

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

# **Poland's National Inventory Report 1990**

Submission under  
the United Nations Framework  
Convention on Climate Change

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## Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1990. The inventory covers the following GHGs: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). 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 1990. Totals in tables may not sum due to independent rounding.

### Total national GHG emissions

The GHG emissions in base year (1988/1995) and 1990, expressed as CO<sub>2</sub> equivalents, are presented in table ES.1 In 1990 the total national emission of GHG were about 485.41 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 1990 emissions have decreased by 17.3%.

Table ES.1 National emissions of greenhouse gases for the years base year (1988/1995)-1990. [Gg CO<sub>2</sub> eq.]

Pollutant	Base year	1990	(1990-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	364 135.18	-0.21
CO <sub>2</sub> – without LUCF.	494 885.88	396 860.67	-0.20
CH <sub>4</sub>	49 256.41	49 277.34	0.00
N <sub>2</sub> O	42 478.82	39 272.39	-0.08
HFCs	26.44	NE	NE
PFCs	250.18	NE	NE
SF <sub>6</sub>	13.15	NE	NE
TOTAL without CO <sub>2</sub> from LUCF	586 910.88	485 410.40	-0.17
TOTAL with LUCF	553 976.16	452 684.91	-0.18

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

### Carbon dioxide emissions

The CO<sub>2</sub> emissions in 1990 were estimated as 396.86 million tones. This is 19.8% lower than in the base year. CO<sub>2</sub> emission was accounted for 81.8% of total GHG emissions in Poland in 1990. 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 95.53% in 1990. The shares of the main subcategories were as follows: *Energy industries* – 61.9%, *Manufacture Industries and Construction* – 11.3%, *Transport* – 6.9% and *Other Sectors* – 15.0%. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.2% in 1990. *Mineral Products* (especially *Cement*

*Production*) is the main emission source in this sector. The CO<sub>2</sub> removal in LUCF sector in 1990, was calculated to be approximately 32.7 million tones. It means that app. 7.2% 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 2 346.54 Gg in 1990 i.e. 49.28 million tones of CO<sub>2</sub> equivalents. The contribution of CH<sub>4</sub> to the national total GHG emission was 10.2% in 1990. Three of main CH<sub>4</sub> emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture and Waste*. They contributed 37.7%, 38.6% and 22.7% to the national methane emission in 1990, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (30.1% of total CH<sub>4</sub> emission) and Oil and Natural Gas system (7.6% of total CH<sub>4</sub> emission). Waste disposal sites contributed to 9.7% of the methane emission from total CH<sub>4</sub> emission and Wastewater Handling contributed to 13.0% of total CH<sub>4</sub> emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 31.7% of total CH<sub>4</sub> emission in 1990.

### **Nitrous oxide emissions**

The nitrous oxide emissions in 1990 were 126.69 Gg i.e. 39.27 million tonnes of CO<sub>2</sub> equivalents. The emission was app. 7.5% lower than the respective figure for the base year. The contribution of N<sub>2</sub>O to the national total GHG emission was 8.1% in 1990. The main N<sub>2</sub>O emission sources and its shares in total N<sub>2</sub>O emission in 1990 are as follow: *Agricultural Soils* – 58.2%, *Manure Management* – 23.3%, *Chemical Industry* – 9.4% and *Fuel Combustion* – 5.9%.

# **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>) and nitrous oxide (N<sub>2</sub>O). 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 1990 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 1990 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 1990

### 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 81.8% share (in 1990), while the methane contributes with 10.2% to the national total. Nitrous oxide contribution is 8.1%.

Table 2.1 Greenhouse gas emissions in 1990 in CO<sub>2</sub> eq.

Pollutant	1990	
	Emission in CO <sub>2</sub> eq. [Gg]	Share [ %]
CO <sub>2</sub> – net emission (with LUCF)	364 135.18	
CO <sub>2</sub> – without LUCF.	396 860.67	81.76
CH <sub>4</sub>	49 277.34	10.15
N <sub>2</sub> O	39 272.39	8.09
HFCs	NE	NE
PFCs	NE	NE
SF <sub>6</sub>	NE	NE
TOTAL without CO <sub>2</sub> from LUCF	485 410.40	100.0
TOTAL with LUCF	452 684.91	

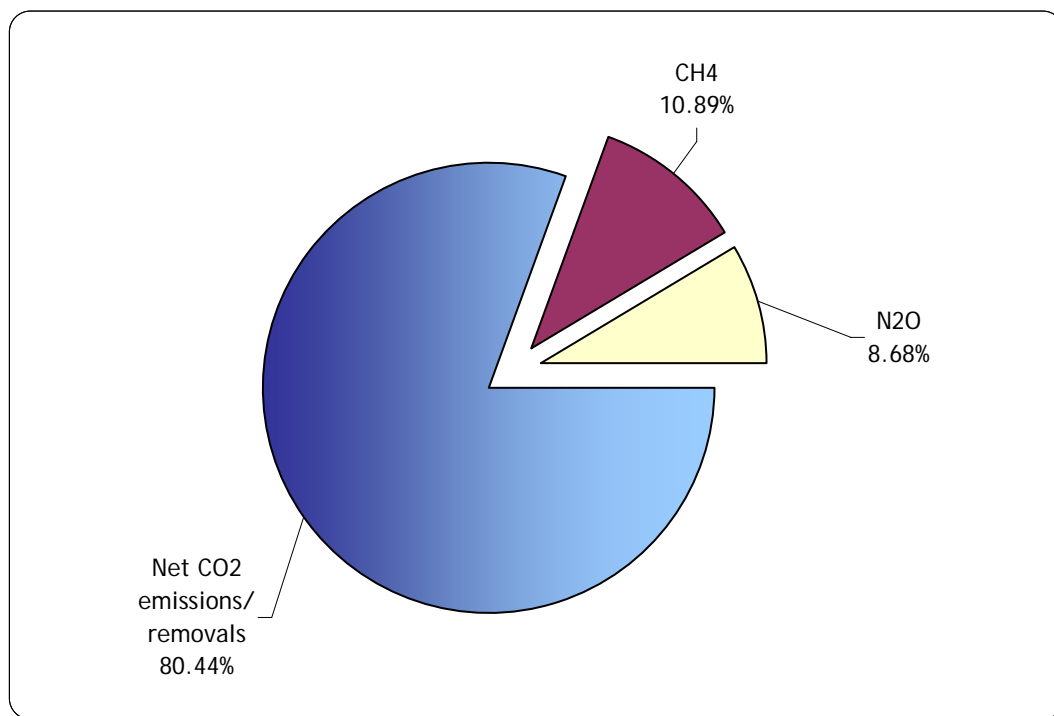


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1990

Emissions of main GHGs in 1990, disaggregated into main source sub-sectors, are given in table 2.2. 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 1990 [Gg]

[Gg]	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
TOTAL without CO <sub>2</sub> from LUCF	396 860.67	2 346.54	126.69
1. Energy	379 178.98	897.32	7.48
A. Fuel Combustion	379 128.09	13.20	7.48
1. Energy Industries	245 585.44	3.26	3.51
2. Manufacturing Industries and Construction	44 889.09	1.93	0.72
3. Transport	27 344.07	6.35	1.64
4. Other Sectors	59 549.86	1.57	1.10
5. Other	1 759.63	0.10	0.51
B. Fugitive Emissions from Fuels	50.89	884.12	NE
1. Solid Fuels	1.58	705.27	NE
2. Oil and Natural Gas	49.30	178.85	NE
2. Industrial Processes	16 717.79	10.91	11.87
A. Mineral Products	8 478.20	NE	NE
B. Chemical Industry	2 613.23	7.69	11.87
C. Metal Production	5 626.35	3.22	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	505.23	NE	0.40
4. Agriculture	NE	905.17	103.35
A. Enteric Fermentation	NE	742.75	NE
B. Manure Management	NE	160.94	29.52
D. Agricultural Soils	NE	NE	73.75
F. Field Burning of Agricultural Residues	NE	1.48	0.08
5. Land Use, Land-Use Change and Forestry	-32 725.49	0.17	0.0011
A. Forest Land	-40 042.52	NE	NE
B. Cropland	6 666.93	NE	NE
C. Grassland	3 699.30	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	-3 049.21	0.17	0.0011
F. Other Land	NE	NE	NE
6. Waste	458.68	532.97	3.59
A. Solid Waste Disposal on Land	NE	227.78	NE
B. Wastewater Handling	NE	305.19	3.54
C. Waste Incineration	458.68	NE	0.05

As a supplement to the table 2.2, table 2.3 includes percentage contributions of main source sectors to the national totals in 1990 for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.

Table 2.3 Percentage shares of individual source sectors in 1990 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	95.54	38.24	5.91
A. Fuel Combustion	95.53	0.56	5.91
1. Energy Industries	61.88	0.14	2.77
2. Manufacturing Industries and Construction	11.31	0.08	0.57
3. Transport	6.89	0.27	1.29
4. Other Sectors	15.01	0.07	0.87
5. Other	0.44	0.00	0.41
B. Fugitive Emissions from Fuels	0.01	37.68	NE
1. Solid Fuels	0.0004	30.06	NE
2. Oil and Natural Gas	0.01	7.62	NE
2. Industrial Processes	4.21	0.47	9.37
A. Mineral Products	2.14	NE	NE
B. Chemical Industry	0.66	0.33	9.37
C. Metal Production	1.42	0.14	NE
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	0.13	NE	0.32
4. Agriculture	NE	38.57	81.58
A. Enteric Fermentation	NE	31.65	NE
B. Manure Management	NE	6.86	23.30
D. Agricultural Soils	NE	NE	58.22
F. Field Burning of Agricultural Residues	NE	0.06	0.06
5. Land Use, Land-Use Change and Forestry	NE	0.01	0.0009
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	0.0009
F. Other Land	NE	NE	NE
6. Waste	0.12	22.71	2.83
A. Solid Waste Disposal on Land	NE	9.71	NE
B. Wastewater Handling	NE	13.01	2.79
C. Waste Incineration	0.12	NE	0.04

## 2.2 GHG emissions by gas

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

In 1990, the net CO<sub>2</sub> emissions (with LULUCF) were estimated as 364.14 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 396.86 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 95.53% in 1990. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 61.9%, *Manufacture Industries and Construction* – 11.3%, *Transport* – 6.9% and *Other Sectors* – 15.0%. Sector 2. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.2% in 1990. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO<sub>2</sub> emission/removal in LULUCF sector in 1990, was calculated to be approximately 32.7 million tones. It means that app. 7.2% of the total CO<sub>2</sub> emissions are offset by CO<sub>2</sub> uptake by forests.

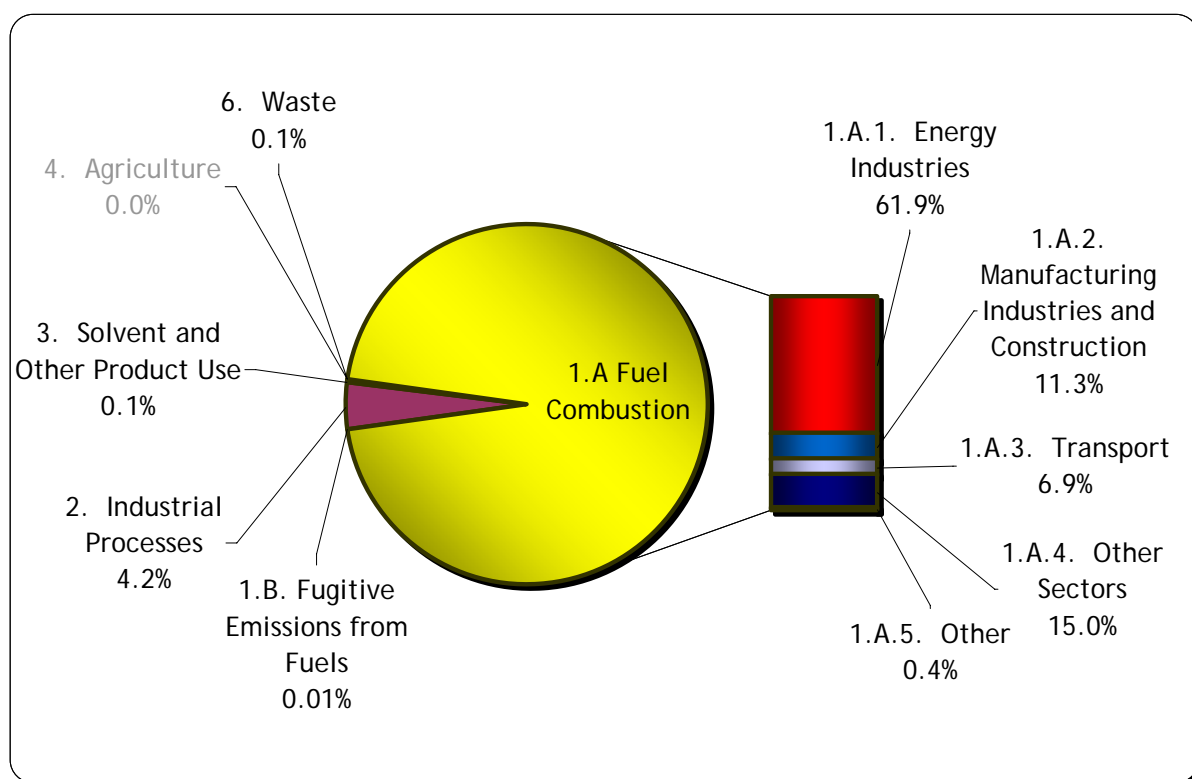


Figure 2.2 Carbon dioxide emission in 1990 by sector

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

The CH<sub>4</sub> emission amounted to 2 346.54 Gg in 1990 i.e. 49.28 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 37.7%, 38.6% and 22.7% of the national methane emission in 1990 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 30.1% of total CH<sub>4</sub> emission) and *Oil and Natural Gas* system (about 7.6% of total emission), *Disposal sites* contributed to 9.71% of the methane emission and *Wastewater Handling* contributed to 13.01%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 31.7% of total methane emission in 1990.

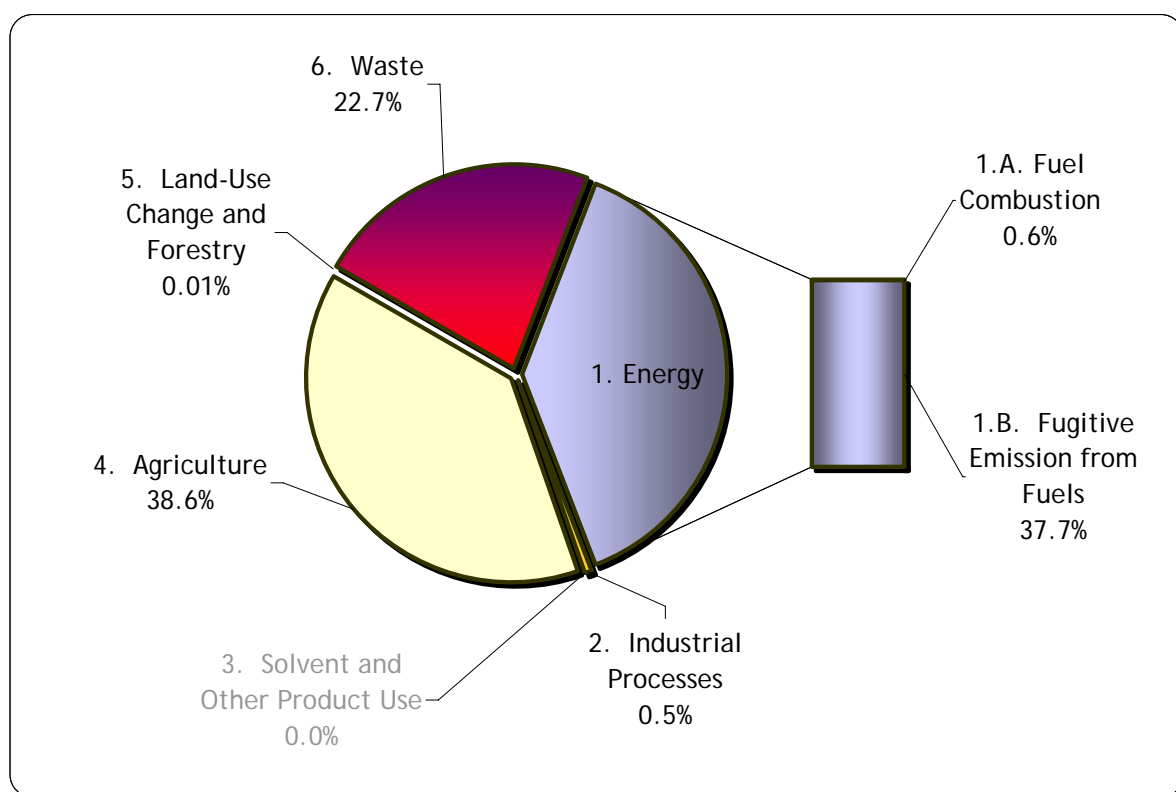


Figure 2.3 Methane emission in 1990 by sector



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

The nitrous oxide emissions in 1990 were 126.69 Gg i.e. 39.27 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 1990 are: *Agricultural Soils* – 58.2%, *Manure Management* – 23.3%, *Chemical Industry* – 9.4% and *Fuel Combustion* – 5.9%.

