NATIONAL ADMINISTRATION OF THE EMISSIONS TRADING SCHEME
NATIONAL EMISSION CENTRE

Poland's

National Inventory Report 2001

Submission under

the United Nations Framework

Convention on Climate Change

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Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 2001. 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 2001. Totals in tables may not sum due to independent rounding.

Total national GHG emissions

The GHG emissions in base year (1988/1995) and 2001, expressed as CO_2 equivalents, are presented in table ES.1 In 2001 the total national emission of GHG were about 402.11 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 2001 emissions have decreased by 31.5%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-2001. [Gg CO_2 eq.]

Pollutant	Base year	2001	(2001-base)/base
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO_2 – net emission (with LUCF)	461 951.16	299 748.75	-0.35
CO_2 – without LUCF.	494 885.88	330 818.76	-0.33
CH_4	49 256.41	38 448.98	-0.22
N_2O	42 478.82	31 481.41	-0.26
HFCs	26.44	1 073.35	39.59
PFCs	250.18	269.95	0.08
SF_6	13.15	18.45	0.40
TOTAL without CO_2 from LUCF	586 910.88	402 110.90	-0.31
TOTAL with LUCF	553 976.16	371 040.89	-0.33

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

Carbon dioxide emissions

The CO_2 emissions in 2001 were estimated as 330.82 million tones. This is 33.2% lower than in the base year. CO_2 emission was accounted for 82.3% of total GHG emissions in Poland in 2001. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission by 95.58% in 2001. The shares of the main subcategories were as follows: *Energy industries* – 54.9%, *Manufacture Industries and Construction* – 14.4%, *Transport* – 9.7% and *Other Sectors* – 15.6%. *Industrial Processes* contributed to the total CO_2 emission by 4.1% in 2001. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 removal in LUCF sector in 2001, was calculated to be approximately 31.1 million tones. It means that app. 8.4% of the total CO_2 emissions are offset by CO_2 uptake by forests.

Methane emissions

The CH_4 emission amounted to 1 830.90 Gg in 2001 i.e. 38.45 million tones of CO_2 equivalents. The contribution of CH_4 to the national total GHG emission was 9.6% in 2001. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed 38.6%, 33.0% and 26.9% to the national methane emission in 2001, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (26.9% of total CH_4 emission) and Oil and Natural Gas system (11.7% of total CH_4 emission). Waste disposal sites contributed to 17.0% of the methane emission from total CH_4 emission and Wastewater Handling contributed to 9.8% of total CH_4 emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.3% of total CH_4 emission in 2001.

Nitrous oxide emissions

The nitrous oxide emissions in 2001 were 101.55 Gg i.e. 31.48 million tonnes of CO_2 equivalents. The emission was app. 25.9% lower than the respective figure for the base year. The contribution of N_2O to the national total GHG emission was 7.8% in 2001. The main N_2O emission sources and its shares in total N_2O emission in 2001 are as follow: *Agricultural Soils* – 53.7%, *Manure Management* – 20.2%, *Chemical Industry* – 13.8% and *Fuel Combustion* – 8.2%.

Hydrofluorocarbons (HFCs) emissions

The total emission of HFCs in 2001 was 1.07 million tones CO_2 equivalents. The contribution of HFCs to the national total GHG emission in 2001 was relatively low and has been estimated at 0.27%. The emissions of HFCs-gases had increased 41 times between the base year (1995) and 2001. 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 2001 was 0.27 million tonnes of CO_2 equivalents. The contribution of PFCs to the national total GHG emission in 2001 was 0.07%. The emission of PFCs had fluctuated to a limited extend, and followed the trends in aluminium production-its main source. The emission changes between 2001 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 2001 was 0.02 million tones of CO_2 equivalents. The contribution of SF_6 to the national total GHG emission is insignificant, and in 2001 amounted to app. 0.005%. SF_6 emissions in 2001 were by 1.4 times higher 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 2001 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 2001 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 2001

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 82.3% share (in 2001), while the methane contributes with 9.6% to the national total. Nitrous oxide contribution is 7.8% and all industrial GHG together contribute 0.3%.

Table 2.1 Greenhouse gas emissions in 2001 in CO_2 eq.

Pollutant	2001	
	Emission in CO_2 eq. [Gg]	Share [%]
CO_2 – net emission (with LUCF)	299 748.75	
CO_2 – without LUCF.	330 818.76	82.27
CH_4	38 448.98	9.56
N_2O	31 481.41	7.83
HFCs	1 073.35	0.27
PFCs	269.95	0.07
SF_6	18.45	0.005
TOTAL without CO_2 from LUCF	402 110.90	100.0
TOTAL with LUCF	371 040.89	

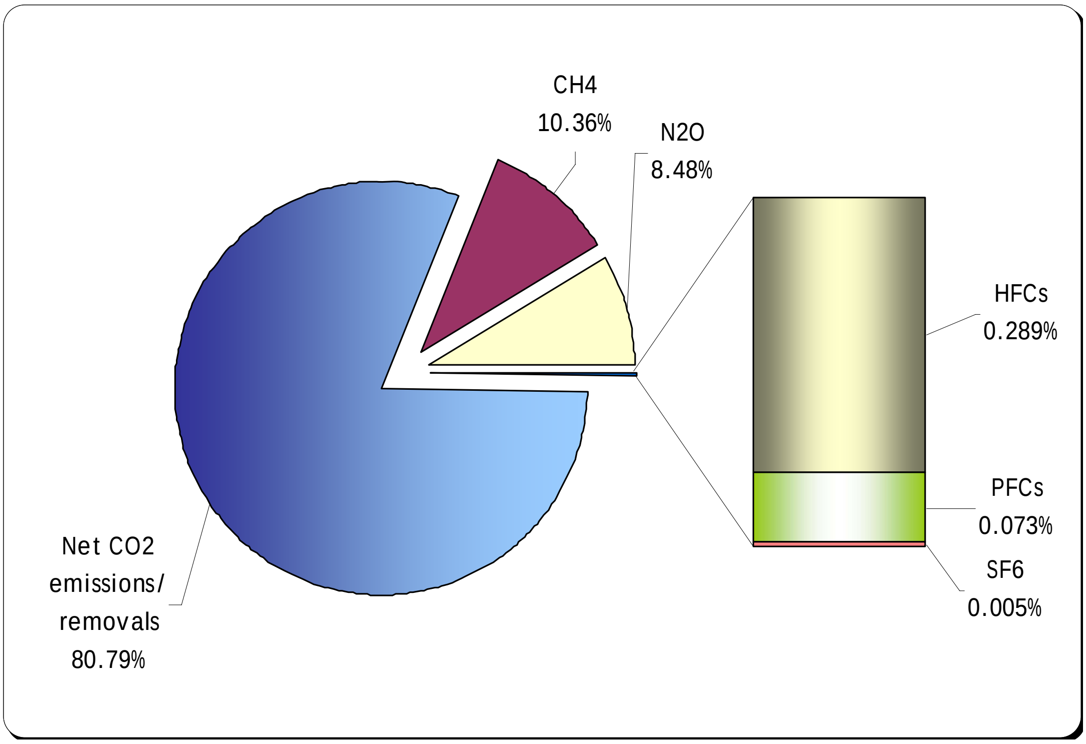

Figure 2.1 Percentage share of greenhouse gases in national total emission total in 2001

Emissions of main GHGs in 2001, 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 2001 [Gg]

[Gg]	CO_2	CH_4	N_2O
TOTAL without CO_2 from LUCF	330 818.76	1 830.90	101.55
1. Energy	316 403.98	721.56	8.37
A. Fuel Combustion	316 187.99	14.78	8.37
1. Energy Industries	181 720.66	2.19	2.60
2. Manufacturing Industries and Construction	47 649.91	2.26	0.74
3. Transport	32 007.05	5.31	3.52
4. Other Sectors	51 766.43	4.96	1.50
5. Other	3 043.94	0.07	0.01
B. Fugitive Emissions from Fuels	215.99	706.77	NE
1. Solid Fuels	0.73	492.85	NE
2. Oil and Natural Gas	215.26	213.93	NE
2. Industrial Processes	13 470.31	12.67	14.03
A. Mineral Products	6 949.90	NE	NE
B. Chemical Industry	3 198.03	10.46	14.03
C. Metal Production	3 322.38	2.21	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	513.21	NE	0.40
4. Agriculture	NE	604.50	75.17
A. Enteric Fermentation	NE	445.02	NE
B. Manure Management	NE	158.20	20.53
D. Agricultural Soils	NE	NE	54.58
F. Field Burning of Agricultural Residues	NE	1.28	0.06
5. Land Use, Land-Use Change and Forestry	-31 070.01	0.14	0.0010
A. Forest Land	-37 925.79	NE	NE
B. Cropland	8 268.23	NE	NE
C. Grassland	4 587.83	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-6 000.28	0.14	0.0010
F. Other Land	NE	NE	NE
6. Waste	431.26	492.04	3.58
A. Solid Waste Disposal on Land	NE	311.82	NE
B. Wastewater Handling	NE	180.22	3.46
C. Waste Incineration	431.26	NE	0.12

Table 2.3 Emissions of industrial gases: HFCs, PFCs and SF_6 in 2001 [eq. Gg]

2001	HFCs	PFCs	SF_6	Total in eq. CO_2
Total Industrial gases [Gg eq. CO_2]	1 073.35	269.95	18.45	1 361.75
C. Metal Production	NE	247.15	NE	247.15
3. Aluminium Production	NE	247.15	NE	247.15
F. Consumption of Halocarbons and SF_6	1 073.35	22.80	18.45	1 114.60
1. Refrigeration and Air Conditioning Equipment	915.34	NE	NE	915.34
2. Foam Blowing	10.56	NE	NE	10.56
3. Fire Extinguishers	3.17	22.80	NE	25.97
4. Aerosols	144.29	NE	NE	144.29
8. Electrical Equipment	NE	NE	18.45	18.45

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 2001 for CO_2, CH_4 and N_2O.

Table 2.4 Percentage shares of individual source sectors in 2001 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	95.64	39.41	8.25
A. Fuel Combustion	95.58	0.81	8.25
1. Energy Industries	54.93	0.12	2.56
2. Manufacturing Industries and Construction	14.40	0.12	0.72
3. Transport	9.68	0.29	3.47
4. Other Sectors	15.65	0.27	1.48
5. Other	0.92	0.00	0.01
B. Fugitive Emissions from Fuels	0.07	38.60	NE
1. Solid Fuels	0.0002	26.92	NE
2. Oil and Natural Gas	0.07	11.68	NE
2. Industrial Processes	4.07	0.69	13.82
A. Mineral Products	2.10	NE	NE
B. Chemical Industry	0.97	0.57	13.82
C. Metal Production	1.00	0.12	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.16	NE	0.39
4. Agriculture	NE	33.02	74.02
A. Enteric Fermentation	NE	24.31	NE
B. Manure Management	NE	8.64	20.22
D. Agricultural Soils	NE	NE	53.74
F. Field Burning of Agricultural Residues	NE	0.07	0.06
5. Land Use, Land-Use Change and Forestry	NE	0.01	0.0010
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	0.0010
F. Other Land	NE	NE	NE
6. Waste	0.13	26.87	3.52
A. Solid Waste Disposal on Land	NE	17.03	NE
B. Wastewater Handling	NE	9.84	3.41
C. Waste Incineration	0.13	NE	0.12

2.2 GHG emissions by gas

Carbon dioxide (CO_2)

In 2001, the net CO_2 emissions (with LULUCF) were estimated as 299.75 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 330.82 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 95.58% in 2001. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 54.9%, *Manufacture Industries and Construction* – 14.4%, *Transport* – 9.7% and *Other Sectors* – 15.6%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission by 4.1% in 2001. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 2001, was calculated to be approximately 31.1 million tones. It means that app. 8.4% of the total CO_2 emissions are offset by CO_2 uptake by forests.

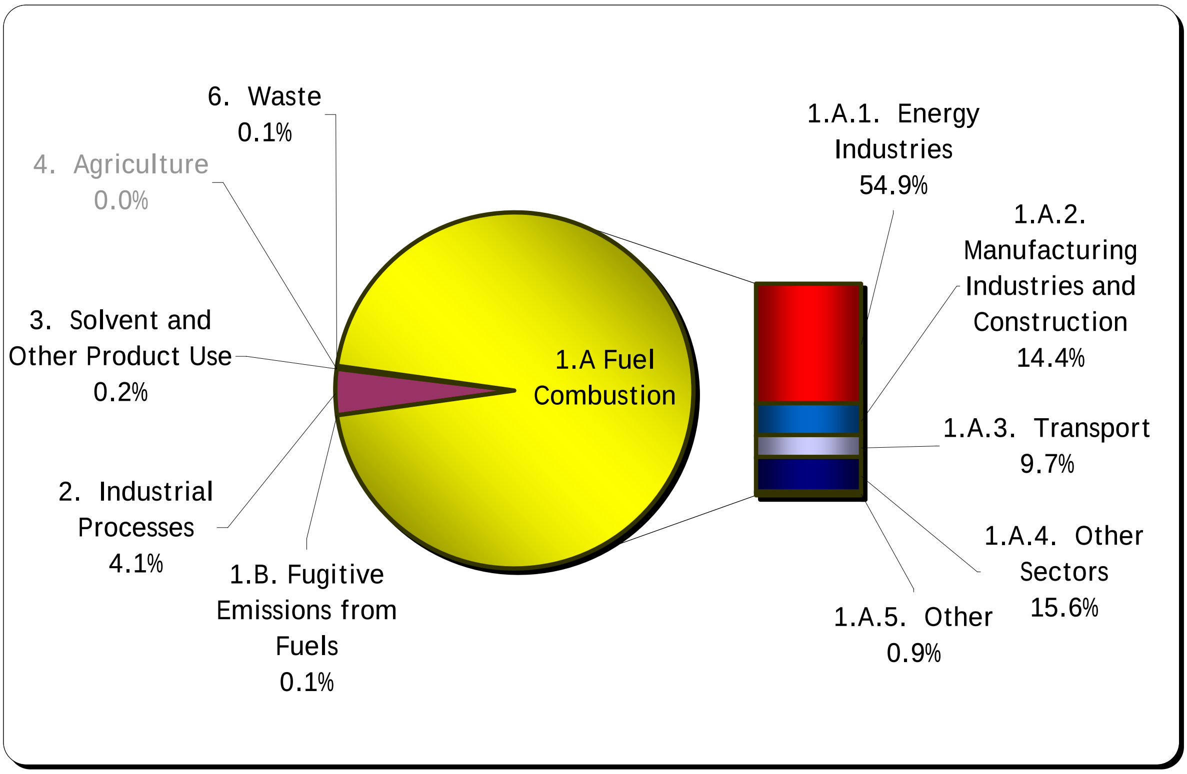

Figure 2.2 Carbon dioxide emission in 2001 by sector

Methane (CH_4)

The CH_4 emission amounted to 1 830.90 Gg in 2001 i.e. 38.45 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 38.6%, 33.0% and 26.9% of the national methane emission in 2001 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 26.9% of total CH_4 emission) and *Oil and Natural Gas* system (about 11.7% of total emission), *Disposal sites* contributed to 17.03% of the methane emission and *Wastewater Handling* contributed to 9.84%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 24.3% of total methane emission in 2001.

