46			7.1%			6.61	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 1996 – Uncertainty analysis, part 2, sector 3-6

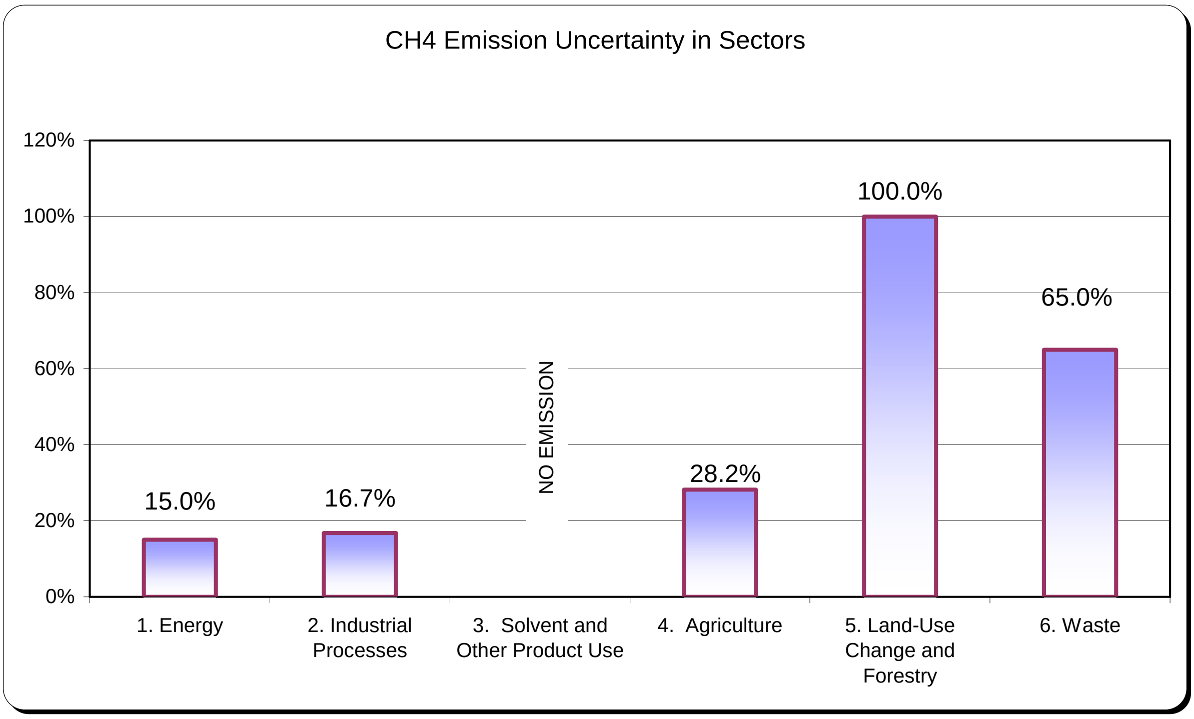
1996	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	**123.91**		NA						**423.11**		**0.40**	28.3%		50.0%	119.74	0.00	0.20
4. Agriculture										**656.98**	**78.53**		28.2%	65.4%	0.00	185.16	51.34
A. Enteric Fermentation										496.66			34.7%		0.00	172.50	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 461.0	5.0%		89.70			50.0%			310.45			50.2%		0.00	156.00	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 675.0	5.0%		39.07			50.0%			143.58			50.2%		0.00	72.15	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	552.0	5.0%		8.23			50.0%			4.54			50.2%		0.00	2.28	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179.3	5.0%		5.00			50.0%			0.90			50.2%		0.00	0.45	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	569.0	5.0%		18.00			50.0%			10.24			50.2%		0.00	5.15	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	17 964.0	5.0%		1.50			50.0%			26.95			50.2%		0.00	13.54	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	209 453.7	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
B. Manure Management										159.06	22.94		42.3%	148.6%	0.00	67.28	34.09
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 461	5.0%		4.78			50.0%			16.55			50.2%		0.00	8.31	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 675	5.0%		2.13			50.0%			7.84			50.2%		0.00	3.94	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	552	5.0%		0.17			50.0%			0.10			50.2%		0.00	0.05	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179	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]	569	5.0%		1.39			50.0%			0.79			50.2%		0.00	0.40	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	17 964	5.0%		6.54			50.0%			117.42			50.2%		0.00	59.00	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	209 454	5.0%		0.08			50.0%			16.34			50.2%		0.00	8.21	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.23			150.1%	0.00	0.00	0.34
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			22.71			150.1%	0.00	0.00	34.08
D. Agricultural Soils											55.53			69.1%	0.00	0.00	38.39
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	766 800 000	5.0%			0.01			150.0%			10.71			150.1%	0.00	0.00	16.08
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	678 302 552	5.0%			0.01			150.0%			10.66			150.1%	0.00	0.00	16.00
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	40 680 000	5.0%			0.01			150.0%			0.64			150.1%	0.00	0.00	0.96
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	180 044 000	5.0%			0.01			150.0%			2.83			150.1%	0.00	0.00	4.25
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]	72 507 163	5.0%			0.02			150.0%			2.28			150.1%	0.00	0.00	3.42
