

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

# **Poland's National Inventory Report 1997**

Submission under  
the United Nations Framework  
Convention on Climate Change

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

**December 2006**



## Table of contents

<b>Executive Summary .....</b>	<b>4</b>
Total national GHG emissions .....	4
Carbon dioxide emissions .....	4
Methane emissions .....	5
Nitrous oxide emissions .....	5
Hydrofluorocarbons (HFCs) emissions.....	5
Perfluorocarbons (PFCs) emissions .....	5
Sulfur hexafluoride emissions .....	5
 <b>1. Introduction .....</b>	 <b>6</b>
1.1 Background information on greenhouse gas inventories and climate change .....	6
1.2 A description of institutional arrangement for inventory preparation.....	6
1.3 Brief description of the process for inventory preparation .....	6
1.4 General description of methodologies and data sources used.....	7
1.5 Brief description of key source methodologies.....	8
1.6 Information on the QA/QC plan including verification .....	9
1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals.....	9
1.8 General assessment of the completeness.....	9
 <b>2. Greenhouse gas emissions and removals in 1997 .....</b>	 <b>11</b>
2.1 GHG aggregated emissions.....	11
2.2 GHG emissions by gas .....	15
2.3 GHG emissions by category.....	18
2.4 Comparison to base year (1988/1995) .....	20
2.5 Comparison of greenhouse gas emissions 1997 and 1996 .....	22
2.6 Emission trends for indirect greenhouse gases (CO, NO <sub>x</sub> and NMVOC) and SO <sub>2</sub> .....	26
 <b>3. Energy (CRF sector 1) .....</b>	 <b>29</b>
3.1 Key categories .....	29
3.2 Methodological issues .....	29
 <b>4. Industrial Processes (CRF sector 2) .....</b>	 <b>41</b>
4.1 Key categories .....	41
4.2 Methodological issues .....	41
 <b>5. Solvent and Other Product Use (CRF sector 3) .....</b>	 <b>45</b>
5.1 Key categories .....	45
5.2 Methodological issues .....	45
 <b>6. Agriculture (CRF sector 4).....</b>	 <b>45</b>
6.1 Key categories .....	45
6.2 Methodological issues .....	45
 <b>7. Land Use Change and Forestry (CRF sector 5) .....</b>	 <b>52</b>
7.1 Key categories .....	52
7.2 Methodological issues .....	52
 <b>8. Waste (CRF sector 6) .....</b>	 <b>59</b>

8.1 Key categories .....	59
8.2 Methodological issues .....	59
<b>References .....</b>	<b>64</b>
<b>Annex 1. Key sources .....</b>	
<b>Annex 2. Energy balance data for main fuels .....</b>	
<b>Annex 3. National energy balance 1997 .....</b>	
<b>Annex 4. National energy balance 1997 - OECD.....</b>	
<b>Annex 5. Uncertainty estimation of the 1997 inventory .....</b>	
<b>Annex 6. Common Reporting Format 1997.....</b>	

## Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1997. The inventory covers the following GHGs: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF<sub>4</sub>), perfluoroethane (C<sub>2</sub>F<sub>6</sub>), perfluorobutane (C<sub>4</sub>F<sub>10</sub>), and sulfur hexafluoride (SF<sub>6</sub>). The following GHG precursors are also reported: carbon monoxide - CO, nitrogen oxides (NO + NO<sub>2</sub>) - NO<sub>x</sub>, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO<sub>2</sub>.

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 1997. Totals in tables may not sum due to independent rounding.

### Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1997, expressed as CO<sub>2</sub> equivalents, are presented in table ES.1 In 1997 the total national emission of GHG were about 461.86 million tones of CO<sub>2</sub>-eq., excluding GHG emissions and sinks from category 5. (Land use change and forestry). Compared to the base year (1988/1995), the 1997 emissions have decreased by 21.3%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1997. [Gg CO<sub>2</sub> eq.]

Pollutant	Base year	1997	(1997- base)/base
	Emission in CO <sub>2</sub> eq. [Gg]	Emission in CO <sub>2</sub> eq. [Gg]	
CO <sub>2</sub> – net emission (with LUCF)	461 951.16	354 444.50	-0.23
CO <sub>2</sub> – without LUCF.	494 885.88	385 954.31	-0.22
CH <sub>4</sub>	49 256.41	43 043.55	-0.13
N <sub>2</sub> O	42 478.82	32 455.22	-0.24
HFCs	26.44	153.56	4.81
PFCs	250.18	248.89	-0.01
SF <sub>6</sub>	13.15	9.01	-0.31
TOTAL without CO <sub>2</sub> from LUCF	586 910.88	461 864.54	-0.21
TOTAL with LUCF	553 976.16	430 354.73	-0.22

\* 1995 is the base year for HFCs, PFCs and SF<sub>6</sub>

### Carbon dioxide emissions

The CO<sub>2</sub> emissions in 1997 were estimated as 385.95 million tones. This is 22.0% lower than in the base year. CO<sub>2</sub> emission was accounted for 83.6% of total GHG emissions in Poland in 1997. The main CO<sub>2</sub> emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO<sub>2</sub> emission by 95.10% in 1997. The shares of the main

subcategories were as follows: *Energy industries* – 49.4%, *Manufacture Industries and Construction* – 19.5%, *Transport* – 8.1% and *Other Sectors* – 17.1%. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.7% in 1997. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO<sub>2</sub> removal in LUCF sector in 1997, was calculated to be approximately 31.5 million tonnes. It means that app. 7.3% of the total CO<sub>2</sub> emissions are offset by CO<sub>2</sub> uptake by forests.

### **Methane emissions**

The CH<sub>4</sub> emission amounted to 2 049.69 Gg in 1997 i.e. 43.04 million tonnes of CO<sub>2</sub> equivalents. The contribution of CH<sub>4</sub> to the national total GHG emission was 9.3% in 1997. Three of main CH<sub>4</sub> emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture and Waste*. They contributed 39.5%, 32.8% and 26.1% to the national methane emission in 1997, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (30.2% of total CH<sub>4</sub> emission) and Oil and Natural Gas system (9.3% of total CH<sub>4</sub> emission). Waste disposal sites contributed to 13.7% of the methane emission from total CH<sub>4</sub> emission and Wastewater Handling contributed to 12.4% of total CH<sub>4</sub> emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 25.0% of total CH<sub>4</sub> emission in 1997.

### **Nitrous oxide emissions**

The nitrous oxide emissions in 1997 were 104.69 Gg i.e. 32.46 million tonnes of CO<sub>2</sub> equivalents. The emission was app. 23.6% lower than the respective figure for the base year. The contribution of N<sub>2</sub>O to the national total GHG emission was 7.0% in 1997. The main N<sub>2</sub>O emission sources and its shares in total N<sub>2</sub>O emission in 1997 are as follow: *Agricultural Soils* – 54.1%, *Manure Management* – 22.3%, *Chemical Industry* – 11.8% and *Fuel Combustion* – 8.1%.

### **Hydrofluorocarbons (HFCs) emissions**

The total emission of HFCs in 1997 was 0.15 million tonnes CO<sub>2</sub> equivalents. The contribution of HFCs to the national total GHG emission in 1997 was relatively low and has been estimated at 0.03%. The emissions of HFCs-gases had increased 6 times between the base year (1995) and 1997. 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 1997 was 0.25 million tonnes of CO<sub>2</sub> equivalents. The contribution of PFCs to the national total GHG emission in 1997 was 0.05%. The emission of PFCs had fluctuated to a limited extend, and followed the trends in aluminium production-its main source. The emission changes between 1997 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<sub>6</sub> in 1997 was 0.01 million tonnes of CO<sub>2</sub> equivalents. The contribution of SF<sub>6</sub> to the national total GHG emission is insignificant, and in 1997 amounted to app. 0.002%. SF<sub>6</sub> emissions in 1997 were by 0.7 times lower than in 1995. Leakage from electrical equipment during its use and production is the main SF<sub>6</sub> 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<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons - HFCs (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HCF227ea, HFC-365mfc and HFC-245fa), perfluorocarbons - PFCs (perfluoromethane (CF<sub>4</sub>), perfluoroethane (C<sub>2</sub>F<sub>6</sub>), perfluorobutane (C<sub>4</sub>F<sub>10</sub>), and sulfur hexafluoride (SF<sub>6</sub>). The GHG precursors, in turn, are: carbon monoxide - CO, nitrogen oxides (NO + NO<sub>2</sub>) - NO<sub>x</sub>, non-methane volatile organic compounds - NMVOC and sulfur dioxide - SO<sub>2</sub> (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<sub>2</sub>O emissions from animal waste in agriculture, and CH<sub>4</sub> and N<sub>2</sub>O 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<sub>2</sub> gases are expressed in units of CO<sub>2</sub> 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 <sup>3</sup> 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 <sub>2</sub> 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<sub>2</sub> emission factor for the given fuel. The calculations of these CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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 1997 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 1997 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<sub>2</sub> and CH<sub>4</sub> from *Solid Fuel Transformation*
- CO<sub>2</sub> from *Coal Mining and Handling*
- some individual processes in *Oil and Natural Gas* systems

in *Industrial Processes*:

- CO<sub>2</sub> from *Asphalt Roofing*
- CO<sub>2</sub> from *Road Paving with Asphalt*
- CH<sub>4</sub> from *Ferroalloys Production*
- CH<sub>4</sub> from *Aluminium Production*

- CO<sub>2</sub> from *Food and Drink Production*
- CH<sub>4</sub> from *Sinter*
- some minor gaps in estimation of the emissions of HFCs, PFCs, SF<sub>6</sub>

in *Agriculture*

- CH<sub>4</sub> from *Agriculture Soils*

in *LULUCF*

- N<sub>2</sub>O from *Forest and Grassland Conversion*
- CO<sub>2</sub> from *Decay*

in *Waste*

- N<sub>2</sub>O from *Industrial Wastewater*
- N<sub>2</sub>O from *Domestic and Commercial Wastewater except Humane Sewage*
- CH<sub>4</sub> from *Waste Incineration*.

## 2. Greenhouse gas emissions and removals in 1997

### 2.1 GHG aggregated emissions

For carbon dioxide, net emission is calculated by subtracting from the total CO<sub>2</sub> emission and removals from category 5. (Land Use Change and Forestry - LUCF). According to IPCC methodology, CO<sub>2</sub> emissions are given with and without contributions from category 5. Also following IPCC, emission of CO<sub>2</sub> from biomass, is not included in the national total.

For non-CO<sub>2</sub> gases, the inventory results can also be presented (table 2.1) in units of CO<sub>2</sub> 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 83.6% share (in 1997), while the methane contributes with 9.3% to the national total. Nitrous oxide contribution is 7.0% and all industrial GHG together contribute 0.1%.

Table 2.1 Greenhouse gas emissions in 1997 in CO<sub>2</sub> eq.

Pollutant	1997	
	Emission in CO <sub>2</sub> eq. [Gg]	Share [%]
CO <sub>2</sub> – net emission (with LUCF)	354 444.50	
CO <sub>2</sub> – without LUCF.	385 954.31	83.56
CH <sub>4</sub>	43 043.55	9.32
N <sub>2</sub> O	32 455.22	7.03
HFCs	153.56	0.03
PFCs	248.89	0.05
SF <sub>6</sub>	9.01	0.002
TOTAL without CO <sub>2</sub> from LUCF	461 864.54	100.0
TOTAL with LUCF	430 354.73	

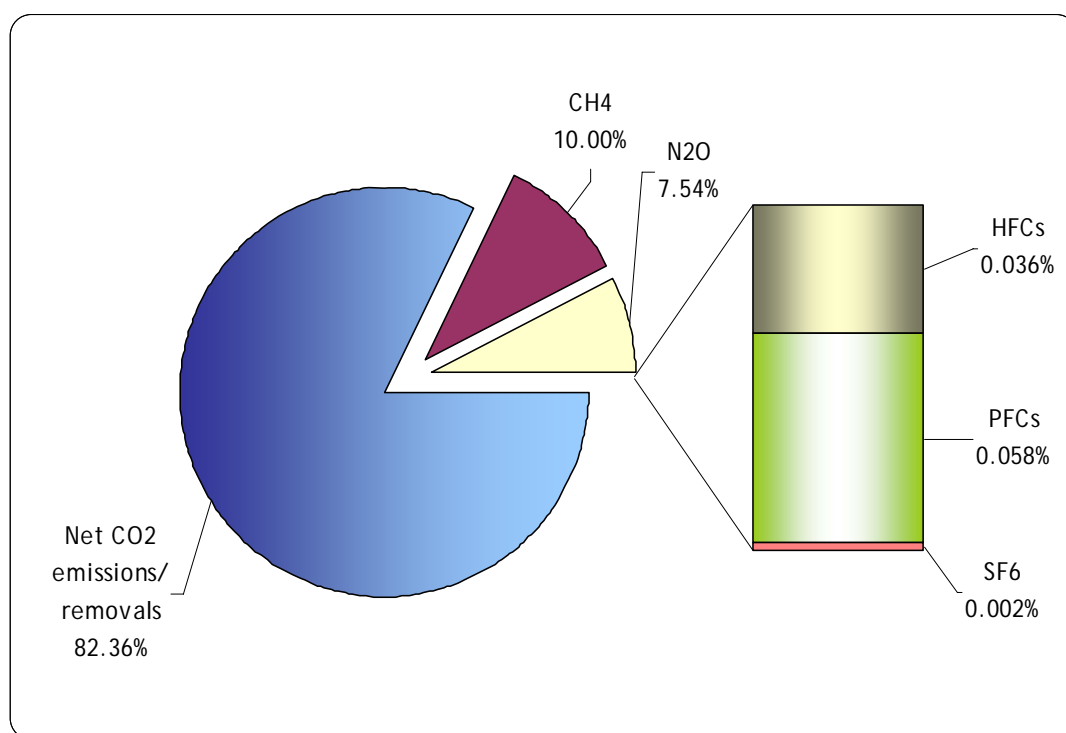


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1997

Emissions of main GHGs in 1997, 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<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in 1997 [Gg]

[Gg]	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
TOTAL without CO <sub>2</sub> from LUCF	385 954.31	2 049.69	104.69
1. Energy	367 110.42	827.72	8.43
A. Fuel Combustion	367 024.11	18.23	8.43
1. Energy Industries	190 589.66	2.13	2.77
2. Manufacturing Industries and Construction	75 370.67	2.89	1.24
3. Transport	31 127.72	8.11	2.03
4. Other Sectors	66 174.14	4.96	1.74
5. Other	3 761.93	0.13	0.66
B. Fugitive Emissions from Fuels	86.31	809.50	NE
1. Solid Fuels	0.76	618.98	NE
2. Oil and Natural Gas	85.55	190.52	NE
2. Industrial Processes	18 025.19	13.87	12.32
A. Mineral Products	9 078.00	NE	NE
B. Chemical Industry	3 510.15	11.28	12.32
C. Metal Production	5 437.04	2.58	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	418.72	NE	0.40
4. Agriculture	NE	673.17	80.03
A. Enteric Fermentation	NE	513.13	NE
B. Manure Management	NE	158.86	23.35
D. Agricultural Soils	NE	NE	56.62
F. Field Burning of Agricultural Residues	NE	1.17	0.06
5. Land Use, Land-Use Change and Forestry	-31 509.81	0.16	0.0011
A. Forest Land	-37 775.81	NE	NE
B. Cropland	5 806.80	NE	NE
C. Grassland	3 222.04	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-2 762.84	0.16	0.0011
F. Other Land	NE	NE	NE
6. Waste	399.97	534.78	3.52
A. Solid Waste Disposal on Land	NE	280.81	NE
B. Wastewater Handling	NE	253.97	3.47
C. Waste Incineration	399.97	NE	0.05

Table 2.3 Emissions of industrial gases: HFCs, PFCs and SF<sub>6</sub> in 1997 [eq. Gg]

1997	HFCs	PFCs	SF <sub>6</sub>	Total in eq. CO <sub>2</sub>
Total Industrial gases [Gg eq. CO <sub>2</sub> ]	153.56	248.89	9.01	411.46
C. Metal Production	NE	242.63	NE	242.63
3. Aluminium Production	NE	242.63	NE	242.63
F. Consumption of Halocarbons and SF <sub>6</sub>	153.56	6.26	9.01	168.83
1. Refrigeration and Air Conditioning Equipment	39.37	NE	NE	39.37
3. Fire Extinguishers	0.11	6.26	NE	6.37
4. Aerosols	114.08	NE	NE	114.08
8. Electrical Equipment	NE	NE	9.01	9.01

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 1997 for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.

Table 2.4 Percentage shares of individual source sectors in 1997 emissions

Percentage share of source sectors in biezacy emissions	Share [%]		
	CO <sub>2</sub> without LUCF	CH <sub>4</sub>	N <sub>2</sub> O
TOTAL	100.00	100.00	100.00
1. Energy	95.12	40.38	8.05
A. Fuel Combustion	95.10	0.89	8.05
1. Energy Industries	49.38	0.10	2.65
2. Manufacturing Industries and Construction	19.53	0.14	1.18
3. Transport	8.07	0.40	1.94
4. Other Sectors	17.15	0.24	1.66
5. Other	0.97	0.01	0.63
B. Fugitive Emissions from Fuels	0.02	39.49	NE
1. Solid Fuels	0.0002	30.20	NE
2. Oil and Natural Gas	0.02	9.29	NE
2. Industrial Processes	4.67	0.68	11.77
A. Mineral Products	2.35	NE	NE
B. Chemical Industry	0.91	0.55	11.77
C. Metal Production	1.41	0.13	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.11	NE	0.38
4. Agriculture	NE	32.84	76.44
A. Enteric Fermentation	NE	25.03	NE
B. Manure Management	NE	7.75	22.31
D. Agricultural Soils	NE	NE	54.08
F. Field Burning of Agricultural Residues	NE	0.06	0.05
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	0.10	26.09	3.36
A. Solid Waste Disposal on Land	NE	13.70	NE
B. Wastewater Handling	NE	12.39	3.31
C. Waste Incineration	0.10	NE	0.04

## 2.2 GHG emissions by gas

### Carbon dioxide (CO<sub>2</sub>)

In 1997, the net CO<sub>2</sub> emissions (with LULUCF) were estimated as 354.44 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 385.95 million tones (table 2.2). The main CO<sub>2</sub> emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO<sub>2</sub> emission by 95.10% in 1997. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 49.4%, *Manufacture Industries and Construction* – 19.5%, *Transport* – 8.1% and *Other Sectors* – 17.1%. Sector 2. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.7% in 1997. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO<sub>2</sub> emission/removal in LULUCF sector in 1997, was calculated to be approximately 31.5 million tones. It means that app. 7.3% of the total CO<sub>2</sub> emissions are offset by CO<sub>2</sub> uptake by forests.

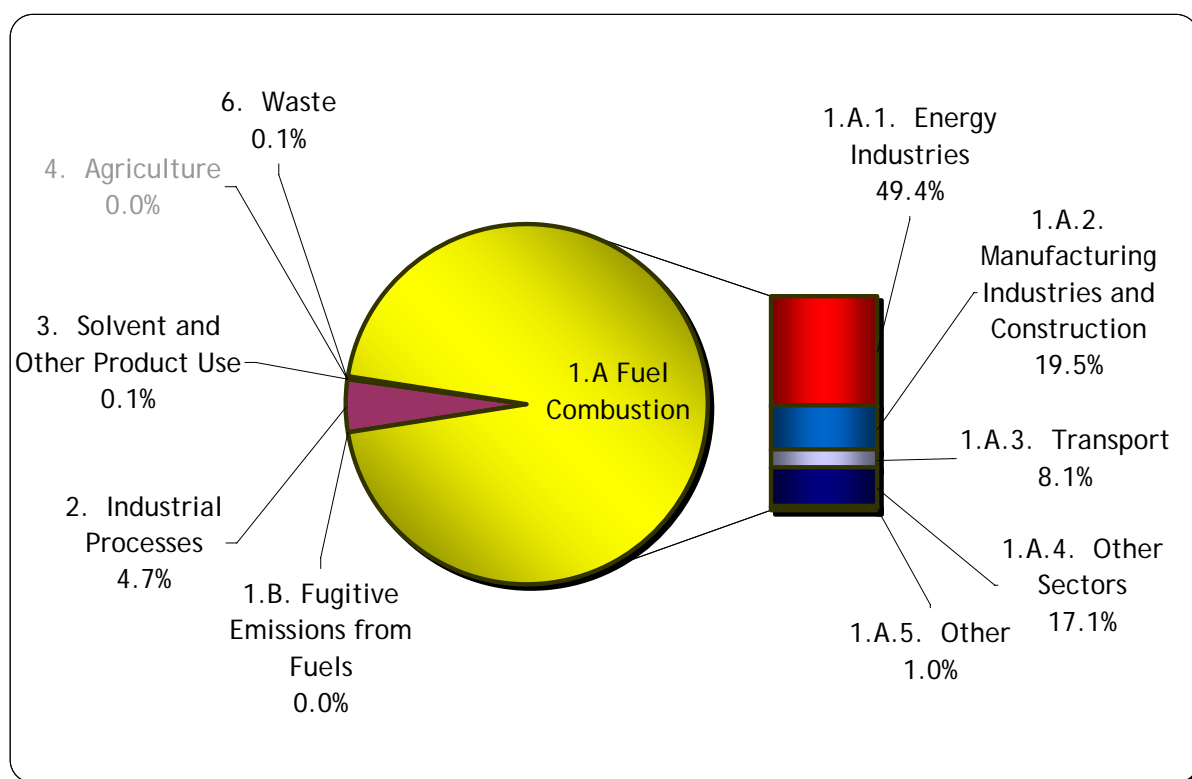


Figure 2.2 Carbon dioxide emission in 1997 by sector



## Methane (CH<sub>4</sub>)

The CH<sub>4</sub> emission amounted to 2 049.69 Gg in 1997 i.e. 43.04 million tones of CO<sub>2</sub> equivalents (table 2.2). Three of main CH<sub>4</sub> emission sources include the following categories: *Fugitive Emissions from Fuels*, *Agriculture* and *Waste*. They contributed to 39.5%, 32.8% and 26.1% of the national methane emission in 1997 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 30.2% of total CH<sub>4</sub> emission) and *Oil and Natural Gas* system (about 9.3% of total emission), *Disposal sites* contributed to 13.70% of the methane emission and *Wastewater Handling* contributed to 12.39%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 25.0% of total methane emission in 1997.