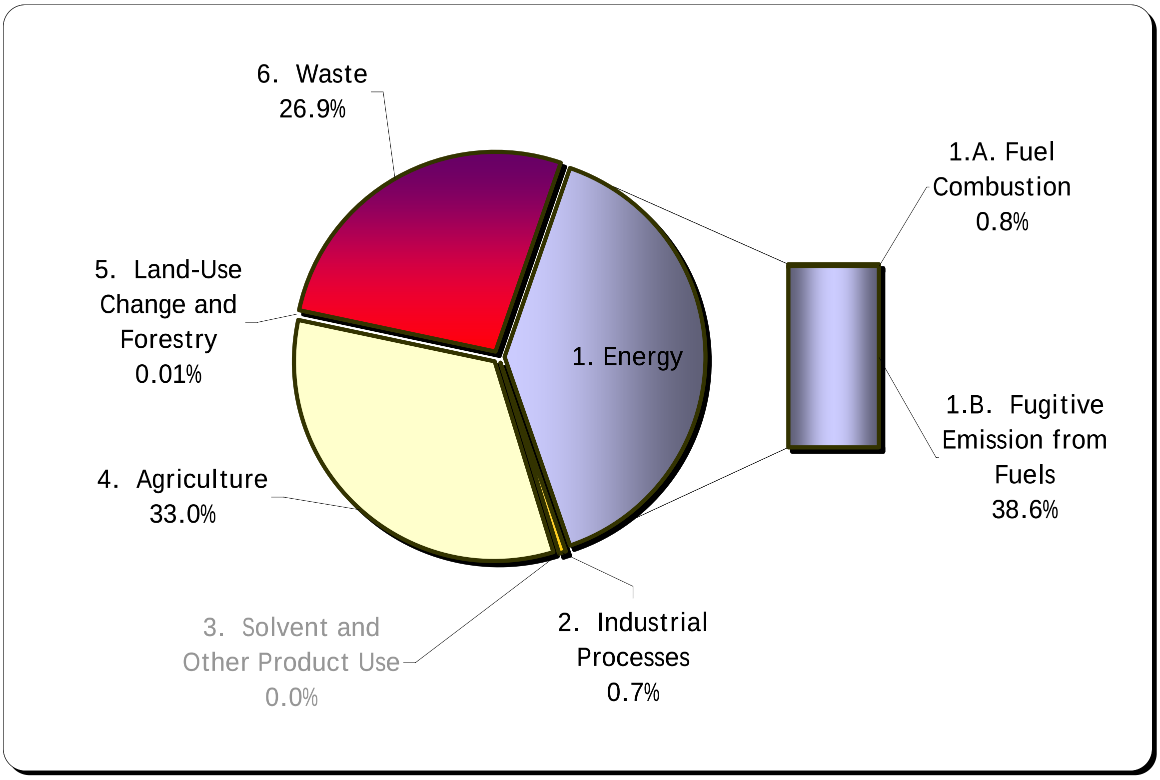

Figure 2.3 Methane emission in 2001 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions in 2001 were 101.55 Gg i.e. 31.48 million tonnes of CO_2 equivalents (table 2.2). The main N_2O emission sources and its shares in total N_2O emission in 2001 are: *Agricultural Soils* – 53.7%, *Manure Management* – 20.2%, *Chemical Industry* – 13.8% and *Fuel Combustion* – 8.2%.

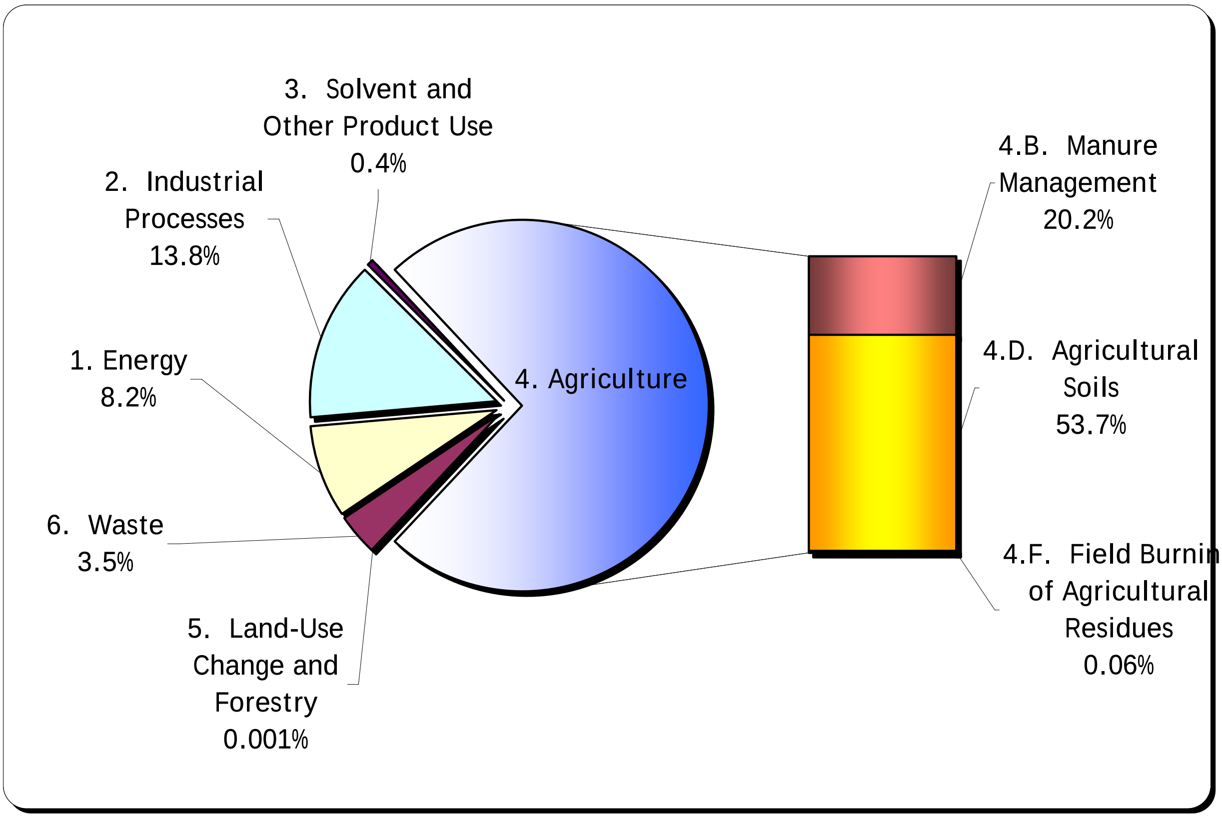

Figure 2.4 Nitrous oxide emission in 2001 by sector

Industrial gases

The total emission of HFCs in 2001 was 1.07 million tones of CO_2 equivalents. The emissions of HFCs-gases had increased 41 times between the base year (1995) and 2001. 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 2001 was 0.27 million tonnes of CO_2 equivalents. The emissions of PFCs-gases had increased by 7.9% between the base year (1995) and 2001. 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 2001 was 0.02 million tones of CO_2 equivalents. SF_6 emissions in 2001 were by 1.4 time higher 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 0.3% to national total in 2001.

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 2001

	Total [Gg eq. CO_2]		(2001-base)/base
	Base year	2001	
TOTAL with LUCF	553 976.2	371 040.89	-0.33
TOTAL without LUCF	586 902.6	402 107.62	-0.31
1. Energy	497 964.7	334 152.41	-0.33
2. Industrial Processes	27 356.2	19 448.20	-0.29
3. Solvent and Other Product Use	1 006.5	637.21	-0.37
4. Agriculture	52 378.1	35 996.21	-0.31
5. Land-Use Chpole and Forestry	-32 926.5	-31 066.73	-0.06
6. Waste	8 197.2	11 873.59	0.45

2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 2001 was 334.2 million tons of CO_2 equivalent. CO_2 emission share exceeded 94.7% 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 2001

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	334 152.41	100.0	94.7	4.5	0.8
A. Fuel Combustion	319 094.22	95.5	94.6	0.1	0.8
1. Energy Industries	182 571.79	54.6	54.4	0.0	0.2
2. Manufacturing Industries and Construction	47 925.30	14.3	14.3	0.0	0.1
3. Transport	33 210.38	9.9	9.6	0.0	0.3
4. Other Sectors	52 336.89	15.7	15.5	0.0	0.1
5. Other	3 049.87	0.9	0.9	0.0	0.0
B. Fugitive Emissions from Fuels	15 058.19	4.5	0.1	4.4	0.0
1. Solid Fuels	10 350.50	3.1	0.0	3.1	0.0
2. Oil and Natural Gas	4 707.69	1.4	0.1	1.3	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 2001. CO_2 is dominating among GHGs – it's contribution exceeds 69.3%. 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 (19.5%) and CO_2 emissions (recalculated from NMVOC) (80.5%).

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 2001

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	19 448.20	100.0	69.3	1.4	22.4	7.0
A. Mineral Products	6 949.90	35.7	35.7	0.0	0.0	
B. Chemical Industry	7 767.70	39.9	16.4	1.1	22.4	
C. Metal Production	3 616.00	18.6	17.1	0.2	0.0	1.3
D. Other Production	NE	NE				
F. Consumption of Halocarbons and SF6	1 114.60	5.7				5.7
G. Other	0.00	0.0				
Total Solvent and Other Product Use	637.21	100	80.5	0.0	19.5	

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 2001 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 2001

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	35 996.21	100.0	35.3	64.7
A. Enteric Fermentation	9 345.33	26.0	26.0	0.0
B. Manure Management	9 687.12	26.9	9.2	17.7
D. Agricultural Soils	16 918.41	47.0	0.0	47.0
F. Field Burning of Agricultural Residues	45.35	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 2001 (almost 87.0%). 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 2001

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	11 873.59	100	3.6	87.0	9.3
A. Solid Waste Disposal on Land	6 548.23	55.1	0.0	55.1	0.0
B. Wastewater Handling	4 856.99	40.9	0.0	31.9	9.0
C. Waste Incineration	468.36	3.9	3.6	0.0	0.3

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 2001 with respect to base year 1988/1995

Pollutant	Base year	2001	2001/base year [%]
	Emission in CO_2 eq. [Gg]	Emission in CO_2 eq. [Gg]	
CO_2 – net emission (with LUCF)	461 951.16	299 748.75	64.89
CO_2 – without LUCF.	494 885.88	330 818.76	66.85
CH_4	49 256.41	38 448.98	78.06
N_2O	42 478.82	31 481.41	74.11
HFCs	26.44	1 073.35	4059.37
PFCs	250.18	269.95	107.90
SF_6	13.15	18.45	140.36
TOTAL without CO_2 from LUCF	586 910.88	402 110.90	68.51
TOTAL with LUCF	553 976.16	371 040.89	66.98

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

Carbon dioxide

CO_2 emission had decreased by app. 33.2% from the base year to 2001.
The following changes took place in the structure of fuel use:

- share in of solid fuels decreased from 85.3% in 1988 to 74.7% in 2001
- share of liquid fuels increased from 11.4% (1988) to 19.6% (2001)
- share of gaseous fuels increased from 3.3% (1988) to 5.7% (2001).

Methane

CH_4 emission had decreased by app. 21.9% from the base year to 2001. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 41.4%
- the decrease in *Fugitive Emission* by 34.6%
- the increase in emission from *Waste* by 60.1%.

Nitrous oxide

The nitrous oxide emissions in 2001 were app. 25.9% lower than the respective figure for the base year. The share in *Manure Management* decreased from 22.0% in 1988 to 20.2% in 2001, in *Agricultural Soils* decreased from 55.6% (1988) to 53.7% (2001) and in *Chemical Industry* increased from 11.8% in 1988 to 13.8% in 2001.

Industrial gases: HFCs, PFCs and SF_6

HFCs emissions in 2001 were 41 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 2001 were 7.9% higher than in base year (1995). The PFCs emission changes between 2001 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 2001 were about than 1.4 times higher 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. 0.3% to the national total in 2001.

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 2001 decreased from 84.3% to 82.3%.

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	

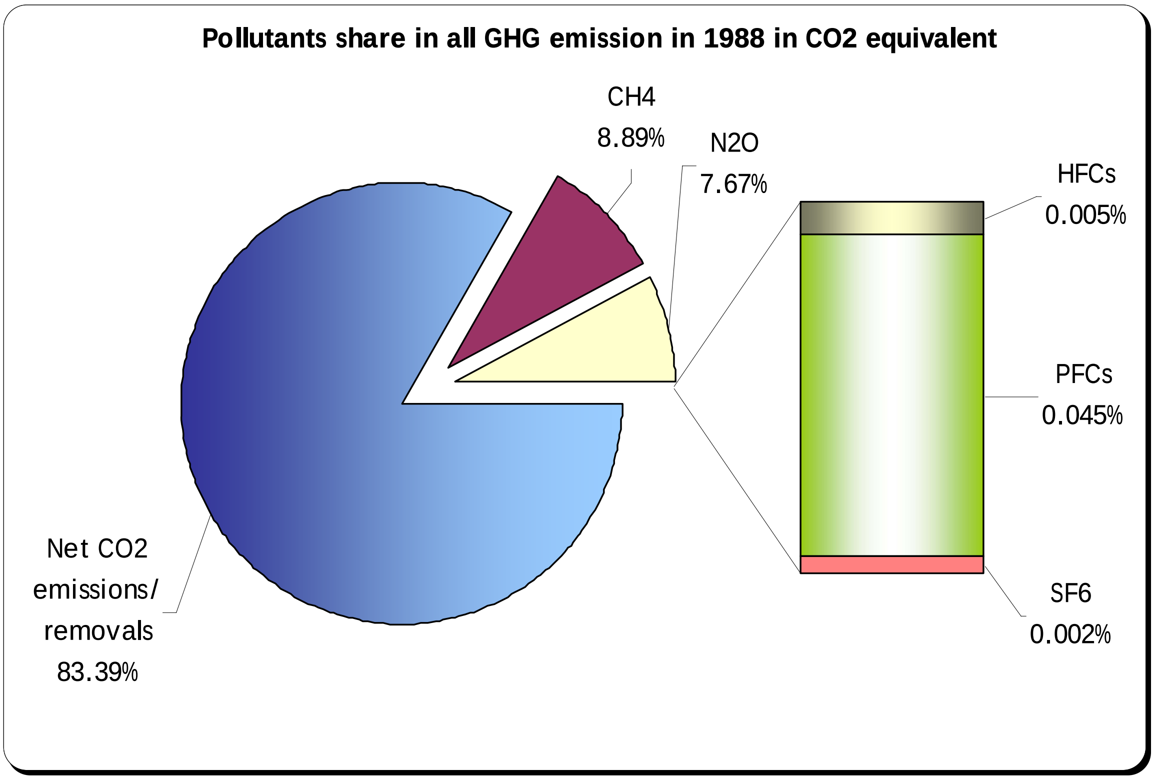

Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

2.5 Comparison of greenhouse gas emissions 2001 and 2000

Changes of national emissions and sinks of GHGs in 2001 compared to 2000 were:

CO_2	- net emission fall to	98.21%
CH_4	- emission fall to	97.01%
N_2O	- emission rise to	100.38%
HFC [eq. CO_2]	- actual emission rise to	180.50%
PFC [eq. CO_2]	- actual emission rise to	120.30%
SF_6 [eq. CO_2]	- actual emission rise to	113.20%

Below results are discussed separately for each greenhouse gas with respect to 2001 emissions and change between 2000 and 2000.

Carbon dioxide (CO_2)

In 2001, the net CO_2 emissions (with LULUCF) was 1.8% lower than in 2000. The CO_2 emission in 2001 from category *Energy* was higher by 0.2% and from category *Industrial Processes* was lower by 18.1% than in 2000. In comparison to 2000 the CO_2 emission from category *Waste* in 2001 fall by 3.7%.