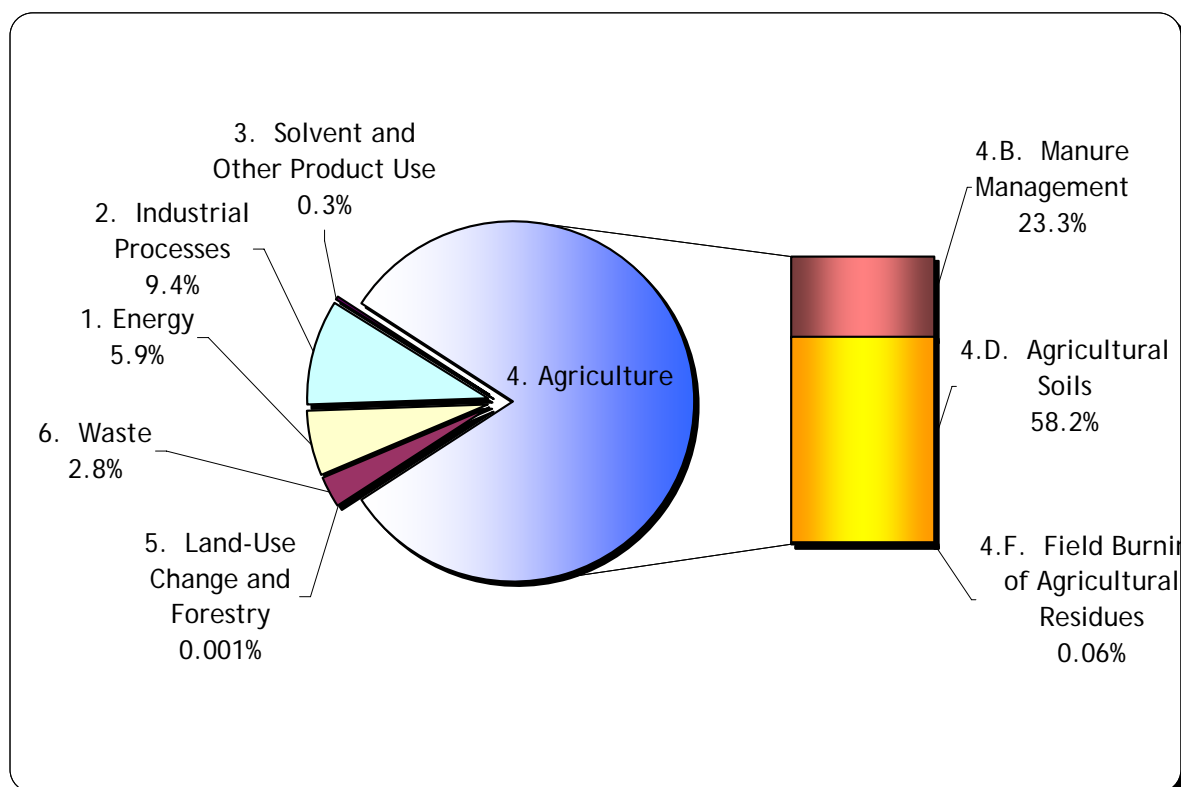


Figure 2.4 Nitrous oxide emission in 1990 by sector

## 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 2.4. GHG emissions according to main sectors in base year (1988/1995) and 1990

	Total [Gg eq. CO <sub>2</sub> ]		(1990-base)/base
	Base year	1990	
TOTAL with LUCF	553 976.2	452 684.91	-0.18
TOTAL without LUCF	586 902.6	485 406.57	-0.17
1. Energy	497 964.7	400 341.86	-0.20
2. Industrial Processes	27 356.2	20 625.31	-0.25
3. Solvent and Other Product Use	1 006.5	629.23	-0.37
4. Agriculture	52 378.1	51 046.64	-0.03
5. Land-Use Change and Forestry	-32 926.5	-32 721.66	-0.01
6. Waste	8 197.2	12 763.53	0.56

### 2.3.1 Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1990 was 400.3 million tons of CO<sub>2</sub> equivalent. CO<sub>2</sub> emission share exceeded 94.7% of the total GHG emissions within 1.*Energy* category (table 2.5). The most emission intensive category was 1.A.1.*Fuel combustion activities* related mostly to heavy industry sector, highly energy consuming.

Table 2.5. GHG emissions from sub-sectors in category *Energy* in 1990

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	400 341.86	100.0	94.7	4.7	0.6
A. Fuel Combustion	381 724.54	95.3	94.7	0.1	0.6
1. Energy Industries	246 743.11	61.6	61.3	0.0	0.3
2. Manufacturing Industries and Construction	45 152.33	11.3	11.2	0.0	0.1
3. Transport	27 985.18	7.0	6.8	0.0	0.1
4. Other Sectors	59 922.99	15.0	14.9	0.0	0.1
5. Other	1 920.93	0.5	0.4	0.0	0.0
B. Fugitive Emissions from Fuels	18 617.32	4.7	0.0	4.6	0.0
1. Solid Fuels	14 812.22	3.7	0.0	3.7	0.0
2. Oil and Natural Gas	3 805.10	1.0	0.0	0.9	0.0

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

Table 2.6 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 1990. CO<sub>2</sub> is dominating among GHGs – its contribution exceeds 81.1%. The main GHG emission sources in this category were: production processes of cement, nitric acid and ammonia.

The emissions of GHG from *Solvent and Other Use* sector includes N<sub>2</sub>O emissions from anaesthesia (19.7%) and CO<sub>2</sub> emissions (recalculated from NMVOC) (80.3%).

Table 2.6. 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 1990

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	20 625.31	100.0	81.1	1.1	17.8	0.0
A. Mineral Products	8 478.20	41.1	41.1	0.0	0.0	NE
B. Chemical Industry	6 453.15	31.3	12.7	0.8	17.8	NE
C. Metal Production	5 693.95	27.6	27.3	0.3	0.0	NE
D. Other Production	NE	NE	NE	NE	NE	NE
F. Consumption of Halocarbons and SF <sub>6</sub>	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE
Total Solvent and Other Product Use	629.23	100	80.3	0.0	19.7	

### 2.3.3 Agriculture (IPCC category 4)

The main sources of GHG in category 4 *Agriculture* were: 4.D. *Agricultural Soils*, 4.B. *Enteric Fermentation* and 4.A. *Manure Management* (table 2.7). N<sub>2</sub>O emission share was largest in total GHG emission from *Agriculture* in 1990 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 2.7. GHG emissions from sub-sectors in category 4 *Agriculture* in 1990

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	51 046.64	100.0	37.2	62.8
A. Enteric Fermentation	15 597.83	30.6	30.6	0.0
B. Manure Management	12 530.80	24.5	6.6	17.9
D. Agricultural Soils	22 863.58	44.8	0.0	44.8
F. Field Burning of Agricultural Residues	54.43	0.1	0.1	0.0

### 2.3.4 Waste (IPCC category 6)

As it can be seen in table 2.8, the emission of CH<sub>4</sub> dominated in this sector in 1990 (almost 87.7%). The main part of GHG emissions came from *solid waste disposal on land* and *wastewater handling*.

Table 2.8. GHG emissions from sub-sectors in category 6 *Waste* in 1990

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	12 763.53	100	3.6	87.7	8.7
A. Solid Waste Disposal on Land	4 783.42	37.5	0.0	37.5	0.0
B. Wastewater Handling	7 505.10	58.8	0.0	50.2	8.6
C. Waste Incineration	475.01	3.7	3.6	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 2.9.

Table 2.9 Changes of greenhouse gas emissions in 1990 with respect to base year 1988/1995

Pollutant	Base year	1990	1990/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	364 135.18	78.83
CO <sub>2</sub> – without LUCF.	494 885.88	396 860.67	80.19
CH <sub>4</sub>	49 256.41	49 277.34	100.04
N <sub>2</sub> O	42 478.82	39 272.39	92.45
HFCs	26.44	NE	NE
PFCs	250.18	NE	NE
SF <sub>6</sub>	13.15	NE	NE
TOTAL without CO <sub>2</sub> from LUCF	586 910.88	485 410.40	82.71
TOTAL with LUCF	553 976.16	452 684.91	81.72

\* 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. 19.8% from the base year to 1990.

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

- share in of solid fuels decreased from 85.3% in 1988 to 83.3% in 1990
- share of liquid fuels increased from 11.4% (1988) to 12.8% (1990)
- share of gaseous fuels increased from 3.3% (1988) to 3.8% (1990).

### Methane

CH<sub>4</sub> emission had increased by app. 0.0% from the base year to 1990. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 2.2%,
- the decrease in *Fugitive Emission* by 18.2%,
- the increase in emission from *Waste* by 73.4%.

### Nitrous oxide

The nitrous oxide emissions in 1990 were app. 7.5% lower than the respective figure for the base year. The share in *Manure Management* increased from 22.0% in 1988 to 23.3% in 1990, in *Agricultural Soils* increased from 55.6% (1988) to 58.2% (1990) and in *Chemical Industry* decreased from 11.8% in 1988 to 9.4% in 1990.

### 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 2.10 and Figure 2.5 Compared to 1988/1995, the percentage share of CO<sub>2</sub> in 1990 decreased from 84.3% to 81.8%.

Table 2.10 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	

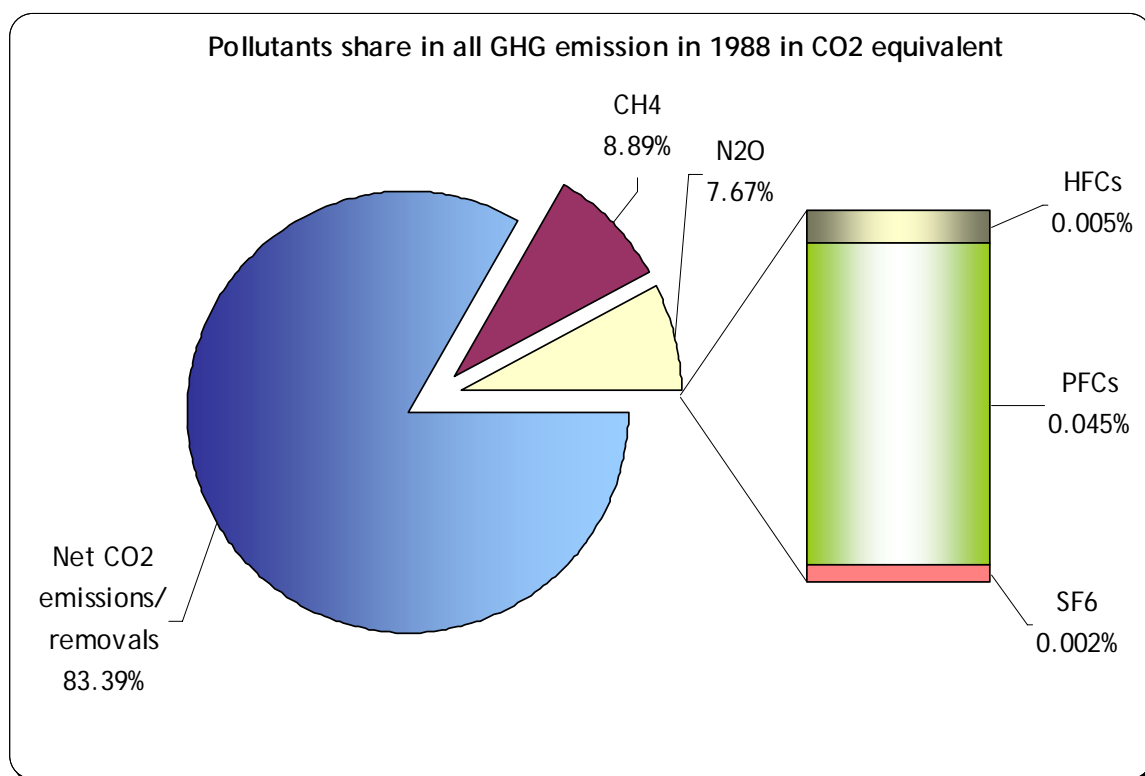


Figure 2.5 Percentage share of national greenhouse gas emissions in base year (1988/1995) including emission from sector 5.

## 2.5 Comparison of greenhouse gas emissions 1990 and 1989

Changes of national emissions and sinks of GHGs in 1990 compared to 1989 were:

CO <sub>2</sub>	- net emission fall to	83.41%
CH <sub>4</sub>	- emission fall to	92.23%
N <sub>2</sub> O	- emission fall to	89.38%

Below results are discussed separately for each greenhouse gas with respect to 1990 emissions and change between 1990 and 1989.

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

In 1990, the net CO<sub>2</sub> emissions (with LULUCF) was 16.6% lower than in 1989. The CO<sub>2</sub> emission in 1990 from category *Energy* was lower by 15.7% and from category *Industrial Processes* was lower by 19.4% than in 1989. In comparison to 1989 the CO<sub>2</sub> emission from category *Waste* in 1990 fall by 14.3%.

Table 2.11. Comparison of carbon dioxide emission in 1989 and 1990

Year	CO <sub>2</sub> [Gg]		1990/1989 [%]
	1989	1990	
TOTAL without LUCF	472 028.1	396 860.7	84.1
1. Energy	449 929.8	379 179.0	84.3
A. Fuel Combustion	449 879.1	379 128.1	84.3
1. Energy Industries	265 783.8	245 585.4	92.4
2. Manufacturing Industries and Construction	54 849.9	44 889.1	81.8
3. Transport	23 351.0	27 344.1	117.1
4. Other Sectors	100 199.8	59 549.9	59.4
5. Other	5 694.6	1 759.6	30.9
B. Fugitive Emissions from Fuels	50.7	50.9	100.4
1. Solid Fuels	1.8	1.6	86.1
2. Oil and Natural Gas	48.9	49.3	100.9
2. Industrial Processes	20 740.8	16 717.8	80.6
A. Mineral Products	10 983.3	8 478.2	77.2
B. Chemical Industry	4 044.1	2 613.2	64.6
C. Metal Production	5 713.4	5 626.4	98.5
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	822.1	505.2	61.5
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	-35 492.1	-32 725.5	92.2
A. Forest Land	-43 078.0	-40 042.5	93.0
B. Cropland	6 889.9	6 666.9	96.8
C. Grassland	3 823.0	3 699.3	96.8
D. Wetlands	NE	NE	NE
E. Settlements	-3 127.0	-3 049.2	97.5
F. Other Land	NE	NE	NE
6. Waste	535.3	458.7	85.7
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	NE	NE	NE
C. Waste Incineration	535.3	458.7	85.7

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

The emission in 1990 was lower than in 1989 by 7.8%. The main sources are *Agriculture*, *Energy* and *Waste*. Emission from *Manure Management* in the *Agriculture* sector was lower by 2.76% in 1990 and from *Waste* sector was lower by 3.1% than in 1989. *Fugitive emission* in *Energy* sector was lower by 12.6% in 1990 compared to 1989.