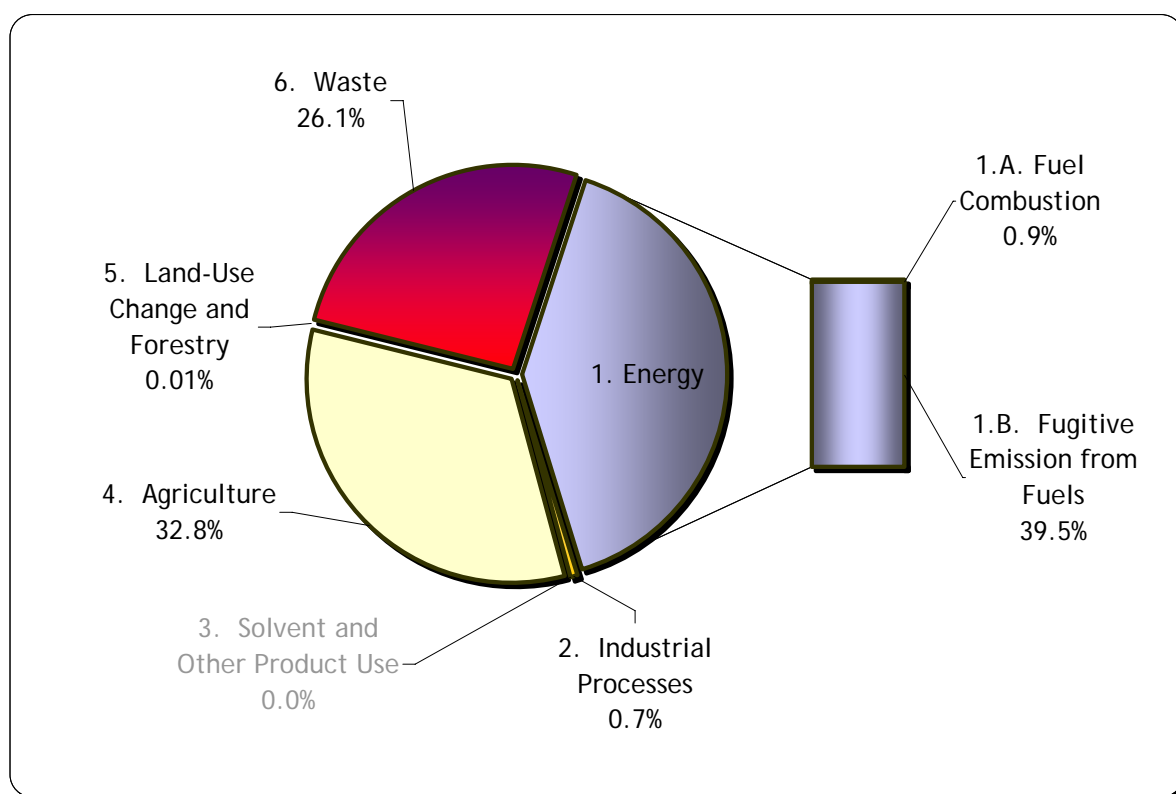


Figure 2.3 Methane emission in 1997 by sector

## Nitrous oxide (N<sub>2</sub>O)

The nitrous oxide emissions in 1997 were 104.69 Gg i.e. 32.46 million tonnes of CO<sub>2</sub> equivalents (table 2.2). The main N<sub>2</sub>O emission sources and its shares in total N<sub>2</sub>O emission in 1997 are: *Agricultural Soils* – 54.1%, *Manure Management* – 22.3%, *Chemical Industry* – 11.8% and *Fuel Combustion* – 8.1%.

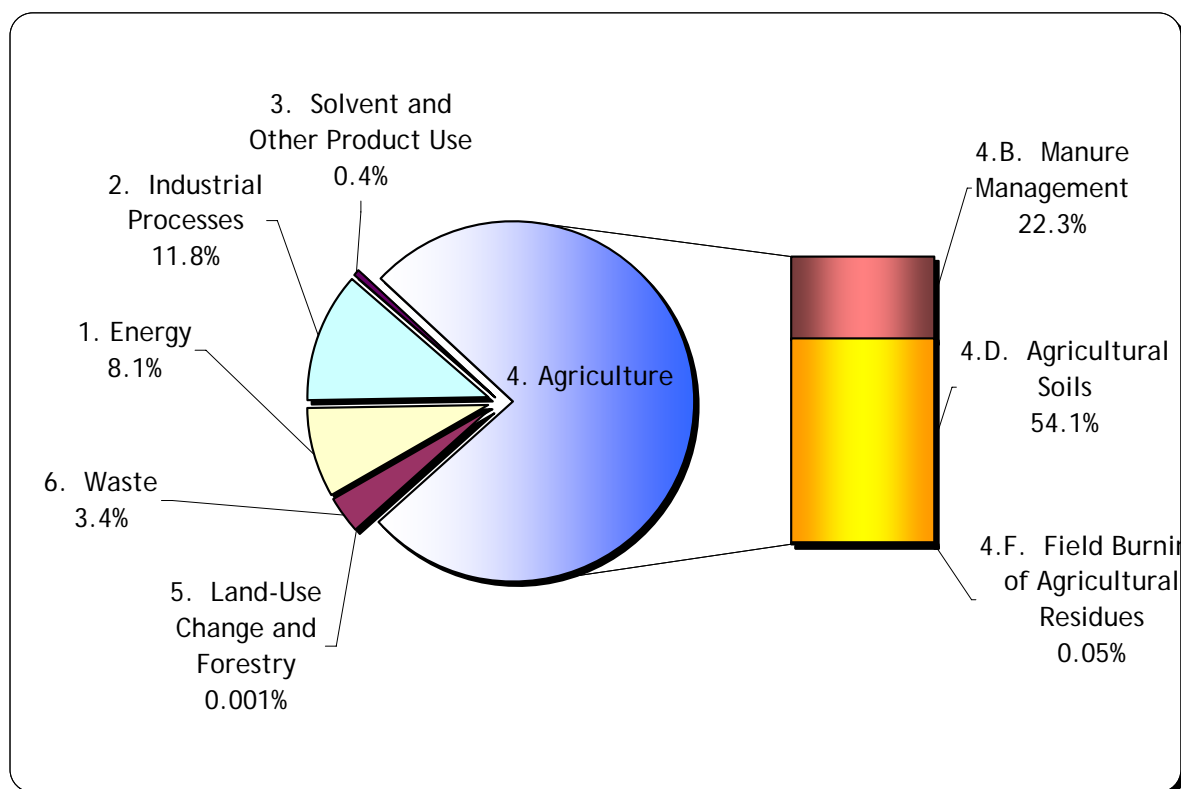


Figure 2.4 Nitrous oxide emission in 1997 by sector

## Industrial gases

The total emission of HFCs in 1997 was 0.15 million tonnes of CO<sub>2</sub> equivalents. The emissions of HFCs-gases had increased 6 times between the base year (1995) and 1997. 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 1997 was 0.25 million tonnes of CO<sub>2</sub> equivalents. The emissions of PFCs-gases had decreased by 0.5% between the base year (1995) and 1997. It is due to the growth in aluminium production and in the use of C<sub>4</sub>H<sub>10</sub> 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<sub>6</sub> in 1997 was 0.01 million tonnes of CO<sub>2</sub> equivalents. SF<sub>6</sub> emissions in 1997 were by 0.7 time lower than in 1995. Leakage from electrical equipment, is the main SF<sub>6</sub> emission source. Insignificant emission of SF<sub>6</sub> occurs during production of soundproof windows.

Large percentage increase of industrial F-gas emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contributed merely 0.1% to national total in 1997.

## 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 1997

	Total [Gg eq. CO <sub>2</sub> ]		(1997-base)/base
	Base year	1997	
TOTAL with LUCF	553 976.2	430 354.73	-0.22
TOTAL without LUCF	586 902.6	461 860.91	-0.21
1. Energy	497 964.7	387 106.68	-0.22
2. Industrial Processes	27 356.2	22 546.63	-0.18
3. Solvent and Other Product Use	1 006.5	542.72	-0.46
4. Agriculture	52 378.1	38 944.71	-0.26
5. Land-Use Change and Forestry	-32 926.5	-31 506.18	-0.04
6. Waste	8 197.2	12 720.17	0.55

### 2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1997 was 387.1 million tons of CO<sub>2</sub> equivalent. CO<sub>2</sub> emission share exceeded 94.8% 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 1997

GHG emission categories	GHG Emission [Tg CO <sub>2</sub> -eq]	% share in the total emission from Energy	% Share in total GHG emission from a given sub-sector		
			CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
Total Energy	387 106.68	100.0	94.8	4.5	0.7
A. Fuel Combustion	370 020.94	95.6	94.8	0.1	0.7
1. Energy Industries	191 493.13	49.5	49.2	0.0	0.2
2. Manufacturing Industries and Construction	75 814.92	19.6	19.5	0.0	0.1
3. Transport	31 926.06	8.2	8.0	0.0	0.2
4. Other Sectors	66 818.75	17.3	17.1	0.0	0.1
5. Other	3 968.08	1.0	1.0	0.0	0.1
B. Fugitive Emissions from Fuels	17 085.74	4.4	0.0	4.4	0.0
1. Solid Fuels	12 999.36	3.4	0.0	3.4	0.0
2. Oil and Natural Gas	4 086.38	1.1	0.0	1.0	0.0

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

Table 2.7 shows detailed information on emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in *Industrial Processes* sector and in *Solvent and Other Use* sector in 1997. CO<sub>2</sub> is dominating among GHGs – its contribution exceeds 79.9%. 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<sub>2</sub>O emissions from anaesthesia (22.8%) and CO<sub>2</sub> emissions (recalculated from NMVOC) (77.2%).

Table 2.7. The emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from sub-sectors in category *Industrial Processes* and in category *Solvents and Other Product Use* in 1997

GHG emission categories	GHG Emission [Tg CO <sub>2</sub> -eq]	% share in the total emission from Industrial Processes	% Share in total GHG emission from a given sub-sector			
			CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFC, PFC and SF <sub>6</sub>
Total Industrial Processes	22 546.63	100.0	79.9	1.3	16.9	1.8
A. Mineral Products	9 078.00	40.3	40.3	0.0	0.0	
B. Chemical Industry	7 565.85	33.6	15.6	1.1	16.9	
C. Metal Production	5 733.95	25.4	24.1	0.2	0.0	1.1
D. Other Production	NE	NE				
F. Consumption of Halocarbons and SF <sub>6</sub>	168.83	0.7				0.7
G. Other	0.00	0.0				
Total Solvent and Other Product Use	542.72	100	77.2	0.0	22.8	

### 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<sub>2</sub>O emission share was largest in total GHG emission from *Agriculture* in 1997 and came from both – direct (mineral and organic fertilisation) and indirect (volatilisation, leaching and runoff from applied synthetic fertiliser and animal manure) N<sub>2</sub>O emissions from soils.

Table 2.8. GHG emissions from sub-sectors in category 4 *Agriculture* in 1997

GHG emission categories	GHG Emission [Tg CO <sub>2</sub> -eq]	% share in the total emission from Agriculture	% Share in total GHG emission from a given sub-sector	
			CH <sub>4</sub>	N <sub>2</sub> O
Total Agriculture	38 944.71	100.0	36.3	63.7
A. Enteric Fermentation	10 775.81	27.7	27.7	0.0
B. Manure Management	10 575.83	27.2	8.6	18.6
D. Agricultural Soils	17 550.89	45.1	0.0	45.1
F. Field Burning of Agricultural Residues	42.18	0.1	0.1	0.0

### 2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.9, the emission of CH<sub>4</sub> dominated in this sector in 1997 (almost 88.3%). The main part of GHG emissions came from *solid waste disposal on land* and *wastewater handling*.

Table 2.9. GHG emissions from sub-sectors in category 6 *Waste* in 1997

GHG emission categories	GHG Emission [Tg CO <sub>2</sub> -eq]	% share in the total emission from Waste	% Share in total GHG emission from a given sub-sector		
			CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
Total Waste	12 720.17	100	3.1	88.3	8.6
A. Solid Waste Disposal on Land	5 897.04	46.4	0.0	46.4	0.0
B. Wastewater Handling	6 409.03	50.4	0.0	41.9	8.5
C. Waste Incineration	414.10	3.3	3.1	0.0	0.1

## 2.4 Comparison to base year (1988/1995)

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

Table 2.10 Changes of greenhouse gas emissions in 1997 with respect to base year 1988/1995

Pollutant	Base year	1997	1997/base year [%]
	Emission in CO <sub>2</sub> eq. [Gg]	Emission in CO <sub>2</sub> eq. [Gg]	
CO <sub>2</sub> – net emission (with LUCF)	461 951.16	354 444.50	76.73
CO <sub>2</sub> – without LUCF.	494 885.88	385 954.31	77.99
CH <sub>4</sub>	49 256.41	43 043.55	87.39
N <sub>2</sub> O	42 478.82	32 455.22	76.40
HFCs	26.44	153.56	580.76
PFCs	250.18	248.89	99.48
SF <sub>6</sub>	13.15	9.01	68.55
TOTAL without CO <sub>2</sub> from LUCF	586 910.88	461 864.54	78.69
TOTAL with LUCF	553 976.16	430 354.73	77.68

\* for industrial gases: HFC, PFC and SF<sub>6</sub> the base year is 1995

### Carbon dioxide

CO<sub>2</sub> emission had decreased by app. 22.0% from the base year to 1997.

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

- share in of solid fuels decreased from 85.3% in 1988 to 79.3% in 1997
- share of liquid fuels increased from 11.4% (1988) to 16.1% (1997)
- share of gaseous fuels increased from 3.3% (1988) to 4.6% (1997).

### Methane

CH<sub>4</sub> emission had decreased by app. 12.6% from the base year to 1997. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 32.5%,
- the decrease in *Fugitive Emission* by 25.1%,
- the increase in emission from *Waste* by 74.0%.

### Nitrous oxide

The nitrous oxide emissions in 1997 were app. 23.6% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 22.3% in 1997, in *Agricultural Soils* decreased from 55.6% (1988) to 54.1% (1997) and in *Chemical Industry* increased from 11.8% in 1988 to 11.8% in 1997.

**Industrial gases: HFCs, PFCs and SF<sub>6</sub>**

HFCs emissions in 1997 were 6 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 1997 were 0.5% lower than in base year (1995). The PFCs emission changes between 1997 and the preceding years depend on the aluminium production levels (main PFC source) and the use of C4F10 in fire extinguishers.

SF<sub>6</sub> emissions in 1997 were about 0.7 times lower than in 1995. Leakage from electrical equipment during its use and production is the main SF<sub>6</sub> emission. Large percentage increase of industrial gases emissions, compared to the base year, does not influence significantly the national total GHG emission trend, because all the industrial gases together contribute merely app. 0.1% to the national total in 1997.

**Emissions of greenhouse gases in base year (1988/1995) in CO<sub>2</sub> 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<sub>2</sub> in 1997 decreased from 84.3% to 83.6%.

Table 2.11 Emissions of greenhouse gases in base year (1988/1995) in CO<sub>2</sub> equivalent

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

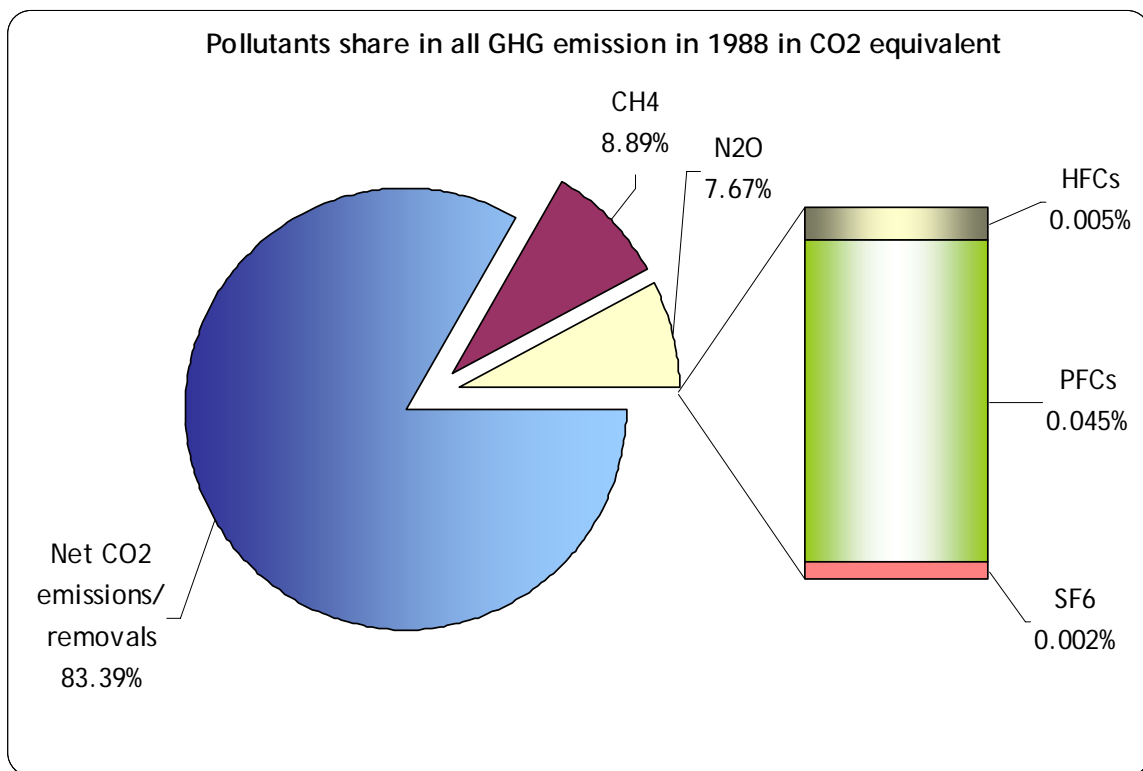


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

## 2.5 Comparison of greenhouse gas emissions 1997 and 1996

Changes of national emissions and sinks of GHGs in 1997 compared to 1996 were:

CO <sub>2</sub>	- net emission fall to	97.14%
CH <sub>4</sub>	- emission rise to	100.90%
N <sub>2</sub> O	- emission rise to	100.62%
HFC [eq. CO <sub>2</sub> ]	- actual emission rise to	158.60%
PFC [eq. CO <sub>2</sub> ]	- actual emission rise to	105.60%
SF <sub>6</sub> [eq. CO <sub>2</sub> ]	- actual emission rise to	119.30%

Below results are discussed separately for each greenhouse gas with respect to 1997 emissions and change between 1997 and 1996.

## Carbon dioxide (CO<sub>2</sub>)

In 1997, the net CO<sub>2</sub> emissions (with LULUCF) was 2.9% lower than in 1996. The CO<sub>2</sub> emission in 1997 from category *Energy* was lower by 3.9% and from category *Industrial Processes* was higher by 13.7% than in 1996. In comparison to 1996 the CO<sub>2</sub> emission from category *Waste* in 1997 fall by 0.3%.

Table 2.12. Comparison of carbon dioxide emission in 1996 and 1997

Year	CO <sub>2</sub> [Gg]		1997/1996 [%]
	1996	1997	
TOTAL without LUCF	398 762.8	385 954.3	96.8
1. Energy	382 081.5	367 110.4	96.1
A. Fuel Combustion	381 987.5	367 024.1	96.1
1. Energy Industries	195 661.0	190 589.7	97.4
2. Manufacturing Industries and Construction	82 702.9	75 370.7	91.1
3. Transport	32 960.0	31 127.7	94.4
4. Other Sectors	67 438.5	66 174.1	98.1
5. Other	3 225.2	3 761.9	116.6
B. Fugitive Emissions from Fuels	94.0	86.3	91.9
1. Solid Fuels	0.8	0.8	101.1
2. Oil and Natural Gas	93.2	85.6	91.8
2. Industrial Processes	15 857.1	18 025.2	113.7
A. Mineral Products	8 501.7	9 078.0	106.8
B. Chemical Industry	3 437.4	3 510.2	102.1
C. Metal Production	3 918.0	5 437.0	138.8
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	423.1	418.7	99.0
4. Agriculture	NE	NE	NE
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	NE	NE	NE
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	-33 893.7	-31 509.8	93.0
A. Forest Land	-39 673.3	-37 775.8	95.2
B. Cropland	5 031.7	5 806.8	115.4
C. Grassland	2 792.0	3 222.0	115.4
D. Wetlands	NE	NE	NE
E. Settlements	-2 044.1	-2 762.8	135.2
F. Other Land	NE	NE	NE
6. Waste	401.1	400.0	99.7
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	401.1	400.0	99.7



## Methane (CH<sub>4</sub>)

The emission in 1997 was higher than in 1996 by 0.9%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was lower by 0.1% in 1997 and from *Waste* sector was higher by 2.4% than in 1996. *Fugitive emission* in *Energy* sector was lower by 1.2% in 1997 compared to 1996.