Table 2.12. Comparison of carbon dioxide emission in 2000 and 2001

Year	CO_2 [Gg]		2001/2000 [%]
	2000	2001	
TOTAL without LUCF	333 253.2	330 818.8	99.3
1. Energy	315 865.5	316 404.0	100.2
A. Fuel Combustion	315 681.5	316 188.0	100.2
1. Energy Industries	179 045.2	181 720.7	101.5
2. Manufacturing Industries and Construction	52 889.5	47 649.9	90.1
3. Transport	32 807.1	32 007.1	97.6
4. Other Sectors	48 786.0	51 766.4	106.1
5. Other	2 153.7	3 043.9	141.3
B. Fugitive Emissions from Fuels	184.0	216.0	117.4
1. Solid Fuels	0.7	0.7	106.4
2. Oil and Natural Gas	183.3	215.3	117.4
2. Industrial Processes	16 447.7	13 470.3	81.9
A. Mineral Products	8 307.9	6 949.9	83.7
B. Chemical Industry	3 418.3	3 198.0	93.6
C. Metal Production	4 721.5	3 322.4	70.4
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	492.1	513.2	104.3
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	-28 047.7	-31 070.0	110.8
A. Forest Land	-34 414.6	-37 925.8	110.2
B. Cropland	7 498.3	8 268.2	110.3
C. Grassland	4 160.6	4 587.8	110.3
D. Wetlands	NE	NE	NE
E. Settlements	-5 292.0	-6 000.3	113.4
F. Other Land	NE	NE	NE
6. Waste	448.0	431.3	96.3
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	448.0	431.3	96.3

Methane (CH_4)

The emission in 2001 was lower than in 2000 by 3.0%. The main sources are *Agriculture*, *Energy* and *Waste.* Emission from *Manure Management* in the *Agriculture* sector was lower by 0.6% in 2001 and from *Waste* sector was higher by 0.8% than in 2000. *Fugitive emission* in *Energy* sector was lower by 5.5% in 2001 compared to 2000.

Table 2.13 Comparison of methane emission in 2000 and 2001

Year	CH_4 [Gg]		2001/2000 [%]
	2000	2001	
TOTAL	1 887.28	1 830.90	97.0
1. Energy	762.92	721.56	94.6
A. Fuel Combustion	14.88	14.78	99.4
1. Energy Industries	2.10	2.19	104.3
2. Manufacturing Industries and Construction	2.39	2.26	94.2
3. Transport	5.58	5.31	95.2
4. Other Sectors	4.77	4.96	104.1
5. Other	0.04	0.07	168.4
B. Fugitive Emissions from Fuels	748.04	706.77	94.5
1. Solid Fuels	544.08	492.85	90.6
2. Oil and Natural Gas	203.96	213.93	104.9
2. Industrial Processes	13.42	12.67	94.4
A. Mineral Products	NE	NE	NE
B. Chemical Industry	11.12	10.46	94.0
C. Metal Production	2.29	2.21	96.4
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	622.62	604.50	97.1
A. Enteric Fermentation	462.33	445.02	96.3
B. Manure Management	159.10	158.20	99.4
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.19	1.28	107.9
5. Land Use, Land-Use Change and Forestry	0.19	0.14	73.1
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.19	0.14	73.1
F. Other Land	NE	NE	NE
6. Waste	488.14	492.04	100.8
A. Solid Waste Disposal on Land	304.79	311.82	102.3
B. Wastewater Handling	183.34	180.22	98.3
C. Waste Incineration	NE	NE	NE

Nitrous oxide (N_2O)

The emission was higher than in 2000 (by 0.4%). The main sources of N_2O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was lower by 1.5% in 2001 and from *Agricultural Soils* was higher by 0.9% than in 2000.

Table 2.14. Comparison of nitrous oxide emission in 2000 and 2001

Year	N_2O [Gg]		2001/2000 [%]
	2000	2001	
TOTAL	101.16	101.55	100.4
1. Energy	8.52	8.37	98.2
A. Fuel Combustion	8.52	8.37	98.2
1. Energy Industries	2.56	2.60	101.3
2. Manufacturing Industries and Construction	0.82	0.74	89.8
3. Transport	3.65	3.52	96.5
4. Other Sectors	1.48	1.50	101.8
5. Other	0.01	0.01	121.4
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	13.68	14.03	102.5
A. Mineral Products	NE	NE	NE
B. Chemical Industry	13.68	14.03	102.5
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	74.98	75.17	100.2
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	20.84	20.53	98.5
D. Agricultural Soils	54.09	54.58	100.9
F. Field Burning of Agricultural Residues	0.06	0.06	100.3
5. Land Use, Land-Use Change and Forestry	0.0013	0.0010	73.1
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0013	0.0010	73.1
F. Other Land	NE	NE	NE
6. Waste	3.57	3.58	100.2
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.49	3.46	99.0
C. Waste Incineration	0.08	0.12	151.3

Industrial gases

The total emission of HFCs in 2001 by 80.5% higher than in 2000. PFCs emissions in 2001 were by app. 20.3% higher than in 2000. SF_6 emissions in 2001 were by 13.2% higher than in 2000.

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.

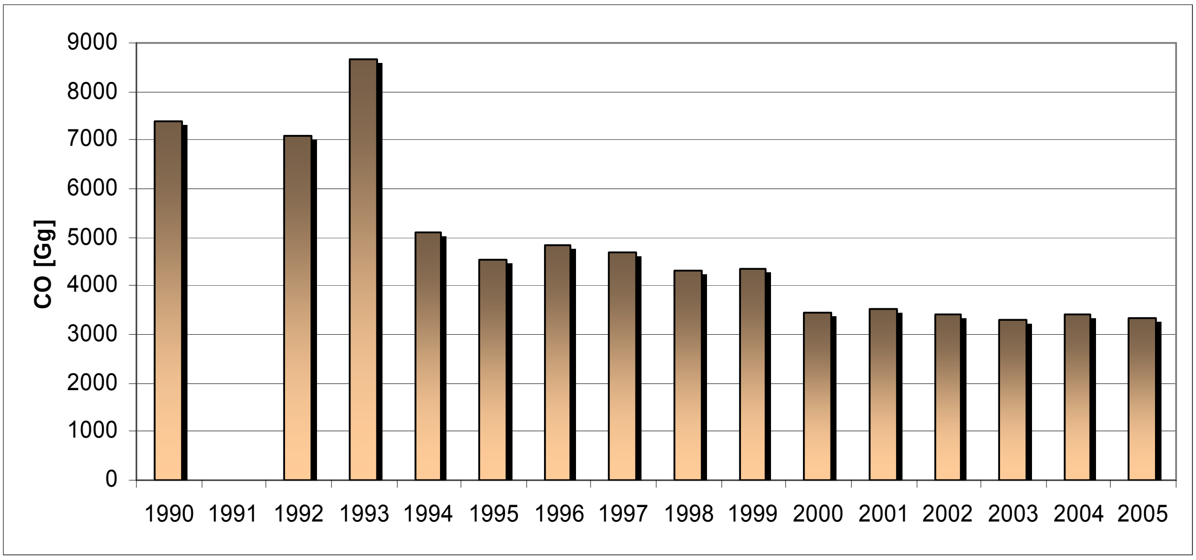

Figure 2.6 Emissions of CO (1990-2005).

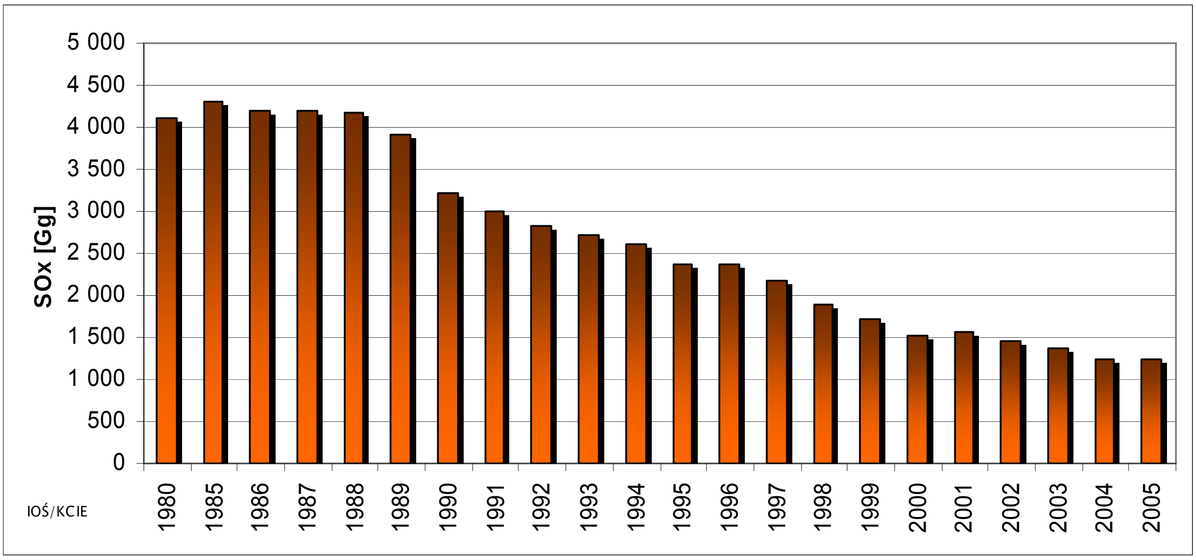

Figure 2.7 Emissions of SO_x, (1980-2005).

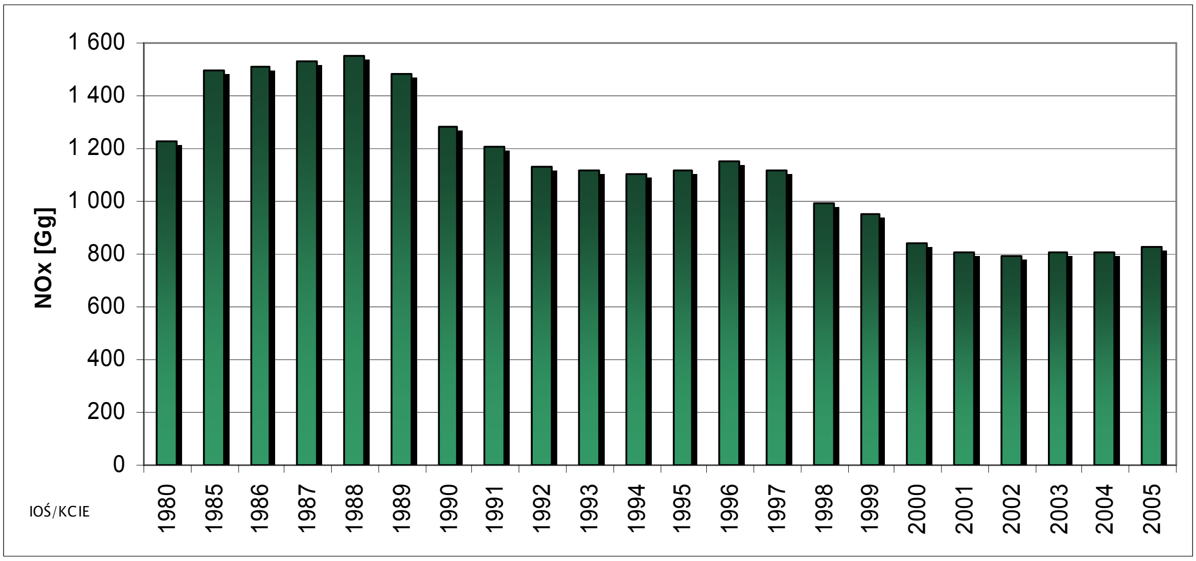

Figure 2.8 Emissions of NO_x (1980-2005).

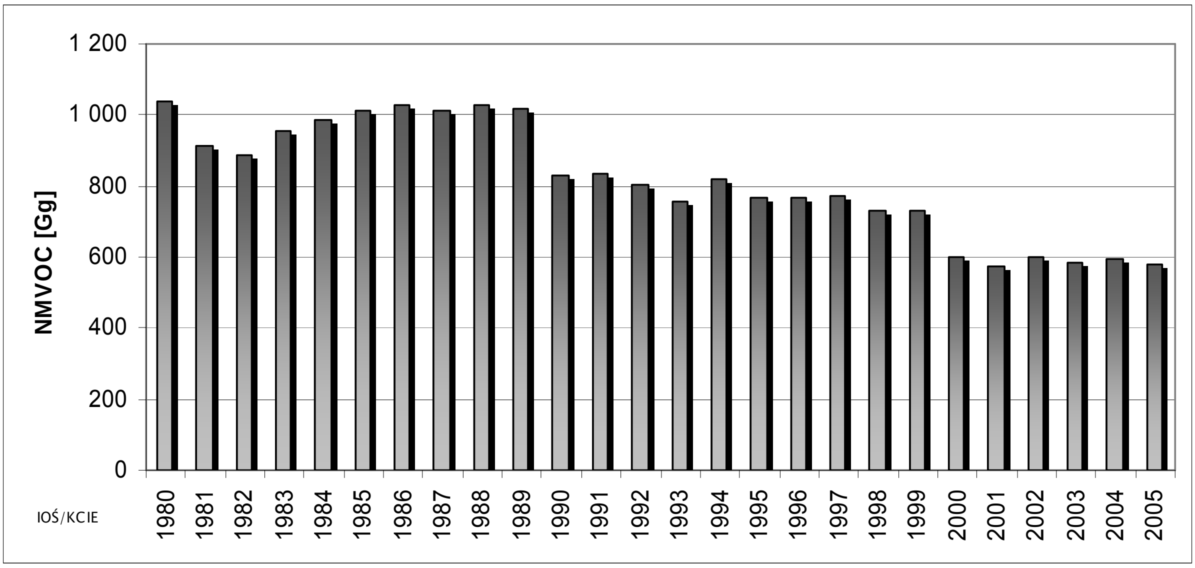

Figure 2.9 Emissions of NMVOC (1980-2005).

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 70.7%
- 1.A.3.b Transport Road Transportation (CO2 emission), share in total GHG emission 7.4%
- 1.B.1.a. Coal Mining and Handling (CH4 emission), share in total GHG emission 2.6%
- 1.B.2.b. Natural Gas (CH4 emission), share in total GHG emission 1.1%

Share of these categories in total Poland's GHG emissions is 81.8%.

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):

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

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:

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

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:

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

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:

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

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

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

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:

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

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:

$$EF_{abc} = C_{max} * 44/12 * FO_{abc}\ [kgCO_2/GJ]$$

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, 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 2003a]
- Energy Balance Poland – OECD [ARE 2002]

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
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	*48.44*	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Biogas	54.60	0.0010	0.0001
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

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

Fuel	EF CO_2	EF CH_4	EF N_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
Other Energy Sources	*77.22*	*0.0029*	*0.0006*
Gaseous Waste Fuels	*57.27*	*0.0015*	*0.0006*
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	*54.73*	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0100	0.0015
Coke Oven Gas	*48.44*	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Biogas	54.60	0.0010	0.0001
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

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

Fuel	EF CO_2	EF CH_4	EF N_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
Feedstocks	73.30	0.0030	0.0006
Other Energy Sources	*77.22*	*0.0029*	*0.0006*
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	*54.73*	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	*48.44*	0.0010	0.0001
Town Gas		0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
Municipal Wastes - (non-biomass fraction)	91.70	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Solid Biomass and Animal Products	100.00	0.0300	0.0040
Municipal Wastes - (biomass fraction)	100.00	0.0300	0.0040

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

Fuel	EF CO_2	EF CH_4	EF N_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
Feedstocks	*57.27*	*0.0015*	*0.0006*
Other Energy Sources	*77.22*	*0.0029*	*0.0006*
Gaseous Waste Fuels	*57.27*	*0.0015*	*0.0006*
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Nitrified Natural Gas	*54.73*	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	*48.44*	0.0010	0.0001
Town Gas		0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040
Solid Biomass and Animal Products	100.00	0.0300	0.0040

As concerns sector 1.A.3 *Transport,* activity data for road transport were taken from [ITS 2002]. CO_2 emissions factors for road transport come also from [ITS 2002]. 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 2002],
- Questionnaire/Report G-03, [GUS 2002e],
- Statistical Yearbook of The Republic of Poland [GUS 2003],
- Non-published data from Energy Market Agency

Table 3.5 Emission factors [kg/GJ] for transport in 2001

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.	70.60	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.60	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	70.74	0.030	0.002
	2.i.a.LG	63.08	0.020	0.0002
	2.i.a.ON	73.16	0.002	0.004
	2.i.b.BS	70.74	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	70.29	0.007	0.0200
	2.i.g.LG	63.08	0.020	0.0002
	2.i.g.ON	73.16	0.002	0.004
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	70.74	0.020	0.001
	2.ii.a.LG	63.08	0.030	0.0002
	2.ii.a.ON	73.16	0.001	0.0040
	2.ii.b.BS	70.74	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	70.29	0.020	0.001
	2.ii.g.LG	63.08	0.010	0.0002
	2.ii.g.ON	73.16	0.001	0.004
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	70.74	0.020	0.001
	2.iii.a.ON	73.16	0.006	0.003
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. with catalysts	2.iii.g.ON	73.16	0.006	0.003
1.A.3.b.iii Autobusy	2.iii.a.ON	73.16	0.0039	0.0013
	2.iii.g.ON	73.16	0.0039	0.0013
1.A.3.b.iv Motorcycles	2.iv.BS	70.74	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	70.74	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.16	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.