Table 2.12 Comparison of methane emission in 1989 and 1990

Year	CH <sub>4</sub> [Gg]		1990/1989 [%]
	1989	1990	
TOTAL	2 544.36	2 346.54	92.2
1. Energy	1 027.71	897.32	87.3
A. Fuel Combustion	15.90	13.20	83.0
1. Energy Industries	3.51	3.26	92.8
2. Manufacturing Industries and Construction	2.35	1.93	82.2
3. Transport	6.61	6.35	95.9
4. Other Sectors	2.38	1.57	66.1
5. Other	1.04	0.10	9.2
B. Fugitive Emissions from Fuels	1 011.81	884.12	87.4
1. Solid Fuels	821.13	705.27	85.9
2. Oil and Natural Gas	190.68	178.85	93.8
2. Industrial Processes	16.16	10.91	67.5
A. Mineral Products	NE	NE	NE
B. Chemical Industry	12.24	7.69	62.9
C. Metal Production	3.92	3.22	82.1
D. Other Production	NE	NE	NE
G. Other	NE	NE	NE
3. Solvent and Other Product Use	NE	NE	NE
4. Agriculture	950.13	905.17	95.3
A. Enteric Fermentation	783.07	742.75	94.9
B. Manure Management	165.51	160.94	97.24
D. Agricultural Soils	NE	NE	NE
F. Field Burning of Agricultural Residues	1.54	1.48	95.7
5. Land Use, Land-Use Change and Forestry	0.18	0.17	89.8
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.18	0.17	89.8
F. Other Land	NE	NE	NE
6. Waste	550.17	532.97	96.9
A. Solid Waste Disposal on Land	216.29	227.78	105.3
B. Wastewater Handling	333.88	305.19	91.4
C. Waste Incineration	NE	NE	NE



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

The emission was lower than in 1989 (by 10.6%). 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 lower by 2.9% in 1990 and from *Agricultural Soils* was lower by 9.3% than in 1989.

Table 2.13. Comparison of nitrous oxide emission in 1989 and 1990

Year	N <sub>2</sub> O [Gg]		1990/1989 [%]
	1989	1990	
TOTAL	141.74	126.69	89.4
1. Energy	9.96	7.48	75.1
A. Fuel Combustion	9.96	7.48	75.1
1. Energy Industries	3.78	3.51	93.0
2. Manufacturing Industries and Construction	0.86	0.72	83.4
3. Transport	1.58	1.64	104.0
4. Other Sectors	1.83	1.10	60.0
5. Other	1.91	0.51	26.8
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	16.35	11.87	72.6
A. Mineral Products	NE	NE	NE
B. Chemical Industry	16.35	11.87	72.6
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	111.79	103.35	92.4
A. Enteric Fermentation	NE	NE	NE
B. Manure Management	30.41	29.52	97.1
D. Agricultural Soils	81.31	73.75	90.7
F. Field Burning of Agricultural Residues	0.08	0.08	98.3
5. Land Use, Land-Use Change and Forestry	0.0013	0.0011	89.8
A. Forest Land	NE	NE	NE
B. Cropland	NE	NE	NE
C. Grassland	NE	NE	NE
D. Wetlands	NE	NE	NE
E. Settlements	0.0013	0.0011	89.8
F. Other Land	NE	NE	NE
6. Waste	3.24	3.59	110.8
A. Solid Waste Disposal on Land	NE	NE	NE
B. Wastewater Handling	3.18	3.54	111.3
C. Waste Incineration	0.06	0.05	84.2

## 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>.

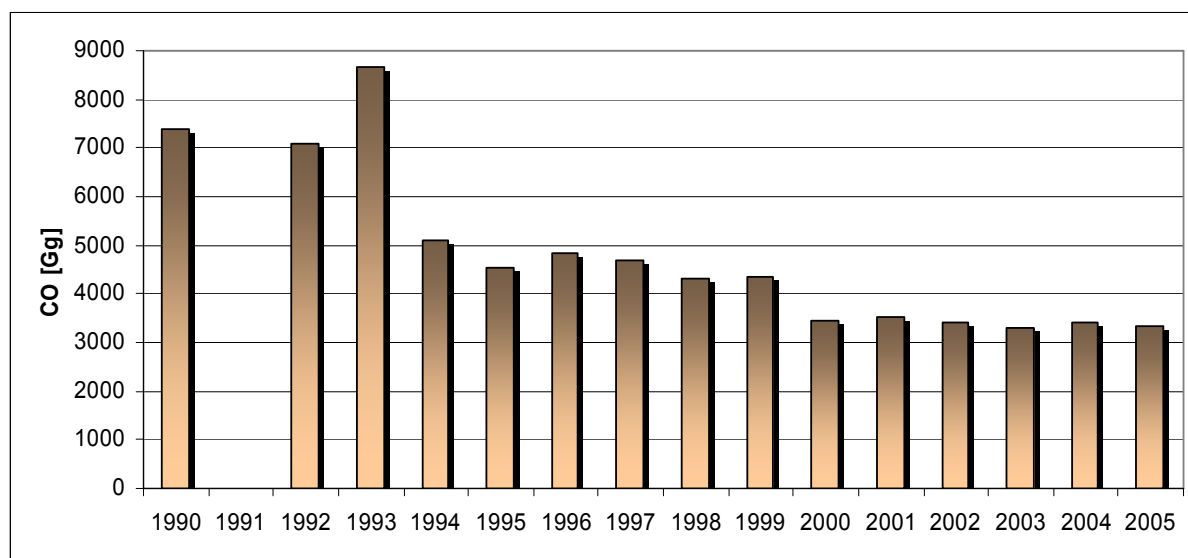


Figure 2.6 Emissions of CO (1990-2005).

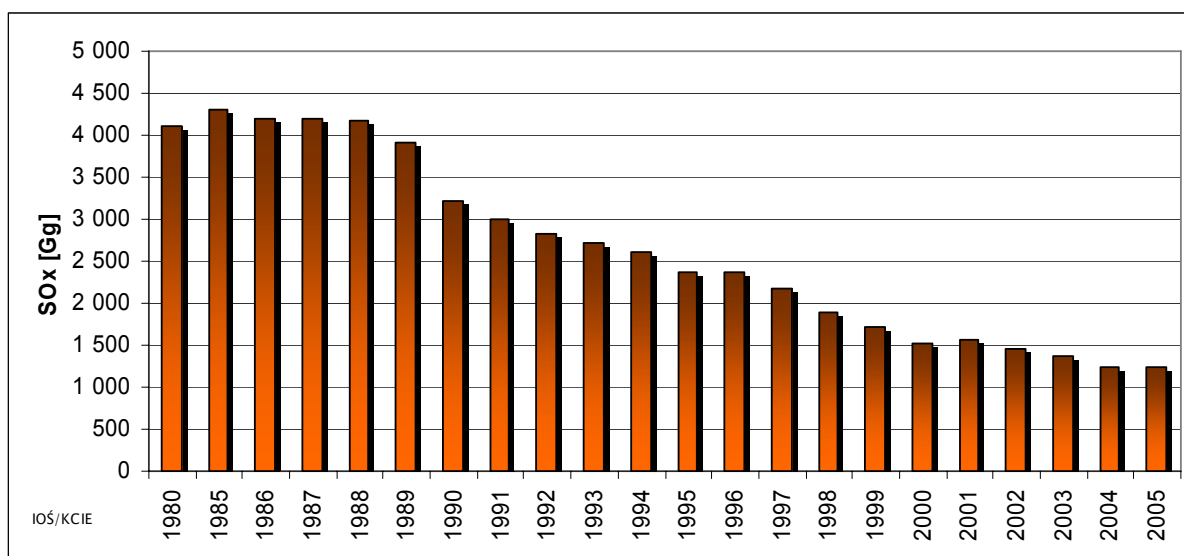


Figure 2.7 Emissions of SO<sub>x</sub>, (1980-2005).

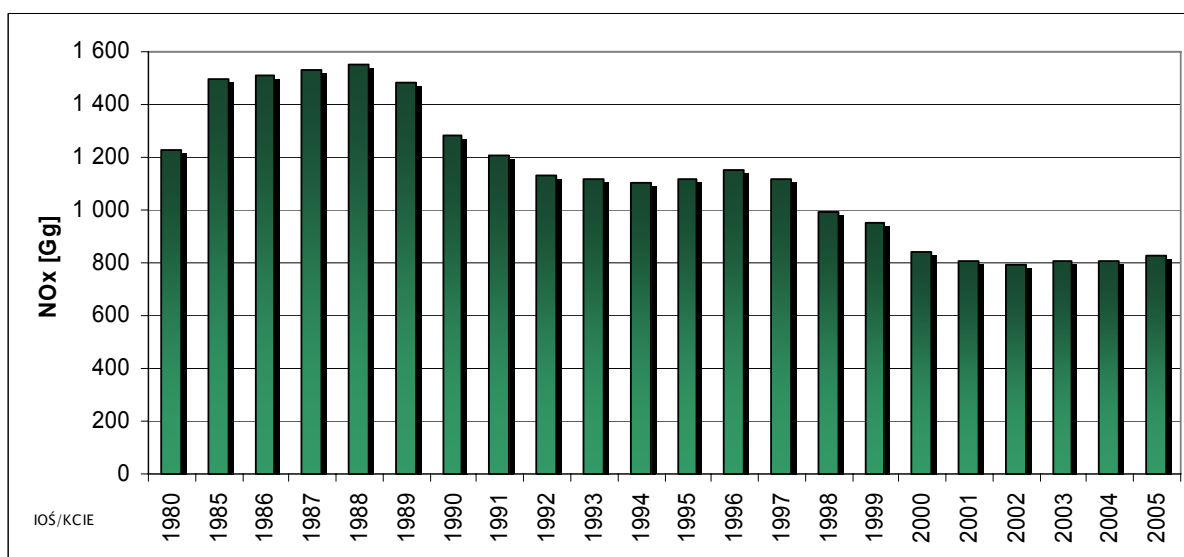


Figure 2.8 Emissions of NO<sub>x</sub> (1980-2005).

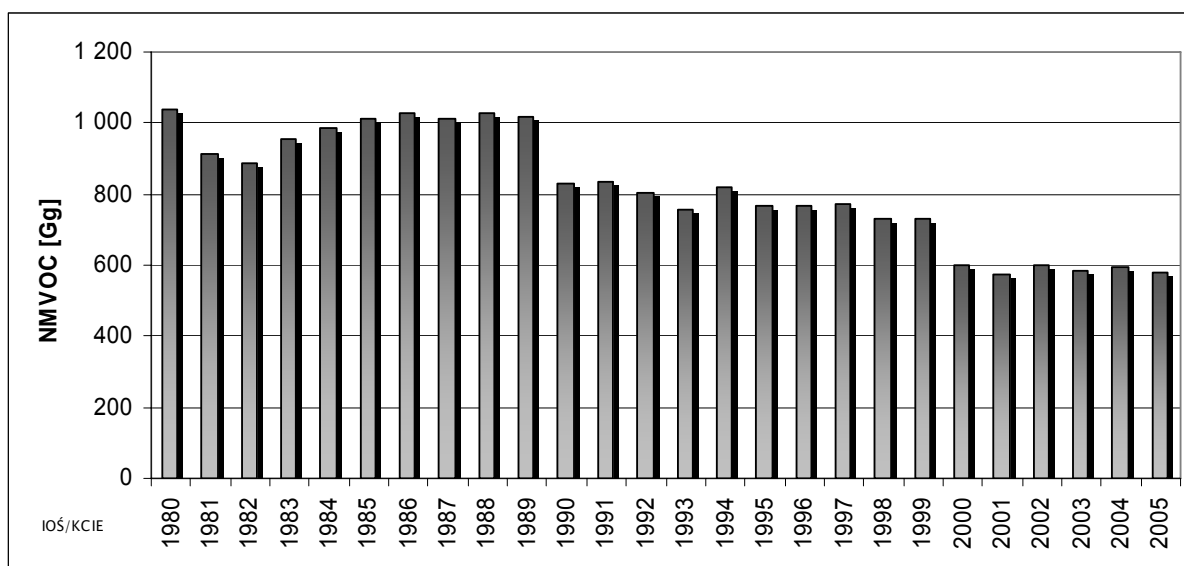


Figure 2.9 Emissions of NMVOC (1980-2005).

### 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 72.2%
- 1.A.3.b Transport Road Transportation (CO<sub>2</sub> emission), share in total GHG emission 4.4%
- 1.B.1.a. Coal Mining and Handling (CH<sub>4</sub> emission), share in total GHG emission 3.0%
- 1.B.2.b. Natural Gas (CH<sub>4</sub> emission), share in total GHG emission 0.8%

Share of these categories in total Poland's GHG emissions is 80.4%.

#### 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:

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

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

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

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

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

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

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

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

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

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

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

the emission factor for elemental carbon from fuel oil:

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

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

the emission factor for high-methane natural gas:

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

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

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<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 1992a]
- Energy Balance Poland – OECD [ARE 1992]

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
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

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
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0100	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Blast Furnace Gas		0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

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

Fuel	EF CO <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
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Coal-bed Methane		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

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

Fuel	EF CO <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
Crude Oil	73.30	0.0030	0.0006
Non-energy Products	76.50	0.0030	0.0006
Liquide and Gaseous Waste Fuels	57.27	0.0015	0.0006
GAS FUELS			
High – Methane Natural Gas		0.0010	0.0001
Nitrified Natural Gas	54.73	0.0010	0.0001
SOLID FUELS			
Hard Coal		0.0010	0.0015
Lignite		0.0010	0.0015
Coke		0.0010	0.0015
Coke Oven Gas	44.70	0.0010	0.0001
Town Gas		0.0010	0.0001
Gas Manufactured from Coal	116	0.0010	0.0001
Solid Waste Fuels	143.00	0.0300	0.0040
BIOMAS			
Fuel Wood	112.00	0.0300	0.0040

As concerns sector 1.A.3 *Transport*, activity data for road transport were taken from [FEWE, 1997]. CO<sub>2</sub> emission factors for road transport come from [ITS 1995]. 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 1992],
- ♦ Questionnaire/Report G-03, [GUS 1991e],
- ♦ Statistical Yearbook of The Republic of Poland [GUS 1992],
- ♦ Non-published data from Agency of Energy Market

Table 3.5 Emission factors [kg/GJ] for transport in 1990

Type of transport	Vehicle specification	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.	70.33	0.0005	0.0022
1.A.3.a.i i International Aviation - bunker	1.i.PL.	70.33	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	72.82	0.030	0.002
	2.i.a.LG	66.76	0.020	0.0002
	2.i.a.ON	73.84	0.002	0.004
	2.i.b.BS	72.82	0.020	0.001
1.A.3.b. Passenger Cars with catalysts	2.i.g.BS	72.82	0.007	0.0200
1.A.3.b.ii Light Duty Vehicles < 3.5 t without catalysts	2.ii.a.BS	72.82	0.020	0.001
	2.ii.a.ON	73.84	0.001	0.0040
	2.ii.b.BS	72.82	0.020	0.001
1.A.3.b.ii Light Duty Vehicles < 3.5 t with catalysts	2.ii.g.BS	72.82	0.020	0.001
1.A.3.b.iii Heavy Duty Vehicles > 3.5 t. without catalysts	2.iii.a.BS	72.82	0.020	0.001
	2.iii.a.ON	73.84	0.006	0.003
	2.iii.b.ON	73.84	0.006	0.003
1.A.3.b.iv Motorcycles	2.iv.BS	72.82	0.100	0.001
1.A.3.b.iv Mopeds	2.iv.BS	72.82	0.100	0.001
1.A.3.b.vi Tractors	2.vi.ON	73.84	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.