Table 2.13 Comparison of methane emission in 1996 and 1997

Year	CH <sub>4</sub> [Gg]		1997/1996 [%]
	1996	1997	
TOTAL	2 031.32	2 049.69	100.9
1. Energy	838.73	827.72	98.7
A. Fuel Combustion	19.14	18.23	95.2
1. Energy Industries	2.20	2.13	96.9
2. Manufacturing Industries and Construction	3.03	2.89	95.1
3. Transport	8.84	8.11	91.8
4. Other Sectors	4.97	4.96	99.8
5. Other	0.10	0.13	138.6
B. Fugitive Emissions from Fuels	819.58	809.50	98.8
1. Solid Fuels	627.52	618.98	98.6
2. Oil and Natural Gas	192.06	190.52	99.2
2. Industrial Processes	13.45	13.87	103.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	10.96	11.28	103.0
C. Metal Production	2.49	2.58	103.6
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	656.98	673.17	102.5
A. Enteric Fermentation	496.66	513.13	103.3
B. Manure Management	159.06	158.86	99.9
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.27	1.17	92.7
5. Land Use, Land-Use Change and Forestry	0.11	0.16	139.1
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.11	0.16	139.1
F. Other Land	NE	NE	NE
6. Waste	522.04	534.78	102.4
A. Solid Waste Disposal on Land	273.20	280.81	102.8
B. Wastewater Handling	248.84	253.97	102.1
C. Waste Incineration	NE	NE	NE

## Nitrous oxide (N<sub>2</sub>O)

The emission was higher than in 1996 (by 0.6%). The main sources of N<sub>2</sub>O emission are *Manure Management* and *Agricultural Soils*. Emission from *Manure Management* in the *Agriculture* sector was higher by 1.8% in 1997 and from *Agricultural Soils* was higher by 1.9% than in 1996.

Table 2.14. Comparison of nitrous oxide emission in 1996 and 1997

Year	N <sub>2</sub> O [Gg]		1997/1996 [%]
	1996	1997	
TOTAL	104.05	104.69	100.6
1. Energy	8.47	8.43	99.6
A. Fuel Combustion	8.47	8.43	99.6
1. Energy Industries	2.82	2.77	98.1
2. Manufacturing Industries and Construction	1.34	1.24	92.1
3. Transport	2.15	2.03	94.1
4. Other Sectors	1.79	1.74	97.6
5. Other	0.36	0.66	181.3
B. Fugitive Emissions from Fuels	NE	NE	NE
1. Solid Fuels	NE	NE	NE
2. Oil and Natural Gas	NE	NE	NE
2. Industrial Processes	13.09	12.32	94.1
A. Mineral Products	NE	NE	NE
B. Chemical Industry	13.09	12.32	94.1
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	78.53	80.03	101.9
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	22.94	23.35	101.8
D. Agricultural Soils	55.53	56.62	101.9
F. Field Burning of Agricultural Residues	0.06	0.06	87.2
5. Land Use, Land-Use Change and Forestry	0.0008	0.0011	139.1
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0008	0.0011	139.1
F. Other Land	NE	NE	NE
6. Waste	3.56	3.52	98.8
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.51	3.47	98.8
C. Waste Incineration	0.05	0.05	99.9

## Industrial gases

The total emission of HFCs in 1997 by % 58.6 than in 1996. PFCs emissions in 1997 were by app. % 5.6 than in 1996. SF<sub>6</sub> emissions in 1997 were by % 19.3 than in 1996.

## 2.6 Emission trends for indirect greenhouse gases (CO, NO<sub>x</sub> and NMVOC) and SO<sub>2</sub>

Precursors of greenhouse gases e.g. NO<sub>x</sub>, 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<sub>2</sub> 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<sub>2</sub>, NO<sub>x</sub>, NMVOC (1980-2005) and CO (1990-2005). Emissions of SO<sub>2</sub> 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<sub>x</sub> 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<sub>2</sub>. 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<sub>2</sub> and NO<sub>x</sub>.

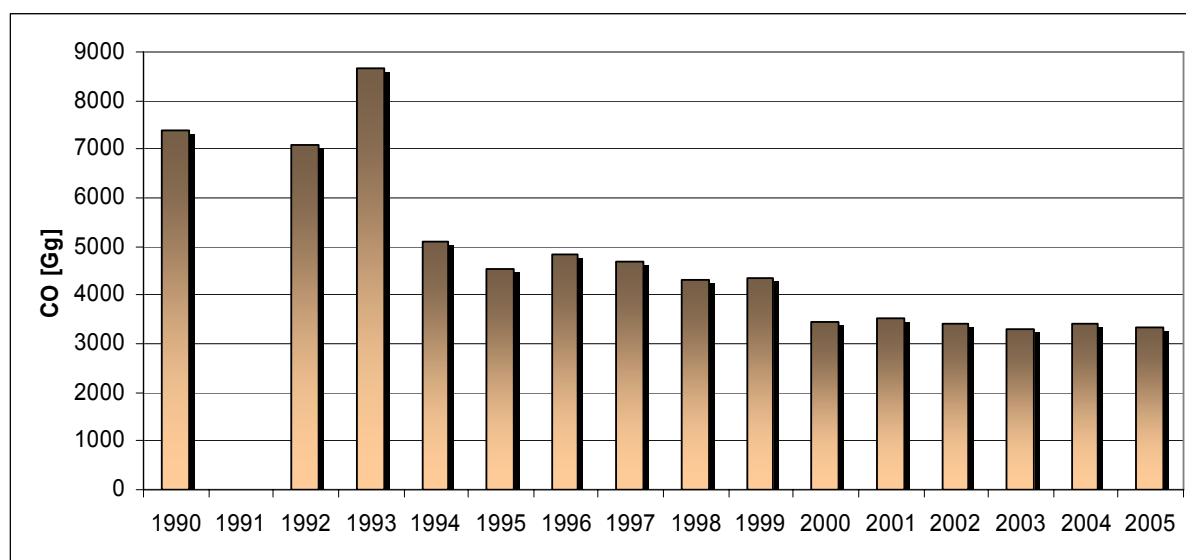


Figure 2.6 Emissions of CO (1990-2005).

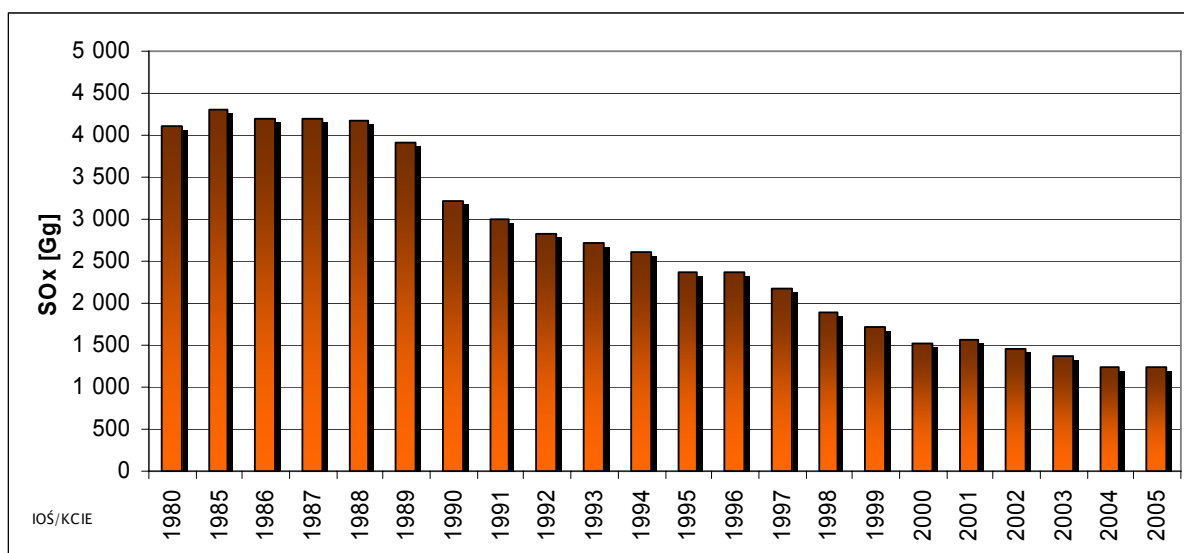


Figure 2.7 Emissions of SO<sub>x</sub>, (1980-2005).

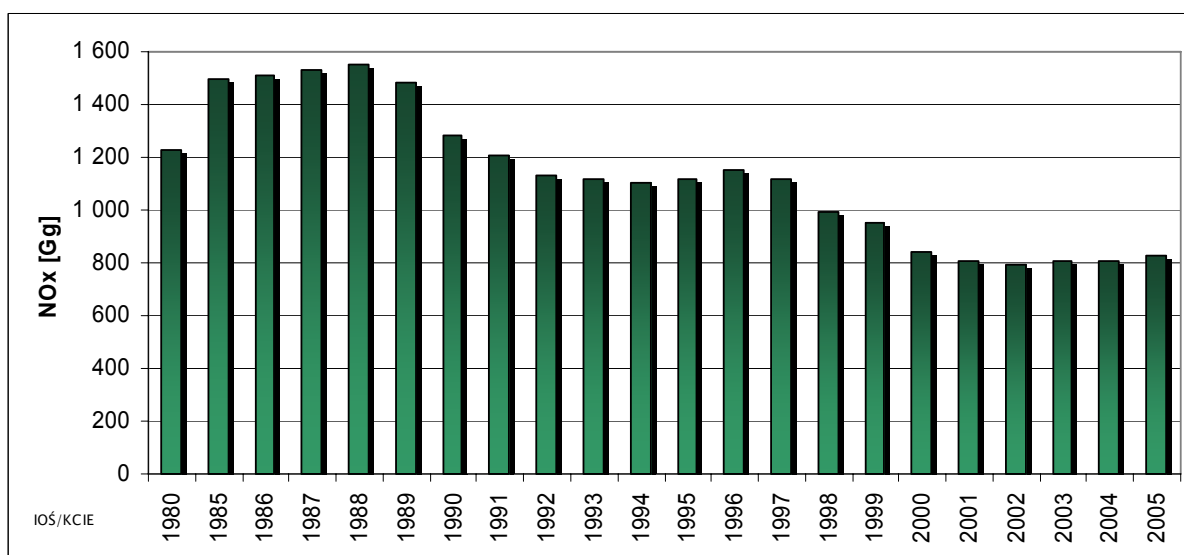


Figure 2.8 Emissions of NO<sub>x</sub>, (1980-2005).

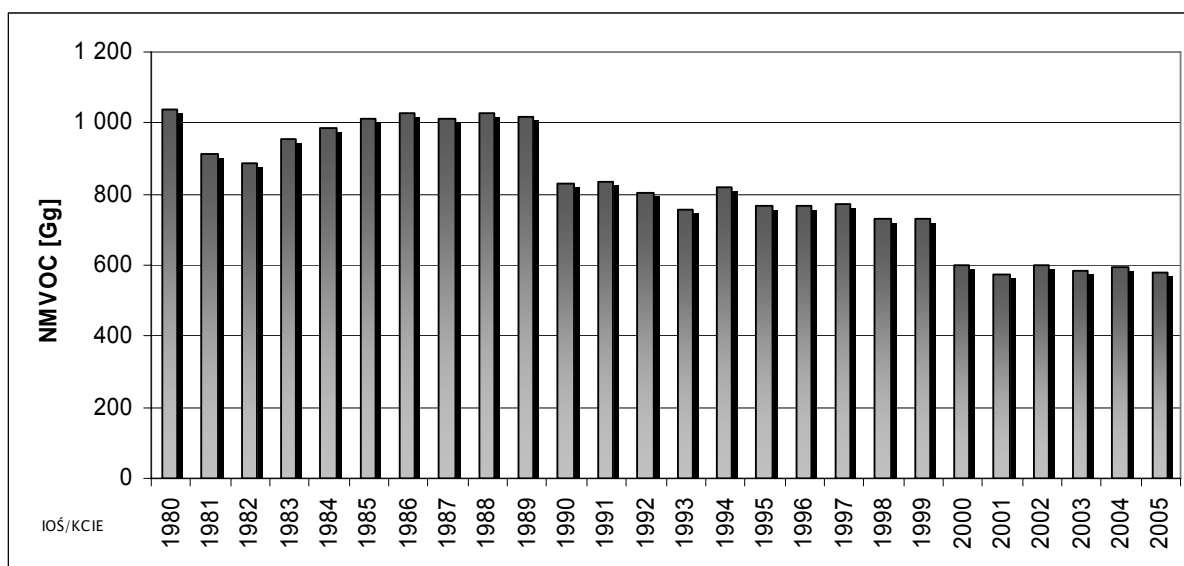


Figure 2.9 Emissions of NMVOC (1980-2005).

### 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<sub>2</sub> emission), share in total GHG emission 72.4%
- 1.A.3.b Transport Road Transportation (CO<sub>2</sub> emission), share in total GHG emission 6.0%
- 1.B.1.a. Coal Mining and Handling (CH<sub>4</sub> emission), share in total GHG emission 2.8%
- 1.B.2.b. Natural Gas (CH<sub>4</sub> emission), share in total GHG emission 0.9%

Share of these categories in total Poland's GHG emissions is 82.1%.

#### 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<sub>max</sub>, the maximum emission factor for CO<sub>2</sub>. 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):

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

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:

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

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

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

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

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

the emission factor for elemental carbon from fuel oil:

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

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

the emission factor for high-methane natural gas:

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

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

the emission factor for nitrified natural gas:

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

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

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

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

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

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

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

Calculation of the CO<sub>2</sub> emission factor, when the  $C_{max}$  [kg C/GJ] is already known is done with the following formula:

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

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

CO<sub>2</sub> 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<sub>4</sub> and N<sub>2</sub>O applied emission factors are default factors taken from [IPCC 1997, 2006]. The emission factors for other pollutants (e.g. NO<sub>x</sub>, 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<sup>1</sup> 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)

---

<sup>1</sup> PKD – (Polska Klasyfikacja Działalności) – Polish Classification of Economic Activities

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

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

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

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

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

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

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

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

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

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

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

#### *Sources of information*

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

- precise determination of activities for categories: 1.A.1, 1.A.2, 1.A.4 and 1.A.5 and
- correct calculation or selection of emission factors for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

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 1999a]
- Energy Balance Poland – OECD [ARE 1998]

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<sub>2</sub> 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 <sub>2</sub>	EF CH <sub>4</sub>	EF N <sub>2</sub> O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Crude Oil	73.30	0.0030	0.0006
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	73.30	0.0030	0.0006
Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
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

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

Fuel	EF CO <sub>2</sub>	EF CH <sub>4</sub>	EF N <sub>2</sub> O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Rafinery Gas	51.30	0.0010	0.0001
Crude Oil	73.30	0.0030	0.0006
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	73.30	0.0030	0.0006
Other Energy Sources	77.22	0.0029	0.0006
Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0100	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Industrial Wastes	143.00	0.0300	0.0040
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

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

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

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

Fuel	EF CO <sub>2</sub>	EF CH <sub>4</sub>	EF N <sub>2</sub> O
LIQUID FUELS			
Fuel Oil		0.0030	0.0006
Liquid Petroleum Gas (LPG)	63.10	0.0010	0.0001
Non-energy Products	76.50	0.0030	0.0006
Feedstocks	57.27	0.0015	0.0006
Other Energy Sources	77.22	0.0029	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	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 [FEWE, 1999]. CO<sub>2</sub> emissions factors for road transport come also from [ITS 1997]. All other emission factors are default values from [IPCC 1997, 2006]. Applied emission factors are presented in the table 3.5.

Other activity data sources are as follows:

- ♦ OECD Energy Balance for Poland, [ARE 1998],
- ♦ Questionnaire/Report G-03, [GUS 1998e],
- ♦ Statistical Yearbook of The Republic of Poland [GUS 1999],
- ♦ Non-published data from Energy Market Agency

Table 3.5 Emission factors [kg/GJ] for transport in 1997

Type of transport	Category code	EF CO <sub>2</sub>	EF CH <sub>4</sub>	EF N <sub>2</sub> O
1.A.3.a.ii Civil Aviation. Domestic	1.i.PL.	70.85	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.85	0.0005	0.0022
1.A.5.b. Other Aviation	1.ii.BL.	72.10	0.060	0.0009
	1.ii.PL.	72.80	0.002	0.0002
1.A.3.b.i Passenger Cars without catalysts	2.i.a.BS	70.75	0.030	0.002
	2.i.a.LG	63.11	0.020	0.0002
	2.i.a.ON	72.78	0.002	0.004
	2.i.b.BS	70.75	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	70.31	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	70.75	0.020	0.001
	2.ii.a.LG	63.11	0.030	0.0002
	2.ii.a.ON	72.78	0.001	0.0040
	2.ii.b.BS	70.75	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	70.31	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	70.75	0.020	0.001
	2.iii.a.ON	72.78	0.006	0.003
	2.iii.b.ON	72.78	0.006	0.003
1.A.3.b.iv Motorcycles	2.iv.BS	70.75	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	70.75	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	72.78	0.004	0.0039
1.A.3.c. Railways	3.ON	73.00	0.004	0.030
	3.WK	75.00	0.006	0.002
1.A.3.d.ii Domestic Navigation - inland	4.ON	73.00	0.004	0.030
1.A.3.d.ii Domestic Navigation - marine	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.3.d.i Domestic Navigation - bunker	5.i.ON	74.10	0.007	0.002
	5.i.OP	77.60	0.007	0.002
1.A.4.c.iii Fishery	5.ii.ON	74.10	0.007	0.002
	5.ii.OP	77.60	0.007	0.002
1.A.4.c.ii Agriculture - Off-Road Vehicles	6.i.ON	73.00	0.004	0.0039
1.A.4.c.ii Agriculture - Machines	6.ii.ON	73.00	0.004	0.030
1.A.2. Off-Road Vehicles in Industry na Other	7.i.ON	73.00	0.004	0.030
1.A.3.e.ii Other Off-Road Transport	7.ii.BS	71.00	0.120	0.002
	7.ii.LG	63.10	0.062	0.0002
	7.ii.ON	73.00	0.004	0.0300

Abbreviation explanations to table 3.5:

catal - catalytic converter

BS - motor gasoline

ON - diesel oil

LG – liquid gas

OP - fuel oil

PL - jet fuel

BL - aviation gasoline.

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

The CO<sub>2</sub> emissions from fuel combustion category was estimated also by use of reference approach characterising “top–down” approach to GHG emissions estimations. The difference between reference and sectoral approaches in CO<sub>2</sub> emissions is 2.48% in favour of sectoral approach [Radwański 2006a]. More data on energy consumption and CO<sub>2</sub> emissions for both approaches are given in annex 6, in CRF table 1.A(c).

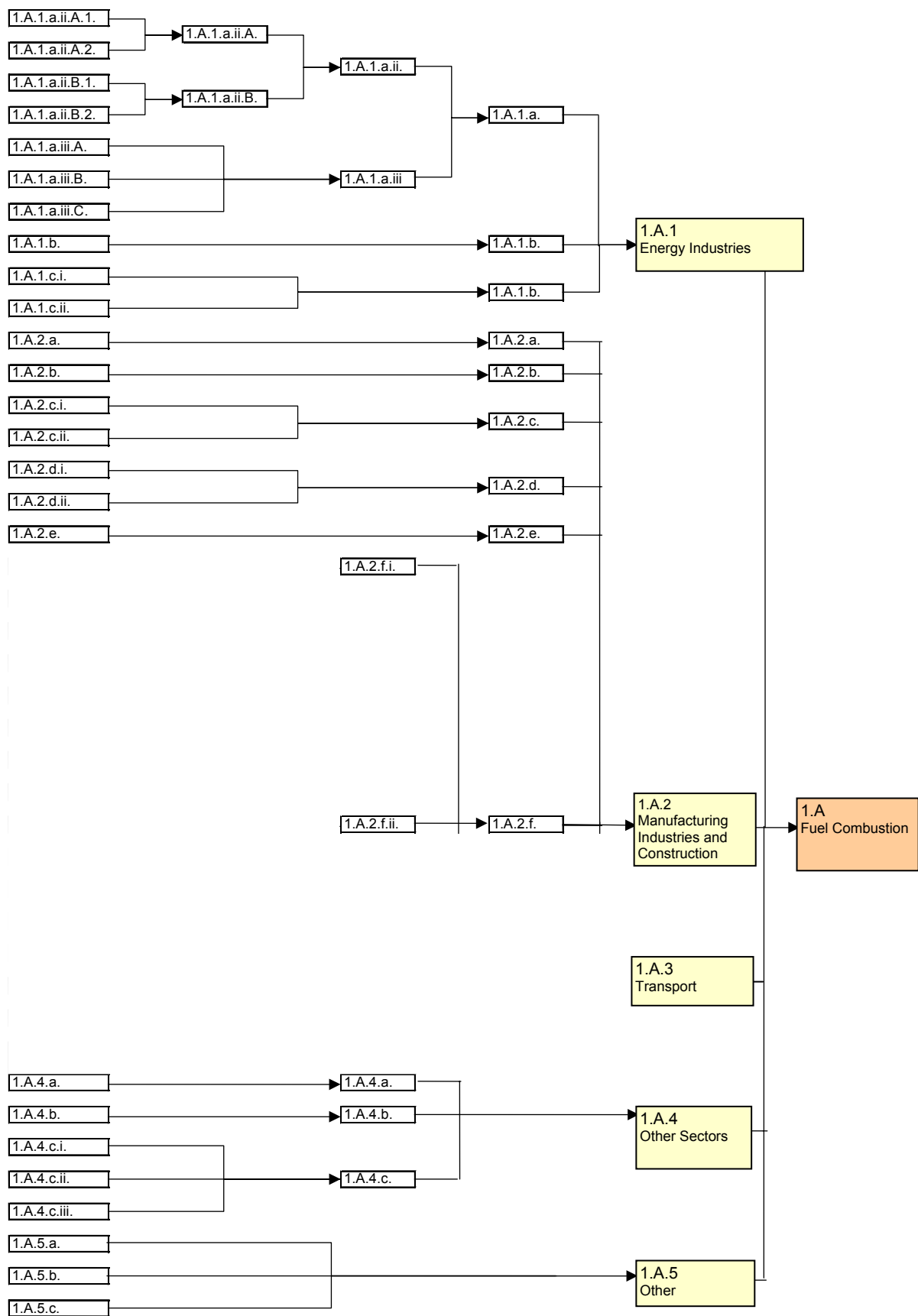


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

### 3.2.2 Fugitive emissions from fuels (CRF 1.B)

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

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

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

Table 3.6. Methane emission factors analysis

Emissions sources	[Gawlik 1994]		[Gawlik 2001]		[Kwarciński 2005]	
	Nm <sup>3</sup> CH <sub>4</sub> /Mg Coal	Nm <sup>3</sup> CH <sub>4</sub> /Mg Coal	Nm <sup>3</sup> CH <sub>4</sub> /Mg Coal	Nm <sup>3</sup> CH <sub>4</sub> /Mg Coal	Nm <sup>3</sup> CH <sub>4</sub> /Mg Coal	Nm <sup>3</sup> CH <sub>4</sub> /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 1997 were used:

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

Table 3.7 contains the data on coal mining as well as methane captured and used for 1997. 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 1997

Coal mining	Methane capture	Methane use	Emission from de-methane systems		
			mln m <sup>3</sup>	mln Nm <sup>3</sup>	Gg CH <sub>4</sub>
132.6	205.2	140.4	64.8	62.66	41.98

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

Fugitive emission of CH<sub>4</sub> from surface mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG, 1998] 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<sup>3</sup> CH<sub>4</sub> / t of extracted coal
- Ventilation emission from surrounding rocks - 0.012 m<sup>3</sup> CH<sub>4</sub> / t of extracted coal.