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	99 701 433	20.0%			1.25000351			150.0%			12.46			151.3%			18.86
F. Field Burning of Agricultural Residues										1.27	0.06		20.6%	105.6%	0.00	0.26	0.07
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	8 575 900	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]	3 437 000	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]	350 000	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]	1 581 000	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]	5 653 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.11	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]	5 701 000	30.0%		0.1562	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)	277 000	30.0%		0.0423	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]	27 217 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.49	0.04		36.1%	153.0%	0.00	0.18	0.06
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, Tabacco, Hop, Hey [Activity in t of crop prod., EF in kg/ t of crop]	25 800 000	30.0%		0.0133	0.0006		20.0%	150.0%		0.34	0.02		36.1%	153.0%	0.00	0.12	0.03
													0.0%	0.0%	0.00	0.00	0.00
5. Land-Use Change and Forestry									**-33893.69**	**0.11**	**0.00**	59.2%	100.0%	100.0%	-20070.28	0.11	0.001
A. Forest Land									-39673.32			50.0%			-19836.66	0.00	0.000
B. Cropland									5031.73			50.0%			2515.87	0.00	0.000
C. Grassland									2791.98			50.0%			1395.99	0.00	0.000
D. Wetlands									0.00			50.0%			0.00	0.00	0.000
E. Settlements									-2044.09	0.11	0.0008	50.0%	100.0%	100.0%	-1022.04	0.11	0.001
F. Other Land									0.00	0.00	0.0000	50.0%	100.0%	100.0%	0.00	0.00	0.000
6. Waste									**401.11**	**522.04**	**3.56**	51.0%	65.0%	51.5%	204.53	339.25	1.83
A. Solid Waste Disposal on Land										273.20			102.6%		0.00	280.33	0.00
1 Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%						100.0%		0.00	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 Guidlines 2006) [Activity in Gg, EF in t/t MSW]	11 402.00	23.0%					100.0%			273.20			102.6%		0.00	280.33	0.00
B. Wastewater Handling										248.84	3.51		76.8%	52.2%	0.00	191.07	1.83
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	1 940.74			0.09			100.0%			174.67			100.0%		0.00	174.67	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	361.03	30.0%		0.205459989			100.0%			74.18			104.4%		0.00	77.44	0.00
N2O from human sewage [Activity in 1000s of population, EF in kg N2O-N/kg sewage N produced]	38 639.00	15.0%			0.0000909			50.0%			3.51			52.2%	0.00	0.00	1.83
C. Waste Incineration									401.11		0.05	51.0%		27.2%	204.53	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			106.46		0.00	51.0%		30.0%	54.29	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			401.11		0.04	51.0%		30.0%	204.53	0.00	0.01