Domestic statistics for year 1990 do not contain division of activity data concerning consumption of non-energy products for particular economy sectors. For that reason estimation of non-energy products use for a given sector is based on total consumption of non-energy products in year 1990 [GUS 1992a] and on four-years average (from years 1996-1999) share of mentioned fuel energy consumption for this sector in total domestic consumption. Based on these calculations, the following shares of energy consumption of non-energy products have been estimated for IPCC subcategories: 1.A.1 – 10.6%, 1.A.2 – 29.9%, 1.A.4.- 21% and 1.A.5 – 1.4 %. Finally, energy consumption stands for about 63% of total consumption of non-energy products.

#### 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 1.26% 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).

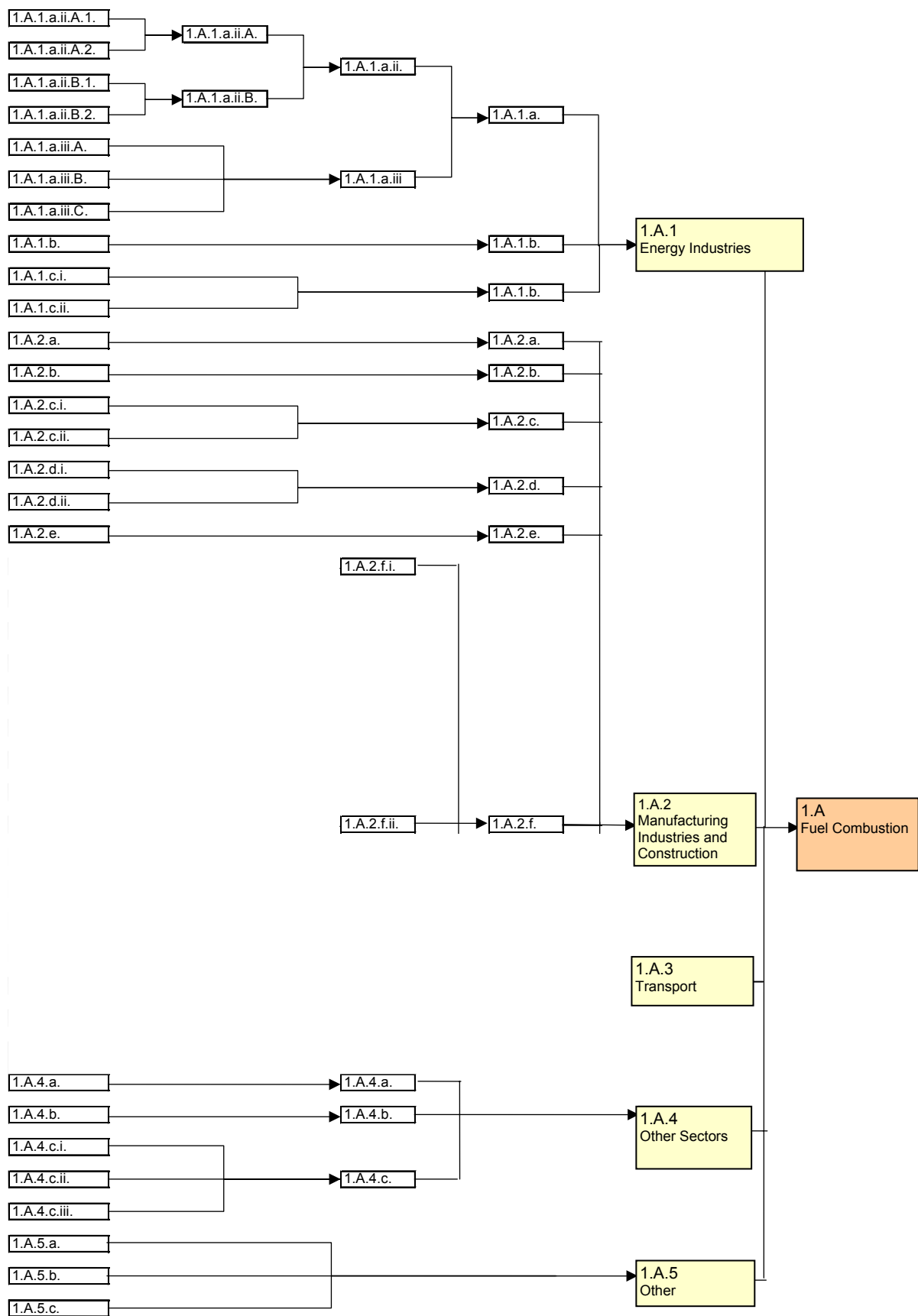


Figure 3.1. Flowchart of summing up sub-sectors in sector 1.A - Fuel Combustion

### 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 1990 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 1990. 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 1990

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>
151.7	261.2	194.7	66.5	64.31	43.08

##### *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, 1991] 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 1992a].

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 1992a]:

production	PJ	6.614
distribution	Gg	13286

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 1992a] 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]	38.150
Gas processing	Gas use [PJ]	336.008
Gas transmission	Gas use [PJ]	336.008
Underground gas storage	Gas use [PJ]	336.008
Gas distribution	Gas use [PJ]	336.008
Nitrified natural gas system:		
Gas production	Gas production [PJ]	61.409
Gas processing	Gas use [PJ]	38.4308
Gas transmission	Gas use [PJ]	38.4308
Gas distribution	Gas use [PJ]	38.4308



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 1.1%
- 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 2.2%.

### 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 1995b]. 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 1995b]. 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 1991e]. 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 1995b]. The applied country specific emission factor, which is equal 6.47 kg/Mg nitric acid [Kozłowski 2001].

#### 4.2.2.3. *Adipic Acid production* (CRF 2.B.3)

Activity data concerning adipic acid production are taken from adipic production plant. CO<sub>2</sub> emission factor for this category, which is equal 0.300 Mg CO<sub>2</sub>/ Mg, was taken from [IPCC 1997].

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

Activity data concerning calcium carbide production are published in [GUS 1995b]. 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].

#### 4.2.2.5. *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 1995b]. 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 1995b]. 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 1995b]. 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 1991e]. Country specific emission factor of CO<sub>2</sub>, which is equal 70.80 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 1995b]. 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 1995b]. 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 1995b]. 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 1995b]. 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 1995b] 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 1995b]. 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 1995b]. 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.

## 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 1995]. 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	3.2%
- 4.B. Manure Management (CH <sub>4</sub> emission), share in total GHG emission	0.7%
- 4.B. Manure Management (N <sub>2</sub> O emission), share in total GHG emission	1.9%
- 4.D.1. Direct Soil Emissions (N <sub>2</sub> O emission), share in total GHG emission	3.2%
- 4.D.3. Indirect Soil Emissions (N <sub>2</sub> O emission), share in total GHG emission	1.2%

Share of these categories in total Poland's GHG emissions is 10.2%.

### 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 1991]. For goats population activity was taken from 1996 because of lack of data from earlier years.

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 1990

Livestock	Population [millions]	GE Gross Energy Intake [MJ/animal/day]	EF Emission Factor [kg CH <sub>4</sub> / animal / year]
4.A Enteric Fermentation	34.792	---	---
1 Cattle	10.049	---	---
a. Dairy cattle	4.919	232.837	91.629
b Non-dairy cattle	5.130	104.8557	41.264
3 Sheep	4.159	18.192	8.011
4 Goats	0.179	---	5.000
6 Horses	0.941	---	18.000
8 Swine	19.464	---	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 1991]. For goats population activity was taken from 1996 because of lack of data from earlier years.

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	262.813	---	---
1 Cattle	10.049	---	---
a. Dairy cattle	4.919	4.760	5.628
b Non-dairy cattle	5.130	1.760	1.613
3 Sheep	4.159	0.363	0.169
4 Goats	0.179	0.280	0.120
6 Horses	0.941	1.720	1.390
8 Swine	19.464	0.500	5.403
9 Poultry	228.021	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 1991]. For goats population activity was taken from 1996 because of lack of data from earlier years.

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

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

Livestock	Type of AWMS		
	Liquid System	Solid Storage and Drylot	Pasture Range and Paddock
Dairy cattle	0.0267	0.7606	0.2127
Non-dairy cattle	0.0317	0.7943	0.1740
Sheep	---	0.5000	0.50
Goats	---	0.9000	0.10
Horses	---	0.9000	0.10
Swine	0.2321	0.7679	---
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	0.0267	9193.611
1.b. Non-dairy cattle	50.0	0.0317	8131.050
3 Sheep	16.0	--	0.000
4 Goats	25.0	--	0.000
6 Horses	25.0	--	0.000
8 Swine	20.0	0.2321	90340.621
9 Poultry	0.6	0.2000	27362.473

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	0.7606	261908.876
1.b. Non-dairy cattle	50.0	0.7943	203737.950
3 Sheep	16.0	0.5000	33272.000
4 Goats	25.0	0.9000	4034.610
6 Horses	25.0	0.9000	21172.500
8 Swine	20.0	0.7679	298939.379
9 Poultry	0.6	0.8000	109449.892

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 1991]. 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 1991] 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 1991]. 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 1991].

#### 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 1991]. 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 Nex [kg/head/yr]	Fraction of manure nitrogen per AWMS [ % / 100 ]	Nitrogen excreted in AWMS [ kg N / year / 1000 ]	EF Emission factor for AWMS [kg N <sub>2</sub> O-N/ kg N ]
1.a. Dairy cattle	70.0	0.21	73227.513	
1.b. Non-dairy cattle	50.0	0.17	44631.000	
3 Sheep	16.0	0.50	33272.000	
4 Goats	25.0	0.10	448.290	
6 Horses	25.0	0.10	2352.500	
8 Swine	--	--	--	
9 Poultry	--	--	--	
		total	153931.303	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 1990 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 1991],

$N_{\text{ex}}$  – 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]
1 274	0.1	153 931.30	0.2	0.01	1.58

#### 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<sub>2O(L)→N</sub> – N<sub>2</sub>O produced from leaching and runoff of applied fertiliser and animal manure N,

N<sub>FERT</sub> – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1991],

N<sub>ex</sub> – total amount of animal manure nitrogen excreted in AWMS system (table 6.6),

Frac<sub>LEACH</sub> – fraction nitrogen input to soil that is lost through leaching and runoff, default value,

EF – emission factor for N<sub>2</sub>O 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<sub>2</sub>O–N from nitrogen leaching and run-off

N <sub>fert</sub> [Gg/year]	N <sub>ex</sub> [kgN/year /1000]	Frac <sub>LEACH</sub> [kg N/kg N]	EF [kgN <sub>2</sub> O-N/kg N]	N <sub>2O(L)→N</sub> [GgN <sub>2</sub> O-N]
1 274	153931.30	0.3	0.025	10.709

The following equation is a conversion of N<sub>2</sub>O→N emissions to N<sub>2</sub>O emissions:

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

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

CH<sub>4</sub> and N<sub>2</sub>O 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 1991]. 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 1990 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 1990 (and comparing to 1989) 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 1989 and 1990 [IPCC 2003]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1989			1990		
	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	-35 492.10	0.185	0.001	-32 725.49	0.166	0.001
5A. Forest Land	-43 078.01			-40 042.52		
1. Forest Land remaining Forest Land	IE			IE		
2. Land converted to Forest Land	IE			IE		
5B. Cropland	6 889.89			6 666.93		
1. Cropland remaining Cropland	IE			IE		
2. Land converted to Cropland	IE			IE		
5C. Grassland	3 823.02			3 699.30		
1. Grassland remaining Grassland	IE			IE		
2. Land converted to Grassland	IE			IE		
5D. Wetlands	IE			IE		
1. Wetlands remaining Wetlands	IE			IE		
2. Land converted to Wetlands	IE			IE		
5E. Settlements	-3 127.00	0.185	0.001	-3 049.21	0.166	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 1989 and 1990 [IPCC 1997]

Greenhouse gas source and sink categories	1989					1990				
	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	48 956.47	-84 448.56	-35 492.10	0.185	0.001	41 678.47	-74 403.97	-32 725.49	0.166	0.001
5A. Changes in Forest and Other Woody Biomass Stocks	40 469.12	-67 491.18	-27 022.07			33 312.92	-57 198.48	-23 885.56		
1. Tropical Forests										
2. Temperate Forests	40 469.12	-67 491.18	-27 022.07			33 312.92	-57 198.48	-23 885.56		
3. Boreal Forests										
4. Grasslands/Tundra										
5. Other (please specify)										
Harvested Wood										
5B. Forest and Grassland Conversion	74.25		74.25			65.64		65.64		
1. Tropical Forests										
2. Temperate Forests	74.2			0.185	0.001	65.6			0.166	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	8 413.10	-16 957.38	-8 544.28			8 299.92	-17 205.49	-8 905.57		
Cultivation of Mineral Soils	8 413.10		8 413.10			8 299.92		8 299.92		
Cultivation of Organic Soils										
Liming of Agricultural Soils		2 299.8	2 299.81				2 066.3	2 066.32		
Forest Soils		-16 055.94	-16 055.94				-16 156.96	-16 156.96		
Other Land (please specify)		-3 201.25	-3 201.25				-3 114.85	-3 114.85		
5E. Other (please specify)										

According to calculation for 1990, Sector 5. Land-Use Change and Forestry, was net CO<sub>2</sub> sink. Removals/emissions balance decreased from 35 492 Gg CO<sub>2</sub> in 1989 to 32 725 Gg CO<sub>2</sub> in 1990 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 1990 net CO<sub>2</sub> removals decreased to 23 886 Gg CO<sub>2</sub> from about 27 thousand Gg CO<sub>2</sub> in 1989. This change was caused by woody biomass decrease (about 0.63 t dm/ha) and harvest of thick decrease (about 4.15 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 1990 this category was a net CO<sub>2</sub> emissions and accounted for about 66 Gg CO<sub>2</sub>. Net emission in year 1990 was lower than in 1989 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. In 1990 net CO<sub>2</sub> sink was about 8 906 Gg CO<sub>2</sub> and was higher by about 361 Gg CO<sub>2</sub> than in previous year. It is mainly caused by afforestation of agriculture lands.

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 1990**

Land-use/ management system	Soil type	Carbon in soils (Mg C/ha)	Area (Mha)
Forest management	High Activity Soils	110.0	3.518
	Low Activity Soils	70.0	1.688
	Sandy	30.0	3.305
	Wetland	230.0	0.373
Sum			8.884
Grassland/Rangeland	High Activity Soils	90.0	0.574
	Low Activity Soils	60.0	1.695
	Sandy	25.0	1.240
	Wetland	120.0	0.421
Sum			3.930
Agricultural crops	High Activity Soils	70.0	4.133
	Low Activity Soils	60.0	5.538
	Sandy	25.0	2.856
	Wetland	120.0	1.663
Sum			14.190
Other land	High Activity Soils	56.0	0.933
	Low Activity Soils	48.0	1.752
	Sandy	20.0	1.102
	Wetland	96.0	0.478
Sum			4.265
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 | 1.0% |
| - 6.B. Wastewater Handling (CH <sub>4</sub> emission), share in total GHG emission          | 1.3% |

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

### 8.2 Methodological issues

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

The methane emissions from solid waste disposals in 1990 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 1992]
- Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. The same method was used for 1976. In domestic statistics data were given in  $dm^3$ . To recalculate data into Gg a conversion factor was used. According to GUS this conversion factor is  $0.25 t/m^3$ .