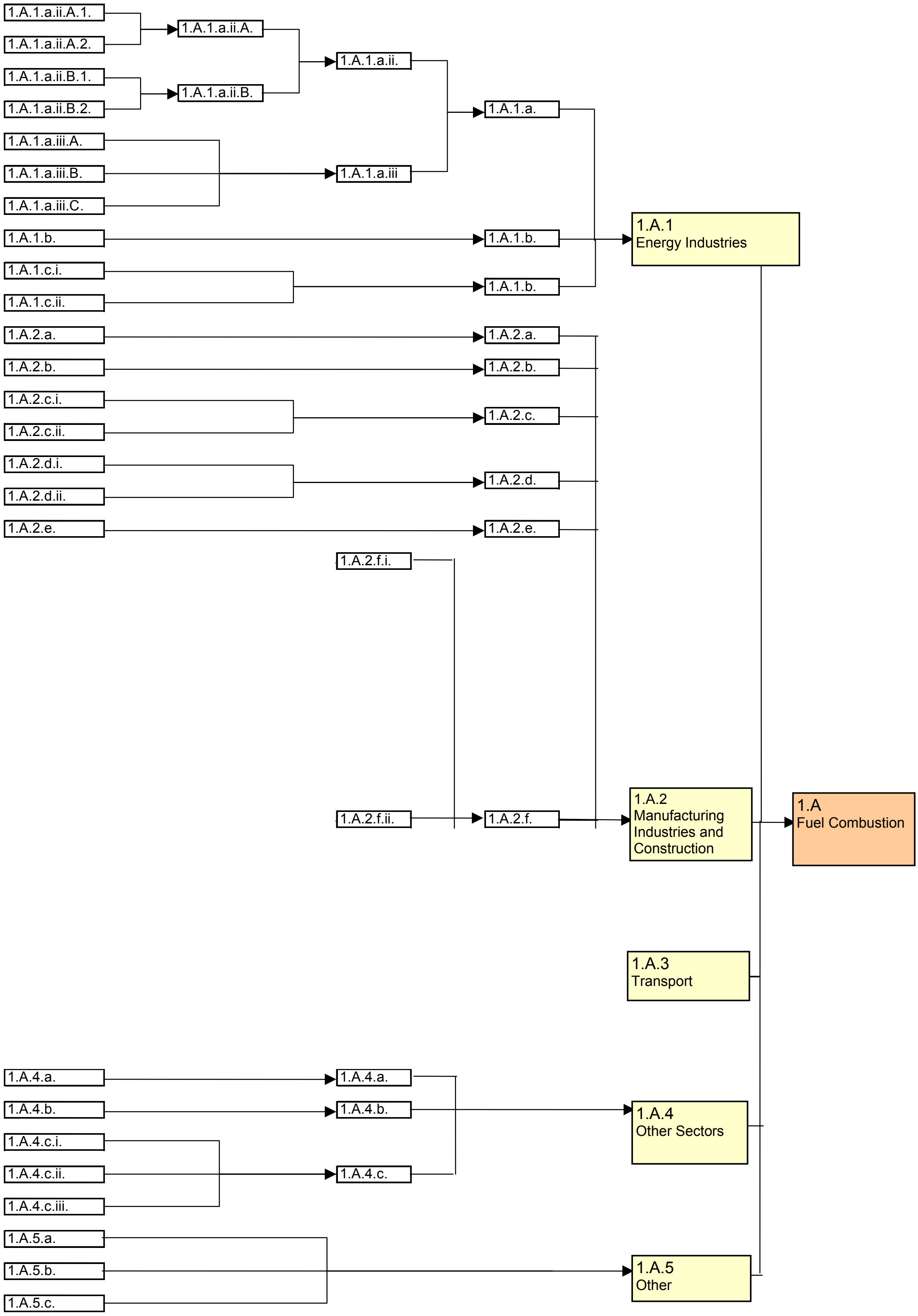

Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

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 2001 were used:

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

Table 3.7 contains the data on coal mining as well as methane captured and used for 2001. 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 2001

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
102.5	219.7	131.8	87.9	85.00	56.95

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, 2002] 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 2003a].

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 2003a]:

production	PJ	32.652
distribution	Gg	18325

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 2003a] 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]	68.895
Gas processing	Gas use [PJ]	387.268
Gas transmission	Gas use [PJ]	387.268
Underground gas storage	Gas use [PJ]	387.268
Gas distribution	Gas use [PJ]	387.268
Nitrified natural gas system:		
Gas production	Gas production [PJ]	77.309
Gas processing	Gas use [PJ]	50.932
Gas transmission	Gas use [PJ]	50.932
Gas distribution	Gas use [PJ]	50.932

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 1.2%
- 2.B.2. Nitric Acid Production (N2O emission), share in total GHG emission 1.0%

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

4.2 Methodological issues

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

4.2.1.1. *Cement Production* (CRF 2.A.1)
CO_2 emission from cement production was estimated based on data on clinker production from [GUS 2003b]. The applied emission factor is equal 531 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 2003b]. 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 2002e]. 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].

<u>4.2.2. *Chemical Industry* (CRF 2.B)</u>

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 Producti*on (CRF 2.B.2)
Estimation of N_2O emission from nitric acid production was based on the annual HNO_3 production data from [GUS 2003b]. 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 2003b]. 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 2002e]. 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 2003b]. 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 2003b]. 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 [KASHUE 2006]. Country specific emission factor of CO_2, which is equal 76.24 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 2002e]. 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 2002e]. 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 2003b]. 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 2003b]. 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 2003b] 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 2003b]. 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 2003b]. 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 2001 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 2003b]. *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. Activity data on import of this gas for 2001 is presented in table 4.2 (bold figure). Values on use of SF_6 (marked as underlined) were estimated based on mass analysis (table 4.2). 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**	71.120	72.841	75.346	76.090
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 2003]. 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	2.3%
- 4.B. Manure Management (CH4 emission), share in total GHG emission	0.8%
- 4.B. Manure Management (N2O emission), share in total GHG emission	1.6%
- 4.D.1. Direct Soil Emissions (N2O emission), share in total GHG emission	3.1%
- 4.D.3. Indirect Soil Emissions (N2O emission), share in total GHG emission	1.0%

Share of these categories in total Poland's GHG emissions is 8.8%.

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 1 year, young cattle 1-2 years and other matured cattle (over 2 years). Also domestic emission factor for sheep was estimated based on disaggregating this livestock group for lambs under one year and mature sheep above one year. The emission factors for other livestock like goats, horses and swine come from [IPCC 1997].

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 2003].

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 2001

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH_4 / animal / year]
4.A Enteric Fermentation	23.900	---	---
1 Cattle	5.734	---	---
a. Dairy cattle	3.005	234.326	92.214
b Non-dairy cattle	2.729	119.830	47.157
3 Sheep	0.343	18.873	8.383
4 Goats	0.172	---	5.000
6 Horses	0.546	---	18.000
8 Swine	17.105	---	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 2003].

Table 6.2. Livestock population, volatile solids excreted (Vs) and CH_4 emissions factors in 2001

Livestock	Population [millions]	Vs Volatile Solids Excreted [kg dm /animal/ day]	EF Emission Factor [kg CH_4 / animal / year]
4.B Manure Management	230.627	---	---
1 Cattle	5.734	---	---
a. Dairy cattle	3.005	4.459	6.276
b Non-dairy cattle	2.729	2.052	3.871
3 Sheep	0.343	0.377	0.175
4 Goats	0.172	0.280	0.120
6 Horses	0.546	1.720	1.390
8 Swine	17.105	0.500	6.536
9 Poultry	206.727	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 2003]. 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 in 2001

Livestock	Type of AWSM		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0368	0.8312	0.1320
Non-dairy cattle	0.0931	0.7989	0.1080
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	0.0368	7740.880
1.b. Non-dairy cattle	50.0	0.0931	12703.495
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2863	97943.230
9 Poultry	0.6	0.2000	24807.297

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	0.8312	174842.920
1.b. Non-dairy cattle	50.0	0.7989	109009.905
3 Sheep	16.0	0.5000	2744.000
4 Goats	25.0	0.9000	3869.415
6 Horses	25.0	0.9000	12285.000
8 Swine	20.0	0.7137	244156.770
9 Poultry	0.6	0.8000	99229.189

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 2003]. 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 2003] 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 2003]. 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 2003].

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 2003]. 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	0.13	27766.200	
1.b. Non-dairy cattle	50.0	0.11	14736.600	
3 Sheep	16.0	0.50	2744.000	
4 Goats	25.0	0.10	429.935	
6 Horses	25.0	0.10	1365.000	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	47041.735	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 2001 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 2003].
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]
895	0.1	47 041.74	0.2	0.01	0.99

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 2003].

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 presented in 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]
895	47 041.74	0.3	0.025	7.065

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 2003]. 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 2001 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 2001 (and comparing to 2000) 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 2000 and 2001 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000			2001		
	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	-28 047.71	0.194	0.001	-31 070.01	0.142	0.001
5A. Forest Land	-34 414.61			-37 925.79		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	7 498.29			8 268.23		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	4 160.60			4 587.83		
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	-5 291.99	0.194	0.001	-6 000.28	0.142	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 2000 and 2001 [IPCC 1997]

Greenhouse gas source and sink categories	2000					2001				
	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	58 987.83	-87 035.54	-28 047.71	0.194	0.001	58 437.52	-89 507.54	-31 070.01	0.142	0,001
5A. Changes in Forest and Other Woody Biomass Stocks	48 338.82	-66 790.35	-18 451.52			46 593.70	-68 233.81	-21 640.11		
I. Tropical Forests										
2. Temperate Forests	48 338.82	-66 790.35	-18 451.52			46 593.70	-68 233.81	-21 640.11		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	53.42		53.42			40.17		40.17		
1. Tropical Forests										
2. Temperate Forests	53.42			0.194	0.001	40.17			0.142	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	10 595.60	-20 245.20	-9 649.60			11 803.65	-21 273.72	-9 470.08		
Cultivation of Mineral Soils	10 595.60		10 595.60			11 803.65		11 803.65		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 063.29	1 063.29				1 052.41	1 052.41		
Forest Soils		-15 963.08	-15 963.08				-16 285.68	-16 285.68		
Other Land (please specify)		-5 345.41	-5 345.41				-6 040.45	-6 040.45		
5E. Other *(please specify)*										

According to calculation for 2001, Sector 5. Land-Use Change and Forestry, was net CO_2 sink. Removals/emissions balance increased from 28 048 Gg CO_2 in 2000 to 31 070 Gg CO_2 in 2001 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 2001 net CO_2 removals increased to 21 640 Gg CO_2 from about 18 452 Gg CO_2 in 2000. This change was caused by harvest of thick decrease (about 1.0 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 2001 this category was a net CO_2 emissions and accounted for about 40 Gg CO_2. Net emission in year 2001 was lower than in 2000 and it was caused by lessening forest area transmitted into non-forest tasks.

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. In 2001 net CO_2 sink was about 9 470Gg CO_2 and was lower by about 179 Gg CO_2 than in previous year.

This result is influenced by emission from agriculture lands, which is mainly caused by changes of agriculture lands into other lands, as well as removal increase in other land category – caused by these changes.

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 2001

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.599
	Low Activity Soils	70.0	1.727
	Sandy	30.0	3.381
	Wetland	230.0	0.382
Sum			9.088
Grassland/Rangeland	High Activity Soils	90.0	0.553
	Low Activity Soils	60.0	1.632
	Sandy	25.0	1.193
	Wetland	120.0	0.405
Sum			3.783
Agricultural crops	High Activity Soils	70.0	3.868
	Low Activity Soils	60.0	5.183
	Sandy	25.0	2.672
	Wetland	120.0	1.556
Sum			13.279
Other land	High Activity Soils	56.0	1.119
	Low Activity Soils	48.0	2.103
	Sandy	20.0	1.323
	Wetland	96.0	0.574
Sum			5.119
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:

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

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	1.6%
- 6.B. Wastewater Handling (CH4 emission), share in total GHG emission	0.9%

Share of these categories in total Poland's GHG emissions is 2.6%.

8.2 Methodological issues

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

The methane emissions from solid waste disposals in 2001 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 2003]
– 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]
1997	12183.44	[GUS 1998d]
1998	12275.77	[GUS 1999d]
1999	12316.90	[GUS 2000d]
2000	12226.00	[GUS 2005d]
2001	11109.00	[GUS 2005d]

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 2002d] 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 2002d]. 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 2005] and its value was 0.946 (for this estimation the country specific value of BOD = 369 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: 0.488 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 2005]. These value are as follows: percentage of wastewater anareobically treated – 5%, fractions of sludge anareobically degraded – 81.3% of which with methane recovery – 83.5%.

N_2O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 2003]. 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]. The activity data for incinerated municipal, industrial, medical and sewage sludge wastes were adopted following the expert assessment [Wielgosiński 2003a].

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ANNEXES

Annex 1. Key sources

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

From source categories which have been identify as key sources in level assessment, the most important are:
- Stationary combustion Solid Fuels,
- Stationary combustion Liquid Fuels,
- 1.A.3.b Transport Road Transportation.

Emission from these sources made up 73.6% 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 70.67% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 58.7% of the total GHG emissions.

The most important source categories in level assessment are:
- Stationary combustion Solid Fuels,
- 1.A.3.b Transport Road Transportation,
- Stationary combustion Liquid Fuels.

Share of these sources in national total made up 73.63%.