The conversion factor applied for recalculation of emitted methane volume upto mass of CH<sub>4</sub> is 0.67 kg/m<sup>3</sup>.



### 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 1999a].

Table. 3.8. Emission factors for CO<sub>2</sub> and CH<sub>4</sub> from coke oven gas system

CO <sub>2</sub> emission factors	[Gg/PJ]
gas processing	0.000194
gas transmission	0.020629
gas distribution	0.038056
CH <sub>4</sub> 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 1999a]:

production	PJ	12.286
distribution	Gg	15002

CO<sub>2</sub> and CH<sub>4</sub> 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<sub>2</sub> and CH<sub>4</sub> from oil production and transmission

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

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

Estimation of CO<sub>2</sub> and CH<sub>4</sub> 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 1999a] 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]	65.096
Gas processing	Gas use [PJ]	350.588
Gas transmission	Gas use [PJ]	350.588
Underground gas storage	Gas use [PJ]	350.588
Gas distribution	Gas use [PJ]	350.588
Nitrified natural gas system:		
Gas production	Gas production [PJ]	69.054
Gas processing	Gas use [PJ]	41.712
Gas transmission	Gas use [PJ]	41.712
Gas distribution	Gas use [PJ]	41.712

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<sub>2</sub> and CH<sub>4</sub> from high-methane gas system.

CO <sub>2</sub> 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 <sub>4</sub> 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<sub>2</sub> and CH<sub>4</sub> from nitrified natural gas system.

CO <sub>2</sub> emission factors	[Gg/PJ]
Gas production	0.000060
Gas processing	0.051321
Gas transmission	0.000192
Gas distribution	0.000558
CH <sub>4</sub> 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 (CO<sub>2</sub> emission), share in total GHG emission 1.4%
- 2.B.2. Nitric Acid Production (N<sub>2</sub>O emission), share in total GHG emission 0.8%
- 2.C.1. Iron and Steel Production (CO<sub>2</sub> emission), share in total GHG emission 1.1%

Share of these categories in total Poland's GHG emissions is 3.3%.

### 4.2 Methodological issues

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

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

CO<sub>2</sub> emission from cement production was estimated based on data on clinker production from [GUS 2000b]. The applied emission factor is equal 525 kg / Mg clinker. This country specific emission factor is taken from [IMMB 2006]

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

Emission of CO<sub>2</sub> from lime production was calculated based on data on lime production from [GUS 2000b]. The applied emission factor is equal 785 kg / Mg lime. This is default value given for quicklime (high calcium lime) production in [IPCC 1997].

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

Soda Ash is produced in Poland in the Solvay Process. Emission of CO<sub>2</sub> from this process was assumed as 0. CO<sub>2</sub> 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 1998e]. Value of emission factor taken for inventory calculation it is 415 kg CO<sub>2</sub>/Mg of soda ash used. This emission factor is recommended in [IPCC 1997].

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

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

CO<sub>2</sub> and CH<sub>4</sub> emissions for ammonia production are estimated based on the data on gas and liquid ammonia production from [Radwański 2005]. The CO<sub>2</sub> emission factor (1.5 Mg CO<sub>2</sub>/Mg NH<sub>3</sub>) was taken from [IPCC 1997]. Methane emission factor is 4.9 kg CH<sub>4</sub> /Mg NH<sub>3</sub> produced was taken from [CITEPA 1992]. Emission N<sub>2</sub>O was estimated as 0, according to the study [Kozłowski 2001].

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

Estimation of N<sub>2</sub>O emission from nitric acid production was based on the annual HNO<sub>3</sub> production data from [GUS 2000b]. The applied country specific emission factor, which is equal 6.47 kg/Mg nitric acid [Kozłowski 2001].

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

Activity data concerning calcium carbide production are published in [GUS 2000b]. CO<sub>2</sub> emission factor for this category, which is equal 1.100 Mg CO<sub>2</sub>/ Mg carbide, was taken from [IPCC 1997].

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

##### - *Carbon Black Production*

CH<sub>4</sub> emission from production of black carbon was estimated based on annual black carbon production from [GUS 2000b]. The emission factor, which is equal 10 kg CH<sub>4</sub> /Mg black carbon, was taken from [CITEPA 1992].

##### - *Ethylene Production*

Emission of CO<sub>2</sub> from ethylene production was calculated based on ethylene annual production from [GUS 2000b]. Emission factor was taken from [CITEPA 1992]. Its value is 0.3 kg CO<sub>2</sub> / Mg ethylene produced.

##### - *Caprolactam Production*

Data on annual caprolactam production for inventory calculation purpose was taken from [GUS 2000b]. Applied country specific emission factor of N<sub>2</sub>O, which value is 4.74 kg N<sub>2</sub>O / Mg caprolactam produced, was assessed based on the Polish study [Kozłowski 2001].

#### 4.2.3. Metal Production (CRF 2.C)

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

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

The value of annual iron ore sinter production was taken from [GUS 1998e]. Country specific emission factor of CO<sub>2</sub>, which is equal 73.79 kg CO<sub>2</sub> / 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<sub>2</sub> emission calculation was taken from [GUS 2000b]. Country specific emission factor applied for CO<sub>2</sub> emission estimation is from [FEWE 1994]. Its value is 62 kg CO<sub>2</sub> / Mg steel cast produced.

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

Annual iron cast production for CO<sub>2</sub> emission estimation was taken from [GUS 2000b]. Country specific emission factor applied for CO<sub>2</sub> emission calculation is from [FEWE 1994]. Its value is 61 kg CO<sub>2</sub> / Mg iron cast produced. Applied CH<sub>4</sub> emission factor is 0.20 kg CH<sub>4</sub> / 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<sub>2</sub> from blast furnaces was estimated based on elementary carbon budget in Blast Furnaces Process.

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

Basic oxygen furnace steel production was taken from [GUS 2000b]. Country specific CO<sub>2</sub> emission factor used for inventory report, which value is 11.26 kg CO<sub>2</sub> / Mg steel produced, was calculated in [FEWE 1994] based on composition of gases from basic oxygen furnaces in Polish plants.

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

Annual electric furnace steel production was taken from [GUS 2000b]. Applied CO<sub>2</sub> country specific emission factor is equal 4.30 kg CO<sub>2</sub> / Mg steel produced and it was calculated in [FEWE 1994] based on composition of gases from electric furnaces in Polish plants. CH<sub>4</sub> emission factor, which value is 0.12 kg CO<sub>2</sub> / 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<sub>2</sub> from coking plants was estimated based on elementary carbon budget in coking plants process. CH<sub>4</sub> emission was estimated based on coke production volume from [GUS 2000b] and emission factor is 0.2 kg CH<sub>4</sub> / Mg coke produced [EEA 1996].

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

Emission of CO<sub>2</sub> concerning ferroalloys production was estimated based on annual ferrosilicon production taken from [GUS 2000b]. Applied emission factor, which value is 3900 kg CO<sub>2</sub> / Mg ferrosilicon, was taken from [IPCC 1997] for ferrosilicon – 75% Si.

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

Calculation of CO<sub>2</sub> emission from primary aluminium production is based on the data on aluminium production published in [GUS 2000b]. The emission factor, which is equal 1.8 Mg CO<sub>2</sub> / Mg primary aluminium, was taken from [IPCC 1997] as value recommended for Soderberg Process.

#### 4.2.4. Consumption of Halocarbons and SF<sub>6</sub> (CRF 2.F)

Emissions of HFC, PFCs and SF<sub>6</sub> 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<sub>6</sub> emissions in 1997 are presented in table 4.2. The main source of emission of PFC gases in Poland is aluminium production (table 4.2, marked as bold). Activities on aluminium production were taken from [GUS 2000b]. *Tier 1* method and the following emission factors as in [IPCC 2000] were used for estimation of PFC emissions:

for CF<sub>4</sub> EF = 0.61 kg/Mg aluminium produced

for C<sub>2</sub>F<sub>6</sub> EF = 0.061 kg/Mg aluminium produced

As concerns SF<sub>6</sub> – the only sources estimated in Poland are electrical equipment and sound-proof windows. Because of lack of activity data in use of this gas for 1997 the interpolation method was used based on data from neighboring available years presented in table 4.2 as *Italic* (values marked as underlined were estimated based on mass analysis for 2000–2003). The following emission factors [IPCC 2000] were used for calculation of SF<sub>6</sub> 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<sub>6</sub>

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

## 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<sub>2</sub> emissions within Sector 3, using the common methodology, were carried out on the basis of results of NMVOC emissions [IETU 1998]. from the following activities:

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

CO<sub>2</sub> emission factor was determined assuming, that carbon content in NMVOC is 85%. Then carbon content has been calculated in a stoichiometric way to CO<sub>2</sub>. Calculations were made in accordance with formula:

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

where:

CO<sub>2</sub> – carbon dioxide emission from particular subsectors,

NMVOC – NMVOC emission from particular subsectors.

N<sub>2</sub>O emission from anaesthesiology was taken from the case study [IOŚ 2001].

## 6. Agriculture (CRF sector 4)

### 6.1 Key categories

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

- 4.A. Enteric Fermentation (CH <sub>4</sub> emission), share in total GHG emission	2.3%
- 4.B. Manure Management (N <sub>2</sub> O emission), share in total GHG emission	1.6%
- 4.D.1. Direct Soil Emissions (N <sub>2</sub> O emission), share in total GHG emission	2.8%
- 4.D.3. Indirect Soil Emissions (N <sub>2</sub> O emission), share in total GHG emission	0.9%

Share of these categories in total Poland's GHG emissions is 7.6%.

### 6.2 Methodological issues

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

The emission factors for estimation of CH<sub>4</sub> 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<sub>4</sub> emission factors were estimated for each livestock subcategory within cattle: dairy cows and non-dairy cattle disaggregated for: calves (under 6 months), young cattle (6–12 months) and other cattle (1 year and over). Also domestic emission factor for sheep was estimated based on disaggregating this livestock group for lambs under one year and mature sheep above one

year. The emission factors for other livestock like goats, horses and swine come from [IPCC 1997].

CH<sub>4</sub> 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 1999]. For goats population activity was taken as a mean for years 1996 and 1998 because of lack of data for 1997.

The calculated Gross Energy Intake (GE) values and applied emission factors expressed in kg CH<sub>4</sub> 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<sub>4</sub> emissions factors in 1997

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH <sub>4</sub> / animal / year]
4.A Enteric Fermentation	26.673	---	---
1 Cattle	7.307	---	---
a. Dairy cattle	3.490	229.577	90.346
b Non-dairy cattle	3.817	103.5910	40.766
3 Sheep	0.491	18.668	8.279
4 Goats	0.182	---	5.000
6 Horses	0.558	---	18.000
8 Swine	18.135	---	1.500

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

The IPCC *Tier 2* methodology was used to establish domestic CH<sub>4</sub> 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 1999]. For goats population activity was taken as a mean for years 1996 and 1998 because of lack of data for 1997.

Table 6.2. Livestock population, volatile solids excreted (Vs) and CH<sub>4</sub> emissions factors

Livestock	Population [millions]	Vs Volatile Solids Excreted [kg dm /animal/ day]	EF Emission Factor [kg CH <sub>4</sub> / animal / year]
4.B Manure Management	230.258	---	---
1 Cattle	7.307	---	---
a. Dairy cattle	3.490	4.509	5.060
b Non-dairy cattle	3.817	1.732	1.546
3 Sheep	0.491	0.372	0.173
4 Goats	0.182	0.280	0.120
6 Horses	0.558	1.720	1.390
8 Swine	18.135	0.500	6.536
9 Poultry	203.585	0.100	0.078

The factors recommended for cool climate were used. The country specific CH<sub>4</sub> 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<sub>0</sub> (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<sub>2</sub>O emission calculation from manure management was taken from [GUS 1999]. For goats population activity was taken as a mean for years 1996 and 1998 because of lack of data for 1997.

The fractions of manure managed in given AWMS for each type of animals, taken from [Myczko 2001] and [Walczak 2003, 2006], are presented in the table 6.3.

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

Livestock	Type of AWMS		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0240	0.8147	0.1613
Non-dairy cattle	0.0302	0.8378	0.1320
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<sub>2</sub>O 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	0.0240	5863.200
1.b. Non-dairy cattle	50.0	0.0302	5763.670
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2863	103841.010
9 Poultry	0.6	0.2000	24430.158



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	0.8147	199023.067
1.b. Non-dairy cattle	50.0	0.8378	159894.130
3 Sheep	16.0	0.5000	3928.000
4 Goats	25.0	0.9000	4104.000
6 Horses	25.0	0.9000	12555.000
8 Swine	20.0	0.7137	258858.990
9 Poultry	0.6	0.8000	97720.631

Table 6.5. Factors of N<sub>2</sub>O–N emission for various manure management systems

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

#### 6.2.4. Agricultural Soils (CRF 4.D)

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

###### 6.2.4.1.1. N<sub>2</sub>O from synthetic fertilisers (CRF 4.D.1.1)

N<sub>2</sub>O emission from synthetic fertilisers was estimated based on the amount of synthetic fertiliser nitrogen applied to agricultural fields published in [GUS 1999]. The nitrogen fraction converted to N<sub>2</sub>O was estimated as 0.9 (1–0.1 Frac<sub>gasf</sub> – see 4.D.3) and this is default value from [IPCC 1997]. The country specific emission factor (0.008 kg N<sub>2</sub>O-N / kg N applied) taken from [Mercik 2001] was corrected for 0.009 kg N<sub>2</sub>O-N / kg N as the previous one included the fraction of nitrogen that is emitted as NO<sub>x</sub> + NH<sub>3</sub>.

###### 6.2.4.1.2. N<sub>2</sub>O 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 1999] 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<sub>2</sub>O 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<sub>x</sub> and NH<sub>3</sub> (0.2 kg NH<sub>3</sub>-N + NO<sub>x</sub>-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<sub>2</sub>O from N-fixing crops* (CRF 4.D.1.3)

N<sub>2</sub>O emission from N-fixing crops was calculated based on the data on sown area of N-fixing crops, published in [GUS 1999]. According to study [Mercik 2001] 1% of nitrogen fixed by papilionaceous plants is denitrificated to N<sub>2</sub>O and in this connection the used emission factor value is 0,010 N<sub>2</sub>O-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<sub>2</sub>O 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<sub>2</sub>O from crop residue* (CRF 4.D.1.4)

Emission of N<sub>2</sub>O 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<sub>2</sub>O-N/ kg N contained in residues. Data on sown area of other than N-fixing crops are published in [GUS 1999].

#### 6.2.4.1.5. *N<sub>2</sub>O 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<sub>2</sub>O emission from cultivation of histosols was estimated based on default emission factor for Mid-Latitude Organic Soils from [IPCC 2000]: 8 kg N<sub>2</sub>O-N /ha.

#### 6.2.4.2. *N<sub>2</sub>O from pasture, range and paddock manure* (CRF 4.D.2)

Animal population for calculation of N<sub>2</sub>O emission from pasture range and paddock was taken from [GUS 1999]. 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<sub>2</sub>O 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<sub>2</sub>O–N emission

Livestock	Nitrogen excretion N <sub>ex</sub> [kg/head/yr]	Fraction of manure nitrogen per AWMS [ % / 100 ]	Nitrogen excreted in AWMS [ kg N / year / 1000 ]	EF Emission factor for AWMS [kg N <sub>2</sub> O-N/ kg N ]
1.a. Dairy cattle	70.0	0.16	39413.733	
1.b. Non-dairy cattle	50.0	0.13	25192.200	
3 Sheep	16.0	0.50	3928.000	
4 Goats	25.0	0.10	456.000	
6 Horses	25.0	0.10	1395.000	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	70384.933	0.020

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

The *Tier 1a* method was used for assessing indirect emissions of N<sub>2</sub>O for 1997 in Poland. The basic equation for estimating a country's indirect N<sub>2</sub>O emissions:

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

where:

$N_2O_{\text{indirect} \rightarrow N}$  – emissions of N<sub>2</sub>O in units of nitrogen,

$N_2O_{(G) \rightarrow N}$  – N<sub>2</sub>O 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<sub>2</sub>O produced from leaching and runoff of applied fertiliser and animal manure N (kg N/year).

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

Atmospheric deposition of nitrogen compounds fertilises soils and surface waters. It results in enhanced biogenic N<sub>2</sub>O formation. According to this methodology the amount of N applied to soils is equal to the total amount of synthetic fertiliser nitrogen applied to soils plus the total amount of animal manure nitrogen excreted in country. Those values have to be multiplied by appropriate volatilisation factors. This sum is then multiplied by an emission factor (table 6.7). Calculations were made according to the following equation:

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

where:

$N_2O_{(G) \rightarrow N}$  – N<sub>2</sub>O produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as nitrogen compounds,

$N_{\text{FERT}}$  – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1999],

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

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

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

EF – emission factor for N<sub>2</sub>O emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of N<sub>2</sub>O–N from atmospheric deposition

$N_{\text{fert}}$ [Gg/year]	$\text{Frac}_{\text{GASF}}$ [kg N/kg N]	$N_{\text{ex}}$ [kgN/year/1000]	$\text{Frac}_{\text{GASM}}$ [kg N/kg N]	EF [kgN <sub>2</sub> O-N/kg N]	$N_2O_{(G) \rightarrow N}$ [GgN <sub>2</sub> O-N]
890	0.1	70384.93	0.2	0.01	1.03

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

Part of the nitrogen is lost from agricultural soils through leaching and runoff, and gets to the groundwater, rivers and wetlands. It results in biogenic production of N<sub>2</sub>O. To estimate the amount of applied N that leaches or runs off, the total amount of synthetic fertiliser nitrogen

and the total amount of animal N excretion must be summed and then multiplied by a fraction of N input, that is lost through leaching and runoff. Then it must be multiplied by an appropriate emission factor (table 6.8). Calculations were made according to the following equation:

$$N_2O_{(L) \rightarrow N} = (N_{FERT} + N_{ex}/1000) * \text{Frac}_{LEACH} * EF,$$

where:

$N_2O_{(L) \rightarrow N}$  –  $N_2O$  produced from leaching and runoff of applied fertiliser and animal manure N,

$N_{FERT}$  – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1999],

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

$\text{Frac}_{LEACH}$  – 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  $N_2O-N$  from nitrogen leaching and run-off

$N_{fert}$ [Gg/year]	$N_{ex}$ [kgN/year /1000]	$\text{Frac}_{LEACH}$ [kg N/kg N]	$EF$ [kg $N_2O-N$ /kg N]	$N_2O_{(L) \rightarrow N}$ [Gg $N_2O-N$ ]
852	72 507.16	0.3	0.025	6.934

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

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

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

$CH_4$  and  $N_2O$  emissions from burning of agricultural residues in fields were estimated based on methodology described in [IPCC 1997]. For domestic purposes there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits [Łoboda *et al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 1999]. 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<sub>4</sub> and N<sub>2</sub>O 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 <sub>4</sub>	N <sub>2</sub> O
							[Gg/Gg]	[Gg/Gg]
wheat	1.45	0.86	0.005	0.90	0.4853	0.014	0.0032	0.0001
rye	1.60	0.87	0.005	0.90	0.4800	0.011	0.0032	0.0001
barley	1.25	0.86	0.005	0.90	0.4567	0.015	0.0030	0.0001
oats	1.50	0.89	0.004	0.90	0.4700	0.016	0.0031	0.0001
triticale	1.50	0.86	0.005	0.90	0.4853	0.013	0.0032	0.0001
cereal mixed	1.40	0.87	0.004	0.90	0.4730	0.015	0.0032	0.0001
buckwheat & millet	1.70	0.86	0.002	0.90	0.4500	0.020	0.0030	0.0001
maize	1.30	0.50	0.002	0.90	0.4709	0.020	0.0031	0.0001
edible pulses	1.50	0.88	0.001	0.90	0.4500	0.040	0.0030	0.0002
feed pulses	2.00	0.85	0.001	0.90	0.4500	0.045	0.0030	0.0002
potatoes	0.30	0.25	0.100	0.85	0.4226	0.048	0.0028	0.0002
rape	2.35	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
other oil-bearing crops	3.50	0.87	0.030	0.90	0.4500	0.015	0.0030	0.0001
flax straw	0.25	0.86	0.001	0.90	0.4500	0.016	0.0030	0.0001
tobacco	1.28	0.50	0.002	0.85	0.4500	0.040	0.0030	0.0002
hop	4.00	0.25	0.020	0.90	0.4500	0.035	0.0030	0.0002
hay from greenland	0.05	0.23	0.001	0.90	0.4500	0.044	0.0030	0.0002
hay from pulses	0.05	0.23	0.001	0.90	0.4500	0.045	0.0030	0.0002
hay from legumes	0.05	0.23	0.001	0.90	0.4500	0.061	0.0030	0.0003
tomatoes	0.60	0.15	0.050	0.85	0.4500	0.050	0.0030	0.0002
other ground veget.	0.35	0.15	0.010	0.90	0.4500	0.055	0.0030	0.0003
veget. cult. under cover	0.40	0.35	0.010	0.90	0.4500	0.060	0.0030	0.0003
apples	1.50	0.35	0.050	0.90	0.4500	0.033	0.0030	0.0002
pears & other	1.50	0.35	0.070	0.90	0.4500	0.033	0.0030	0.0002
plums	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
sweet cherries	1.50	0.35	0.100	0.90	0.4500	0.033	0.0030	0.0002
strawberries	0.50	0.18	0.010	0.90	0.4500	0.033	0.0030	0.0002
raspberries	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
currants	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002
gooseberries & other	1.20	0.30	0.250	0.90	0.4500	0.033	0.0030	0.0002

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

### 7.1 Key categories

Sector 5 is not analyzed in key source analyses.