Table 8.4. Data sources for amount of municipal waste

1970	4113.98	[GUS 1987]
1971	4624.65	interpolacja
1972	5135.31	interpolacja
1973	5645.98	interpolacja
1974	6156.64	[GUS 1974d]
1975	6788.96	[GUS 1986d]
1976	7397.99	interpolacja
1977	8007.03	[GUS 1981d]
1978	8702.83	[GUS 1981d]
1979	9052.63	[GUS 1981d]
1980	9868.72	[GUS 1986d]
1981	10014.42	[GUS 1986d]
1982	10329.07	[GUS 1986d]
1983	10541.91	[GUS 1986d]
1984	10864.54	[GUS 1986d]
1985	11086.95	[GUS 1986d]
1986	11546.86	[GUS 1987]
1987	11877.45	[GUS 1989d]
1988	12084.18	[GUS 1989d]
1989	12000.95	[GUS 1990d]
1990	11098.28	[GUS 1996]

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 1991d] 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 1991d]. 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 2006] and its value was 0.712. The emission factors calculated on the basis of the study mentioned above and applied in inventory report are:

- for wastewater: 0.060 kg CH<sub>4</sub> / kg BOD
- for sewage sludge: 0.383 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 2006]. These value are as follows: percentage of wastewater anaerobically treated

– 10%, fractions of sludge anareobically degraded – 63.9% of which with methane recovery – 23.7%.

N<sub>2</sub>O emission from humane sewage was calculated according to default method [IPCC 1997]. Country population was taken from [GUS 1992]. Value of protein consumption per capita per year comes from [FAOSTAT 2006]. Default values were used for fraction of nitrogen in protein and for N<sub>2</sub>O emission factor [IPCC 2000].

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

Waste incineration was estimated based on IPCC methodology [IPCC 2000] and domestic case study [Wielgosiński 2003]. Emission factors as default were taken from [IPCC 2000]. For 1990 no data on municipal and sewage sludge waste incineration were available. The amount of industrial waste was calculated based on [GUS 1991d]. The activity data for incineration of medical waste was based on number of hospital beds [GUS 1991] as well as on annual mean use of hospital bed [GUS 1991]. The indicators describing amount of hospital waste produced and fraction of incinerated waste were taken from [IOS 2003].

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## **ANNEXES**

## Annex 1. Key sources

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

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

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

Emission from these sources made up 73.6% 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 72.21% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 64.9% 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,
- 6.B. Wastewater Handling.

Share of these sources in national total made up 70.63%.

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

### Level Assessment

		IPCC Source Categories	Direct GHG	Current Year Estimate	Level Assessment	Cumulative Total
1	1.A.1, 2, 4, 5.a	Stationary combustion Solid Fuels	CO <sub>2</sub>	315141.59	0.6492	0.65
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO <sub>2</sub>	21290.38	0.0439	0.69
3	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO <sub>2</sub>	20791.61	0.0428	0.74
4	4.A	4.A. Enteric Fermentation	CH <sub>4</sub>	15597.83	0.0321	0.77
5	4.D.1	4.D.1. Direct Soil Emissions	N <sub>2</sub> O	15376.21	0.0317	0.80
6	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH <sub>4</sub>	14717.14	0.0303	0.83
7	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO <sub>2</sub>	14580.14	0.0300	0.86
8	4.B	4.B. Manure Management	N <sub>2</sub> O	9151.14	0.0189	0.88
9	6.B	6.B. Wastewater Handling	CH <sub>4</sub>	6409.05	0.0132	0.89
10	4.D.3	4.D.3. Indirect Soil Emissions	N <sub>2</sub> O	5987.64	0.0123	0.90
11	2.A.1	2.A.1 Cement Production	CO <sub>2</sub>	5412.23	0.0111	0.92
12	2.C1	2.C.1. Iron and Steel Production	CO <sub>2</sub>	5198.06	0.0107	0.93
13	6.A	6.A. Solid Waste Disposal on Land	CH <sub>4</sub>	4783.42	0.0099	0.94
14	1.B.2.b.	1.B.2.b. Natural Gas	CH <sub>4</sub>	3747.06	0.0077	0.94
15	4.B	4.B. Manure Management	CH <sub>4</sub>	3379.66	0.0070	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	315141.59	0.6492	0.0406	32.6363	0.33
2	1.A.3.b	1.A.3.b Transport Road Transportation	CO2	16068.28	21290.38	0.0439	0.0199	16.0183	0.49
3	6.B	6.B. Wastewater Handling	CH4	2170.23	6409.05	0.0132	0.0115	9.2378	0.58
4	1.A.5.b	1.A.5.b Other Mobile	CO2	5049.93	1270.68	0.0026	0.0072	5.8179	0.64
5	4.A	4.A. Enteric Fermentation	CH4	15954.36	15597.83	0.0321	0.0060	4.8100	0.69
6	4.D.1	4.D.1. Direct Soil Emissions	N2O	15747.10	15376.21	0.0317	0.0059	4.7095	0.73
7	1.A.1, 2, 4, 5.a	Stationary combustion Gaseous Fuels	CO2	15562.17	14580.14	0.0300	0.0043	3.4220	0.77
8	4.B	4.B. Manure Management	N2O	9335.10	9151.14	0.0189	0.0036	2.8638	0.80
9	1.A.1, 2, 4, 5.a	Stationary combustion Liquid Fuels	CO2	26824.08	20791.61	0.0428	0.0035	2.7902	0.82
10	6.A	6.A. Solid Waste Disposal on Land	CH4	4284.31	4783.42	0.0099	0.0031	2.4826	0.85
11	4.D.3	4.D.3. Indirect Soil Emissions	N2O	6276.40	5987.64	0.0123	0.0020	1.5949	0.86
12	1.A.3.d	1.A.3.d Transport Navigation	CO2	2334.06	2631.25	0.0054	0.0017	1.4031	0.88
13	1.A.3.c	1.A.3.c Transport Railways	CO2	3355.49	2103.44	0.0043	0.0017	1.3449	0.89
14	2.B.1.	2.B.1. Ammonia Production	CO2	3516.60	2286.00	0.0047	0.0016	1.2462	0.90
15	1.B.1.a.	1.B.1.a. Coal Mining and Handling	CH4	18455.82	14717.14	0.0303	0.0014	1.0952	0.91
16	4.B	4.B. Manure Management	CH4	3435.39	3379.66	0.0070	0.0013	1.0778	0.93
17	2.B.2	2.B.2. Nitric Acid Production	N2O	4386.47	3163.39	0.0065	0.0012	0.9300	0.93
18	2.A.1	2.A.1 Cement Production	CO2	7028.18	5412.23	0.0111	0.0010	0.8019	0.94
19	2.A.2	2.A.2. Lime Production	CO2	3477.55	2512.00	0.0052	0.0009	0.7291	0.95

## Annex 2. 1990 Energy balance data for main fuels

Energy balances in 1990 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>67 584</b>	<b>564 844</b>
From national sources	67 584	564 844
1) Indigenous production	67 584	564 844
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	0	0
<b>Out</b>	<b>67 584</b>	<b>564 844</b>
National consumption	67 391	559 980
1) Transformation input	67 302	559 135
a) input for secondary fuel production	256	2 491
b) fuel combustion	67 046	556 644
2) Direct consumption	89	845
Non-energy use	1	7
Combusted directly	88	838
<b>Combusted in Poland</b>	<b>67 134</b>	<b>557 482</b>
Stock increase	0	0
Export	193	1 737
Losses	0	0
Statistical differences		3 127
Net calorific value	MJ/kg	8.30
CO <sub>2</sub> Emission Factor	kg/GJ	115.32

### Diesel oil consumption

Evaluation of fuel consumption In national combustion processes	Diesel oil	
	10 <sup>3</sup> Mg	TJ
<b>In</b>	<b>5 668</b>	<b>242 042</b>
From national sources	3 974	169 702
1) Indigenous production	0	0
2) Transformation output or return	3 974	169 702
3) Stock decrease	0	0
Import	1 694	72 340
<b>Out</b>	<b>5 668</b>	<b>242 042</b>
National consumption	5 294	226 058
1) Transformation input	27	1 145
a) input for secondary fuel production	3	138
b) fuel combustion	24	1 007
2) Direct consumption	5 267	224 913
Non-energy use	6	254
Combusted directly	5 261	224 659
<b>Combusted in Poland</b>	<b>5 285</b>	<b>225 666</b>
Stock increase	171	7 304
Export	200	8 557
Losses	3	123
Statistical differences		0
Net calorific value	MJ/kg	42.70
CO <sub>2</sub> Emission Factor	kg/GJ	72.73

## Fuel oil consumption

Evaluation of fuel consumption In national combustion processes	Fuel oil	
	10 <sup>3</sup> Mg	TJ
<b>In</b>	<b>4 543</b>	<b>182 907</b>
From national sources	3 631	146 138
1) Indigenous production	0	0
2) Transformation output or return	3 631	146 138
3) Stock decrease	0	0
Import	912	36 769
<b>Out</b>	<b>4 543</b>	<b>182 907</b>
National consumption	3 805	153 297
1) Transformation input	1 910	77 154
a) input for secondary fuel production	172	7 096
b) fuel combustion	1 738	70 058
2) Direct consumption	1 895	76 143
Non-energy use	23	922
Combusted directly	1 872	75 221
<b>Combusted in Poland</b>	<b>3 610</b>	<b>145 279</b>
Stock increase	0	0
Export	983	39 600
Losses	0	2
Statistical differences	-245	-9 992
Net calorific value	MJ/kg	40.24
CO <sub>2</sub> Emission Factor	kg/GJ	79.37

## 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>9 426</b>	<b>337 073</b>
From national sources	1 590	53 479
1) Indigenous production	901	30 267
2) Transformation output or return	689	23 212
3) Stock decrease	0	0
Import	7 836	283 594
<b>Out</b>	<b>9 427</b>	<b>337 072</b>
National consumption	8 938	315 415
1) Transformation input	935	32 881
a) input for secondary fuel production	353	12 285
b) fuel combustion	582	20 596
2) Direct consumption	8 003	282 534
Non-energy use	2 298	80 552
Combusted directly	5 705	201 982
<b>Combusted in Poland</b>	<b>6 287</b>	<b>222 578</b>
Stock increase	250	8 915
Export	1	32
Losses	238	6 586
Statistical differences		6 124
Net calorific value	MJ/m <sup>3</sup>	35.40
CO <sub>2</sub> Emission Factor	kg/GJ	54.40

## 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>2 830</b>	<b>68 536</b>
From national sources	2 830	68 536
1) Indigenous production	2 622	61 409
2) Transformation output or return	208	7 127
3) Stock decrease	0	0
Import	0	0
<b>Out</b>	<b>2 829</b>	<b>68 536</b>
National consumption	2 741	68 546
1) Transformation input	1 272	32 549
a) input for secondary fuel production	1 254	32 116
b) fuel combustion	18	433
2) Direct consumption	1 469	35 997
Non-energy use	16	393
Combusted directly	1 453	35 604
<b>Combusted in Poland</b>	<b>1 471</b>	<b>36 037</b>
Stock increase	0	0
Export	0	0
Losses	88	2 127
Statistical differences		-2 137
Net calorific value	MJ/m <sup>3</sup>	24.49
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>13 671</b>	<b>380 642</b>
From national sources	13 671	380 642
1) Indigenous production	0	0
2) Transformation output or return	13 671	380 642
3) Stock decrease	0	0
Import	0	0
<b>Out</b>	<b>13 670</b>	<b>380 642</b>
National consumption	10 008	277 371
1) Transformation input	2 984	83 423
a) input for secondary fuel production	2 260	64 570
b) fuel combustion	724	18 853
2) Direct consumption	7 024	193 948
Non-energy use	249	6 425
Combusted directly	6 775	187 523
<b>Combusted in Poland</b>	<b>7 499</b>	<b>206 376</b>
Stock increase	0	0
Export	3 662	101 862
Losses	0	0
Statistical differences		1 409
Net calorific value	MJ/kg	27.52
CO <sub>2</sub> Emission Factor	kg/GJ	113.00



### Annex 3. National energy balance 1990 [GUS, 1992a]

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

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

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

TABLE 1. 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	1990	TJ	4114521	1059399	47648	915705	47210
		1991		3972851	895834	52170	705969	38263
2	ENERGIA PIERWOTNA PRIMARY ENERGY	1990	TJ	4114521	841867	-	705853	33543
		1991		3972851	705281	-	501615	46693
3	WĘGIEL KAMIENNY HARD COAL	1990	tys.ton	147736	560	-	28065	305
		1991	10 <sup>3</sup> ton	140376	54	-	19534	2061
		1990	TJ	3390004	16469	-	704085	7051
		1991		3207921	1584	-	490118	48600
4	WĘGIEL BRUNATNY LIGNITE	1990	tys.ton	67584	-	-	193	-
		1991	10 <sup>3</sup> ton	69406	-	-	1275	183
		1990	TJ	564844	-	-	1737	-
		1991		589632	-	-	11476	1479
5	ROPA NAFTOWA CRUDE OIL	1990	tys.ton	160	13126	-	-	440
		1991	10 <sup>3</sup> ton	158	11454	-	-	-114
		1990	TJ	6614	541685	-	-	17577
		1991		6624	481052	-	-	-4795
6	GAZ ZIEMNY WYSOKOMETANOWY HIGH - METHANE NATURAL GAS	1990	mln m <sup>3</sup>	1260	7836	-	1	250
		1991	10 <sup>6</sup> m <sup>3</sup>	1644	6615	-	1	40
		1990	TJ	38150	283594	-	32	8915
		1991		52196	222604	-	21	1409
7	GAZ ZIEMNY ZAAZOTOWANY NITRIFIED NATURAL GAS	1990	mln m <sup>3</sup>	2622	-	-	-	-
		1991	10 <sup>6</sup> m <sup>3</sup>	2504	-	-	-	-
		1990	TJ	61409	-	-	-	-
		1991		59098	-	-	-	-
8	TORF I DREWNO PEAT AND WOOD	1990	tys. m <sup>3</sup>	2325	-	-	-	-
		1991	10 <sup>3</sup> m <sup>3</sup>	3030	-	-	-	-
		1990	TJ	22088	-	-	-	-
		1991		28785	-	-	-	-
9	ENERGIA WODY I WIATRU HYDRO AND WOOD ENERGY	1990	TJ	4740	-	-	-	-
		1991		5153	-	-	-	-
10	PALIWA ODPADOWE STAŁE SOLID WASTE FUEL	1990	TJ	26672	119	-	-	-
		1991		23442	41	-	-	-
11	ENERGIA POCHODNA DERIVED ENERGY	1990	TJ	-	217533	47648	209851	13666
		1991		-	190553	52170	204354	-8431
12	BRYKIETY Z WĘGLA KAMIENNEGO HARD COAL BRIQUETTES	1990	tys.ton	-	-	-	1	-38
		1991	10 <sup>3</sup> ton	-	-	-	10	-26
		1990	TJ	-	-	-	23	-884
		1991		-	-	-	230	-602
13	BRYKIETY Z WĘGLA BRUNATNEGO LIGNITE BRIQUETTES (BKB)	1990	tys.ton	-	-	-	25	-
		1991	10 <sup>3</sup> ton	-	-	-	82	33
		1990	TJ	-	-	-	444	-
		1991		-	-	-	1465	643
14	KOKS I PÓLKOKS COKE AND SEMI-COKE	1990	tys.ton	-	-	-	3662	-
		1991	10 <sup>3</sup> ton	-	-	-	3467	9
		1990	TJ	-	-	-	101862	-
		1991		-	-	-	96446	200
15	GAZ CIEKŁY LIPUEFIED PETROLEUM GAS (LPG)	1990	tys.ton	-	2	-	-	-
		1991	10 <sup>3</sup> ton	-	-	-	-	-
		1990	TJ	-	104	-	-	-
		1991		-	-	-	-	-