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	236134.81	0.5872	0.59
2	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	29986.12	0.0746	0.66
3	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	29949.02	0.0745	0.74
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	18036.58	0.0449	0.78
5	4.D.1	4.D.1. Direct Soil Emissions	N2O	12536.45	0.0312	0.81
6	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	10306.84	0.0256	0.84
7	4.A	4.A. Enteric Fermentation	CH4	9345.33	0.0232	0.86
8	6.A	6.A. Solid Waste Disposal on Land	CH4	6548.23	0.0163	0.88
9	4.B	4.B. Manure Management	N2O	6364.98	0.0158	0.89
10	2.A.1	2.A.1 Cement Production	CO2	4956.94	0.0123	0.91
11	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4449.84	0.0111	0.92
12	2.B.2	2.B.2. Nitric Acid Production	N2O	4131.74	0.0103	0.93
13	4.D.3	4.D.3. Indirect Soil Emissions	N2O	3923.64	0.0098	0.94
14	6.B	6.B. Wastewater Handling	CH4	3784.60	0.0094	0.95
15	4.B	4.B. Manure Management	CH4	3322.14	0.0083	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	236134.81	0.5872	0.1395	35.8857	0.36
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	29949.02	0.0745	0.0687	17.6860	0.54
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	29986.12	0.0746	0.0421	10.8394	0.64
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	18036.58	0.0449	0.0268	6.8861	0.71
5	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	6548.23	0.0163	0.0131	3.3737	0.75
6	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	23.42	0.0001	0.0125	3.2089	0.78
7	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	10306.84	0.0256	0.0085	2.1831	0.80
8	6.B	6.B. Wastewater Handling	CH4	2170.23	3784.60	0.0094	0.0083	2.1456	0.82
9	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	510.71	0.0013	0.0065	1.6698	0.84
10	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	12536.45	0.0312	0.0063	1.6318	0.86
11	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4111.13	4449.84	0.0111	0.0059	1.5250	0.87
12	4.A	4.A. Enteric Fermentation	CH4	15954.36	9345.33	0.0232	0.0058	1.4806	0.89
13	2.C1	2.C.1. Iron and Steel Production	CO2	6556.09	3034.53	0.0075	0.0053	1.3608	0.90
14	2.B.2	2.B.2. Nitric Acid Production	N2O	4386.47	4131.74	0.0103	0.0041	1.0518	0.91
15	4.B	4.B. Manure Management	CH4	3435.39	3322.14	0.0083	0.0035	0.9043	0.92
16	2.F.1	2.F.1. Refrigeration and Air Conditioning Eq	HFC	10.52	915.34	0.0023	0.0033	0.8480	0.93
17	1.A.3.b	1.A.3.b Transport Road Transportation	N2O	153.15	982.29	0.0024	0.0032	0.8193	0.93
18	2.A.2	2.A.2. Lime Production	CO2	3477.55	1608.78	0.0040	0.0028	0.7226	0.94
19	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	832.25	0.0021	0.0028	0.7161	0.95

Annex 2. 2001 Energy balance data for main fuels

Energy balances in 2001 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	**59 553**	**510 967**
From national sources	59 553	510 967
1) Indigenous production	59 552	510 958
2) Transformation output or return	0	0
3) Stock decrease	1	9
Import	0	0
Out	**59 553**	**510 968**
National consumption	59 538	515 549
1) Transformation input	59 168	512 198
a) input for secondary fuel production	0	0
b) fuel combustion	59 168	512 198
2) Direct consumption	370	3 351
Non-energy use	0	0
Combusted directly	370	3 351
Combusted in Poland	**59 538**	**515 549**
Stock increase	0	0
Export	15	127
Losses and statistical differences		-4 708
Net calorific value	MJ/kg	8.66
CO_2 Emission Factor	kg/GJ	113.50

Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10^3 Mg	TJ
In	**5 921**	**256 506**
From national sources	4 946	214 291
1) Indigenous production	0	0
2) Transformation output or return	4 914	212 904
3) Stock decrease	32	1 387
Import	975	42 215
Out	**5 921**	**256 505**
National consumption	5 739	248 660
1) Transformation input	581	25 169
a) input for secondary fuel production	581	25 159
b) fuel combustion	0	11
2) Direct consumption	5 158	223 491
Non-energy use	0	0
Combusted directly	5 158	223 491
Combusted in Poland	**5 158**	**223 502**
Stock increase	0	0
Export	182	7 845
Losses and statistical differences	0	0
Net calorific value	MJ/kg	43.33
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	**6 671**	**280 727**
From national sources	6 370	268 074
1) Indigenous production	0	0
2) Transformation output or return	6 344	266 937
3) Stock decrease	26	1 137
Import	301	12 653
Out	**6 672**	**280 726**
National consumption	4 849	205 358
1) Transformation input	856	35 435
a) input for secondary fuel production	129	5 353
b) fuel combustion	727	30 082
2) Direct consumption	3 993	169 923
Non-energy use	0	0
Combusted directly	3 993	169 923
Combusted in Poland	**4 720**	**200 005**
Stock increase	16	653
Export	1 366	56 660
Losses and statistical differences	441	18 055
Net calorific value	MJ/kg	42.37
CO_2 Emission Factor	kg/GJ	75.85

High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10^6 m^3	TJ
In	**10 995**	**396 141**
From national sources	2 670	94 193
1) Indigenous production	2 088	68 895
2) Transformation output or return	582	25 298
3) Stock decrease	0	0
Import	8 325	301 948
Out	**11 035**	**396 141**
National consumption	10 094	364 341
1) Transformation input	1 187	42 683
a) input for secondary fuel production	717	25 814
b) fuel combustion	470	16 869
2) Direct consumption	8 907	321 658
Non-energy use	1 670	60 216
Combusted directly	7 237	261 442
Combusted in Poland	**7 707**	**278 311**
Stock increase	345	12 289
Export	39	1 416
Losses and statistical differences	557	18 095
Net calorific value	MJ/m^3	36.11
CO_2 Emission Factor	kg/GJ	53.66

Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10^6 m^3	TJ
In	**3 278**	**83 973**
From national sources	3 278	83 973
1) Indigenous production	3 090	77 309
2) Transformation output or return	188	6 664
3) Stock decrease	0	0
Import	0	0
Out	**3 278**	**83 974**
National consumption	3 239	82 959
1) Transformation input	1 588	41 039
a) input for secondary fuel production	1 281	33 041
b) fuel combustion	307	7 998
2) Direct consumption	1 651	41 920
Non-energy use	0	0
Combusted directly	1 651	41 920
Combusted in Poland	**1 958**	**49 918**
Stock increase	0	0
Export	0	0
Losses and statistical differences	39	1 015
Net calorific value	MJ/m^3	25.49
CO_2 Emission Factor	kg/GJ	55

Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10^3 Mg	TJ
In	**8 976**	**253 132**
From national sources	8 946	252 282
1) Indigenous production	0	0
2) Transformation output or return	8 946	252 282
3) Stock decrease	0	0
Import	30	850
Out	**8 976**	**253 132**
National consumption	5 052	138 443
1) Transformation input	1 359	37 679
a) input for secondary fuel production	1 299	36 065
b) fuel combustion	60	1 614
2) Direct consumption	3 693	100 764
Non-energy use	91	2 524
Combusted directly	3 602	98 240
Combusted in Poland	**3 662**	**99 854**
Stock increase	0	0
Export	3 924	109 884
Losses and statistical differences		4 805
Net calorific value	MJ/kg	27.26
CO_2 Emission Factor	kg/GJ	113.77

Annex 3. National energy balance 2001 [GUS, 2003a]

CZĘŚĆ II. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII

TABL. 1(4). SYNTETYCZNY BILANS ENERGII

PART II. BASIC ENERGY SUPPLY AND USE BALANCE

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***	2001	***TJ***	***3357447***	***1296374***	***9386***	***915044***	***-24569***
	TOTAL ENERGY	2002		***3349165***	***1322027***	***7504***	***870186***	***41383***
2	***ENERGIA PIERWOTNA***	2001	***TJ***	***3357447***	***1101138***	-	***645553***	***-24744***
	PRIMARY ENERGY	2002		***3349165***	***1117534***	-	***631954***	***50731***
3	WĘGIEL KAMIENNY ENERGETYCZNY	2001	tys.ton	86937	1367	-	19216	-1447
	STEAM COAL	2002	10^3 ton	87829	2374	-	19102	1748
		2001	TJ	1976712	36901	-	512352	-31630
		2002		2007060	62753	-	504874	38210
4	WĘGIEL KAMIENNY KOKSOWY	2001	tys.ton	17055	511	-	3813	144
	COKING COAL	2002	10^3 ton	15876	363	-	3521	-187
		2001	TJ	502268	15120	-	112944	4259
		2002		466220	10727	-	104165	-5510
5	WĘGIEL BRUNATNY	2001	tys.ton	59552	0	-	15	-1
	LIGNITE	2002	10^3 ton	58210	-	-	41	1
		2001	TJ	510958	0	-	127	-9
		2002		507600	-	-	349	6
6	ROPA NAFTOWA	2001	tys.ton	767	17558	-	440	-227
	CRUDE OIL	2002	10^3 ton	728	17942	-	497	295
		2001	TJ	32652	746633	-	18715	-9653
		2002		30932	762902	-	21121	12535
7	GAZ ZIEMNY WYSOKOMETANOWY	2001	mln m^3	2088	8325	-	39	345
	HIGH - METHANE NATURAL GAS	2002	10^6 m^3	2016	7775	-	40	161
		2001	TJ	68895	301948	-	1416	12289
		2002		67211	281151	-	1445	6036
8	GAZ ZIEMNY ZAAZOTOWANY	2001	mln m^3	3090	-	-	-	-
	NITRIFIED NATURAL GAS	2002	10^6 m^3	3247	-	-	-	-
		2001	TJ	77309	-	-	-	-
		2002		82222	-	-	-	-
9	TORF I DREWNO	2001	tys. m^3	13850	-	-	-	-
	PEAT AND WOOD	2002	10^3 m^3	13817	-	-	-	-
		2001	TJ	131575	-	-	-	-
		2002		131264	-	-	-	-
10	ENERGIA WODY I WIATRU	2001	TJ	8418	-	-	-	-
	HYDRO AND WOOD ENERGY	2002		8423	-	-	-	-
11	ENERGIA GEOTERMALNA	2001	TJ	120	-	-	-	-
	GEOTHERMAL ENERGY	2002		263	-	-	-	-
12	BIOGAZ	2001	TJ	1477	-	-	-	-
	BIOGAS	2002		1267	-	-	-	-
13	PALIWA ODPADOWE STAŁE	2001	TJ	28831	-	-	-	-
	ROŚLINNE I ZWIERZĘCE	2002		33202	-	-	-	-66
	SOLID BIOMASS AND ANIMAL PRODUCTS							
14	ODPADY PRZEMYSŁOWE STAŁE I CIEKŁE	2001	TJ	16595	-	-	-	-
	INDUSTRIAL WASTES	2002		9804	-	-	-	-319

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 *#*
3763346	***2140074***	*x*	***3039117***	***2827095***	***111094***	***37208***	*1*
3759622	***2040543***	*x*	***2917074***	***2791333***	***109285***	***91758***	
3837776	***36794***	*x*	***2870212***	***1047624***	***63907***	***-43266***	*2*
3784013	***35243***	*x*	***2799695***	***1015793***	***58523***	***3768***	
70534	-	70534	52099	20524	9	-2089	3
69353	-	69353	50174	19480	14	-301	
1532891	-	1532891	1120579	510500	282	-98188	
1526728	-	1526728	1085492	478753	474	-37517	
13609	-	13609	12217	178	-	1214	4
12904	-	12904	11941	115	-	848	
400185	-	400185	360757	5313	-	34115	
378292	-	378292	352622	3415	-	22256	
59538	-	59538	59168	370	-	-	5
58168	-	58168	57702	466	-	-	
510840	-	510840	512198	3351	-	-4708	
507244	-	507244	494051	4370	-	8824	
18113	-	18113	17962	0	-	150	6
17878	-	17878	17784	1	-	92	
770223	-	770223	763805	13	-	6405	
760178	-	760178	757195	62	-	2921	
10029	826	10855	1305	8993	1670	557	7
9590	910	10500	1325	9024	1525	151	
357138	30130	387268	46059	323114	60216	18095	
340881	31319	372200	45832	321217	54658	5151	
3090	188	3278	1588	1651	-	39	8
3247	109	3357	1711	1587	-	59	
77309	6664	83973	41039	41920	-	1015	
82222	3925	86147	42865	41149	-	2133	
13850	-	13850	16	13834	-	-	9
13817	-	13817	17	13800	-	-	
131575	-	131575	156	131419	-	-	
131264	-	131264	163	131101	-	-	
8418	-	8418	8418	-	-	-	10
8423	-	8423	8423	-	-	-	
120	-	120	-	120	-	-	11
263	-	263	-	263	-	-	
1477	-	1477	563	914	-	-	12
1267	-	1267	529	738	-	-	
28831	-	28831	4730	24101	-	-	13
33268	-	33268	5817	27451	-	-	
16595	-	16595	10153	6442	3404	-	14
10123	-	10123	3498	6625	3391	-	

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

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

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*
15	ODPADY KOMUNALNE	2001	TJ	22	-	-	-	-
	MUNICIPAL WASTES	2002		0	-	-	-	0
16	PALIWA CIEKŁE Z BIOMASY	2001	TJ	9	-	-	-	-
	LIPUID FUELS FROM BIOMASS	2002		-	-	-	-	-
17	INNE SUROWCE ENERGETYCZNE	2001	TJ	1606	537	-	-	-
	OTHER ENERGY SOURCES	2002		3699	-	-	-	-161
18	***ENERGIA POCHODNA***	2001	***TJ***	-	***195236***	***9386***	***269491***	***175***
	DERIVED ENERGY	2002		-	***204493***	***7504***	***238232***	***-9348***
19	BRYKIETY Z WĘGLA KAMIENNEGO	2001	tys.ton	-	-	-	-	-1
	HARD COAL BRIQUETTES	2002	10^3 ton	-	3	-	-	0
		2001	TJ	-	-	-	-	-13
		2002		-	69	-	-	-1
20	BRYKIETY Z WĘGLA BRUNATNEGO	2001	tys.ton	-	-	-	-	-2
	LIGNITE BRIQUETTES (BKB)	2002	10^3 ton	-	1	-	-	0
		2001	TJ	-	-	-	-	-37
		2002		-	26	-	-	0
21	KOKS I PÓŁKOKS	2001	tys.ton	-	30	-	3924	-
	COKE AND SEMI-COKE	2002	10^3 ton	-	34	-	4226	-167
		2001	TJ	-	850	-	109884	-
		2002		-	962	-	118321	-4677
22	GAZ CIEKŁY	2001	tys.ton	-	1088	-	17	-12
	LIPUEFIED PETROLEUM GAS (LPG)	2002	10^3 ton	-	1412	-	17	-1
		2001	TJ	-	51442	-	810	-568
		2002		-	66768	-	781	-47
23	BENZYNY SILNIKOWE	2001	tys. ton	-	861	-	362	47
	MOTOR GASOLINE	2002	10^3 ton	-	627	-	386	-29
		2001	TJ	-	38583	-	16223	2105
		2002		-	28098	-	17278	-1299
24	BENZYNY LOTNICZE	2001	tys. ton	-	0	-	2	-1
	AVIATION GASOLINE	2002	10^3 ton	-	1	-	0	0
		2001	TJ	-	17	-	107	-45
		2002		-	36	-	14	1
25	PALIWA ODRZUTOWE	2001	tys. ton	-	121	107	393	8
	JET FUEL	2002	10^3 ton	-	0	-	278	8
		2001	TJ	-	5407	4768	17500	357
		2002		-	1	-	12399	357
26	OLEJ NAPĘDOWY I	2001	tys. ton	-	868	-	176	-32
	AUTOMOTIVE DIESEL OIL	2002	10^3 ton	-	968	87	298	-170
		2001	TJ	-	37597	-	7604	-1387
		2002		-	41953	3761	12928	-7366
27	OLEJE NAPĘDOWE POZOSTAŁE	2001	tys. ton	-	107	107	6	-
	OTHER DIESEL OIL	2002	10^3 ton	-	87	87	-	-2
		2001	TJ	-	4618	4618	241	-
		2002		-	3743	3743	-	-80
28	LEKKI OLEJ OPAŁOWY	2001	tys. ton	-	116	-	71	-26
	LIGHT FUEL OIL	2002	10^3 ton	-	492	-	41	176
		2001	TJ	-	5078	-	3124	-1137
		2002		-	21514	-	1815	7698