### 7.2 Methodological issues

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

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

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

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

Table 7.1. Total CO<sub>2</sub> emissions and removals from Land Use Change and Forestry in 1996 and 1997 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1996			1997		
	Net CO <sub>2</sub> emissions/ removals	CH <sub>4</sub>	N <sub>2</sub> O	Net CO <sub>2</sub> emissions/ removals	CH <sub>4</sub>	N <sub>2</sub> O
	(Gg)			(Gg)		
5. Total Land-Use Categories	-33 893.69	0.113	0.001	-31 509.81	0.157	0.001
5A. Forest Land	-39 673.32			-37 775.81		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	5 031.73			5 806.80		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	2 791.98			3 222.04		
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	-2 044.09	0.113	0.001	-2 762.84	0.157	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<sub>2</sub> emissions and removals from sector 5. Land Use Change and Forestry in 1996 and 1997 [IPCC 1997]

Greenhouse gas source and sink categories	1996					1997				
	CO <sub>2</sub> emissions	CO <sub>2</sub> removals	Net CO <sub>2</sub> emissions/removals	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub> emissions	CO <sub>2</sub> removals	Net CO <sub>2</sub> emissions/removals	CH <sub>4</sub>	N <sub>2</sub> O
	Gg					Gg				
5. Total Land-Use Change and Forestry	45 197,00	-79 090,69	-33 893,69	0,113	0,001	48 789,78	-80 299,59	-31 509,81	0,157	0,001
5A. Changes in Forest and Other Woody Biomass Stocks	38 707,67	-62 072,35	-23 364,68			41 245,15	-62 484,18	-21 239,03		
1. Tropical Forests										
2. Temperate Forests	38 707,67	-62 072,35	-23 364,68			41 245,15	-62 484,18	-21 239,03		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	44,63		44,63			52,69		52,69		
1. Tropical Forests										
2. Temperate Forests	44,6			0,113	0,001	52,7			0,157	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 <sub>2</sub> Emissions and Removals from Soil	6 444,69	-17 018,34	-10 573,64			7 491,94	-17 815,41	-10 323,47		
Cultivation of Mineral Soils	6 444,69		6 444,69			7 491,94		7 491,94		
Cultivation of Organic Soils										
Liming of Agricultural Soils		1 379,0	1 379,02				1 536,9	1 536,90		
Forest Soils		-16 308,63	-16 308,63				-16 536,78	-16 536,78		
Other Land (please specify)		-2 088,72	-2 088,72				-2 815,53	-2 815,53		
5E. Other (please specify)										



According to calculation for 1997, Sector 5. Land-Use Change and Forestry, was net CO<sub>2</sub> sink. Removals/emissions balance decreased from 33 894 Gg CO<sub>2</sub> in 1996 to 31 510 Gg CO<sub>2</sub> in 1997 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 1997 net CO<sub>2</sub> removals decreased to 21 239 Gg CO<sub>2</sub> from about 23 365 Gg CO<sub>2</sub> in 1996. This change was caused by harvest of thick increase (about 1.47 million m<sup>3</sup> 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<sup>3</sup>/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 1997 this category was a net CO<sub>2</sub> emissions and accounted for about 53 Gg CO<sub>2</sub>. Net emission in year 1997 was higher than in 1996 and it was caused by lessening forest area transmitted into non-forest tasks.

Emissions ratios for calculation CH<sub>4</sub>, N<sub>2</sub>O, CO and NO<sub>x</sub> emissions from biomass burning are presented in table below.

Table 7.4. Emissions ratios for calculation CH<sub>4</sub>, N<sub>2</sub>O, CO and NO<sub>x</sub> emissions from biomass burning.

Compound	Ratio		
CH <sub>4</sub>	0.012	default	[IPCC 1997]
CO	0.060	default	[IPCC 1997]
N <sub>2</sub> O	0.007	default	[IPCC 1997]
NO <sub>x</sub>	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<sub>2</sub> 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<sub>2</sub> Emissions and Removals from Soil (old CRF 5.D)

GHG balance in this category is a net sink. It is mainly caused by afforestation of agriculture lands. In 1997 net CO<sub>2</sub> sink was about 10 323 Gg CO<sub>2</sub> and was lower by about 250 Gg CO<sub>2</sub> than in previous year.

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

Soil types occurring in Poland are as follow.

#### **Forests soils**

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

Table 7.5. Forest soils type occur in Poland.

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

### ***Agriculture soils***

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

**Table 7.6. Agricultural land by soil valuation classes**

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

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

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

**Table 7.8. Area of soil type by land use system in 1997**

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.562
	Low Activity Soils	70.0	1.709
	Sandy	30.0	3.347
	Wetland	230.0	0.378
Sum			8.996
Grassland/Rangeland	High Activity Soils	90.0	0.580
	Low Activity Soils	60.0	1.712
	Sandy	25.0	1.252
	Wetland	120.0	0.425
Sum			3.969
Agricultural crops	High Activity Soils	70.0	4.003
	Low Activity Soils	60.0	5.364
	Sandy	25.0	2.766
	Wetland	120.0	1.610
Sum			13.743
Other land	High Activity Soils	56.0	0.997
	Low Activity Soils	48.0	1.874
	Sandy	20.0	1.178
	Wetland	96.0	0.511
Sum			4.561
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<sub>2</sub> emissions and removals by soils is approximate and will be corrected by new methodology presented in [IPCC 2003]. Emissions and removals from soils were calculated separately, then the net emission/removal balance was estimated.

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

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

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

where:

M<sub>limestone</sub> - annual amount of sold calcic limestone [Mg/yr],

M<sub>dolomite</sub> - annual amount of sold calcic dolomite [Mg/yr],

EF<sub>limestone</sub> - emission factor for limestone – 0.120 [Mg C/ Mg limestone],

EF<sub>dolomite</sub> - 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<sub>3</sub>)<sub>2</sub>) contains 89.1% of CaCO<sub>3</sub> and 10.9% of MgCO<sub>3</sub>. Carbon (C) is converted to carbon-dioxide (CO<sub>2</sub>) 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 (CH <sub>4</sub> emission), share in total GHG emission | 1.3% |
| - 6.B. Wastewater Handling (CH <sub>4</sub> emission), share in total GHG emission          | 1.2% |

Share of these categories in total Poland's GHG emissions is 2.4%.

### 8.2 Methodological issues

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

The methane emissions from solid waste disposals in 1995 were calculated using the IPCC Waste Model published in [IPCC 2006]. The model establish multiyear series when methane is generated from organic matter decomposition in anaerobic conditions. The emission of CH<sub>4</sub> is diminished by recapturing of this gas.

The following indicators were used for estimation of CH<sub>4</sub> emissions:

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

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

Table 8.1. DOC and  $DOC_f$  indicators

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

Table 8.2. MCF indicators of organic carbon in disposed waste

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

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

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

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

- Population – number of population was taken from [GUS 1999]
- Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. The same method was used for 1976. In domestic statistics data were given in  $dm^3$ . To recalculate data into Gg a conversion factor was used. According to GUS this conversion factor is  $0.25 \text{ t/m}^3$ .

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]

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 1998d] 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 CH<sub>4</sub> emission estimation from Industrial Wastewater Handling

Industry sectors		Degradable organic component (BOD) [kg / dm <sup>3</sup> ]	Fraction of wastewater treated by anaerobically method	Maximum methane producing capacity [Gg CH <sub>4</sub> / 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<sub>4</sub> 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 1998d]. Default value of organic load in biochemical oxygen demand per person, which is equal to 60 g BOD/person/day [IPCC 2000], was taken for the calculations. Fraction of BOD that readily settles and is removed as sludge was estimated basing on the report [Bernacka 2003] and its value was 0.747 (for this estimation the country specific value of BOD = 357 g O<sub>2</sub>/m<sup>3</sup> 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<sub>4</sub> / kg BOD
- for sewage sludge: 0.394 kg CH<sub>4</sub> / kg BOD.

The default value (0.6 kg CH<sub>4</sub> / kg BOD) of maximum methane producing capacity was applied for estimation of sludge and wastewater emission factors. Fractions of wastewater and sludge anaerobically treated with and without methane recovery are estimated according to [Bernacka 2003]. These value are as follows: percentage of wastewater anaerobically treated – 5%, fractions of sludge anaerobically degraded – 65.6% of which with methane recovery – 31.5%.

### 8.2.3. Waste Incineration (CRF 6.C)

Waste incineration was estimated based on IPCC methodology [IPCC 2000] and domestic case study [Wielgościński 2003]. Emission factors as default were taken from [IPCC 2000]. For 1997 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1998d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1998] as well as on annual mean use of hospital bed [GUS 1998]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].



## References

- ARE (1998). Fuel balance according to OECD structure. Agency of Energy Market, Warsaw, 1998.
- Bernacka (2003). Bernacka J., Pawłowska L. Elaboration and analysis of data regarding GHG emissions from municipal wastewater management. Institute of Environmental Protection, 2003 (in Polish).
- BULiGL (1992). Results of updating forest area and woody biomass in State Forests At 1 January 1992. Office for Forest Planning and Management. Warsaw. 1992. (in Polish)
- CITEPA (1992). Default Emission Factors Handbook, CORINAIR INVENTORY, CITEPA, Paris, 1992.
- Czuraj M. (1991). Tables of log volume of butt end and standing trees. PWRiL. Warsaw. 1991 (in Polish).
- EEA (1996). EMEP/CORINAIR The Atmospheric Emission Inventory Guidebook. 1996.
- EEA (2002). EMEP/CORINAR. The Atmospheric Emission Inventory Guidebook. 3rd Ed., European Environmental Agency. 2002.
- EEA (2004). EMEP/CORINAIR Emission Inventory Guidebook. 2004.
- FAOSTAT (2006). FAOSTAT data base, 2006,  
<http://faostat.fao.org/site/502/DesktopDefault.asp1990?PageID=502>.
- FEWE (1994). Determination of GHG emission factors from fuel combustion in industrial technology processes. Foundation on Effective Energy Use – FEWE, 1994. (in Polish).
- FEWE (1999). Inventory of emission and sinks of GHG: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs and SF<sub>6</sub> in Poland in 1997 r., FEWE, Warsaw, 1999 (in Polish).
- Fudała (1994). Fudała J., Hławiczka S., Cenowski M., Butniewicz K. Establishment of a list of sources of the emission of greenhouse gases (in surface industrial activities). determination of emission factors for these sources and calculation of emission for the last year, as well as submission of a methodology for the updating of information. 1994. (in Polish).
- Gawlik (1994). Gawlik L. et al. (1994). Establishment of GHG sources related to handling of coal (hard and brown coal) system and estimation of emission factors in emission system sources; emission calculation for the last year applying OECD/IPCC methodology and current methodology information actualisation. Cracow 1994. (in Polish).
- Gawlik (2001). Gawlik. L., Grzybek I. Study on GHG fugitive emission from the hard coal system. 2001. (in Polish).
- Górka (1991). Górka W., Zajączkowski K., Zajączkowska B. Estimation of wood stock in stand density in Poland. Forest Research Institute. 1991. (in Polish).
- GUS (1974). Statistical Yearbook of The Republic of Poland 1974. GUS, 1974.
- GUS (1985). Statistical Yearbook of The Republic of Poland 1985. GUS. Warsaw, 1985.
- GUS (1981d). Environmental Protection. GUS, Warsaw 1981.
- GUS (1986d). Environmental Protection. GUS, Warsaw 1986.
- GUS (1987). Statistical Yearbook of The Republic of Poland 1987. GUS. Warsaw, 1987.
- GUS (1989d). Environmental Protection. GUS, Warsaw 1989.

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

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

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

GUS (1997z). Use of mineral and lime fertilisers in 1996/1997. Warsaw 1997.

GUS (1998). Statistical Yearbook of The Republic of Poland 1998. GUS, Warsaw 1998.

GUS (1998a). Energy Statistics 1996-1997, GUS, Warsaw 1998.

GUS (1998c). Forestry. GUS. Warsaw, 1998.

GUS (1998d). Environmental Protection 1998. GUS. Warsaw, 1998.

GUS (1998d). Environmental Protection 1998. GUS. Warsaw, 1998.

GUS (1998e). Questionnaire/Report G-03. Selected data from energy statistic system. GUS 1998.

GUS (1999). Statistical Yearbook of The Republic of Poland 1999. GUS, Warsaw 1999.

GUS (1999a). Energy Statistics 1997-1998, GUS, Warsaw 1999.

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

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

GUS (2001r). Statistical Yearbook of Agriculture 2001. GUS, Warsaw 2001.

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

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

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

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

IETU (1999). Emission inventory for 1997 connected with LRTAP Convention. NMVOC and heavy metals emission, 1999

IMMB (2006). Cement sector in Poland. Allocation plan of CO<sub>2</sub> allowances in frames of NAP for 2008-2012. Institute for Mineral Building Materials, Opole, 2006.

IOŚ (2001). Strategy of reduction of GHG emission until 2020 in the division into separate gases (N<sub>2</sub>O, HFCs, PFCs i SF<sub>6</sub>) and sectors. IOŚ, 2001 (in Polish)

IOŚ (2002). Emission Inventory of SO<sub>2</sub>, N<sub>2</sub>O, NH<sub>3</sub>, CO, PMs, HMs, MNVOCs and POPs in Poland in 2000, IOŚ, 2002

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

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

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

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

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

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

Kozłowski (2001). Kozłowski K. Strategy of reduction of N<sub>2</sub>O emission in industry processes. (Part of the report: Radwański E. et al. - Strategy of reduction of GHG emission until 2020 in the division into separate gases (N<sub>2</sub>O, HFCs, PFCs i SF<sub>6</sub>) and sectors up to 2020. (in Polish) 2001.

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

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

Łoboda (1994). Łoboda T., Pietkiewicz S. Estimation of amount of CH<sub>4</sub>, CO, N<sub>2</sub>O and NO<sub>x</sub> released to atmosphere from agricultural residues burning in 1992, Warsaw Agricultural University, 1994 (in Polish).

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

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

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

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

PIG (1998): Balance of mineral resources and underground water in Poland. Polish Geological Institute. Warsaw, 1998 (in Polish)

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

Radwański E. (1999). Radwański E., Szkudlarski S., Kozakiewicz J., Mąkosa J. (1999) Inventory of emission and sinks of GHG: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs and SF<sub>6</sub> in Poland in 1997. Warsaw, FEWE 1999.

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

Radwański E. 2006a. Estimation of emissions of C-CO<sub>2</sub> according to Reference Approach. Warsaw, 2006. (in Polish).

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

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

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

Walczak (2003). Walczak J. Correction of N<sub>2</sub>O emissions in agriculture, in: Realization of tasks of National Emission Centre in the emission inventory. Institute of Environmental Protection, (in Polish) 2003.

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

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

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

## **ANNEXES**

## Annex 1. Key sources

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

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

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

Emission from these sources made up 74.7% of the total GHG emissions in Poland expressed in units of CO<sub>2</sub> equivalents. Combustion of solid, gaseous and liquid fuels in stationary sources, made up 72.38% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 63.0% 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 74.71%.

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

### Level Assessment

		IPCC Source Categories	Direct GHG	Current Year Estimate	Level Assessment	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO <sub>2</sub>	291042.40	0.6302	0.63
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO <sub>2</sub>	27715.74	0.0600	0.69
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO <sub>2</sub>	26295.52	0.0569	0.75
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO <sub>2</sub>	16972.32	0.0367	0.78
5	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH <sub>4</sub>	12953.84	0.0280	0.81
6	4.D.1	4.D.1. Direct Soil Emissions	N <sub>2</sub> O	12854.17	0.0278	0.84
7	4.A	4.A. Enteric Fermentation	CH <sub>4</sub>	10775.81	0.0233	0.86
8	4.B	4.B. Manure Management	N <sub>2</sub> O	7239.71	0.0157	0.88
9	2.A.1	2.A.1 Cement Production	CO <sub>2</sub>	6687.98	0.0145	0.89
10	6.A	6.A. Solid Waste Disposal on Land	CH <sub>4</sub>	5897.04	0.0128	0.91
11	6.B	6.B. Wastewater Handling	CH <sub>4</sub>	5333.27	0.0115	0.92
12	2.C1	2.C.1. Iron and Steel Production	CO <sub>2</sub>	5039.07	0.0109	0.93
13	4.D.3	4.D.3. Indirect Soil Emissions	N <sub>2</sub> O	4010.97	0.0087	0.94
14	1.B.2.b.	1.B.2.b. Natural Gas	CH <sub>4</sub>	3984.70	0.0086	0.95
15	2.B.2	2.B.2. Nitric Acid Production	N <sub>2</sub> O	3627.31	0.0079	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	291042.40	0.6302	0.0669	33.4862	0.33
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	27715.74	0.0600	0.0415	20.7484	0.54
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	26295.52	0.0569	0.0143	7.1402	0.61
4	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	16972.32	0.0367	0.0130	6.5060	0.68
5	6.B	6.B. Wastewater Handling	CH4	2170.23	5333.27	0.0115	0.0100	4.9912	0.73
6	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	5897.04	0.0128	0.0069	3.4769	0.76
7	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	1586.16	0.0034	0.0066	3.2874	0.80
8	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	654.21	0.0014	0.0055	2.7347	0.82
9	4.A	4.A. Enteric Fermentation	CH4	15954.36	10775.81	0.0233	0.0049	2.4498	0.85
10	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	12953.84	0.0280	0.0043	2.1613	0.87
11	2.A.1	2.A.1 Cement Production	CO2	7028.18	6687.98	0.0145	0.0032	1.5931	0.89
12	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	4010.97	0.0087	0.0026	1.2779	0.90
13	2.A.2	2.A.2. Lime Production	CO2	3477.55	1975.06	0.0043	0.0021	1.0485	0.91
14	1.B.2.b.	1.B.2.b. Natural Gas	CH4	4111.13	3984.70	0.0086	0.0021	1.0318	0.92
15	4.B	4.B. Manure Management	CH4	3435.39	3336.12	0.0072	0.0017	0.8710	0.93
16	2.B.1.	2.B.1. Ammonia Production	CO2	3516.60	3377.40	0.0073	0.0017	0.8398	0.94
17	4.D.2	4.D.2. Animal Production	N2O	1575.89	685.75	0.0015	0.0015	0.7632	0.94
18	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	12854.17	0.0278	0.0013	0.6361	0.95

## Annex 2. 1997 Energy balance data for main fuels

Energy balances in 1997 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 <sup>3</sup> Mg	TJ
<b>In</b>	<b>63 180</b>	<b>543 995</b>
From national sources	63 170	543 906
1) Indigenous production	63 169	543 899
2) Transformation output or return	0	0
3) Stock decrease	1	7
Import	10	89
<b>Out</b>	<b>63 181</b>	<b>543 994</b>
National consumption	63 144	537 454
1) Transformation input	62 519	531 963
a) input for secondary fuel production	136	1 317
b) fuel combustion	62 383	530 646
2) Direct consumption	625	5 491
Non-energy use	0	0
Combusted directly	625	5 491
<b>Combusted in Poland</b>	<b>63 008</b>	<b>536 137</b>
Stock increase	0	0
Export	37	319
Losses and statistical differences	0	6 221
Net calorific value	MJ/kg	8.51
CO <sub>2</sub> Emission Factor	kg/GJ	114.25

### Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10 <sup>3</sup> Mg	TJ
<b>In</b>	<b>6 573</b>	<b>284 747</b>
From national sources	5 392	233 602
1) Indigenous production	0	0
2) Transformation output or return	5 293	229 313
3) Stock decrease	99	4 289
Import	1 181	51 145
<b>Out</b>	<b>6 572</b>	<b>284 749</b>
National consumption	6 754	292 590
1) Transformation input	658	28 530
a) input for secondary fuel production	652	28 245
b) fuel combustion	6	285
2) Direct consumption	6 096	264 060
Non-energy use	0	0
Combusted directly	6 096	264 060
<b>Combusted in Poland</b>	<b>6 102</b>	<b>264 345</b>
Stock increase	0	0
Export	14	611
Losses and statistical differences	-196	-8 452
Net calorific value	MJ/kg	43.32
CO <sub>2</sub> Emission Factor	kg/GJ	72.29



## Fuel oil consumption

Evaluation of fuel consumption In national combustion processes	Fuel oil	
	10 <sup>3</sup> Mg	TJ
<b>In</b>	<b>5 603</b>	<b>231 650</b>
From national sources	4 489	185 106
1) Indigenous production	0	0
2) Transformation output or return	4 489	185 106
3) Stock decrease	0	0
Import	1 114	46 544
<b>Out</b>	<b>5 603</b>	<b>231 650</b>
National consumption	3 806	158 175
1) Transformation input	737	30 298
a) input for secondary fuel production	164	6 721
b) fuel combustion	573	23 577
2) Direct consumption	3 069	127 877
Non-energy use	0	0
Combusted directly	3 069	127 877
<b>Combusted in Poland</b>	<b>3 642</b>	<b>151 454</b>
Stock increase	47	1 979
Export	1 334	54 338
Losses and statistical differences	416	17 158
Net calorific value	MJ/kg	41.59
CO <sub>2</sub> Emission Factor	kg/GJ	77.15

## High-methane natural gas consumption

Evaluation of fuel consumption In national combustion processes	High-methane natural gas	
	10 <sup>6</sup> m <sup>3</sup>	TJ
<b>In</b>	<b>10 195</b>	<b>362 367</b>
From national sources	2 513	85 420
1) Indigenous production	1 776	60 066
2) Transformation output or return	737	25 354
3) Stock decrease	0	0
Import	7 682	276 947
<b>Out</b>	<b>10 196</b>	<b>362 367</b>
National consumption	9 783	351 453
1) Transformation input	364	12 703
a) input for secondary fuel production	239	8 389
b) fuel combustion	125	4 313
2) Direct consumption	9 419	338 751
Non-energy use	2 238	79 872
Combusted directly	7 181	258 879
<b>Combusted in Poland</b>	<b>7 306</b>	<b>263 192</b>
Stock increase	433	15 473
Export	38	1 335
Losses and statistical differences	-58	-5 894
Net calorific value	MJ/m <sup>3</sup>	36.03
CO <sub>2</sub> Emission Factor	kg/GJ	53.75

## Nitrified natural gas consumption

Evaluation of fuel consumption In national combustion processes	Nitrified natural gas	
	10 <sup>6</sup> m <sup>3</sup>	TJ
<b>In</b>	<b>2 982</b>	<b>73 723</b>
From national sources	2 982	73 723
1) Indigenous production	2 848	69 054
2) Transformation output or return	134	4 669
3) Stock decrease	0	0
Import	0	0
<b>Out</b>	<b>2 982</b>	<b>73 723</b>
National consumption	2 998	75 237
1) Transformation input	1 281	33 115
a) input for secondary fuel production	1 241	32 016
b) fuel combustion	40	1 099
2) Direct consumption	1 717	42 122
Non-energy use	2	44
Combusted directly	1 715	42 078
<b>Combusted in Poland</b>	<b>1 755</b>	<b>43 177</b>
Stock increase	0	0
Export	0	0
Losses and statistical differences	-16	-1 514
Net calorific value	MJ/m <sup>3</sup>	24.60
CO <sub>2</sub> Emission Factor	kg/GJ	55

## Coke consumption

Evaluation of fuel consumption In national combustion processes	Coke	
	10 <sup>3</sup> Mg	TJ
<b>In</b>	<b>10 953</b>	<b>309 766</b>
From national sources	10 898	308 176
1) Indigenous production	0	0
2) Transformation output or return	10 536	298 048
3) Stock decrease	362	10 128
Import	55	1 590
<b>Out</b>	<b>10 953</b>	<b>309 767</b>
National consumption	8 197	229 409
1) Transformation input	1 826	52 072
a) input for secondary fuel production	1 640	47 083
b) fuel combustion	187	4 989
2) Direct consumption	6 371	177 337
Non-energy use	142	3 912
Combusted directly	6 229	173 425
<b>Combusted in Poland</b>	<b>6 416</b>	<b>178 414</b>
Stock increase	0	0
Export	3 234	91 981
Losses and statistical differences	-478	-11 623
Net calorific value	MJ/kg	27.81
CO <sub>2</sub> Emission Factor	kg/GJ	112.15

### Annex 3. National energy balance 1997 [GUS, 1999a]

#### CZĘŚĆ II. ZBIORCZY BILANS PRZYCHODU I ROZDYSPONOWANIA ENERGII

#### PART II. BASIC ENERGY SUPPLY AND USE BALANCE

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

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

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
"	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
1	ENERGIA OGÓŁEM TOTAL ENERGY	1997	TJ	4171722	1264959	29750	927128	167167
		1998		3662184	1276484	4856	887302	-25443
2	ENERGIA PIERWOTNA PRIMARY ENERGY	1997	TJ	4171722	998164	-	732794	178976
		1998		3662184	1048605	-	683118	-41975
3	WĘGIEL KAMIENNY ENERGETYCZNY STEAM COAL	1997	tys. ton	111235	327	-	20328	6295
		1998	10 <sup>3</sup> ton	93687	561	-	21549	-1738
		1997	TJ	2530607	7911	-	462466	150893
		1998		2144490	13580	-	490236	-41667
4	WĘGIEL KAMIENNY KOKSOWY COKING COAL	1997	tys. ton	26520	2917	-	9138	274
		1998	10 <sup>3</sup> ton	22039	3637	-	6506	200
		1997	TJ	779674	86186	-	268667	7627
		1998		647948	107473	-	191290	5568
5	WĘGIEL BRUNATNY BROWN COAL	1997	tys. ton	63169	10	-	37	-1
		1998	10 <sup>3</sup> ton	62820	73	-	23	11
		1997	TJ	543899	89	-	319	-7
		1998		540254	618	-	202	93
6	ROPA NAFTOWA CRUDE OIL	1997	tys. ton	289	14713	-	0	116
		1998	10 <sup>3</sup> ton	360	15367	-	0	-298
		1997	TJ	12286	625149	-	7	4913
		1998		15292	652943	-	2	-12663
7	GAZ ZIEMNY WYSOKOMETANOWY HIGH - METHANE NATURAL GAS	1997	mln m <sup>3</sup>	1988	7682	-	38	433
		1998	10 <sup>6</sup> m <sup>3</sup>	2101	7539	-	39	221
		1997	TJ	65096	276947	-	1335	15473
		1998		69298	271616	-	1388	7895
8	GAZ ZIEMNY ZAAZOTOWANY NITRIFIED NATURAL GAS	1997	mln m <sup>3</sup>	2848	-	-	-	-
		1998	10 <sup>6</sup> m <sup>3</sup>	2751	-	-	-	-
		1997	TJ	69054	-	-	-	-
		1998		66714	-	-	-	-
9	TORF I DREWNO PEAT AND WOOD	1997	tys. m <sup>3</sup>	13451	-	-	-	30
		1998	10 <sup>3</sup> m <sup>3</sup>	13452	-	-	-	1
		1997	TJ	127789	-	-	-	282
		1998		127801	-	-	-	7
10	ENERGIA WODY I WIATRU HYDRO AND WOOD ENERGY	1997	TJ	7065	-	-	-	-
		1998		8330	-	-	-	-
11	ENERGIA GEOTERMALNA GEOTHERMAL ENERGY	1997	TJ	47	-	-	-	-
		1998		107	-	-	-	-
12	GAZ GNILNY (BIOGAZ) BIOGAS	1997	TJ	689	-	-	-	-27
		1998		872	-	-	-	-
13	PALIWA ODPADOWE STAŁE ROŚLINNE I ZWIERZĘCE SOLID BIOMASS AND ANIMAL PRODUCTS	1997	TJ	16082	-	-	-	-
		1998		23599	-	-	-	-1416
14	ODPADY PRZEMYSŁOWE STAŁE I CIEKŁE INDUSTRIAL WASTES	1997	TJ	18785	-	-	-	-57
		1998		13260	-	-	-	207

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	
4342386	2110098	x	3047880	3373608	142479	30997	1
4076809	2106520	x	3015012	3136366	134394	31950	
4258116	30023	x	2863682	1391939	81977	32517	2
4069646	30872	x	2825294	1232319	80019	42905	
84939	-	84939	56208	33007	9	-4276	3
74438	-	74438	52774	27115	11	-5452	
1925159	-	1925159	1213607	832287	280	-120735	
1709501	-	1709501	1149595	686363	359	-126458	
20024	-	20024	14337	433	1	5254	4
18969	-	18969	12694	203	-	6073	
589565	-	589565	422237	12888	16	154439	
558562	-	558562	375002	6110	-	177451	
63144	-	63144	62519	625	-	-	5
62859	-	62859	62267	592	-	-	
543676	-	543676	531963	5491	-	6221	
540578	-	540578	536332	5906	-	-1660	
14886	-	14886	14885	2	-	-	6
16025	-	16025	16023	2	-	-	
632514	-	632514	632442	72	-	-	
680895	-	680895	680805	91	-	-	
9200	737	9937	442	9553	2238	-58	7
9380	709	10089	828	9278	2093	-18	
325235	25354	350588	15241	341242	79872	-5894	
331630	24377	356008	28926	326318	74842	763	
2848	134	2982	1281	1717	2	-16	8
2751	184	2935	1263	1784	1	-111	
69054	4669	73724	33115	42122	44	-1514	
66714	6495	73209	32777	47624	38	-7191	
13422	-	13422	53	13369	-	-	9
13451	-	13451	37	13414	-	-	
127507	-	127507	503	127004	-	-	
127794	-	127794	352	127442	-	-	
7065	-	7065	7065	-	-	-	10
8330	-	8330	8330	0	-	-	
47	-	47	-	47	-	-	11
107	-	107	-	107	-	-	
716	-	716	88	629	-	-	12
872	-	872	196	676	-	-	
16082	-	16082	1778	14304	-	-	13
25015	-	25015	3321	21694	-	-	
18842	-	18842	3411	15431	1735	-	14
13053	-	13053	4775	8278	4723	-	

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

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

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
#	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
15	ODPADY KOMUNALNE <i>MUNICIPAL WASTES</i>	1997	TJ	-	-	-	-	-
		1998		0	-	-	-	-
16	PALIWA CIEKLE Z BIOMASY <i>LIQUID FUELS FROM BIOMASS</i>	1997	TJ	0	-	-	-	-
		1998		0	-	-	-	0
17	INNE SUROWCE ENERGETYCZNE <i>OTHER ENERGY SOURCES</i>	1997	TJ	649	1883	-	-	-121
		1998		4218	2376	-	-	-
18	ENERGIA POCHODNA <i>DERIVED ENERGY</i>	1997	TJ	-	266795	29750	194333	-11809
		1998		-	227878	4856	204184	16532
19	BRYKIETY Z WĘGLA KAMIENNEGO <i>HARD COAL BRIQUETTES</i>	1997	tys. ton	-	0	-	7	-9
		1998	10 <sup>3</sup> ton	-	0	-	1	-1
		1997	TJ	-	2	-	162	-219
		1998		-	0	-	15	-17
20	BRYKIETY Z WĘGLA BRUNATNEGO <i>BROWN COAL BRIQUETTES (BKB)</i>	1997	tys. ton	-	1	-	49	0
		1998	10 <sup>3</sup> ton	-	2	-	56	0
		1997	TJ	-	9	-	896	-5
		1998		-	41	-	1009	-1
21	KOKS I PÓLKOKS <i>COKE AND SEMI-COKE</i>	1997	tys. ton	-	55	-	3234	-362
		1998	10 <sup>3</sup> ton	-	23	-	3252	186
		1997	TJ	-	1590	-	91981	-10128
		1998		-	658	-	92500	5279
22	GAZ CIEKLY <i>LIQUEFIED PETROLEUM GAS (LPG)</i>	1997	tys. ton	-	738	-	4	4
		1998	10 <sup>3</sup> ton	-	770	-	9	0
		1997	TJ	-	34908	-	172	180
		1998		-	36422	-	430	15
23	BENZYNY SILNIKOWE <i>MOTOR GASOLINE</i>	1997	tys. ton	-	1725	-	0	53
		1998	10 <sup>3</sup> ton	-	1662	-	0	56
		1997	TJ	-	77285	-	0	2392
		1998		-	74441	-	0	2516
24	BENZYNY LOTNICZE <i>AVIATION GASOLINE</i>	1997	tys. ton	-	5	-	0	-2
		1998	10 <sup>3</sup> ton	-	4	-	0	0
		1997	TJ	-	205	-	5	-73
		1998		-	190	-	8	17
25	PALIWA ODRZUTOWE <i>JET FUEL</i>	1997	tys. ton	-	241	110	22	5
		1998	10 <sup>3</sup> ton	-	168	109	3	23
		1997	TJ	-	10722	4906	960	212
		1998		-	7480	4856	152	1005
26	OLEJ NAPEĐOWY I <i>AUTOMOTIVE DIESEL OIL</i>	1997	tys. ton	-	1097	27	14	-90
		1998	10 <sup>3</sup> ton	-	410	-	13	164
		1997	TJ	-	47512	1161	611	-3915
		1998		-	17747	-	571	7124
27	OLEJE NAPEĐOWE POZOSTALE <i>OTHER DIESEL OIL</i>	1997	tys. ton	-	84	84	-	-9
		1998	10 <sup>3</sup> ton	-	9	-	-	-7
		1997	TJ	-	3633	3633	-	-374
		1998		-	378	-	-	-285
28	LEKKI OLEJ OPALOWY <i>LIGHT FUEL OIL</i>	1997	tys. ton	-	447	-	-	15
		1998	10 <sup>3</sup> ton	-	889	-	-	15
		1997	TJ	-	19559	-	-	664
		1998		-	38891	-	-	661

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETYCZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	#
-	-	-	-	-	-	-	15
0	-	0	-	0	-	-	
0	-	0	-	0	-	-	16
-	-	-	-	-	-	-	
2653	-	2653	2232	421	30	-	17
6594	-	6594	4883	1711	56	-	
<b>84271</b>	<b>2080075</b>	<b>x</b>	<b>181298</b>	<b>1984568</b>	<b>48356</b>	<b>-1520</b>	<b>18</b>
<b>7163</b>	<b>2075647</b>	<b>x</b>	<b>186459</b>	<b>1907306</b>	<b>46825</b>	<b>-10955</b>	
3	-	3	2	0	-	-	19
0	-	0	0	0	-	-	
59	-	59	54	5	-	-	
3	-	3	1	1	-	-	
-49	79	31	-	31	-	-	20
-53	63	10	0	10	-	-	
-881	1304	423	-	532	-	-109	
-967	1127	160	0	159	-	-	
-2817	10536	7719	1826	6371	142	-478	21
-3415	9747	6332	1530	4802	115	-	
-80262	298048	217786	52072	177337	3912	-11623	
-97121	266066	168945	43577	125368	3192	-	
731	181	911	6	905	-	-	22
761	225	985	9	977	-	-	
34556	8539	43096	294	42802	-	-	
35977	10630	46607	416	46192	-	-	
1672	3413	5085	131	4954	0	-	23
1606	3465	5071	50	5020	-	-	
74893	152877	227770	5860	221910	0	-	
71925	155190	227115	2257	224858	-	-	
6	-	6	0	6	-	-	24
4	-	4	0	4	-	-	
273	-	273	13	260	-	-	
164	-	164	6	158	-	-	
214	226	440	77	364	-	-	25
142	275	417	52	364	-	-	
9550	10069	19619	3412	16207	-	-	
6323	12256	18579	2330	16249	-	-	
1173	5190	6363	639	5723	0	-	26
232	5852	6084	520	5564	-	-	
50816	224874	275691	27704	247987	0	-	
10053	253568	263621	22534	241087	-	-	
93	103	196	19	373	-	-196	27
15	180	195	9	244	-	-58	
4007	4439	8446	826	16073	-	-8452	
663	7758	8421	398	10502	-	-2480	
432	909	1341	74	1004	-	263	28
874	1081	1955	340	1453	-	162	
18895	39740	58635	3223	43926	-	11486	
38229	47268	85497	14884	63541	-	7072	

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

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

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
#	SPECIFICATION	YEAR	UNIT OF MEASURE	INDIGENOUS PRODUCTION	IMPORT	AMONG WHICH BUNKER	EXPORT	STOCK CHANGE
29	CIEŹKI OLEJ OPALOWY HEAVY FUEL OIL	1997	tys. ton	-	667	498	1334	32
		1998	10 <sup>3</sup> ton	-	136	-	1626	11
		1997	TJ	-	26985	20049	54338	1315
		1998	-	-	5497	-	65524	458
30	PÓLPRODUKTY Z PRZEROBU ROPY NAFTOWEJ FEEDSTOCKS	1997	tys. ton	-	355	-	9	-31
		1998	10 <sup>3</sup> ton	-	316	-	25	11
		1997	TJ	-	14269	-	365	-1240
		1998	-	-	12715	-	1002	455
31	PRODUKTY NIEENERGETYCZNE NON-ENERGY PRODUCTS	1997	TJ	-	10829	-	17692	-618
		1998	-	-	16830	-	13877	-693
32	GAZ RAFINERYJNY REFINERY GAS	1997	tys. ton	-	-	-	-	-
		1998	10 <sup>3</sup> ton	-	-	-	-	-
		1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
33	GAZ KOKSOWNICZY COKE OVEN GAS	1997	mln m <sup>3</sup>	-	-	-	-	-
		1998	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
34	GAZ WIELKOPIECOWY GAS MANUFACTURED FROM COAL	1997	mln m <sup>3</sup>	-	-	-	-	-
		1998	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
35	GAZ MIEJSKI TOWN GAS	1997	mln m <sup>3</sup>	-	-	-	-	-
		1998	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
36	GAZ CZADNICOWY I WYTLEWNY BLAST FURNACE GAS	1997	mln m <sup>3</sup>	-	-	-	-	-
		1998	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
37	ENERGIA ELEKTRYCZNA ELECTRICITY	1997	GWh	-	5357	-	7542	-
		1998	-	-	4608	-	8082	-
		1997	TJ	-	19285	-	27152	-
		1998	-	-	16589	-	29095	-
38	CIEPŁO *) HEAT *)	1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
39	ENERGIA Z ODZYSKU ENERGY FROM RETURNS	1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
40	PALIWA ODPAD. GAZOWE GASEOUS WASTE FUELS	1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-
41	CIEPŁO Z ODZYSKU HEAT FROM RETURNS	1997	TJ	-	-	-	-	-
		1998	-	-	-	-	-	-

\*) Patrz 'Uwagi metodyczne'

\*) See the 'Methodology remarks'

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY I RÓŻNICE BILANSOWE	LP
GLOBAL CONSUMPTION OR EXCHANGE BALANCES	TRANSFORMA- TIONS OUTPUT OR RETURNS	TOTAL CONSUMPTION	TRANSFORMA- TIONS INPUT	DIRECT CONSUMPTION	AMONG WHICH NON-ENERGY USE	LOSSES AND STATISTICAL DIFFERENCE	
-699	3580	2881	663	2065	-	153	29
-1501	4156	2655	1086	2071	-	-503	
-28669	145366	116698	27075	83951	-	5672	
-60485	169852	109368	44560	84162	-	-19354	
377	208	585	357	228	155	-	30
280	281	562	317	244	178	-	
15145	8366	23511	14351	9160	6244	-	
11259	11308	22567	12758	9809	7174	-	
-6244	108100	101856	13374	99257	38030	-10775	31
3646	102036	105682	11714	104848	36326	-10880	
-	413	413	-	413	-	-	32
-	513	513	-	513	-	-	
-	19891	19891	-	19891	-	-	
-	24689	24689	-	24689	-	-	
-	4501	4501	919	3524	9	58	33
-	4209	4209	758	3426	7	25	
-	79286	79286	16450	61886	170	950	
-	73457	73457	13697	59705	133	55	
-	12264	12264	1018	11260	-	-14	34
-	10110	10110	925	9186	-	-	
-	41319	41319	3453	37915	-	-49	
-	34289	34289	3157	31132	-	-	
-	9	9	-	23	-	-14	35
-	8	8	2	14	-	-8	
-	229	229	-	556	-	-326	
-	209	209	45	335	-	-171	
-	107	107	0	107	-	-	36
-	58	58	-	58	-	-	
-	613	613	2	611	-	-	
-	338	338	-	338	-	-	
-2185	142790	140605	2588	121332	-	16685	37
-3474	142789	139315	2806	121179	-	15330	
-7867	514044	506177	9317	436794	-	60066	
-12506	514040	501534	10102	436244	-	55188	
-	422969	422969	3817	467510	-	-48358	38
-	391568	391568	4023	427930	-	-40386	
-	63922	x	2899	61022	12146	-	39
-	59074	x	3259	55815	7550	-	
-	21596	21596	2899	18696	12146	-	40
-	17963	17963	3259	14704	7550	-	
-	42326	42326	-	42326	-	-	41
-	41110	41110	-	41110	-	-	