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY TRANSPORTU I MAGA- ZYNOWANIA	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 OF TRANSPORT AND STORAGE	STATISTICAL DIFFERENCE	
<b>4211006</b>	<b>2465178</b>	<b>x</b>	<b>3620094</b>	<b>3021328</b>	<b>110139</b>	<b>48326</b>	<b>-13565</b>	1
<b>4124453</b>	<b>2314211</b>	<b>x</b>	<b>3438358</b>	<b>2924381</b>	<b>91583</b>	<b>68803</b>	<b>7123</b>	
<b>4216991</b>	<b>30338</b>	<b>x</b>	<b>3384923</b>	<b>859030</b>	<b>85906</b>	<b>8713</b>	<b>-5336</b>	2
<b>4129824</b>	<b>29301</b>	<b>x</b>	<b>3240719</b>	<b>892293</b>	<b>67376</b>	<b>15580</b>	<b>10532</b>	
119926	0	119926	100829	19098	14	0	0	3
118835	0	118835	94843	23991	22	0	0	
2695338	0	2695338	2201559	506220	453	0	-12442	
2670788	0	2670788	2097498	573290	718	0	0	
67391	0	67391	67302	89	1	0	0	4
67947	0	67947	67906	42	2	0	0	
563107	0	563107	559135	845	7	0	3127	
576676	0	576676	565761	383	15	0	10533	
12846	0	12846	12846	0	0	0	0	5
11725	0	11725	11725	0	0	0	0	
530722	0	530722	530721	0	0	0	1	
492471	0	492471	492471	0	0	0	-1	
8645	689	9534	1068	8229	2298	238	0	6
8219	618	8837	961	7471	1808	406	0	
312796	23212	336008	35714	287584	80552	6586	6124	
273370	21960	295330	31933	252183	63697	11214	0	
2622	208	2829	1272	1469	16	88	0	7
2504	212	2716	1099	1438	0	179	0	
61409	7127	68536	32549	35997	393	2127	-2137	
59098	7340	66438	28178	33894	0	4366	0	
2325	0	2325	72	2253	0	0	0	8
3030	0	3030	98	2932	0	0	0	
22088	0	22088	682	21406	0	0	0	
28785	0	28785	928	27857	0	0	0	
4740	0	4740	4740	0	0	0	0	9
5153	0	5153	5153	0	0	0	0	
26791	0	26791	19822	6977	4502	0	-9	10
23483	0	23483	18797	4686	2945	0	0	
<b>-5985</b>	<b>2434839</b>	<b>x</b>	<b>223666</b>	<b>2173804</b>	<b>13020</b>	<b>39613</b>	<b>-8228</b>	11
<b>-5371</b>	<b>2284910</b>	<b>x</b>	<b>184356</b>	<b>2045371</b>	<b>10725</b>	<b>53222</b>	<b>-3409</b>	
37	77	114	104	11	0	0	0	12
16	1	17	15	2	0	0	0	
862	1759	2621	2374	247	0	0	0	
372	13	385	342	51	0	0	-9	
-25	122	97	8	89	0	0	0	13
-115	124	9	3	5	0	0	0	
-444	2174	1730	149	1582	0	0	0	
-2108	2255	146	55	95	0	0	-4	
-3662	13671	10009	2984	7024	249	0	0	14
-3476	11411	7935	2420	5516	172	0	0	
-101862	380642	278780	83423	193948	6425	0	1409	
-96646	320764	224118	67175	156943	4330	0	0	
2	141	143	11	132	88	0	0	15
0	144	144	10	134	107	0	0	
104	6413	6516	504	6010	4047	2	0	
0	6571	6571	445	6124	4918	2	0	

LP	NAZWA NOŚNIKA ENERGII	ROK	JEDNOSTKA MIARY	POZYSKANIE	IMPORT	- W TYM BUNKIER	EKSPORT	ZMIANA ZAPASÓW
	<i>SPECIFICATION</i>	<i>YEAR</i>	<i>UNIT OF MEASURE</i>	<i>INDIGENOUS PRODUCTION</i>	<i>IMPORT</i>	<i>AMONG WHICH BUNKER</i>	<i>EXPORT</i>	<i>STOCK CHANGE</i>
16	BENZYNY <i>GASOLINE</i>	1990	tys. ton	-	1579	146	30	190
		1991	10 <sup>3</sup> ton	-	1602	101	31	-129
		1990	TJ	-	68377	6322	1311	8232
		1991		-	69370	4373	1352	-5589
17	OLEJE NAPĘDOWE <i>DIESEL OIL</i>	1990	tys. ton	-	1694	203	200	171
		1991	10 <sup>3</sup> ton	-	1359	269	246	-114
		1990	TJ	-	72340	8655	8557	7304
		1991		-	58028	11486	10493	-4870
18	OLEJE OPAŁOWE <i>FUEL OIL</i>	1990	tys. ton	-	912	811	983	0
		1991	10 <sup>3</sup> ton	-	913	901	1099	13
		1990	TJ	-	36769	32671	39600	0
		1991		-	36780	36310	44290	539
19	PRODUKTY NIEENERGETYCZNE <i>NON-ENERGY PRODUCTS</i>	1990	TJ	-	2184		16735	-985
		1991		-	2035		16505	1248
20	GAZ RAFINERYJNY <i>REFINERY GAS</i>	1990	tys. ton	-	-	-	-	-
		1991	10 <sup>3</sup> ton	-	-	-	-	-
		1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
21	GAZ KOKSOWNICZY <i>COKE OVEN GAS</i>	1990	mln m <sup>3</sup>	-	-	-	-	-
		1991	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
22	GAZ MIEJSKI <i>TOWN GAS</i>	1990	mln m <sup>3</sup>	-	12	-	-	-
		1991	10 <sup>6</sup> m <sup>3</sup>	-	12	-	-	-
		1990	TJ	-	186	-	-	-
		1991		-	192	-	-	-
23	GAZ CZADNICOWY I WYTLEWNY <i>BLAST FURNACE GAS</i>	1990	mln m <sup>3</sup>	-	-	-	-	-
		1991	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
24	GAZ WIELKOPIECOWY <i>GAS MANUFACTURED FROM COAL</i>	1990	mln m <sup>3</sup>	-	-	-	-	-
		1991	10 <sup>6</sup> m <sup>3</sup>	-	-	-	-	-
		1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
25	ENERGIA ELEKTRYCZNA <i>ELECTRICITY</i>	1990	GWh	-	10437	-	11478	-
		1991		-	6708	-	9326	-
		1990	TJ	-	37574	-	41319	-
		1991		-	24148	-	33572	-
26	CIEPŁO HEAT	1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
27	<b>ENERGIA Z ODZYSKU</b> <i>ENERGY FROM RETURNS</i>	1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
28	PALIWA ODPAD. CIEKŁE I GAZOWE <i>LIQUID AND GASEOUS WASTE FUELS</i>	1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-
29	CIEPŁO Z ODZYSKU <i>HEAT FROM RETURNS</i>	1990	TJ	-	-	-	-	-
		1991		-	-	-	-	-

ZUŻYCIE GLOBALNE LUB SALDO WYM.	UZYSK Z PRZEMIAN LUB ODZYSK	ZUŻYCIE OGÓŁEM	ZUŻYCIE NA WSAD PRZEMIAN	ZUŻYCIE BEZPOŚREDNIE	- W TYM ZUŻYCIE NIEENERGETY- CZNE	STRATY TRANSPORTU I MAGA- ZYNOWANIA	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 OF TRANSPORT AND STORAGE	STATISTICAL DIFFERENCE	
1359	2414	3773	191	3575	18	7	0	16
1700	2400	4100	168	3926	15	6	0	
58834	104531	163365	8283	154777	764	305	0	
73606	103920	177526	6945	170340	661	241	0	
1323	3974	5297	27	5267	6	3	0	17
1227	3695	4922	26	4892	5	4	0	
56479	169702	226181	1145	224913	254	123	0	
52405	157762	210167	1106	208906	234	154	0	
-70	3631	3561	1910	1895	23	0	-245	18
-200	3480	3281	1757	1635	15	0	-112	
-2831	146138	143307	77154	76143	922	2	-9992	
-8049	141394	133345	71108	65633	581	2	-3397	
-13567	129300	115734	1287	114395	0	52	0	19
-15718	99220	83502	576	82903	0	23	0	
0	179	179	20	159	0	0	0	20
0	239	239	0	239	0	0	0	
0	9475	9475	1036	8439	0	0	0	
0	11844	11844	19	11825	0	0	0	
0	5784	5784	473	5249	32	63	0	21
0	5056	5056	449	4476	0	131	0	
0	101734	101734	8319	91484	610	1113	818	
0	89809	89809	7965	79448	0	2396	0	
12	165	177	2	211	0	0	-36	22
12	87	100	1	95	0	4	0	
186	2902	3087	39	3510	0	0	-461	
192	1812	2004	18	1920	0	65	0	
0	1106	1106	31	1075	0	0	0	23
0	924	924	39	886	0	0	0	
0	6509	6509	205	6306	0	0	-3	
0	5446	5446	250	5195	0	0	0	
0	16949	16949	6056	10892	0	0	0	24
0	12499	12499	3762	8736	0	0	0	
0	62969	62969	22490	40480	0	0	0	
0	42811	42811	12961	29849	0	0	0	
-1040	136311	135271	2614	122097	0	10560	0	25
-2618	134697	132079	2704	115392	0	13983	0	
-3745	490721	486976	9411	439550	0	38015	0	
-9424	484908	475483	9734	415410	0	50339	0	
0	819869	819869	7847	812022	0	0	0	26
0	816383	816383	5655	810728	0	0	0	
0	97820	x	11506	86314	11212	0	0	27
0	91195	x	13283	77912	13483	0	0	
0	48464	48464	11506	36958	11212	0	0	28
0	54438	54438	13283	41155	13483	0	0	
0	49357	49357	0	49357	0	0	0	29
0	36757	36757	0	36757	0	0	0	

## Annex 4. National energy balance 1990 – OECD

### Poland : 1990

PRODUCTION AND USES OF ENERGY	Coal (TJ)							Gas (TJ)	
	Hard Coal	Brown Coal	Oven Coke and Gas Coke	Patent Fuel	BKB	Fuel Wood	Other Non- commercial Fuels	Natural Gas	Gas Works Gas
Indigenous Production	3384423.5	564844.0	380642.5	1759.3	2174.4	22088.0	25957.8	100161.4	8343.2
From Other Sources	5580.5							9353.5	494.0
Imports	16469.0							311953.4	204.6
Exports	704085.0	1737.0	101862.0	23.0	444.0			35.2	
International Marine Bunkers									
Stock Changes	-7051.0			884.0				-9806.5	
<b>DOMESTIC SUPPLY</b>	<b>2695337.0</b>	<b>563107.0</b>	<b>278780.5</b>	<b>2620.3</b>	<b>1730.4</b>	<b>22088.0</b>	<b>25957.8</b>	<b>411626.6</b>	<b>9041.8</b>
Returns to Supply							36176.3		
Transfers								-2445.0	1514.1
Total Requirements	2695337.0	563107.0	278780.5	2620.3	1730.4	22088.0	62134.1	409181.6	10555.9
Statistical Difference	-12442.0	3127.0	1409.0		0.0	0.0	-9.0	4385.7	-510.4
<b>TRANSFORMATION SECTOR</b>	<b>2103169.9</b>	<b>557994.4</b>	<b>76014.9</b>	<b>1965.6</b>	<b>115.4</b>	<b>159.1</b>	<b>19681.3</b>	<b>29190.2</b>	<b>184.4</b>
Patent Fuel Plants	1565.2	2265.3							
Coke Ovens	534122.5		976.6					1113.0	
Gas Works	14865.6	225.5	624.0					4271.7	
Blast Furnaces			62969.5						
Oil Refineries									
Autoproducers of Electricity	280058.2	1423.5	16.5				15412.1	2976.1	
Public Plants for CHP	894152.9	550721.8					167.2	286.0	
Heating Plants	378405.5	3358.3	11428.3	1965.6	115.4	159.1	4102.0	20543.4	184.4
Non-Specified									
<b>ENERGY SECTOR</b>	<b>10251.2</b>	<b>61.4</b>	<b>527.4</b>	<b>0.0</b>	<b>13.2</b>	<b>6.3</b>	<b>5222.0</b>	<b>13000.7</b>	<b>6.0</b>
Coal Mines	3957.7	61.4	68.3		13.2			342.3	
Oil and Gas Extraction	33.4		7.4					8369.0	
Patent Fuel Plants	46.5								
Coke Ovens									
Gas Works	113.2		369.3				0.0	2440.0	6.0
Oil Refineries	44.8		1.2				5222.0	1838.3	
Electric Plants									
Pumped Storage									
Non-Specified	6055.6		81.2			6.3		11.1	
Distribution Losses								9584.3	
<b>FINAL CONSUMPTION</b>	<b>594357.9</b>	<b>1924.2</b>	<b>200829.2</b>	<b>654.7</b>	<b>1601.8</b>	<b>21922.6</b>	<b>37239.8</b>	<b>353020.7</b>	<b>10875.9</b>
<b>INDUSTRY SECTOR</b>	<b>153410.2</b>	<b>411.3</b>	<b>141201.6</b>	<b>85.2</b>	<b>55.0</b>	<b>589.6</b>	<b>21061.7</b>	<b>113896.4</b>	<b>7136.0</b>
Iron and Steel	1235.9	1.5	104473.7		0.0			57022.6	2391.9
Chemical	7193.4	36.5	2515.5	2.3		1.4	14171.8	5818.6	235.7
<i>of which: Petrochemical</i>	0.3		1.5				13321.2		
Non-Ferrous Metals	461.2		5676.8				380.1	5044.7	47.0
Non-Metallic Minerals	74086.4	142.2	12958.8	5.5	11.5	72.3	1100.2	26599.4	3596.9
Transport Equipment	3442.3	3.4	1108.7	1.4		0.9	9.5	1627.4	9.5
Machinery	12690.3	35.4	7430.8	15.4	3.4	34.1	23.5	10729.8	765.9
Mining and Quarrying	3170.7	3.6	1049.1	1.1	38.3	0.5	96.6	4321.8	19.2
Food and Tobacco	32284.2	58.3	3220.5	8.2	0.3	86.8	4.1	2166.7	55.7
Paper, Pulp and Print	1495.8	1.0	234.8	2.2		0.7	0.2	111.0	3.0
Wood and Wood Products	4772.8	111.1	303.3	2.5	1.5	312.2	5110.7	104.5	0.5
Constructions	5586.9	7.4	1649.0	46.0		50.2	12.6	168.8	6.2
Textiles and Leather	6547.0	10.7	434.4	0.6		28.8	40.6	153.3	4.0
Non-specified	443.3	0.2	146.2			1.7	111.8	27.8	0.5
<b>TRANSPORT SECTOR</b>	<b>13005.6</b>	<b>15.2</b>	<b>3752.1</b>	<b>52.6</b>	<b>23.7</b>	<b>19.4</b>	<b>3.2</b>	<b>78.1</b>	<b>24.4</b>
Air Transport	12.9								
Road Transport	2331.1	9.1	804.5	15.2	1.3	19.4	0.4	35.7	5.0
Railways	10586.6	6.1	2849.0	37.4	22.4			42.1	18.3
Internal Navigation	75.0		98.6			0.0	2.8	0.3	1.1
<b>OTHER SECTORS</b>	<b>427489.4</b>	<b>1490.9</b>	<b>49450.8</b>	<b>516.9</b>	<b>1523.1</b>	<b>21313.6</b>	<b>461.4</b>	<b>150006.5</b>	<b>3715.5</b>
Agriculture	26663.7	883.5	1454.5	489.3	29.7	168.8	26.2	492.6	1.5
Commerce and Public									
Residential									
Non-Specified	400825.7	607.4	47996.3	27.6	1493.4	21144.8	435.2	149513.9	3714.0
<b>NON-ENERGY USE</b>	<b>452.7</b>	<b>6.8</b>	<b>6424.7</b>				<b>15713.5</b>	<b>89039.7</b>	
in Industry	452.7	6.8	6421.0				9930.4	89039.7	