Industrial gases inventory 1996 – Uncertainty analysis for HFC, PFC and SF_6.

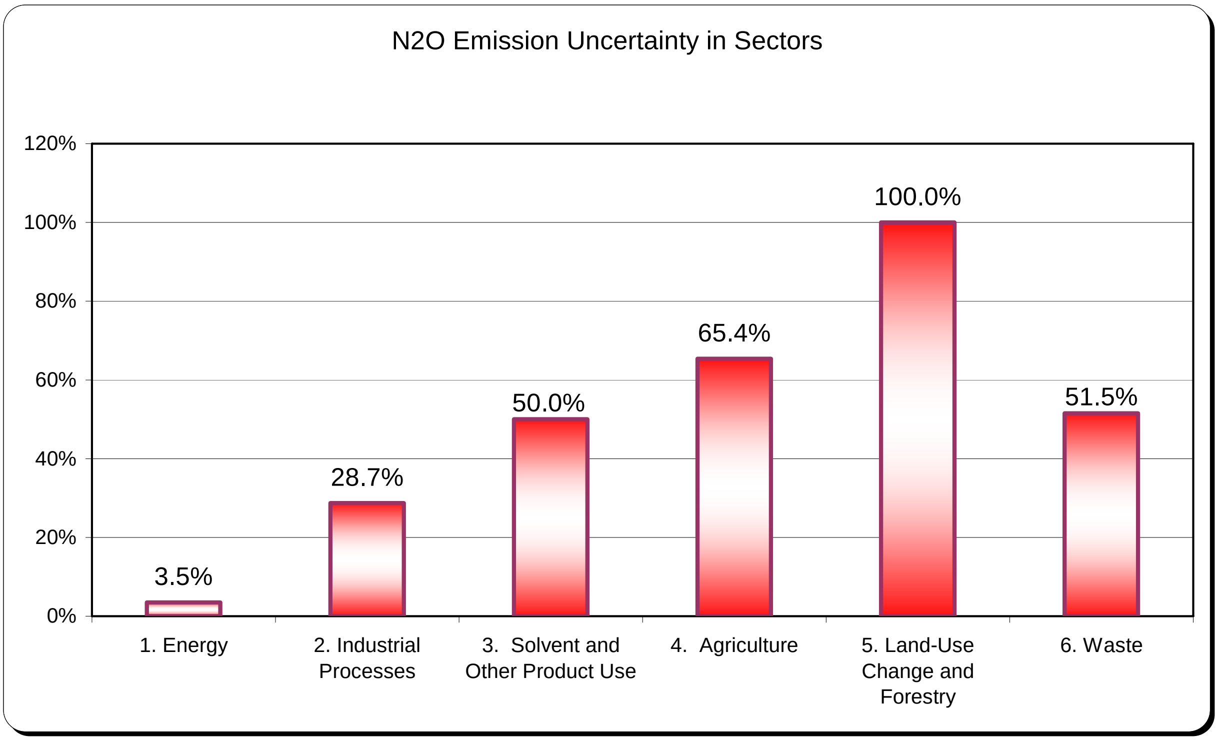
1996	HFC Emission [Gg of CO2 eq.]	PFC Emission [Gg of CO2 eq.]	SF_6 Emission [Gg of CO2 eq.]	HFC Emission uncertainty [%]	PFC Emission uncertainty [%]	SF6 Emission uncertainty [%]	HFC Emission absolute uncertainty [Gg of CO2 eq.]	PFC Emission absolute uncertainty [Gg of CO2 eq.]	SF6 Emission absolute uncertainty [Gg of CO2 eq.]
TOTAL	96.82	235.68	7.55	40.4%	20.0%	100.0%	39.09	47.14	7.55
2. Industrial Processes	**96.82**	**235.68**	**7.55**	**40.4%**	**20.0%**	**100.0%**	**39.09**	**47.00**	**7.55**
C. Metal Production		235.02			20.0%			47.00	
3. Aluminium Production		235.02			20.0%			47.00	
F. Consumption of Halocarbons and SF6	96.82	0.67	7.55	40.4%		100.0%	39.09	0.00	7.55
1. Refrigeration and Air Conditioning Equipment	21.71			50.0%			10.85		
2. Foam Blowing	NE			50.0%				0.00	
3. Fire Extinguishers	0.04	0.67		50.0%	20.0%				
4. Aerosols/ Metered Dose Inhalers	75.08			50.0%			37.54		
8. Electrical Equipment			7.55			100.0%			7.55



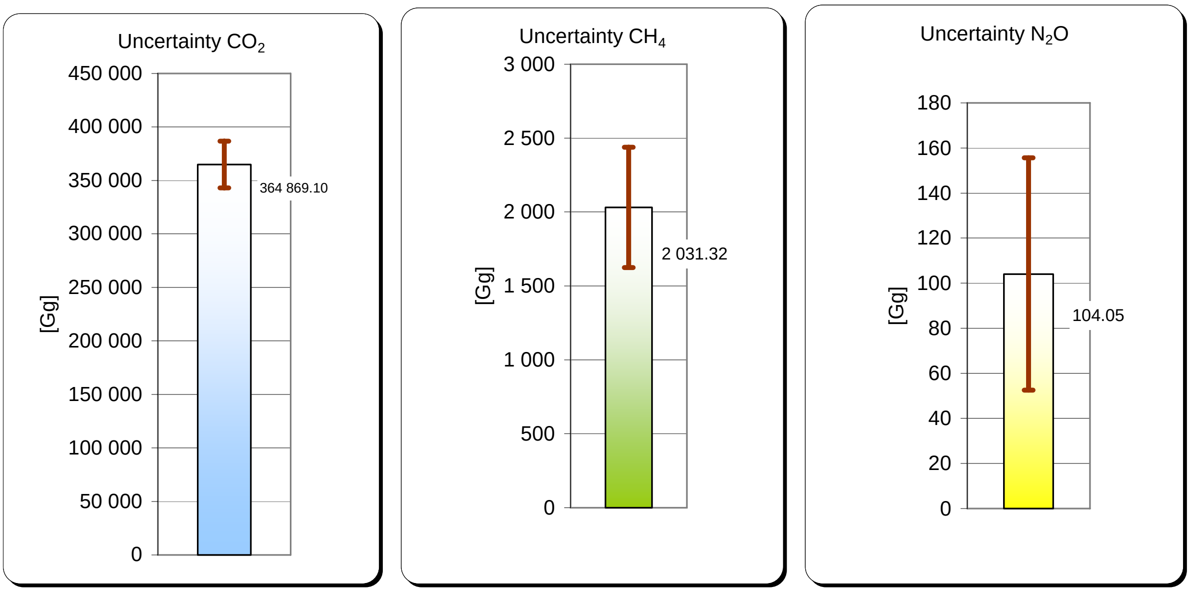
Results of uncertainty analysis in percents for CO_2 with sectoral split.



Results of uncertainty analysis in percents for CH_4 with sectoral split.



Results of uncertainty analysis in percents for N_2O with sectoral split



Emission results with uncertainties bars.