## Annex 4. National energy balance 1997 – OECD

### Poland : 1997

SUPPLY AND CONSUMPTION	Coal (TJ)						Oil (TJ)		
	Coking Coal	Other Bit. Coal	Lignite	Peat	Oven and Gas Coke	Patent Fuel	BKB	Crude Oil	Feedstocks
Production	779673.6	2515664.5	543898.6		298048.5		1304.0	12285.5	
From Other Sources		14942.9							2141.8
Import	86185.5	7911.0	88.6		1590.4	1.7	9.4	625149.3	15088.2
Export	-268667.2	-462466.4	-318.9		-91980.9	-161.8	-811.2	-7.0	
International Marine Bunkers									
Stock Changes	-7627.3	-150892.8	7.4		10128.2	218.7	5.5	-4913.5	
DOMESTIC SUPPLY	589564.6	1925159.2	543675.7		217786.1	58.6	507.6	632514.4	17230.0
Transfers									25920.9
Statistical Differences	-154439.2	120734.9	-6221.1		11623.0		24.3		
TRANSFORMATION	422237.3	1213606.7	531963.2		52072.3	53.9		632442.8	43150.9
Electricity Plants									
CHP Plants	34.4	980801.0	530103.5						
Heat Plants	1346.2	231881.7	542.5		4989.1	53.9			
Blast Furnaces					45450.7				
Gas Works	43.2	924.0							
Coke Ovens	420813.6				1632.5				
Patent Fuel Plants									
BKB Plants			1317.2						
Petroleum Refineries								632442.8	43150.9
Petrochemical Industry									
Other Transform. Sector									
ENERGY SECTOR	5105.6	59665.9	346.0		128.4	0.1	26.7	71.6	
Coal Mines	2063.3	55718.4	333.9		31.2		26.7		
Oil and Gas Extraction		19.6			6.2			71.6	
Petroleum Refineries		1330.2			0.0				
Electr., CHP + Heat Plants	3.9	2331.5	12.1		47.3	0.1			
Patent Fuel Plants									
Coke Ovens	3038.4	35.1			30.6				
Gas Works		231.2			13.0				
BKB									
Pumped Storage (Elec.)									
Other Energy Sector									
Distribution Losses									
FINAL CONSUMPTION	7782.5	772621.5	5145.4		177208.5	4.5	505.2		
INDUSTRY SECTOR	7397.0	360051.1	1812.8		108595.7	2.8	29.9		
Iron and Steel	40.1	23317.9	5.1		85859.8				
Chemical and Petrochemical		58239.0	418.8		1401.7				
of which: Feedstocks		8.9							
Non-Ferrous Metals		3714.9			6390.7				
Non-Metallic Minerals	213.5	83227.5	733.5		8203.9		29.8		
Transport Equipment	5.0	8319.5			565.1				
Machinery	65.3	25304.4	60.9		1189.5	2.3			
Mining and Quarrying	1.7	7638.9	0.8		557.2				
Food and Tobacco	189.6	82035.8	242.9		2786.5				
Paper, Pulp and Print		23509.9			136.1				
Wood and Wood Products	1.2	8500.7	0.4		40.2				
Construction	6859.0	4454.4	5.4		679.4				
Textile and Leather	17.4	18056.6	330.5		468.5		0.1		
Non-specified (Industry)	4.3	13731.6	14.5		317.1	0.5			
TRANSPORT SECTOR		198.3							
Air Transport									
Road									
Rail		198.3							
Pipeline Transport									
Internal Navigation									
Non-specified (Transport)									
OTHER SECTORS	369.6	412092.4	3332.6		64700.6	1.7	475.3		
Agriculture	346.8	62819.7	1275.0		5008.3	1.7			
Commerce and Public Services	22.8	21518.0	16.8		27694.5		475.3		
Residential		327754.8	2040.8		31997.7				
Non-specified (Other)	0.0		0.0		0.0	0.0	0.0		
NON-ENERGY USE	15.9	279.8			3912.1				
in Industry/Transf/Energy	15.9	279.8			3912.1				
in Transport									
in Other Sectors									

### Poland : 1997

SUPPLY AND CONSUMPTION	Oil (TJ)										
	Additives	Refinery Gas	LPG + Ethane	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/ Diesel	Heavy Fuel Oil	Naphtha	Other Prod.
Production	228.3	19894.8	8541.5	143050.5		10011.2	492.2	220941.7	174607.2	37649.7	50331.6
From Other Sources											
Import	1883.1		34916.3	77300.3	205.2	5819.4	2994.8	46355.0	24798.9		6647.2
Export			-171.7		-4.9	-960.0	-5.3	-611.4	-53622.3		-5663.2
International Marine Bunkers								-719.3	-5504.9		
Stock Changes	120.6		-180.3	-2392.7	73.5	-211.8	-34.6	4290.9	-1908.0	8.6	1905.6
DOMESTIC SUPPLY	2231.9	19894.8	43105.9	217958.1	273.7	14658.8	3447.2	270256.9	138371.0	37658.3	53221.1
Transfers				4497.8	-13.0	-3352.7	-264.3	-19863.6	-799.8	-1068.0	-5097.3
Statistical Differences								8497.7	-10315.6	-331.3	10920.6
TRANSFORMATION	2231.9		293.8					259.1	23018.3		5628.7
Electricity Plants											
CHP Plants								94.9	12624.3		5628.7
Heat Plants			50.6					164.2	10393.6		
Blast Furnaces											
Gas Works			243.2								
Coke Ovens											
Patent Fuel Plants											
BKB Plants											
Petroleum Refineries	2231.9								0.4		
Petrochemical Industry											
Other Transform. Sector											
ENERGY SECTOR		9946.0	101.7	1017.4			29.3	2951.4	12379.9	0.5	2045.0
Coal Mines			1.4	17.5			20.6	1428.7	28.9		538.2
Oil and Gas Extraction				1.8			0.4	302.0	0.4		8.0
Petroleum Refineries		9946.0	68.1	935.0				188.9	12230.4	0.5	1102.5
Electr., CHP + Heat Plants			16.1	30.9			6.1	341.0	116.6		337.2
Patent Fuel Plants											
Coke Ovens							0.4	15.2			9.6
Gas Works			16.1	32.3			1.8	675.6	3.6		49.4
BKB											
Pumped Storage (Elec.)											
Other Energy Sector											
Distribution Losses											
FINAL CONSUMPTION		9948.9	42710.3	221438.5	260.7	11306.1	3153.6	255680.4	91857.3	36258.5	51370.7
INDUSTRY SECTOR		9948.9	4742.0	2850.1	15.2	89.2	1314.3	16604.5	55026.6	36258.5	4745.6
Iron and Steel			30.8	445.7			640.5	497.5	4833.6		0.4
Chemical and Petrochemical		9948.9	3896.5	28.2			309.8	930.8	29919.9	36258.5	3107.3
of which: Feedstocks		9948.9	3883.7	5.8				177.7		36275.6	208.2
Non-Ferrous Metals			0.9	5.4			54.7	192.4	683.7		0.8
Non-Metallic Minerals			116.4	126.3			7.0	1910.1	4975.1		1389.9
Transport Equipment			46.8	146.5	14.3	88.7	39.8	821.6	227.5		2.8
Machinery			93.2	142.0		0.4	139.1	872.7	601.3		3.6
Mining and Quarrying			0.9	9.4			2.2	2015.0	948.2		0.8
Food and Tobacco			201.5	52.4			5.7	634.0	6255.7		65.5
Paper, Pulp and Print			80.0	10.3			10.1	545.1	1443.7		6.4
Wood and Wood Products			3.3	35.4			5.7	225.8	2465.5		90.4
Construction			203.0	1250.8	0.9		64.3	5247.2	1768.1		23.3
Textile and Leather			43.1	32.3			6.1	93.6	491.2		4.4
Non-specified (Industry)			25.5	565.4			29.3	2618.6	413.2		49.8
TRANSPORT SECTOR			15896.4	217365.8	245.5	11216.9	38.5	150147.1	8.0		
Air Transport					245.5	11216.9		9.1			
Road			15896.4	217364.9			24.1	140608.2			
Rail							14.4	8758.1			
Pipeline Transport				0.9				10.0	8.0		
Internal Navigation								761.8			
Non-specified (Transport)											
OTHER SECTORS		0.0	22071.9	1222.6	0.0	0.0	1800.8	88928.8	36822.7	0.0	
Agriculture			1419.3	1222.6			0.9	88928.8	26698.4		
Commerce and Public Services			1728.3				1800.0		4095.3		
Residential			18924.3						6029.0		
Non-specified (Other)		0.0		0.0	0.0	0.0	0.0	0.0		0.0	
NON-ENERGY USE											46625.1
in Industry/Trans/Energy											26995.9
in Transport											798.2
in Other Sectors											18831.0

### Poland : 1997

SUPPLY AND CONSUMPTION	Gas (TJ)				Comb.Renew.& Waste (TJ)				(TJ)	(TJ)
	Natural Gas	Gas Works	Coke Ovens	Blast Furnaces	Solid Biomass	Gas/Liquids from Biomass	Municipal Waste	Industrial Waste	Electricity	Heat
Production	149055.7	689.0	88095.8	41318.8	153405.9	689.0		6217.9	514044.4	422968.6
From Other Sources		246.4						21595.6		
Import	307718.8								19284.8	
Export	-1482.9								-27152.0	
International Marine Bunkers										
Stock Changes	-17192.6				-281.8	27.4		57.0		
DOMESTIC SUPPLY	438099.0	935.5	88095.8	41318.8	153124.1	716.4		27870.5	506177.2	422968.6
Transfers	0.6									
Statistical Differences	28395.5	-7.1	-491.3	49.4						
TRANSFORMATION	10348.1	2.2	18278.3	3452.7	3292.6	87.8		3281.1		3816.6
Electricity Plants						81.0				
CHP Plants	3027.2		17281.5	2901.7	2646.0			3130.3		3816.6
Heat Plants	5806.3	2.2	996.8	404.2	646.6	6.8		136.2		
Blast Furnaces										
Gas Works										
Coke Ovens	1514.6			146.9				14.7		
Patent Fuel Plants										
BKB Plants										
Petroleum Refineries										
Petrochemical Industry										
Other Transform. Sector										
ENERGY SECTOR	42928.1	21.2	41110.7	1745.6	2.5	27.8		300.5	104942.7	53042.4
Coal Mines	1389.9		475.9		0.7				29332.4	10298.0
Oil and Gas Extraction	9957.8								100.1	14.6
Petroleum Refineries	4367.9							162.9	2139.6	9757.1
Electr., CHP + Heat Plants	126.5	0.2			1.6	27.8			49454.3	11215.2
Patent Fuel Plants										
Coke Ovens	633.3		40634.7	1745.6				137.5	2473.9	11699.0
Gas Works	26452.8	21.0	0.2		0.2				704.9	295.5
BKB									12.2	230.8
Pumped Storage (Elec.)									9317.0	
Other Energy Sector									11408.4	9532.3
Distribution Losses	20164.3	0.7	563.9						60066.0	
FINAL CONSUMPTION	393054.6	904.4	27651.6	36169.9	149829.0	600.8		24288.9	341168.5	366109.6
INDUSTRY SECTOR	198749.8	623.7	27321.5	36169.9	23798.5	1.5		10408.1	175794.1	71870.1
Iron and Steel	29904.7	65.2	26762.8	36120.7	3.5				32217.6	7266.9
Chemical and Petrochemical	100885.2		156.4	12.5	0.0			6860.3	33130.2	26373.4
of which: Feedstocks								46.8	3780.4	3528.9
Non-Ferrous Metals	6026.8				42.0			2361.0	11615.3	859.0
Non-Metallic Minerals	28506.3	557.1	391.6	36.6	5.4			46.8	13463.2	2354.4
Transport Equipment	2525.7				0.5			3.3	6416.5	5940.7
Machinery	8319.0	1.4	10.5		23.8			37.0	16434.7	8113.8
Mining and Quarrying	1844.6				1.3			19.5	8487.4	4456.4
Food and Tobacco	14363.4				75.3	0.4		0.0	18467.8	5168.2
Paper, Pulp and Print	1218.0				16466.9			5.0	9651.1	2315.9
Wood and Wood Products	851.4				5157.0			986.3	5208.3	329.4
Construction	1226.5		0.1		8.6	1.1		2.1	2846.0	1941.6
Textile and Leather	2569.5				103.8			0.6	8043.7	4966.1
Non-specified (Industry)	508.8				1910.5			86.3	9812.2	1784.4
TRANSPORT SECTOR	29.3								16955.2	
Air Transport										
Road										
Rail									16467.8	
Pipeline Transport	29.3								487.4	
Internal Navigation										
Non-specified (Transport)										
OTHER SECTORS	194275.5	280.7	141.5		126030.4	599.2			148419.2	294239.5
Agriculture	633.8				17000.0				19345.4	1452.3
Commerce and Public Services	26950.2	80.0	141.5		9030.4	599.2			57898.4	37787.2
Residential	166691.4	200.7			100000.0				71175.5	255000.0
Non-specified (Other)			0.0			0.0			0.0	
NON-ENERGY USE			188.7					13880.8		
in Industry/Transf/Energy			188.7					13880.8		
in Transport										
in Other Sectors										

## Annex 5. Uncertainty estimation of the 1997 inventory

Uncertainty analysis for the year 1997 was performed with Tier1 methodology. This simplified methodology is based on the assumptions listed below:

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

Conclusions from the 2005 in-depth review of the Polish GHG emission inventory were taken into account and additional analyses were made in *Agriculture* sector. For sector 5. *LUFC* and *Industrial gases* (HFC, PFC, SF<sub>6</sub>) due to lack of appropriate information, uncertainty estimates were made directly to emission values.

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

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

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

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

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

where:  $U_{\text{emission}}$  – 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<sub>4</sub> and N<sub>2</sub>O 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<sub>2</sub> 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 <sub>2</sub> – 5.9%	CH <sub>4</sub> – 20.2%	N <sub>2</sub> O – 50.1%
HFC – 39.3%	PFC – 20.0%	SF <sub>6</sub> – 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<sub>2</sub> emission factors

Most uncertain values for CO<sub>2</sub> 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<sub>2</sub> (5.9%) 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<sub>4</sub> emission factors

Most uncertain values for CH<sub>4</sub> 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<sub>4</sub> emission is app. 20.2% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

### N<sub>2</sub>O emission factors

Most uncertain values for N<sub>2</sub>O 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<sub>2</sub>O (50.1%) and is a result of high uncertainty of the emission factors in sector of *Agriculture* (*4.B.11 Liquid systems*, *4.B.12 Solid Storage and Dry Lot*, *4.D Agricultural Soils* and *4.Field Burning of Agricultural residues* – 150%).

### Industrial Gases

Simplified analysis were made for industrial gases HFC, PFC and SF<sub>6</sub> – uncertainty estimates were applied directly to emission values of each pollutant. Results are HFC – 39.3%, PFC – 20.0%, SF<sub>6</sub> – 100.0%. Due to lack of information, additional analysis need to be done for these gases.

The uncertainty assessment of GHG Inventory for 1997 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 (418.72 Gg) compared to total CO<sub>2</sub> and high uncertainty have very little influence on uncertainty of values of total national CO<sub>2</sub> emission.

## GHG inventory 1997 – Uncertainty analysis, part 1, sectors 1-2

1997																	
TOTAL																	
	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]
1. Energy									354 444.50	2 049.69	104.69	5.9%	20.2%	50.1%	20 924.86	414.02	52.47
A. Fuel Combustion									367 110.42	827.72	8.43	2.2%	15.0%	3.3%	8169.02	124.31	0.28
1. Energy Industries									367 024.11	18.23	8.43	2.2%	7.7%	3.3%	8169.02	1.40	0.28
Liquid Fuels	63 227	3.0%	66.69	2.15	0.41	1.0%	41.8%	3.8%	4 216.77	0.14	0.03	3.2%	41.9%	3.2%	133.35	0.06	0.00
Solid Fuels	1 873 777	3.0%	99.06	1.02	1.46	2.0%	13.5%	11.7%	185 622.53	1.91	2.73	3.6%	13.8%	3.6%	6692.72	0.26	0.10
Gaseous Fuels	13 344	3.0%	56.23	1.00	0.10	2.0%	17.0%	20.0%	750.35	0.01	0.00	3.6%	17.3%	3.6%	27.05	0.00	0.00
Biomass	2 487	3.0%				0.0%	24.0%	37.0%	245.49	0.07	0.01	3.0%	24.2%	3.0%	0.02	0.00	0.00
2. Manufacturing Industries and Construction									75 370.67	2.89	1.24	4.3%	11.7%	8.5%	3243.10	0.34	0.10
Liquid Fuels	122 165.81	5.0%	75.11	3.00	3.12	1.0%	41.8%	3.8%	9 175.52	0.37	0.38	5.1%	42.1%	6.3%	467.86	0.15	0.02
Solid Fuels	557 242.72	5.0%	106.20	3.47	1.40	2.0%	13.5%	11.7%	59 178.31	1.93	0.78	5.4%	14.4%	12.7%	3186.85	0.28	0.10
Gaseous Fuels	127 693.02	5.0%	54.95	1.00	0.10	2.0%	17.0%	20.0%	7 016.84	0.13	0.01	5.4%	17.7%	20.6%	377.87	0.02	0.00
Biomass	15 890.61	5.0%	99.03	28.90	3.85	0.0%	24.0%	37.0%	1 573.63	0.46	0.06	5.0%	24.5%	37.3%	0.11	0.02	0.00
3. Transport									31 127.72	8.11	2.03	7.1%	11.4%	5.5%	2200.01	0.92	0.11
Liquid Fuels	412 381.29	5.0%	75.45	19.66	4.91	5.0%	10.2%	2.3%	31 112.85	8.11	2.03	7.1%	11.4%	5.5%	2200.01	0.92	0.11
Solid Fuels	198.26	5.0%	75.00	6.00	2.00	5.0%	13.5%	11.7%	14.87	0.00	0.00	7.1%	14.4%	12.7%	1.05	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									66 174.14	4.96	1.74	3.9%	19.3%	12.1%	2557.76	0.96	0.21
Liquid Fuels	161 943.83	5.0%	72.66	3.36	3.21	1.0%	41.8%	3.8%	11 766.55	0.54	0.52	5.1%	42.1%	6.3%	599.98	0.23	0.03
Solid Fuels	468 755.73	5.0%	96.54	1.00	1.50	2.0%	13.5%	11.7%	45 254.91	0.47	0.70	5.4%	14.4%	12.7%	2437.05	0.07	0.09
Gaseous Fuels	171 908.37	5.0%	53.24	1.00	0.10	2.0%	17.0%	20.0%	9 152.67	0.17	0.02	5.4%	17.7%	20.6%	492.89	0.03	0.00
Biomass	126 001.07	5.0%	112.00	30.00	4.00		24.0%	37.0%	14 112.11	3.78	0.50	5.0%	24.5%	37.3%	0.93	0.19	0.00
5. Other									3 761.93	0.13	0.66	4.0%	91.9%	6.1%	148.68	0.12	0.04
Liquid Fuels	39 365.84	5.0%	69.17	3.11	16.29	1.0%	100.0%	3.8%	2 722.83	0.12	0.64	5.1%	100.1%	6.3%	138.84	0.12	0.04
Solid Fuels	9 790.54	5.0%	100.78	1.00	1.50	2.0%	80.0%	11.7%	986.64	0.01	0.01	5.4%	80.2%	12.7%	53.13	0.01	0.00
Gaseous Fuels	944.43	5.0%	55.54	1.00	0.10	2.0%	90.0%	20.0%	52.45	0.00	0.00	5.4%	90.1%	20.6%	2.82	0.00	0.00
Biomass	14.82	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	1.66	0.00	0.00	5.0%	95.1%	37.3%	0.00	0.00	0.00
B. Fugitive Emissions from Fuels									86.31	809.50	0.00	6.0%	15.4%		5.16	124.31	0.00
1. Solid Fuels									0.76	618.98	0.00	6.6%	20.0%		0.05	123.82	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]	132.58	2.0%		4.64673			20.0%			616.05			20.1%		0.00	123.82	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	63.20	2.0%		0.01273			20.0%			0.80			20.1%		0.00	0.16	0.00
1. B. 1. c. Other [CO2 Emission from Coking Gas Subsystem]	0.37	2.0%	2 060 765	5 791 695.00			20.0%		0.76	2.13		6.6%	15.0%		0.05	0.32	0.00
2. Oil and Natural Gas									85.55	190.52	0.00	6.0%	5.7%		5.16	10.94	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	12.29	0.5%	6 315 000	61 800.00		6.6%	8.1%		77.59	0.76		6.6%	8.1%		5.14	0.06	0.00
iii. Transport [Activity in Gg]	15 002.00	0.5%	NE	NE		6.6%	8.1%		0.09	0.01		6.6%	8.1%		0.01	0.00	0.00
1. B. 2. b. Natural Gas															0.00	0.00	0.00
i. Production / Processing [Activity in PJ, EFs in kg/PJ]	134.15	0.5%	53 733.00	98 081.70		6.6%	8.1%		7.21	13.16		6.6%	8.1%		0.48	1.07	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	392.30	0.5%	519.08	136 923.25		6.6%	8.1%		0.20	53.72		6.6%	8.1%		0.01	4.36	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	392.30	0.5%	1 171.95	313 216.94		6.6%	8.1%		0.46	122.88		6.6%	8.1%		0.03	9.97	0.00
2. Industrial Processes									18025.19	13.87	12.32	6.5%	16.7%	28.6%	1172.54	2.32	3.52
A. Mineral Products									9078.00			0	12.1%		1094.52	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	12 739.00	5.0%	0.525			15.0%			6687.98			15.8%			1057.46	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	2 516.00	10.0%	0.785			10.0%			1975.06			14.1%			279.32	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	999.91	10.0%	0.415			0.0%			414.96			10.0%			41.50	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									3510.15	11.28	12.32	6.8%	20.2%	28.6%	239.00	2.28	3.52
1. Ammonia Production [Activity in kt, EF in t/t]	2 251.60	5.0%	1.5	0.0049		5.0%	20.0%		3377.40	11.03		7.1%	20.6%		238.82	2.27	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 808.50	2.0%			0.01			30.0%			11.70			30.1%	0.00	0.00	3.52
3. Adipic Acid Production [Activity in kt, EF in t/t]	NO	5.0%			0.00			10.0%	NO					11.2%	0.00	0.00	0.00
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	120.60	5.0%	1.1			5.0%			132.66			7.1%		11.2%	9.38	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	25.00	5.0%		0.01			20.0%			0.25			20.6%		0.00	0.05	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	307.92	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]	863.90	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	130.29	5.0%			0.0047			20.0%			0.62			20.6%	0.00	0.00	0.13
C. Metal Production									5437.04	2.58	0	6.4%	17.1%		346.07	0.44	0.00
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	8 980.79	5.0%	0.07			10.0%			662.69			11.2%			74.09	0.00	0.00
Coke [Activity in kt, EF in t/t]	10 536.00	5.0%	0.16	0.000200		10.0%	20.0%		1678.87	2.11		11.2%	20.6%		187.70	0.43	0.00
Open-heart Steel [Activity in kt, EF in t/t]	1 057.00	5.0%	0.052			10.0%			54.96			11.2%		NE			
Electric Furnace Steel [Activity in kt, EF in t/t]	2 994.00	5.0%	0.00430	0.000120		10.0%	20.0%		12.87	0.36		11.2%	20.6%		1.44	0.07	0.00
Pig Iron [Activity in kt, EF in t/t]	7 417.98	5.0%	0.33760			10.0%			2504.34			11.2%			279.99	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	589.60	5.0%	0.061	0.000200		10.0%	20.0%		35.97	0.12		11.2%	20.6%		4.02	0.02	0.00
Steel Cast [Activity in kt, EF in t/t]	73.70	5.0%	0.062			10.0%			4.57			11.2%			0.51	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	7 531.00	5.0%	0.01126			10.0%			84.80			11.2%			9.48	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	77.30	5.0%	3.9			5.0%			301.47			7.1%			21.32	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	53.61	5.0%	1.8			5.0%			96.51			7.1%			6.82	0.00	0.00
D. Other Production															0.00	0.00	0.00
G. Other															0.00	0.00	0.00