PRODUCTION AND USES OF ENERGY			Gas (TJ)		Heat	Oil (TJ)				
	Coke Oven Gas	Blast Furnace Gas	Electricity			Crude Oil + Feedstocks + Other Inputs	Crude Oil + NGL	Feed- stocks	Other Inputs	Refinery Gas
			Total	of which Hydro						
Indigenous Production	106515.5	62969.5	483893.6	5099.4	739569.1	7331.7	6614.0		717.7	8599.3
From Other Sources	3245.0		6826.7	6826.7	4152.3					
Imports			37573.2			548999.1	541685.0	7194.6	119.6	
Exports			41320.8							
International Marine Bunkers										
Stock Changes						-17577.0	-17577.0			
<b>DOMESTIC SUPPLY</b>	<b>109760.5</b>	<b>62969.5</b>	<b>486972.7</b>	<b>11926.1</b>	<b>743721.4</b>	<b>538753.8</b>	<b>530722.0</b>	<b>7194.6</b>	<b>837.3</b>	<b>8599.3</b>
Returns to Supply					49357.0	6616.6		6616.6		
Transfers	930.8									
Total Requirements	110691.4	62969.5	486972.7	11926.1	793078.4	545370.4	530722.0	13811.2	837.2	8599.3
Statistical Difference	899.8		0.0	11926.1	0.0			0.0	0.0	0.0
<b>TRANSFORMATION SECTOR</b>	<b>7836.8</b>	<b>22489.9</b>	<b>0.0</b>	<b>0.0</b>	<b>7786.4</b>	<b>545370.4</b>	<b>530722.0</b>	<b>13811.2</b>	<b>837.2</b>	<b>943.7</b>
Patent Fuel Plants										
Coke Ovens		113.1								
Gas Works										
Blast Furnaces										
Oil Refineries										
Autoproducers of Electricity	5825.8	19915.6			6583.7	545370.4	530722.0	13811.2	837.2	943.7
Public Plants for CHP	3.7				728.1					
Heating Plants	2007.3	2461.2			474.6					
Non-Specified										
<b>ENERGY SECTOR</b>	<b>47913.4</b>	<b>3848.0</b>	<b>103622.9</b>	<b>0.0</b>	<b>80235.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>7255.9</b>
Coal Mines			32420.1		20723.0					
Oil and Gas Extraction			578.5		158.2					
Patent Fuel Plants			14.6	398T6						
Coke Ovens	47833.7	3848.0	2752.3		14921.1					
Gas Works	75.8		742.7		1393.2					
Oil Refineries			1418.7		12780.7					7255.9
Electric Plants			34521.8		4591.2					
Pumped Storage			9410.4							
Non-Specified	3.9		21763.8		25668.0					
Distribution Losses	1224.3		38016.0							
<b>FINAL CONSUMPTION</b>	<b>52817.0</b>	<b>36631.6</b>	<b>345333.8</b>		<b>705056.6</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.1</b>	<b>399.7</b>
<b>INDUSTRY SECTOR</b>	<b>34127.5</b>	<b>36631.6</b>	<b>153879.7</b>	<b>0.0</b>	<b>406428.5</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>799.2</b>
Iron and Steel	28642.3	36483.2	26932.5		47223.7					
Chemical	771.2	47.0	37600.8		128556.1					399.6
of which: Petrochemical			3171.6		24468.8					399.6
Non-Ferrous Metals	436.7		7788.0		3729.2					
Non-Metallic Minerals	2311.3	101.4	11403.9		11696.2					
Transport Equipment	71.7		4638.6		13486.1					
Machinery	1737.1		19460.9		32399.8					
Mining and Quarrying	9.4		11494.4		40292.2					
Food and Tobacco	122.2		10279.7		49330.8					
Paper, Pulp and Print	3.3		7067.2		30250.4					
Wood and Wood Products	0.1		4559.8		9935.2					
Constructions	7.3		4569.7		13037.8					
Textiles and Leather	14.9		7685.6		25782.1					
Non-specified	0.0		3							

# Poland : 1990

PRODUCTION AND USES OF ENERGY	Oil (TJ)		Petroleum Products (TJ)						
	Liquified Petroleum Gases	Motor Gasoline	Aviation Gasoline	Jet Fuel	Kerosene	Gas/Diesel Oil	Residual Fuel Oil	Naphta	Other Petroleum Products
Indigenous Production	6670.8	98226.7		8949.0	37.5	171714.8	145941.8	44321.0	54072.2
From Other Sources									
Imports	108.8	48076.2	295.5	1699.1		64623.1	4071.6		2198.7
Exports		288.5		1062.9		8010.8	37281.2	2343.6	14257.4
International Marine Bunkers						6523.9	11325.7		
Stock Changes		-8022.6	89.4	-581.0	88.2	-7412.1	0.0		870.3
<b>DOMESTIC SUPPLY</b>	<b>6779.6</b>	<b>137991.8</b>	<b>384.9</b>	<b>9004.2</b>	<b>125.7</b>	<b>214391.1</b>	<b>101406.5</b>	<b>41977.4</b>	<b>42883.8</b>
Returns to Supply									
Transfers		316.4	-52.2	-473.1	-4.5	504.9	0.0		-274.7
Total Requirements	6779.6	138308.3	332.8	8531.1	121.1	214896.0	101406.4	41977.3	42609.0
Statistical Difference	0.0	0.0	0.0	0.0		0.2	-11584.6		0.0
<b>TRANSFORMATION SECTOR</b>	<b>525.2</b>	<b>0.2</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>745.4</b>	<b>72556.7</b>	<b>0.0</b>	<b>0.0</b>
Patent Fuel Plants									
Coke Ovens									
Gas Works	525.2								
Blast Furnaces									
Oil Refineries						143.0	6909.2		
Autoproducers of Electricity						125.7	43670.0		
Public Plants for CHP						117.0	7037.8		
Heating Plants	0.0	0.2				359.7	14939.7		
Non-Specified									
<b>ENERGY SECTOR</b>	<b>83.5</b>	<b>83.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>1877.3</b>	<b>10608.5</b>	<b>0.0</b>	<b>0.0</b>
Coal Mines	0.2	34.0				1336.2			
Oil and Gas Extraction						198.6			
Patent Fuel Plants									
Coke Ovens		0.5				5.5			
Gas Works	0.1	9.1				20.6			
Oil Refineries	80.4					8.7	10570.8		
Electric Plants									
Pumped Storage									
Non-Specified	2.8	40.3				307.7	37.7		
Distribution Losses		313.6				130.0	2.5		40.2
<b>FINAL CONSUMPTION</b>	<b>6170.9</b>	<b>137910.5</b>	<b>332.7</b>	<b>8531.1</b>	<b>121.2</b>	<b>212143.1</b>	<b>29823.4</b>	<b>41977.4</b>	<b>42568.9</b>
<b>INDUSTRY SECTOR</b>	<b>224.1</b>	<b>1364.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>13849.6</b>	<b>23874.8</b>	<b>0.0</b>	<b>0.0</b>
Iron and Steel	17.8	1.3				166.3	11058.3		
Chemical	4.0	67.6				993.9	2750.2		
<i>of which: Petrochemical</i>		0.6				3.4	607.4		
Non-Ferrous Metals	0.1	5.6				56.9	756.6		
Non-Metallic Minerals	19.6	12.7				949.8	4178.7		
Transport Equipment	37.4	132.6				782.9	272.8		
Machinery	74.7	180.0				1101.8	88.1		
Mining and Quarrying		21.2				1372.1	446.7		
Food and Tobacco	37.9	154.3				1205.1	1656.4		
Paper, Pulp and Print	25.1	5.4				59.8	1286.8		
Wood and Wood Products	0.1	7.7				152.7	1126.2		
Constructions	7.3	727.8				6703.4	254.0		
Textiles and Leather		28.4				164.8			
Non-specified	0.1	19.8				140.1			
<b>TRANSPORT SECTOR</b>	<b>6.9</b>	<b>135756.2</b>	<b>332.7</b>	<b>8531.1</b>	<b>0.0</b>	<b>143869.0</b>	<b>2371.4</b>	<b>0.0</b>	<b>0.0</b>
Air Transport			332.7	8531.1		45.2			
Road Transport	0.4	135389.5				124637.4			
Railways	6.4	348.8				17937.6			
Internal Navigation	0.1	17.9				1248.8	2371.4		
<b>OTHER SECTORS</b>	<b>1777.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>54166.6</b>	<b>2649.0</b>	<b>0.0</b>	<b>0.0</b>
Agriculture	5.8					54166.6	2649.0		
Commerce and Public	0.0								
Residential									
Non-Specified	1772.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0
<b>NON-ENERGY USE</b>	<b>4162.0</b>	<b>789.9</b>			<b>121.2</b>	<b>257.9</b>	<b>928.2</b>	<b>41977.4</b>	<b>42568.9</b>
in Industry	6.0	789.9			121.2	161.8	15.8	41977.4	42568.9

## Annex 5. Uncertainty estimation of the 1990 inventory

Uncertainty analysis for the year 1990 was performed with Tier1 methodology. This simplified methodology is based on the assumptions listed below:

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

Conclusions from the 2005 in-depth review of the Polish GHG emission inventory were taken into account and additional analyses were made in *Agriculture* sector. For sector 5. *LUCF* 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> – 6.2%	CH <sub>4</sub> – 19.5%	N <sub>2</sub> O – 52.4%
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#### 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> (6.2%) 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. 19.5% 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 (52.4%) and is a result of high uncertainty of the emission factors in sector of *Agriculture* (*4.B.11 Liquid systems*, *4.B.12 Solid Storage and Dry Lot*, *4.D Agricultural Soils* and *4.Field Burning of Agricultural residues* – 150%).

The uncertainty assessment of GHG Inventory for 1990 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.

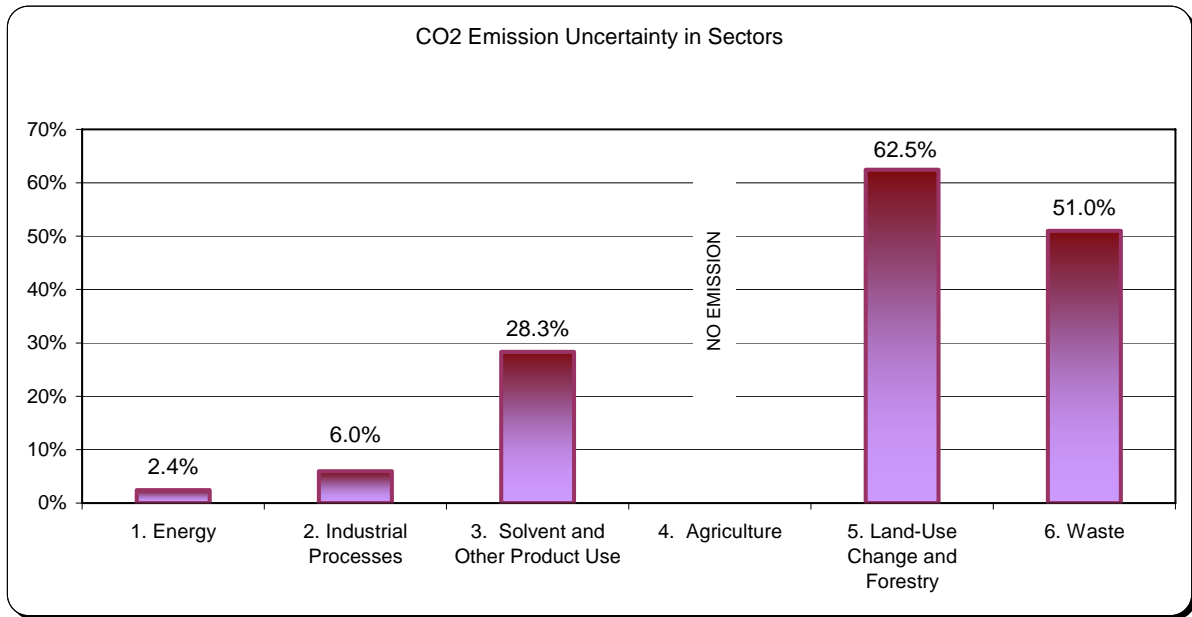
Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small compared to total CO<sub>2</sub> and high uncertainty have very little influence on uncertainty of values of total national CO<sub>2</sub> emission.