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 #
22	-	22	-	22	-	-	15
-	-	-	-	-	-	-	
9	-	9	-	9	-	-	16
-	-	-	-	-	-	-	
2144	-	2144	1756	388	6	-	17
3860	-	3860	3208	652	0	-	
-74430	***2103280***	*x*	***166566***	***1781809***	***42455***	***80474***	***18***
-24391	***2005299***	*x*	***114269***	***1778649***	***48801***	***87990***	
1	-	1	0	0	-	-	19
3	-	3	1	2	-	-	
13	-	13	6	8	-	-	
70	-	70	26	45	-	-	
2	-	2	-	2	-	-	20
1	-	1	-	1	-	-	
37	-	37	-	37	-	-	
26	-	26	-	26	-	-	
-3894	8946	5052	1359	3693	91	-	21
-4024	8723	4698	1228	3471	73	-	
-109035	252282	143248	37679	100764	2524	4805	
-112682	246192	133510	34471	97075	2027	1964	
1082	254	1337	13	1323	-	-	22
1396	255	1651	23	1628	-	-	
51199	12018	63217	626	62590	-	-	
66034	12067	78101	1108	76993	-	-	
452	4294	4746	116	4629	-	-	23
271	4019	4290	87	4203	-	-	
20254	192309	212563	5212	207351	-	-	
12119	180020	192139	3903	188235	-	-	
-1	4	3	-	3	-	-	24
0	3	3	-	3	-	-	
-45	180	134	-	134	-	-	
20	131	151	-	151	-	-	
-279	626	346	6	340	-	-	25
-286	575	289	1	288	-	-	
-12450	27888	15438	266	15172	-	-	
-12754	25618	12864	44	12820	-	-	
724	4913	5637	581	5056	-	-	26
840	4182	5021	127	4895	-	-	
31379	212872	244252	25169	219083	-	-	
36391	181190	217581	5490	212091	-	-	
102	1	102	-	102	-	-	27
89	0	89	-	89	-	-	
4377	32	4408	-	4408	-	-	
3823	1	3823	-	3823	-	-	
71	2686	2757	52	2317	-	388	28
274	2256	2531	60	2471	-	-	
3091	117492	120583	2261	101344	-	16978	
12001	98691	110692	2620	108072	-	-	

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*
29	CIĘŻKI OLEJ OPAŁOWY	2001	tys. ton	-	185	-	1295	16
	HEAVY FUEL OIL	2002	10^3 ton	-	127	-	177	-81
		2001	TJ	-	7575	-	53536	653
		2002		-	5122	-	7097	-3343
30	PÓŁPRODUKTY Z PRZEROBU ROPY NAFTOWEJ	2001	tys. ton	-	331	-	3	-
	FEEDSTOCKS	2002	10^3 ton	-	107	-	151	-
		2001	TJ	-	13288	-	103	-
		2002		-	4288	-	6060	-
31	PRODUKTY NIEENERGETYCZNE	2001	TJ	-	15280	-	20630	246
	NON-ENERGY PRODUCTS	2002		-	15826	-	20005	-591
32	GAZ RAFINERYJNY	2001	tys. ton	-	-	-	-	-
	REFINERY GAS	2002	10^3 ton	-	-	-	-	-
		2001	TJ	-	-	-	-	-
		2002		-	-	-	-	-
33	GAZ KOKSOWNICZY	2001	mln m^3	-	-	-	-	-
	COKE OVEN GAS	2002	10^6 m^3	-	-	-	-	-
		2001	TJ	-	-	-	-	-
		2002		-	-	-	-	-
34	GAZ WIELKOPIECOWY	2001	mln m^3	-	-	-	-	-
	GAS MANUFACTURED FROM COAL	2002	10^6 m^3	-	-	-	-	-
		2001	TJ	-	-	-	-	-
		2002		-	-	-	-	-
35	GAZ MIEJSKI	2001	mln m^3	-	-	-	-	-
	TOWN GAS	2002	10^6 m^3	-	-	-	-	-
		2001	TJ	-	-	-	-	-
		2002		-	-	-	-	-
36	GAZ CZADNICOWY I WYTLEWNY	2001	mln m^3	-	-	-	-	-
	BLAST FURNACE GAS	2002	10^6 m^3	-	-	-	-	-
		2001	TJ	-	-	-	-	-
		2002		-	-	-	-	-
37	ENERGIA ELEKTRYCZNA	2001	GWh	-	4306	-	11035	-
	ELECTRICITY	2002		-	4469	-	11537	-
		2001	TJ	-	15503	-	39726	-
		2002		-	16088	-	41534	-
38	CIEPŁO *)	2001	TJ	-	-	-	-	-
	HEAT *)	2002		-	-	-	-	-
39	***ENERGIA Z ODZYSKU***	2001	TJ	-	-	-	-	-
	ENERGY FROM RETURNS	2002		-	-	-	-	-
40	PALIWA ODPAD. GAZOWE	2001	TJ	-	-	-	-	-
	GASEOUS WASTE FUELS	2002		-	-	-	-	-
41	CIEPŁO Z ODZYSKU	2001	TJ	-	-	-	-	-
	HEAT FROM RETURNS	2002		-	-	-	-	-

*) Patrz 'Uwagi metodyczne'

*) See the 'Methodology remarks'"

ZUŻYCIE GLOBALNE LUB SALDO WYM. *GLOBAL CONSUMPTION OR EXCHANGE BALANCES*	UZYSK Z PRZEMIAN LUB ODZYSK *TRANSFORMA-TIONS OUTPUT OR RETURNS*	ZUŻYCIE OGÓŁEM *TOTAL CONSUMPTION*	ZUŻYCIE NA WSAD PRZEMIAN *TRANSFORMA-TIONS INPUT*	ZUŻYCIE BEZPOŚREDNIE *DIRECT CONSUMPTION*	- W TYM ZUŻYCIE NIEENERGETY-CZNE *AMONG WHICH NON-ENERGY USE*	STRATY I RÓŻNICE BILANSOWE *LOSSES AND STATISTICAL DIFFERENCE*	LP *#*
-1126	3658	2532	804	1676	-	53	29
32	3328	3360	644	1660	-	1056	
-46615	149445	102830	33174	68579	-	1077	
1368	135190	136557	26363	67677	-	42517	
328	185	513	331	182	173	-	30
-44	368	324	107	217	217	-	
13184	7434	20619	13296	7323	6950	-	
-1772	14782	13010	4288	8722	8702	-	
-5596	103733	98137	12598	79790	32981	5748	31
-3588	114118	110530	1467	85170	38073	23893	
-	666	666	-	666	-	-	32
-	676	676	-	676	-	-	
-	32051	32051	-	32051	-	-	
-	32548	32548	-	32548	-	-	
-	3919	3919	931	2956	-	31	33
-	3752	3752	896	2856	-	-	
-	69009	69009	17080	51173	-	756	
-	65570	65570	16421	49150	-	-	
-	9723	9723	1555	8168	-	-	34
-	8873	8873	1493	7380	-	-	
-	31904	31904	5096	26807	-	-	
-	28752	28752	4869	23882	-	-	
-	6	6	-	6	-	-	35
-	6	6	-	6	-	-	
-	159	159	-	159	-	-	
-	144	144	-	144	-	-	
-	-	-	-	-	-	-	36
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-6729	145615	138886	2601	122088	-	14197	37
-7068	144125	137057	2249	121994	-	12814	
-24224	524213	499990	9363	439518	-	51109	
-25446	518851	493405	8095	439180	-	46130	
-	370259	370259	4740	365519	-	-	38
-	351434	351434	5104	372845	-	-26515	
-	***59452***	***x***	***2338***	***57114***	***4732***	-	*39*
-	***56674***	***x***	***3109***	***53565***	***1962***	-	
-	15992	15992	2338	13653	4732	-	40
-	14499	14499	3109	11390	1962	-	
-	43460	43460	-	43460	-	-	41
-	42175	42175	-	42175	-	-	

Annex 4. National energy balance 2001 – OECD

Poland : 2001

	Coal (TJ)							Oil (TJ)	
SUPPLY AND CONSUMPTION	Coking Coal	Other Bit. Coal	Lignite	Peat	Oven and Gas Coke	Patent Fuel	BKB	Crude Oil	Feed-stocks
Production	502267.8	1961050.7	510958.2		252282.5			32652.4	
From Other Sources		15661.5							9901.6
Import	15119.7	36900.9	0.0		849.5			746632.7	14066.2
Export	-112943.8	-512351.9	-126.9		-109884.5			-18714.8	
International Marine Bunkers									
Stock Changes	-4258.5	31630.0	9.1		-2282.1	13.1	36.7	9652.7	
DOMESTIC SUPPLY	**400185.2**	**1532891.2**	**510840.4**		**140965.5**	**13.1**	**36.7**	**770223.0**	**23967.8**
Transfers									8701.5
Statistical Differences	-34115.1	98187.7	4708.5		-4804.8			-6405.0	
TRANSFORMATION	**360757.4**	**1120579.0**	**512198.1**		**37678.9**	**5.6**		**763805.1**	**32669.2**
Electricity Plants									
CHP Plants	5.9	944930.6	511731.0						
Heat Plants	1416.0	175648.5	467.1		1613.7	5.6			
Blast Furnaces					35094.1				
Gas Works									
Coke Ovens	359335.5				971.1				
Patent Fuel Plants									
BKB Plants									
Petroleum Refineries								763805.1	32669.2
Petrochemical Industry									
Other Transform. Sector									
ENERGY SECTOR	**4114.6**	**37330.6**	**305.0**		**27.3**	**0.4**	**0.0**	**12.9**	
Coal Mines	1035.8	32283.4	293.4		4.9				
Oil and Gas Extraction		2.7			1.0			12.9	
Petroleum Refineries		75.8			2.6				
Electr., CHP + Heat Plants									
Patent Fuel Plants									
Coke Ovens	3078.5	15.6			0.6				
Gas Works									
BKB									
Pumped Storage (Elec.)									
Other Energy Sector	0.3	4953.2	11.6		18.3	0.4	0.0		
Distribution Losses									
FINAL CONSUMPTION	**1198.1**	**473169.2**	**3045.9**		**98454.6**	**7.2**	**36.7**		
INDUSTRY SECTOR	**1153.3**	**192572.8**	**307.5**		**76808.4**	**7.0**	**34.1**		
Iron and Steel	9.6	13298.7			61232.9	6.8			
Chemical and Petrochemical	250.3	46587.6			1662.8				
of which: Feedstocks									
Non-Ferrous Metals	803.2	2808.4			5894.5				
Non-Metallic Minerals	68.7	43652.6	10.8		4482.6		25.9		
Transport Equipment	21.2	2998.2			303.8				
Machinery		7380.5			516.8				
Mining and Quarrying		1273.2	3.2		267.0				
Food and Tobacco	0.4	40472.2	145.9		1338.6		8.2		
Paper, Pulp and Print		15383.9			18.0				
Wood and Wood Products		5766.2	0.9		4.7				
Construction		1312.8	5.1		221.7				
Textile and Leather		6558.1	141.7		99.5				
Non-specified (Industry)		5080.5			765.6	0.3			
TRANSPORT SECTOR					**0.0**				
Air Transport									
Road					0.0				
Rail									
Pipeline Transport									
Internal Navigation									
Non-specified (Transport)									
OTHER SECTORS	**44.7**	**280314.6**	**2738.3**		**19121.8**	**0.2**	**2.7**		
Agriculture	28.0	37045.7	1299.4		3640.0	0.2	2.7		
Commerce and Public Services	16.7	13768.9	3.2		3721.8				
Residential		229500.0	1435.7		11760.0				
Non-specified (Other)	0.0	0.0	0.0		0.0	0.0	0.0		
NON-ENERGY USE		**281.8**			**2524.4**				
in Industry/Transf/Energy		281.8			2524.4				
in Transport					0.0				
in Other Sectors					0.0				

Poland : 2001

SUPPLY AND CONSUMPTION	Oil (TJ)											
	Additives	Refinery Gas	LPG + Ethane	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/ Diesel	Light Fuel Oil	Heavy Fuel Oil	Naphtha	Other Prod.
Production	1205.8	32056.6	12020.3	190035.4	180.1	27807.3	168.9	193091.4	116347.5	137610.9	33516.2	45727.1
From Other Sources												
Import	522.5		51453.4	38590.1	17.0	5408.3		37599.9	5031.4	7454.6		13602.6
Export			-810.4	-16226.1	-107.1	######		-7212.4	-3094.9	-45874.2		-5413.6
International Marine Bunkers								-956.8		-9863.8		
Stock Changes			567.7	-2105.5	44.8	-356.7		1386.7	1126.7	-643.1	-45.0	-201.0
DOMESTIC SUPPLY	**1728.3**	**32056.6**	**63230.9**	**210293.9**	**134.8**	**15355.3**	**168.9**	**223908.8**	**119410.8**	**88684.5**	**33471.2**	**53715.1**
Transfers			-272.5	-2945.5		-179.7		-5331.3				-248.8
Statistical Differences							3.1			-6343.3	-2070.8	
TRANSFORMATION	**1728.3**		**354.4**					**10.4**	**2187.5**	**27171.9**		
Electricity Plants												
CHP Plants								6.1	336.3	21424.6		
Heat Plants			180.7					4.3	1851.2	5747.2		
Blast Furnaces												
Gas Works			173.6									
Coke Ovens												
Patent Fuel Plants												
BKB Plants												
Petroleum Refineries	1728.3											
Petrochemical Industry												
Other Transform. Sector												
ENERGY SECTOR		**10172.8**	**35.0**	**38.1**	**0.4**		**9.2**	**1518.8**	**338.4**	**29726.9**		**42.6**
Coal Mines			1.9	14.3			7.9	979.8	25.1			18.5
Oil and Gas Extraction			0.5	1.8				250.5	6.5			
Petroleum Refineries		10172.8	17.5	3.6				73.7	234.4	29609.2		21.7
Electr., CHP + Heat Plants												
Patent Fuel Plants												
Coke Ovens										3.2		0.4
Gas Works			6.6	0.9				1.3	13.9			
BKB												
Pumped Storage (Elec.)												
Other Energy Sector			8.5	17.5	0.4		1.3	213.6	58.5	114.6		2.0
Distribution Losses												
FINAL CONSUMPTION		**21883.8**	**62569.1**	**207310.3**	**134.4**	**15175.6**	**162.8**	**217048.2**	**116884.9**	**25442.3**	**31400.4**	**53423.7**
INDUSTRY SECTOR		**21883.8**	**8848.5**	**311.8**	**25.5**	**86.1**	**151.8**	**5640.7**	**19929.9**	**20179.8**	**31400.4**	**7158.8**
Iron and Steel			169.4	3.1			3.5	46.4	140.4	647.1		
Chemical and Petrochemical		21883.8	4677.1	4.0			99.3	107.9	5347.3	7398.0	31400.4	6717.1
of which: Feedstocks		21883.8	3910.2						4680.9		31400.4	6228.8
Non-Ferrous Metals			1171.4				2.2	104.9	80.6	508.8		0.4
Non-Metallic Minerals			743.3	15.7			1.3	638.3	1335.5	4346.1		1.2
Transport Equipment			187.4	4.0	22.4	79.8	9.6	351.4	244.4	305.9		4.0
Machinery			443.3	78.8	2.2		22.8	737.5	1027.4	25.3		10.5
Mining and Quarrying			36.9	2.7			0.4	1803.5	217.5	257.2		372.6
Food and Tobacco			877.6	61.4			0.9	393.0	6932.5	2731.1		3.2
Paper, Pulp and Print			97.5	13.4			2.6	10.4	491.4	1488.4		1.2
Wood and Wood Products			30.8	17.5			0.9	240.1	232.3	2315.5		3.6
Construction			58.7	60.5			6.6	999.7	2211.3	92.8		28.5
Textile and Leather			127.3	3.6			0.4	8.7	704.2	61.1		1.2
Non-specified (Industry)			228.0	47.0	0.9	6.2	1.3	198.9	965.0	2.4		15.3
TRANSPORT SECTOR			**26794.5**	**206057.7**	**108.9**	**15089.5**	**9.2**	**127131.5**	**7.4**			
Air Transport					108.9	15089.5		2.6				
Road			26794.5	206034.4			2.6	120030.9				
Rail							6.1	6996.2				
Pipeline Transport				23.3				33.4	6.5			
Internal Navigation								68.5				
Non-specified (Transport)							0.4		0.9			
OTHER SECTORS			**26926.0**	**940.8**	**0.0**		**1.8**	**84276.1**	**96947.6**	**5262.5**		**3021.7**
Agriculture			2365.5	940.8				84276.1	43333.4	5262.5		
Commerce and Public Services			3271.1				1.3		31947.5			3021.7
Residential			21289.9						21666.7			
Non-specified (Other)			-0.5	0.0	0.0		0.4	0.0		0.0		0.0
NON-ENERGY USE												**43243.1**
in Industry/Transf/Energy												33925.1
in Transport												4603.7
in Other Sectors												4714.3