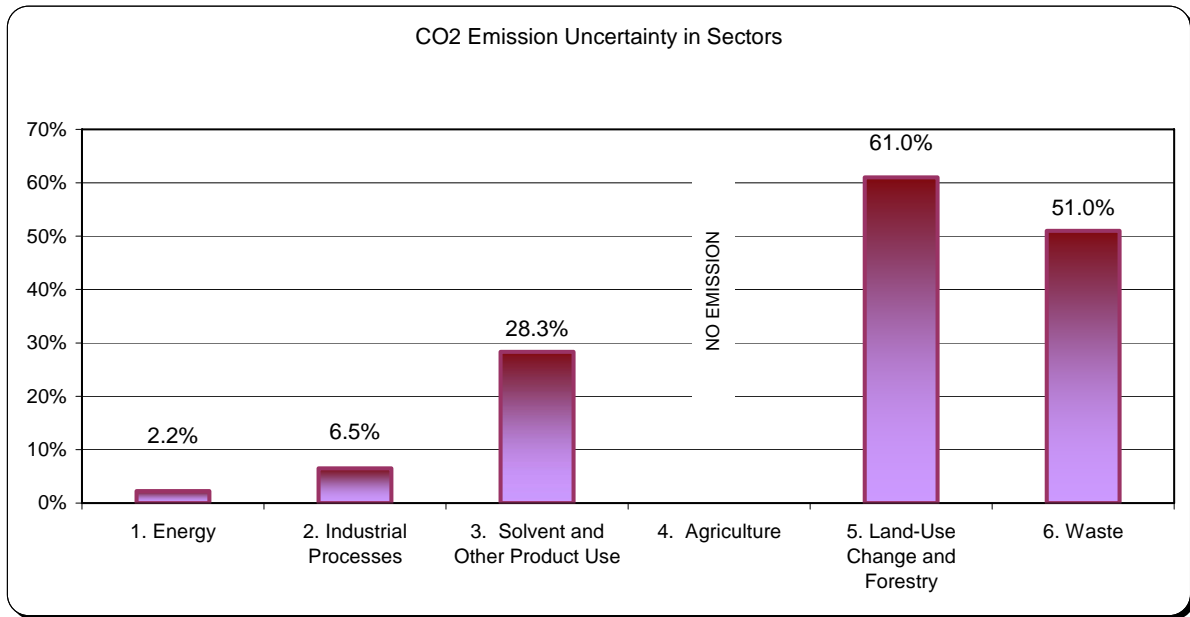
## GHG inventory 1997 – Uncertainty analysis, part 2, sector 3-6

1997	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]
<b>3. Solvent and Other Product Use</b>	123.53		NA						418.72			28.3%			118.50	0.00	0.20
<b>4. Agriculture</b>										673.17	80.03		28.2%	65.4%	0.00	190.04	52.32
<b>A. Enteric Fermentation</b>													34.6%		0.00	177.29	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 490.0	5.0%		90.35		50.0%				315.31			50.2%		0.00	158.44	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 817.0	5.0%		40.77		50.0%				155.60			50.2%		0.00	78.19	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	491.0	5.0%		8.28		50.0%				4.06			50.2%		0.00	2.04	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	182.4	5.0%		5.00		50.0%				0.91			50.2%		0.00	0.46	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	558.0	5.0%		18.00		50.0%				10.04			50.2%		0.00	5.05	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18 135.0	5.0%		1.50		50.0%				27.20			50.2%		0.00	13.67	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	203 584.6	5.0%		0.00		50.0%				0.00			50.2%		0.00	0.00	0.00
<b>B. Manure Management</b>										158.86	23.35		43.1%	148.7%	0.00	66.43	34.72
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 490	5.0%		5.06		50.0%				17.66			50.2%		0.00	8.87	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 817	5.0%		1.55		50.0%				5.90			50.2%		0.00	2.97	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	491	5.0%		0.17		50.0%				0.08			50.2%		0.00	0.04	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	182	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]	558	5.0%		1.39		50.0%				0.78			50.2%		0.00	0.39	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	18 135	5.0%		6.54		50.0%				118.54			50.2%		0.00	59.57	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	203 585	5.0%		0.08		50.0%				15.88			50.2%		0.00	7.98	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.22			150.1%	0.00	0.00	0.33
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			23.13			150.1%	0.00	0.00	34.72
<b>D. Agricultural Soils</b>											56.62			69.1%	0.00	0.00	39.13
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	801 000 000	5.0%			0.01			150.0%			11.19			150.1%	0.00	0.00	16.79
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	686 708 497	5.0%			0.01			150.0%			10.75			150.1%	0.00	0.00	16.20
N-fertilizer Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	42 120 000	5.0%			0.01			150.0%			0.66			150.1%	0.00	0.00	0.99
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	182 658 400	5.0%			0.01			150.0%			2.87			150.1%	0.00	0.00	4.31
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]	70 384 933	5.0%			0.02			150.0%			2.21			150.1%	0.00	0.00	3.32
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	103 076 987	20.0%			1.25523689			150.0%			12.94			151.3%	0.00	0.00	19.58
<b>F. Field Burning of Agricultural Residues</b>										1.17	0.06		19.9%	99.5%	0.00	0.23	0.06
<b>1. Cereals</b>															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	8 192 700	30.0%		0.1816	0.0004		20.0%	150.0%		0.15	0.00		36.1%	153.0%	0.00	0.05	0.01
Barley [Activity in t of crop production, EF in kg/t dm]	3 866 000	30.0%		0.1473	0.0004		20.0%	150.0%		0.06	0.00		36.1%	153.0%	0.00	0.02	0.00
Maize [Activity in t of crop production, EF in kg/t dm]	415 000	30.0%		0.0367	0.0001		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
Oats [Activity in t of crop production, EF in kg/t dm]	1 630 000	30.0%		0.1506	0.0004		20.0%	150.0%		0.02	0.00		36.1%	153.0%	0.00	0.01	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	5 299 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.11	0.00		36.1%	153.0%	0.00	0.04	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	5 995 000	30.0%		0.1530	0.0004		20.0%	150.0%		0.09	0.00		36.1%	153.0%	0.00	0.03	0.00
<b>2 Pulses (Other non-specified)</b>	260 000	30.0%		0.0421	0.0003		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
<b>3 Tuber and Root</b>															0.00	0.00	0.00
Potatoes [Activity in t of crop production, EF in kg/t dm]	20 776 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.37	0.03		36.1%	153.0%	0.00	0.13	0.05
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
<b>5 Other</b>															0.00	0.00	0.00
Fruits, Veget., Rape, Tobacco, Hop, Hay [Activity in t of crop prod., EF in kg/t of crop]	26 017 700	30.0%		0.0142	0.0007		20.0%	150.0%		0.37	0.02		36.1%	153.0%	0.00	0.13	0.03
<b>5. Land-Use Change and Forestry</b>									-31509.81	0.16	0.00	61.0%	100.0%	100.0%	-19227.23	0.16	0.001
A. Forest Land									-37775.81			50.0%			-18887.91	0.00	0.000
B. Cropland									5806.80			50.0%			2903.40	0.00	0.000
C. Grassland									3222.04			50.0%			1611.02	0.00	0.000
D. Wetlands									0.00			50.0%			0.00	0.00	0.000
E. Settlements									-2762.84	0.16	0.0011	50.0%	100.0%	100.0%	-1381.42	0.16	0.001
F. Other Land									0.00	0.00	0.0000	50.0%	100.0%	100.0%	0.00	0.00	0.000
<b>6. Waste</b>									399.97	534.78	3.52	51.0%	64.7%	51.5%	203.95	346.18	1.81
<b>A. Solid Waste Disposal on Land</b>										280.81			102.6%		0.00	288.14	0.00
1. Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]													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 Guidelines 2006) [Activity in Gg, EF in t/t MSW]	11 964.00	23.0%								280.81			102.6%		0.00	288.14	0.00
<b>B. Wastewater Handling</b>										253.97	3.47		75.5%	52.2%	0.00	191.87	1.81
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	1 904.80			0.09			100.0%			171.43			100.0%		0.00	171.43	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	394.92	30.0%		0.208988372			100.0%			82.53			104.4%		0.00	86.17	0.00
N2O from human sewage [Activity in 1000s of population, EF in kg N2O-N/kg sewage N produced]	38 660.00	15.0%			0.0000898			50.0%			3.47			52.2%	0.00	0.00	1.81
<b>C. Waste Incineration</b>									399.97		0.05	51.0%		27.2%	203.95	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			105.06		0.00	51.0%		30.0%	53.57	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%				50.0%			399.97		0.04	51.0%		30.0%	203.95	0.00	0.01

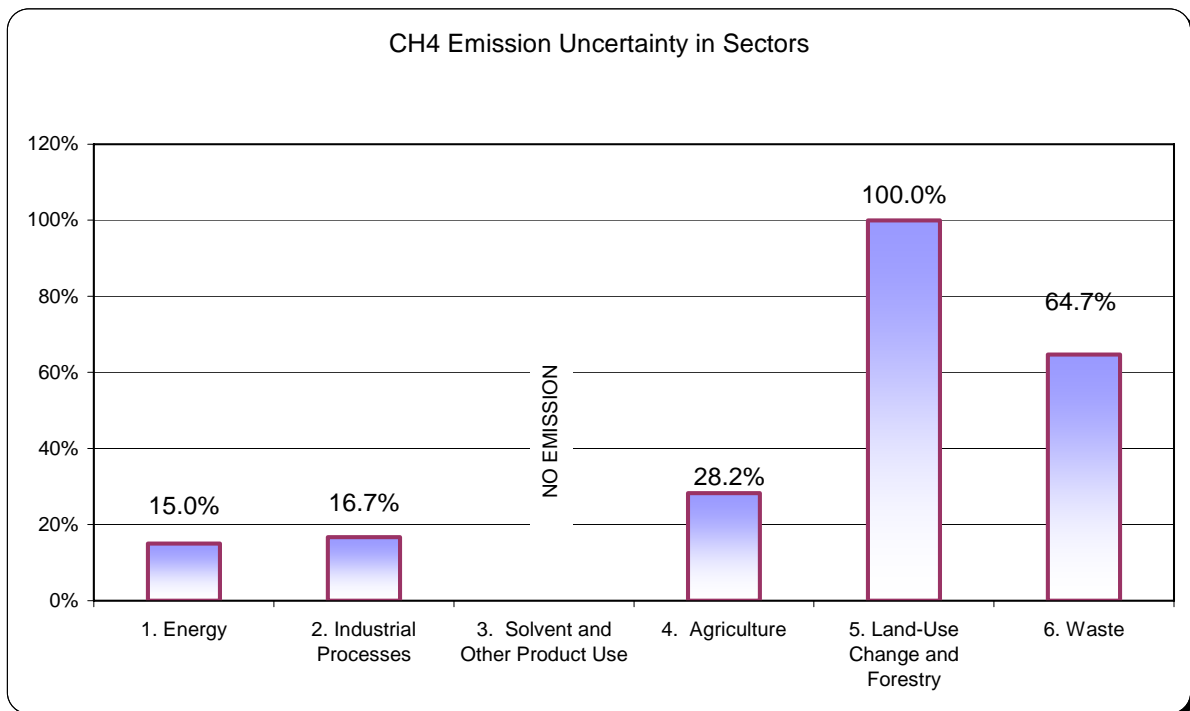
# **Industrial gases inventory 1997 – Uncertainty analysis for HFC, PFC and SF<sub>6</sub>.**

1997	HFC Emission [Gg of CO2 eq.]	PFC Emission [Gg of CO2 eq.]	SF <sub>6</sub> Emission [Gg of CO2 eq.]	HFC Emission uncertainty [%]	PFC Emission uncertainty [%]	SF <sub>6</sub> Emission uncertainty [%]	HFC Emission absolute uncertainty [Gg of CO2 eq.]	PFC Emission absolute uncertainty [Gg of CO2 eq.]	SF <sub>6</sub> Emission absolute uncertainty [Gg of CO2 eq.]
TOTAL	153.56	248.89	9.01	39.3%	20.0%	100.0%	60.38	49.78	9.01
<b>2. Industrial Processes</b>	<b>153.56</b>	<b>248.89</b>	<b>9.01</b>	<b>39.3%</b>	<b>20.0%</b>	<b>100.0%</b>	<b>60.38</b>	<b>48.53</b>	<b>9.01</b>
C. Metal Production		242.63			20.0%			48.53	
3. Aluminium Production		242.63			20.0%			48.53	
F. Consumption of Halocarbons and SF <sub>6</sub>	153.56	6.26	9.01	39.3%		100.0%	60.38	0.00	9.01
1. Refrigeration and Air Conditioning Equipment	39.37			50.0%			19.69		
2. Foam Blowing	NE			50.0%				0.00	
3. Fire Extinguishers	0.11	6.26		50.0%	20.0%				
4. Aerosols/ Metered Dose Inhalers	114.08			50.0%			57.04		
8. Electrical Equipment			9.01			100.0%			9.01

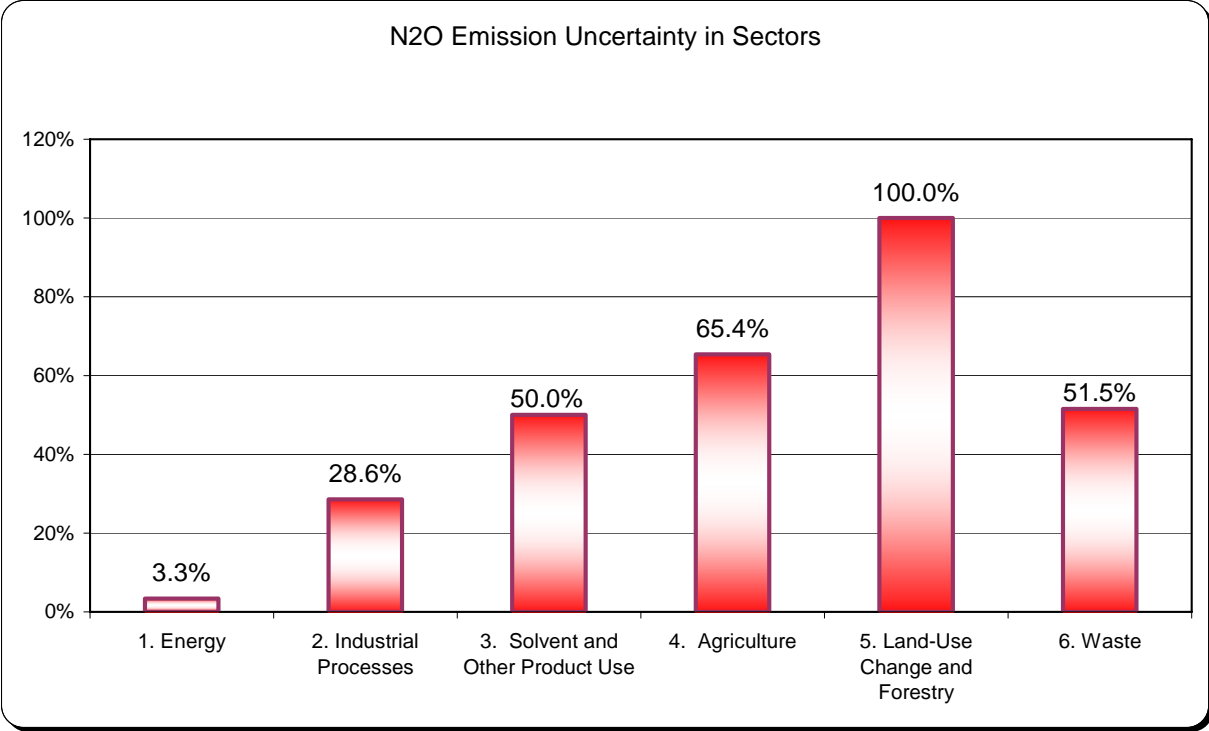




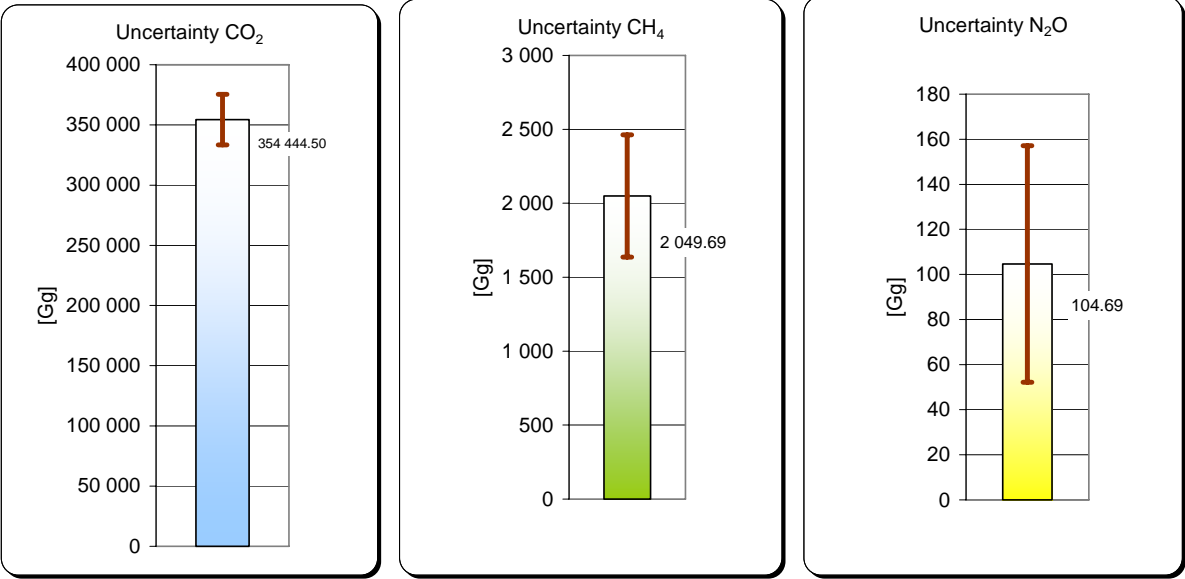
**Results of uncertainty analysis in percents for CO<sub>2</sub> with sectoral split.**



**Results of uncertainty analysis in percents for CH<sub>4</sub> with sectoral split.**



**Results of uncertainty analysis in percents for N<sub>2</sub>O with sectoral split**



**Emission results with uncertainties bars.**