Poland : 2001

SUPPLY AND CONSUMPTION	Gas (TJ)				Comb.Renew.& Waste (TJ)				(TJ)	
	Natural Gas	Gas Works	Coke Ovens	Blast Furnaces	Solid Biomass	Gas/Liquids from Biomass	Municipal Waste	Industrial Waste	Electricity	Heat
Production	146204.4		69008.7	31903.7	160406.0	1485.8	22.3	7478.1	524216.9	370259.0
From Other Sources		158.8						15991.7		
Import	301947.8								15502.7	
Export	-1416.0								-39726.3	
International Marine Bunkers										
Stock Changes	-12289.1									
DOMESTIC SUPPLY	**434447.0**	**158.8**	**69008.7**	**31903.7**	**160406.0**	**1485.8**	**22.3**	**23469.8**	**499993.3**	**370259.0**
Transfers										
Statistical Differences	878.7	0.0	-95.6							
TRANSFORMATION	**29309.9**		**17080.0**	**5096.4**	**4886.2**	**563.4**		**3374.6**		**4740.3**
Electricity Plants						532.4				
CHP Plants	16973.1		16013.3	4903.6	4239.6			3342.1		4740.3
Heat Plants	11269.2		1066.7	71.9	646.6	31.0		26.6		
Blast Furnaces										
Gas Works										
Coke Ovens	1067.6			120.9				5.8		
Patent Fuel Plants										
BKB Plants										
Petroleum Refineries										
Petrochemical Industry										
Other Transform. Sector										
ENERGY SECTOR	**38208.1**	**3.6**	**33212.0**	**2171.3**	**39.0**	**11.8**	**1.3**	**282.5**	**102454.5**	**48841.3**
Coal Mines	375.3		319.6		2.7				23355.0	6623.4
Oil and Gas Extraction	6363.2								193.9	3.7
Petroleum Refineries	19299.2								2059.7	9989.9
Electr., CHP + Heat Plants									50103.0	10575.7
Patent Fuel Plants										
Coke Ovens	253.0		32646.2	27.8					2450.7	9512.7
Gas Works	11751.1	3.6							184.8	15.5
BKB										
Pumped Storage (Elec.)									9362.8	
Other Energy Sector	166.3		246.2	2143.4	36.3	11.8	1.3	282.5	14744.6	12120.4
Distribution Losses	12669.8		660.6						51105.6	
FINAL CONSUMPTION	**355137.9**	**155.2**	**17960.5**	**24636.0**	**155480.8**	**910.6**	**21.0**	**19812.7**	**346433.2**	**316677.5**
INDUSTRY SECTOR	**166012.5**		**17959.3**	**24636.0**	**26201.2**	**41.8**		**11585.7**	**139733.5**	**58536.1**
Iron and Steel	17260.9		16892.3	24624.9	5.7			2.1	22538.3	7313.2
Chemical and Petrochemical	80064.6		150.5	7.8				6670.5	30039.5	27543.0
of which: Feedstocks								3742.7	5527.9	9502.2
Non-Ferrous Metals	5700.1				4.6			2550.7	13155.3	878.9
Non-Metallic Minerals	31857.9		897.0	3.3	274.7			523.9	11214.1	1776.2
Transport Equipment	2582.8				0.2			0.7	5172.1	3746.0
Machinery	7754.8		19.5		5.7			11.1	11966.4	4481.5
Mining and Quarrying	1108.3				1.6			0.4	4805.7	2971.4
Food and Tobacco	11363.8				62.2	41.8		14.0	13453.5	2818.0
Paper, Pulp and Print	1445.2				15138.4			11.0	9741.7	2533.0
Wood and Wood Products	1498.9				8032.0			1686.8	4906.8	173.2
Construction	792.5				17.3			0.2	1774.2	570.7
Textile and Leather	1971.6							0.1	4144.0	2391.1
Non-specified (Industry)	2611.0				2658.7			114.3	6821.7	1339.8
TRANSPORT SECTOR	**3262.9**					**8.7**			**16695.2**	
Air Transport										
Road						8.7				
Rail									15433.2	
Pipeline Transport	3262.9								1262.0	
Internal Navigation										
Non-specified (Transport)										
OTHER SECTORS	**185862.6**	**155.2**	**1.2**		**129279.6**	**860.1**	**21.0**	**91.3**	**190004.5**	**258141.4**
Agriculture	777.0	151.2			19042.9		21.0		16596.0	1200.0
Commerce and Public Services	51348.0	4.0	1.2	0.0	5736.7	860.1	0.0	91.3	96454.9	24941.4
Residential	133737.6				104500.0				76953.6	232000.0
Non-specified (Other)	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
NON-ENERGY USE								**8135.6**		
in Industry/Transf/Energy								8135.6		
in Transport										
in Other Sectors										

Annex 5. Uncertainty estimation of the 2001 inventory

Uncertainty analysis for the year 2001 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 – 7.0%	CH_4 – 22.0%	N_2O – 48.4%
HFC – 43.7%	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 (7.0%) 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. 22.0% 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 (48.4%) 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 – 43.7%, 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 2001 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 (513.21 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 2001 – Uncertainty analysis, part 1, sectors 1-2

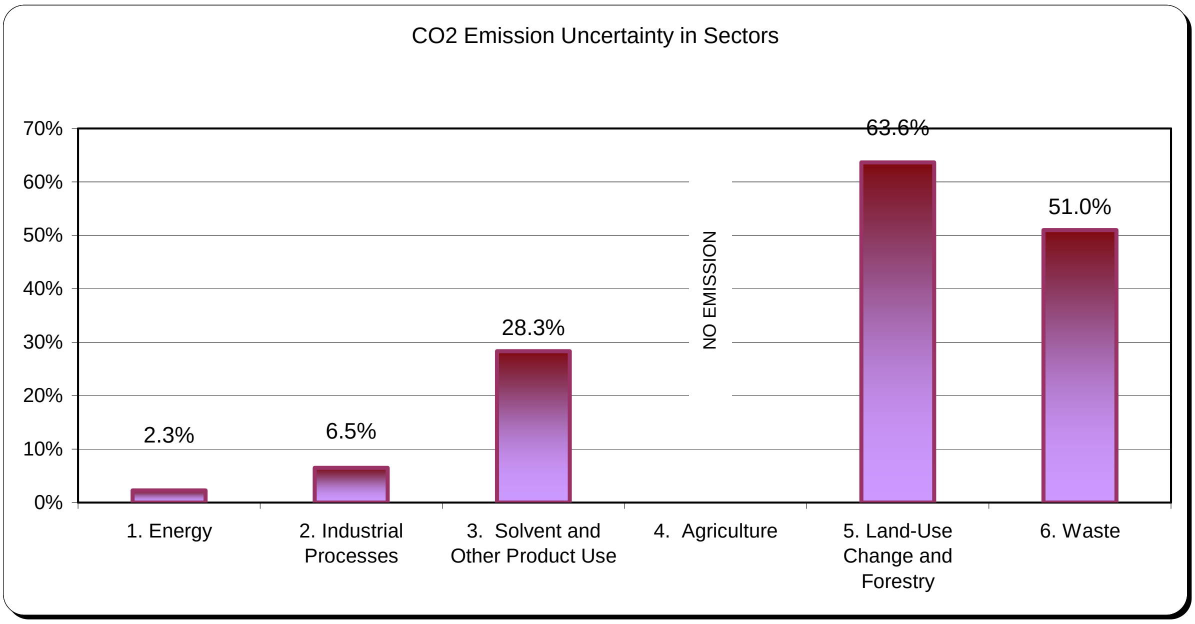
2001	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									299 748.75	1 830.90	101.55	7.0%	22.0%	48.4%	21 035.06	403.13	49.12
1. Energy									**316 403.98**	**721.56**	**8.37**	2.3%	13.8%	3.6%	**7120.44**	**99.26**	**0.30**
A. Fuel Combustion									**316 187.99**	**14.78**	**8.37**	2.3%	8.2%	3.6%	7120.43	1.22	0.30
1. Energy Industries									181 720.66	2.19	2.60	3.4%	12.2%	3.5%	6223.37	0.27	0.09
Liquid Fuels	109 519	3.0%	67.69	2.25	0.43	1.0%	41.8%	3.8%	7 413.00	0.25	0.05	3.2%	41.9%	3.2%	234.42	0.10	0.00
Solid Fuels	1 735 178	3.0%	99.40	1.02	1.46	2.0%	13.5%	11.7%	172 472.97	1.77	2.53	3.6%	13.8%	3.6%	6218.60	0.24	0.09
Gaseous Fuels	33 544	3.0%	54.69	1.00	0.10	2.0%	17.0%	20.0%	1 834.69	0.03	0.00	3.6%	17.3%	3.6%	66.15	0.01	0.00
Biomass	5 578	3.0%				0.0%	24.0%	37.0%	530.21	0.15	0.02	3.0%	24.2%	3.0%		0.04	0.00
2. Manufacturing Industries and Construction									47 649.91	2.26	0.74	4.0%	12.0%	9.2%	1926.15	0.27	0.07
Liquid Fuels	87 373.84	5.0%	73.99	2.85	2.22	1.0%	41.8%	3.8%	6 464.53	0.25	0.19	5.1%	42.1%	6.3%	329.63	0.10	0.01
Solid Fuels	318 731.42	5.0%	108.63	3.45	1.33	2.0%	13.5%	11.7%	34 623.69	1.10	0.42	5.4%	14.4%	12.7%	1864.54	0.16	0.05
Gaseous Fuels	120 655.41	5.0%	54.38	1.00	0.10	2.0%	17.0%	20.0%	6 561.68	0.12	0.01	5.4%	17.7%	20.6%	353.36	0.02	0.00
Biomass	27 111.19	5.0%	99.45	29.04	3.87	0.0%	24.0%	37.0%	2 696.29	0.79	0.10	5.0%	24.5%	37.3%		0.19	0.04
3. Transport									32 007.05	5.31	3.52	7.1%	11.4%	5.5%	2263.24	0.60	0.19
Liquid Fuels	448 303.36	5.0%	71.40	11.83	7.86	5.0%	10.2%	2.3%	32 007.05	5.31	3.52	7.1%	11.4%	5.5%	2263.24	0.60	0.19
Solid Fuels	NE,NO	5.0%				5.0%	13.5%	11.7%				7.1%	14.4%	12.7%	0.00	0.00	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	24.0%	37.0%	0.00	0.00	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
Other Fuels	NE	5.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	0.00	0.00	0.00	5.0%	50.2%	50.2%	0.00	0.00	0.00
4. Other Sectors									51 766.43	4.96	1.50	3.4%	19.9%	13.6%	1767.44	0.99	0.20
Liquid Fuels	190 973.34	5.0%	72.72	3.19	2.73	1.0%	41.8%	3.8%	13 887.82	0.61	0.52	5.1%	42.1%	6.3%	708.14	0.26	0.03
Solid Fuels	298 933.21	5.0%	95.69	1.00	1.50	2.0%	13.5%	11.7%	28 605.72	0.30	0.45	5.4%	14.4%	12.7%	1540.47	0.04	0.06
Gaseous Fuels	173 589.65	5.0%	53.42	1.00	0.10	2.0%	17.0%	20.0%	9 272.88	0.17	0.02	5.4%	17.7%	20.6%	499.36	0.03	0.00
Biomass	129 270.21	5.0%	111.99	30.00	4.00		24.0%	37.0%	14 477.60	3.88	0.52	5.0%	24.5%	37.3%		0.95	0.19
5. Other									3 043.94	0.07	0.01	3.9%	83.8%	6.5%	118.44	0.06	0.00
Liquid Fuels	34 104.97	5.0%	65.80	1.65	0.22	1.0%	100.0%	3.8%	2 244.20	0.06	0.01	5.1%	100.1%	6.3%	114.43	0.06	0.00
Solid Fuels	4 288.62	5.0%	100.83	1.00	1.50	2.0%	80.0%	11.7%	432.43	0.00	0.01	5.4%	80.2%	12.7%	23.29	0.00	0.00
Gaseous Fuels	6 727.33	5.0%	54.60	1.00	0.10	2.0%	90.0%	20.0%	367.32	0.01	0.00	5.4%	90.1%	20.6%	19.78	0.01	0.00
Biomass	13.88	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	1.55	0.00	0.00	5.0%	95.1%	37.3%		0.00	0.00
B. Fugitive Emissions from Fuels									**215.99**	**706.77**	**0.00**	6.3%	14.0%		13.67	99.25	0.00
1. Solid Fuels									0.73	492.85	0.00	6.6%	20.0%		0.05	98.50	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]	102.48	2.0%		4.78199			20.0%			490.04			20.1%		0.00	98.50	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	59.55	2.0%		0.01273			20.0%			0.76			20.1%		0.00	0.15	0.00
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	0.35	2.0%	2 060 765	5 791 695.00			20.0%		0.73	2.04		6.6%	15.0%		0.05	0.31	
2. Oil and Natural Gas									215.26	213.93	0.00	6.3%	5.7%		13.67	12.21	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	32.65	0.5%	6 315 000	61 800.00		6.6%	8.1%		206.20	2.02		6.6%	8.1%		13.65	0.16	0.00
iii. Transport [Activity in Gg]	18 325.00	0.5%	NE	NE		6.6%	8.1%		0.11	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]	146.20	0.5%	56 157.71	100 937.08		6.6%	8.1%		8.21	14.76		6.6%	8.1%		0.54	1.20	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	438.20	0.5%	515.46	136 619.11		6.6%	8.1%		0.23	59.87		6.6%	8.1%		0.01	4.86	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	438.20	0.5%	1 165.15	313 266.29		6.6%	8.1%		0.51	137.27		6.6%	8.1%		0.03	11.14	0.00
2. Industrial Processes									**13470.31**	**12.67**	**14.03**	6.5%	17.0%	28.6%	870.91	2.16	4.01
A. Mineral Products									6949.90		0	11.8%			817.02	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	9 335.10	5.0%	0.531			15.0%			4956.94			15.8%			783.76	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 049.40	10.0%	0.785			10.0%			1608.78			14.1%			227.52	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	925.74	10.0%	0.415			0.0%			384.18			10.0%			38.42	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									3198.03	10.46	14.03	7.0%	20.3%	28.6%	223.16	2.13	4.01
1. Ammonia Production [Activity in kt, EF in t/t]	2 103.80	5.0%	1.5	0.0049		5.0%	20.0%		3155.70	10.31		7.1%	20.6%		223.14	2.13	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	2 060.00	2.0%			0.01			30.0%			13.33			30.1%	0.00	0.00	4.01
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]	38.40	5.0%	1.1			5.0%			42.24			7.1%			2.99	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	14.70	5.0%		0.01			20.0%			0.15			20.6%		0.00	0.03	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	308.30	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]	687.70	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	148.60	5.0%			0.0047			20.0%			0.70			20.6%	0.00	0.00	0.15
C. Metal Production									3322.38	2.21	0	6.1%	17.0%		202.90	0.38	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	7 352.76	5.0%	0.07			10.0%			516.46			11.2%			57.74	0.00	0.00
Coke [Activity in kt, EF in t/t]	8 954.30	5.0%	0.16	0.000200		10.0%	20.0%		1441.15	1.79		11.2%	20.6%		161.13	0.37	0.00
Open-heart Steel [Activity in kt, EF in t/t]	177.60	5.0%	0.052			10.0%			9.24			11.2%			NE		
Electric Furnace Steel [Activity in kt, EF in t/t]	2 809.10	5.0%	0.00430	0.000120		10.0%	20.0%		12.08	0.34		11.2%	20.6%		1.35	0.07	0.00
Pig Iron [Activity in kt, EF in t/t]	5 442.85	5.0%	0.17685			10.0%			962.55			11.2%			107.62	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	424.00	5.0%	0.061	0.000200		10.0%	20.0%		25.86	0.08		11.2%	20.6%		2.89	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	26.30	5.0%	0.062			10.0%			1.63			11.2%			0.18	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	5 822.50	5.0%	0.01126			10.0%			65.56			11.2%			7.33	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	48.61	5.0%	3.9			5.0%			189.57			7.1%			13.40	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	54.60	5.0%	1.8			5.0%			98.28			7.1%			6.95	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

GHG inventory 2001 – Uncertainty analysis, part 2, sector 3-6

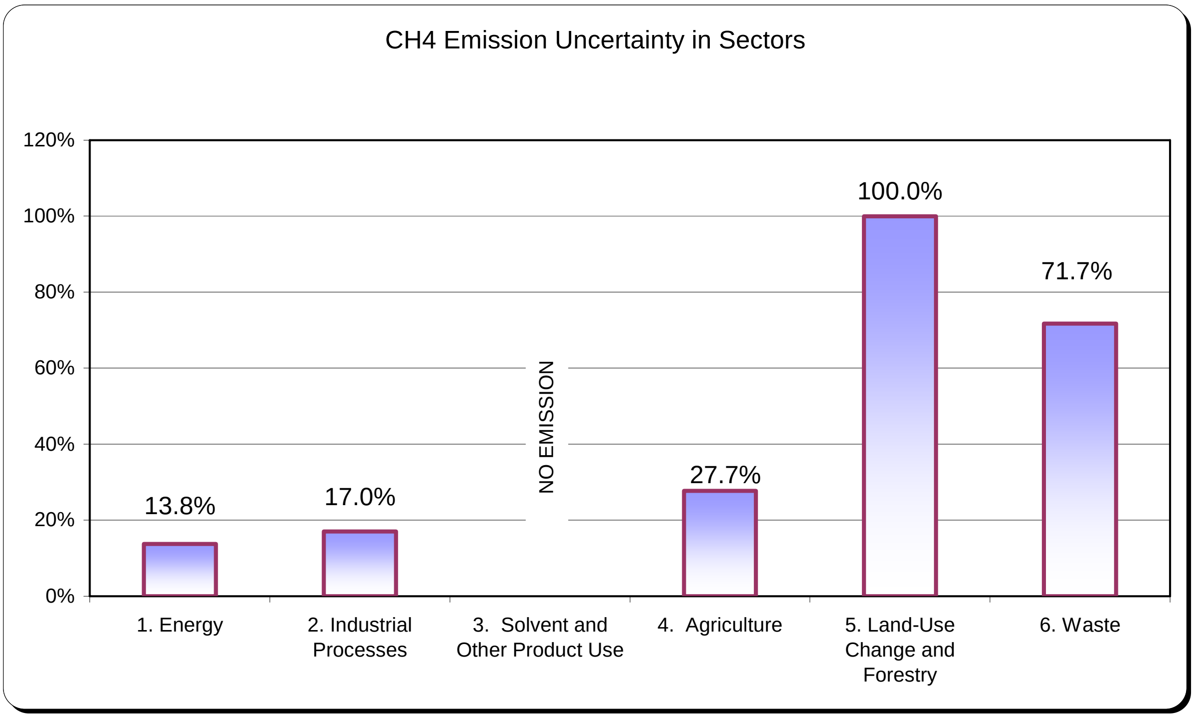
2001	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
3. Solvent and Other Product Use	**149.91**		**NA**						**513.21**		**0.40**	28.3%		50.0%	145.24	0.00	0.20
4. Agriculture										**604.50**	**75.17**		27.7%	65.1%	0.00	167.54	48.92
A. Enteric Fermentation										445.02			34.6%		0.00	154.15	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 005.0	5.0%		92.21			50.0%			277.10			50.2%		0.00	139.24	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 729.0	5.0%		47.16			50.0%			128.69			50.2%		0.00	64.67	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	343.0	5.0%		8.38			50.0%			2.88			50.2%		0.00	1.44	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	172.0	5.0%		5.00			50.0%			0.86			50.2%		0.00	0.43	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	546.0	5.0%		18.00			50.0%			9.83			50.2%		0.00	4.94	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	17 105.0	5.0%		1.50			50.0%			25.66			50.2%		0.00	12.89	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	206 727.5	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
B. Manure Management										158.20	20.53		41.5%	148.4%	0.00	65.62	30.48
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 005	5.0%		6.28			50.0%			18.86			50.2%		0.00	9.48	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 729	5.0%		3.87			50.0%			10.57			50.2%		0.00	5.31	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	343	5.0%		0.17			50.0%			0.06			50.2%		0.00	0.03	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	172	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]	546	5.0%		1.39			50.0%			0.76			50.2%		0.00	0.38	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	17 105	5.0%		6.54			50.0%			111.81			50.2%		0.00	56.18	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	206 727	5.0%		0.08			50.0%			16.12			50.2%		0.00	8.10	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%			20.31			150.1%	0.00	0.00	30.48
D. Agricultural Soils											54.58			70.1%	0.00	0.00	38.27
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	805 500 000	5.0%			0.01			150.0%			11.25			150.1%	0.00	0.00	16.89
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	622 057 334	5.0%			0.01			150.0%			9.78			150.1%	0.00	0.00	14.67
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	38 430 000	5.0%			0.01			150.0%			0.60			150.1%	0.00	0.00	0.91
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	181 776 800	5.0%			0.01			150.0%			2.86			150.1%	0.00	0.00	4.29
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]	47 041 735	5.0%			0.02			150.0%			1.48			150.1%	0.00	0.00	2.22
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	98 908 347	20.0%			1.27966033			150.0%			12.66			151.3%			19.15
F. Field Burning of Agricultural Residues										1.28	0.06		20.7%	97.8%	0.00	0.27	0.06
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	9 283 000	30.0%		0.1816	0.0004		20.0%	150.0%		0.17	0.00		36.1%	153.0%	0.00	0.06	0.01
Barley [Activity in t of crop production, EF in kg/t dm]	3 330 000	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]	1 362 000	30.0%		0.0367	0.0001		20.0%	150.0%		0.01	0.00		36.1%	153.0%	0.00	0.00	0.00
Oats [Activity in t of crop production, EF in kg/t dm]	1 305 000	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]	4 864 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.10	0.00		36.1%	153.0%	0.00	0.04	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	6 816 000	30.0%		0.1574	0.0004		20.0%	150.0%		0.11	0.00		36.1%	153.0%	0.00	0.04	0.00
2 Pulses (Other non-specified)	211 000	30.0%		0.0416	0.0003		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
3 Tuber and Root															0.00	0.00	0.00
Potatoes [Activity in t of crop production, EF in kg/t dm]	19 379 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.35	0.03		36.1%	153.0%	0.00	0.13	0.04
Other Tuber and Root [Activity in t of crop production, EF in kg/t dm]	0	30.0%		0.0000	0.0000		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
5 Other															0.00	0.00	0.00
Fruits, Veget., Rape, Tabacco, Hop, Hey [Activity in t of crop prod., EF in kg/ t of crop]	24 826 400	30.0%		0.0197	0.0009		20.0%	150.0%		0.49	0.02		36.1%	153.0%	0.00	0.18	0.03
													0.0%	0.0%	0.00	0.00	0.00
5. Land-Use Change and Forestry									**-31070.01**	**0.14**	**0.00**	63.6%	100.0%	100.0%	-19772.33	0.14	0.001
A. Forest Land									-37925.79			50.0%			-18962.90	0.00	0.000
B. Cropland									8268.23			50.0%			4134.12	0.00	0.000
C. Grassland									4587.83			50.0%			2293.91	0.00	0.000
D. Wetlands									0.00			50.0%			0.00	0.00	0.000
E. Settlements									-6000.28	0.14	0.0010	50.0%	100.0%	100.0%	-3000.14	0.14	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									**431.26**	**492.04**	**3.58**	51.0%	71.7%	50.5%	219.90	352.97	1.81
A. Solid Waste Disposal on Land										311.82			102.6%		0.00	319.96	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]	10 637.57	23.0%					100.0%			311.82			102.6%		0.00	319.96	0.00
B. Wastewater Handling										180.22	3.46		82.7%	52.2%	0.00	149.04	1.81
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	1 602.54			0.09			100.0%			144.23			100.0%		0.00	144.23	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	462.80	30.0%		0.077767097			100.0%			35.99			104.4%		0.00	37.57	0.00
N2O from human sewage [Activity in 1000s of population, EF in kg N2O-N/kg sewage N produced]	38 242.00	15.0%			0.0000905			50.0%			3.46			52.2%	0.00	0.00	1.81
C. Waste Incineration									431.26		0.12	51.0%		21.8%	219.90	0.00	0.03
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			175.74		0.07	51.0%		30.0%	89.61	0.00	0.02
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			431.26		0.05	51.0%		30.0%	219.90	0.00	0.01

Industrial gases inventory 2001 – Uncertainty analysis for HFC, PFC and SF_6.

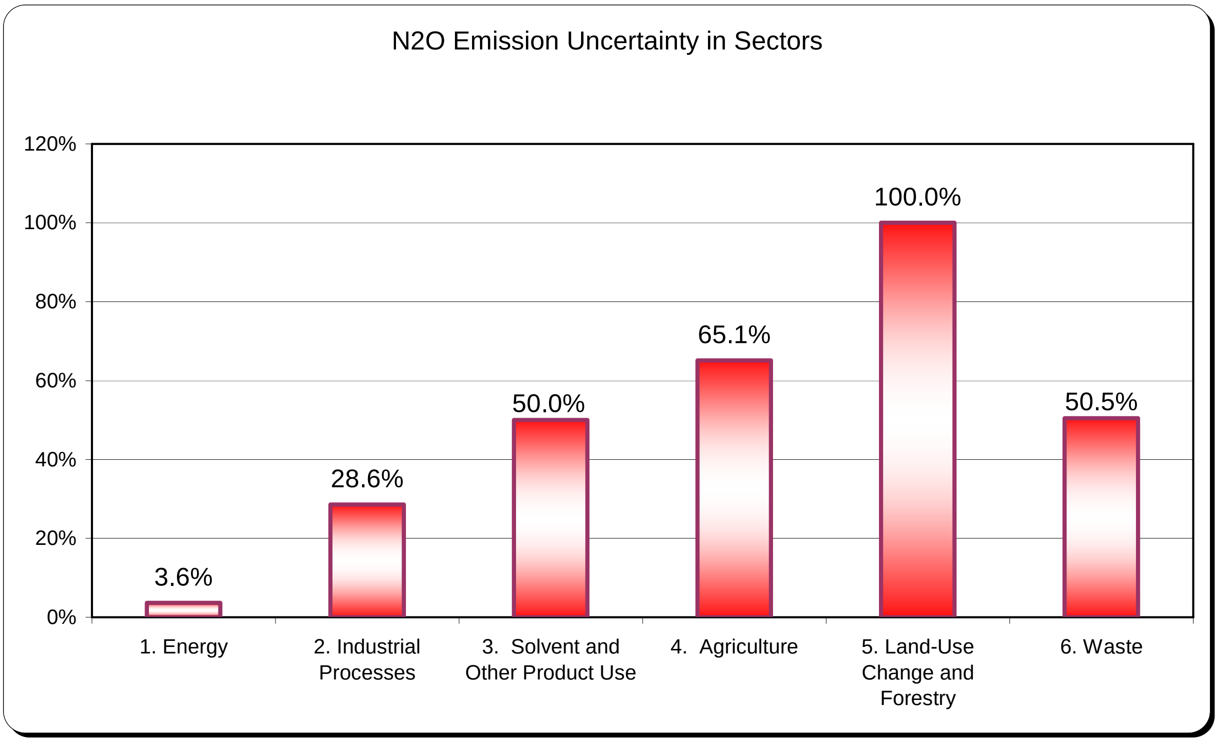
2001	**HFC Emission [Gg of CO2 eq.]**	**PFC Emission [Gg of CO2 eq.]**	**SF_6 Emission [Gg of CO2 eq.]**	**HFC Emission uncertainty [%]**	**PFC Emission uncertainty [%]**	**SF6 Emission uncertainty [%]**	**HFC Emission absolute uncertainty [Gg of CO2 eq.]**	**PFC Emission absolute uncertainty [Gg of CO2 eq.]**	**SF6 Emission absolute uncertainty [Gg of CO2 eq.]**
TOTAL	1 073.35	269.95	18.45	43.7%	20.0%	100.0%	469.32	53.99	18.45
2. Industrial Processes	**1 073.35**	**269.95**	**18.45**	**43.7%**	**20.0%**	**100.0%**	**469.32**	**49.43**	**18.45**
C. Metal Production		247.15			20.0%			49.43	
3. Aluminium Production		247.15			20.0%			49.43	
F. Consumption of Halocarbons and SF6	1 073.35	22.80	18.45	43.7%		100.0%	469.32	0.00	18.45
1. Refrigeration and Air Conditioning Equipment	915.34			50.0%			457.67		
2. Foam Blowing	10.56			50.0%				0.00	
3. Fire Extinguishers	3.17	22.80		50.0%	20.0%				
4. Aerosols/ Metered Dose Inhalers	144.29			50.0%			72.14		
8. Electrical Equipment			18.45			100.0%			18.45



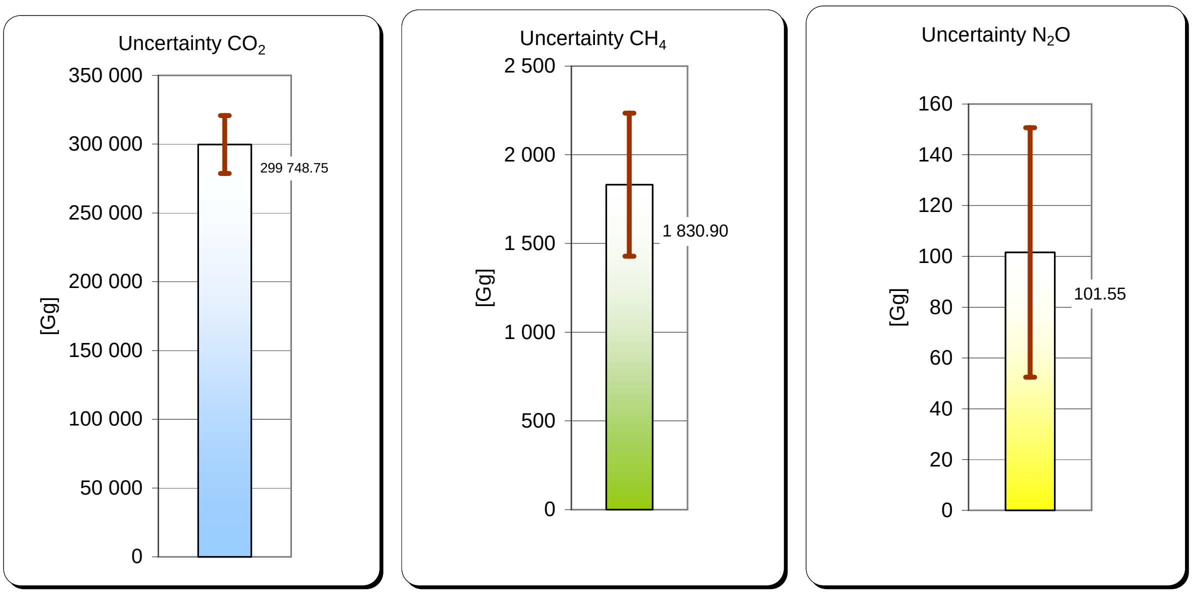
Results of uncertainty analysis in percents for CO_2 with sectoral split.



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.