# GHG inventory 1990 – Uncertainty analysis, part 1, sectors 1-2

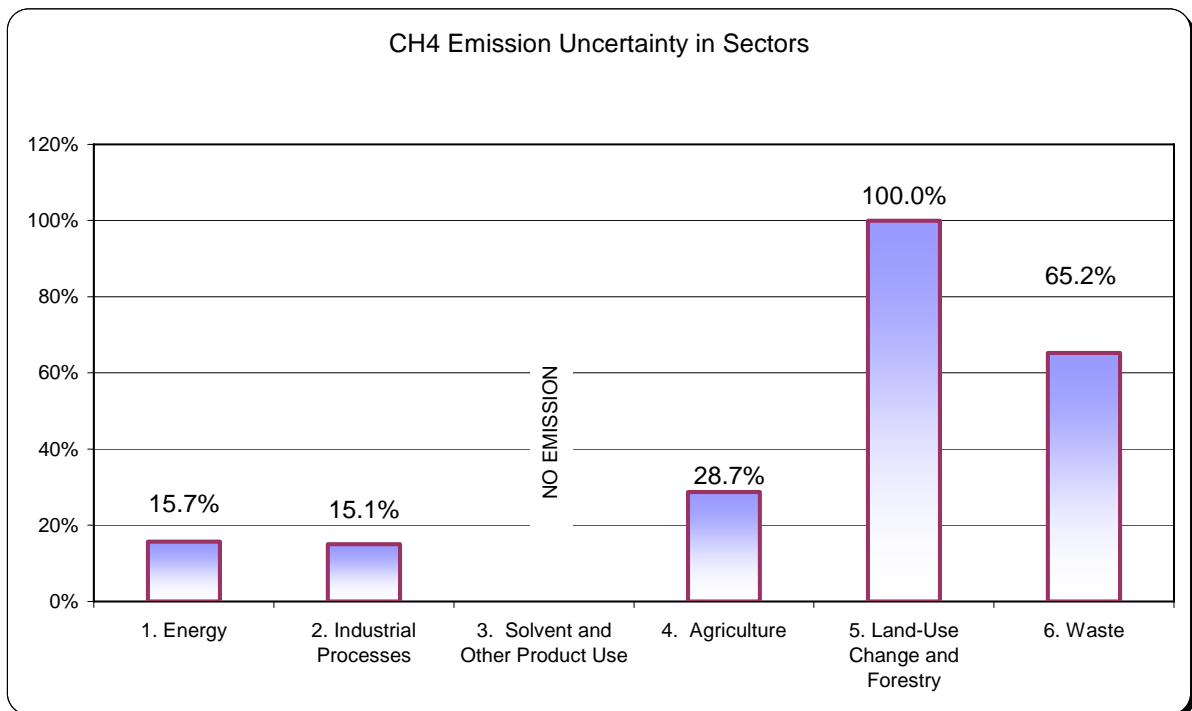
1990	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
TOTAL									364 135.18	2 346.54	126.69	6.2%	19.5%	52.4%	22 450.23	456.59	66.41
<b>1. Energy</b>									<b>379 178.98</b>	<b>897.32</b>	<b>7.48</b>	<b>2.4%</b>	<b>15.7%</b>	<b>2.5%</b>	<b>9232.06</b>	<b>141.08</b>	<b>0.19</b>
<b>A. Fuel Combustion</b>									<b>379 128.09</b>	<b>13.20</b>	<b>7.48</b>	<b>2.4%</b>	<b>6.8%</b>	<b>2.5%</b>	<b>9232.06</b>	<b>0.90</b>	<b>0.19</b>
1. Energy Industries									245 585.44	3.28	3.51	3.4%	12.9%	3.5%	8471.00	0.14	0.12
Liquid Fuels	126 876	3.0%	72.55	2.57	0.55	1.0%	41.8%	3.8%	9 205.27	0.33	0.07	3.2%	41.9%	3.2%	291.10	0.40	0.12
Solid Fuels	2 332 718	3.0%	100.85	1.24	1.47	2.0%	13.5%	11.7%	234 799.22	2.88	3.44	3.6%	13.8%	3.6%	8465.81	0.40	0.12
Gaseous Fuels	28 400	3.0%	55.67	1.00	0.10	2.0%	17.0%	20.0%	1 580.95	0.03	0.00	3.6%	17.3%	3.6%	57.00	0.00	0.00
Biomass	682	3.0%				0.0%	24.0%	37.0%	76.38	0.02	0.00	3.0%	24.2%	3.0%	0.00	0.00	0.00
2. Manufacturing Industries and Construction									44 889.09	1.93	0.72	4.1%	12.9%	6.8%	1852.29	0.25	0.05
Liquid Fuels	77 004.78	5.0%	74.82	3.00	4.78	1.0%	41.8%	3.8%	5 761.81	0.23	0.37	5.1%	42.1%	6.3%	293.80	0.10	0.02
Solid Fuels	291 841.01	5.0%	114.75	5.45	1.16	2.0%	13.5%	11.7%	33 489.51	1.59	0.34	5.4%	14.4%	12.7%	1803.47	0.23	0.04
Gaseous Fuels	102 102.86	5.0%	55.22	1.00	0.10	2.0%	17.0%	20.0%	5 637.76	0.10	0.01	5.4%	17.7%	20.6%	303.60	0.02	0.00
Biomass	215.00	5.0%	112.00	30.00	4.00	0.0%	24.0%	37.0%	24.08	0.01	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
3. Transport									27 344.07	6.35	1.64	6.9%	11.2%	5.4%	1878.21	0.71	0.09
Liquid Fuels	331 140.07	5.0%	80.18	18.97	4.88	5.0%	10.2%	2.3%	26 550.07	6.28	1.82	7.1%	11.4%	5.5%	1877.37	0.71	0.09
Solid Fuels	10 586.60	5.0%	75.00	8.00	NE	5.0%	13.5%	11.7%	794.00	0.06	0.02	7.1%	14.4%	12.7%	56.14	0.01	0.00
Biomass	NE	5.0%	0.00	0.00	0.00	0.0%	24.0%	37.0%	0.00	0.00	0.00	5.0%	24.5%	37.3%	0.00	0.00	0.00
Other Fuels	NE	5.0%	0.00	0.00	0.00	0.0%	50.0%	50.0%	0.00	0.00	0.00	5.0%	50.2%	50.2%	0.00	0.00	0.00
4. Other Sectors									59 549.86	1.57	1.10	4.3%	13.7%	8.9%	2551.28	0.22	0.10
Liquid Fuels	76 549.19	5.0%	74.52	3.96	3.72	1.0%	41.8%	3.8%	5 704.15	0.30	0.28	5.1%	42.1%	6.3%	290.86	0.13	0.02
Solid Fuels	494 166.70	5.0%	94.07	1.00	1.44	2.0%	13.5%	11.7%	46 488.69	0.49	0.71	5.4%	14.4%	12.7%	2503.49	0.07	0.09
Gaseous Fuels	136 350.60	5.0%	53.96	1.00	0.10	2.0%	17.0%	20.0%	7 357.02	0.14	0.01	5.4%	17.7%	20.6%	396.19	0.02	0.00
Biomass	21 303.80	5.0%	112.00	30.00	4.00		24.0%	37.0%	2 386.03	0.64	0.09	5.0%	24.5%	37.3%	0.16	0.03	0.00
5. Other									1 759.63	0.10	0.51	4.2%	96.5%	6.2%	73.59	0.09	0.03
Liquid Fuels	18 986.52	5.0%	73.27	4.88	26.80	1.0%	100.0%	3.8%	1 391.06	0.09	0.51	5.1%	100.1%	6.3%	70.93	0.09	0.03
Solid Fuels	3 339.40	5.0%	109.05	1.01	1.49	2.0%	80.0%	11.7%	364.16	0.00	0.00	5.4%	80.2%	12.7%	19.61	0.00	0.00
Gaseous Fuels	80.00	5.0%	55.15	1.00	0.10	2.0%	90.0%	20.0%	4.41	0.00	0.00	5.4%	90.1%	20.6%	0.24	0.00	0.00
Biomass	1.00	5.0%	112.00	30.00	4.00	0.0%	95.0%	37.0%	0.11	0.00	0.00	5.0%	95.1%	37.3%	0.00	0.00	0.00
<b>B. Fugitive Emissions from Fuels</b>									<b>50.89</b>	<b>884.12</b>	<b>0.00</b>	<b>5.5%</b>	<b>16.0%</b>		<b>2.81</b>	<b>141.08</b>	<b>0.00</b>
1. Solid Fuels									1.58	705.27	0.00	6.6%	19.9%		0.10	140.69	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]	151.70	2.0%		4.61407			20.0%			699.95			20.1%		0.00	140.69	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	67.68	2.0%		0.01273			20.0%			0.86			20.1%		0.00	0.17	0.00
1. B. 1. c. Other [CO2 Emission from Coking Gas Subsystem]	0.77	2.0%	2 060 765	5 791 695.00					1.58	4.45		6.6%	15.0%		0.10	0.67	0.00
2. Oil and Natural Gas									49.30	178.85	0.00	5.7%	5.8%		2.81	10.42	0.00
1. B. 2. a. Oil															0.00	0.00	0.00
ii. Production [Activity in PJ, EFs in kg/PJ]	6.61	0.5%	6 315 000	61 800.00		6.6%	8.1%		41.77	0.41		6.6%	8.1%		2.76	0.03	0.00
iii. Transport [Activity in Gg]	13 286.00	0.5%	NE	NE		6.6%	8.1%		0.08	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]	99.56	0.5%	68 492.96	98 893.00		6.6%	8.1%		6.82	9.85		6.6%	8.1%		0.45	0.80	0.00
ii. Transmission [Activity in PJ, EFs in kg/PJ]	374.44	0.5%	520.44	137 036.65		6.6%	8.1%		0.19	51.31		6.6%	8.1%		0.01	4.16	0.00
ii. Distribution [Activity in PJ, EFs in kg/PJ]	374.44	0.5%	1 174.49	313 198.54		6.6%	8.1%		0.44	117.27		6.6%	8.1%		0.03	9.52	0.00
<b>2. Industrial Processes</b>									<b>16717.79</b>	<b>10.91</b>	<b>11.87</b>	<b>6.0%</b>	<b>15.1%</b>	<b>25.9%</b>	<b>999.18</b>	<b>1.64</b>	<b>3.07</b>
<b>A. Mineral Products</b>									<b>8478.20</b>		<b>0</b>	<b>10.9%</b>			<b>928.21</b>	<b>0.00</b>	<b>0.00</b>
1. Cement Production [Activity in kt, EF in t/t]	10 309.00	5.0%	0.525			15.0%			5412.23			15.8%			855.75	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	3 200.00	10.0%	0.785			10.0%			2512.00			14.1%			355.25	0.00	0.00
4. Soda Ash (production) [Activity in kt, EF in t/t]	1 334.89	10.0%	0.415			0.0%			553.98			10.0%			55.40	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>B. Chemical Industry</b>									<b>2613.23</b>	<b>7.69</b>	<b>11.87</b>	<b>6.2%</b>	<b>20.0%</b>	<b>25.9%</b>	<b>163.29</b>	<b>1.54</b>	<b>3.07</b>
1. Ammonia Production [Activity in kt, EF in t/t]	1 524.00	5.0%	1.5	0.0049		5.0%	20.0%		2286.00	7.47		7.1%	20.6%		161.64	1.54	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	1 572.20	2.0%			0.01			30.0%			10.20			30.1%	0.00	0.00	3.07
3. Adipic Acid Production [Activity in kt, EF in t/t]	4.00	5.0%			0.00			10.0%	NE		1.20			11.2%			
4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t]	297.40	5.0%	1.1			5.0%			327.14			7.1%			23.13	0.00	0.00
5. Other (Carbon Black) [Activity in kt, EF in t/t]	22.65	5.0%		0.01			20.0%			0.23			20.6%		0.00	0.05	0.00
5. Other (Ethylene) [Activity in kt, EF in t/t]	308.21	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]	986.60	5.0%	0			5.0%						7.1%			0.00	0.00	0.00
5. Other (Caprolactam) [Activity in kt, EF in t/t]	97.29	5.0%			0.0047			20.0%			0.46			20.6%	0.00	0.00	0.10
<b>C. Metal Production</b>									<b>5626.35</b>	<b>3.22</b>	<b>0</b>	<b>5.9%</b>	<b>17.7%</b>		<b>331.84</b>	<b>0.57</b>	<b>0.00</b>
1. Iron and Steel Production															0.00	0.00	0.00
Sinter [Activity in kt, EF in t/t]	11 779.44	5.0%	0.07			10.0%			833.98			11.2%			93.24	0.00	0.00
Coke [Activity in kt, EF in t/t]	13 738.73	5.0%	0.15	0.000200		10.0%	20.0%		2060.87	2.75		11.2%	20.6%		230.41	0.57	0.00
Open-heart Steel [Activity in kt, EF in t/t]	3 964.70	5.0%	0.052			10.0%			206.16			11.2%		NE			
Electric Furnace Steel [Activity in kt, EF in t/t]	2 446.90	5.0%	0.00430	0.000120		10.0%	20.0%		10.52	0.29		11.2%	20.6%		1.18	0.06	0.00
Pig Iron [Activity in kt, EF in t/t]	8 656.71	5.0%	0.22412			10.0%			1940.14			11.2%			216.91	0.00	0.00
Iron Cast [Activity in kt, EF in t/t]	887.80	5.0%	0.061	0.000200		10.0%	20.0%		54.16	0.18		11.2%	20.6%		6.05	0.04	0.00
Steel Cast [Activity in kt, EF in t/t]	178.60	5.0%	0.062			10.0%			11.07			11.2%			1.24	0.00	0.00
Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]	7 207.00	5.0%	0.01126			10.0%			81.15			11.2%			9.07	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	88.60	5.0%	3.9			5.0%			345.54			7.1%			24.43	0.00	0.00
3. Aluminium Production [Activity in kt, EF in t/t]	45.97	5.0%	1.8			5.0%			82.75			7.1%			5.85	0.00	0.00
<b>D. Other Production</b>															0.00	0.00	0.00
<b>G. Other</b>															0.00	0.00	0.00

## GHG inventory 1990 – Uncertainty analysis, part 2, sector 3-6

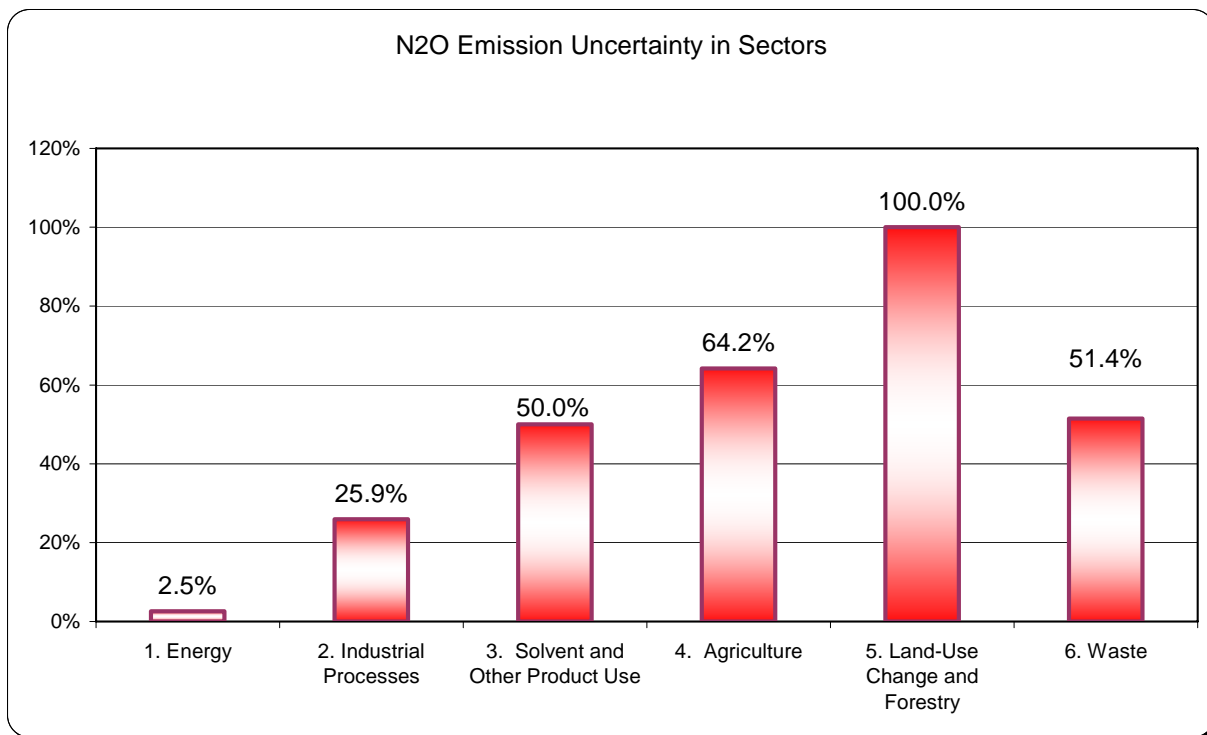
1990	Activity [TJ]	Activity uncertainty [%]	EF CO2 [t/TJ]	EF CH4 [kg/TJ]	EF N2O [kg/TJ]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [Gg]	CH4 [Gg]	N2O [Gg]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [Gg]	CH4 Emission absolute uncertainty [Gg]	N2O Emission absolute uncertainty [Gg]
<b>3. Solvent and Other Product Use</b>	158.02		NA						505.23		0.40	28.3%		50.0%	142.98	0.00	0.20
<b>4. Agriculture</b>										905.17	103.35		28.7%	64.2%	0.00	260.15	66.31
<b>A. Enteric Fermentation</b>										742.75			33.8%		0.00	251.35	0.00
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 919.0	5.0%		91.63			50.0%			450.72			50.2%		0.00	226.48	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	5 130.0	5.0%		41.26			50.0%			211.68			50.2%		0.00	106.37	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	4 159.0	5.0%		8.01			50.0%			33.32			50.2%		0.00	16.74	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179.3	5.0%		5.00			50.0%			0.90			50.2%		0.00	0.45	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	941.0	5.0%		18.00			50.0%			16.94			50.2%		0.00	8.51	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	19 464.0	5.0%		1.50			50.0%			29.20			50.2%		0.00	14.67	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	228 020.6	5.0%		0.00			50.0%			0.00			50.2%		0.00	0.00	0.00
<b>B. Manure Management</b>										160.94	29.52		41.7%	149.0%	0.00	67.07	43.99
1. Cattle															0.00	0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	4 919	5.0%		5.63			50.0%			27.69			50.2%		0.00	13.91	0.00
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	5 130	5.0%		1.61			50.0%			8.28			50.2%		0.00	4.16	0.00
3. Sheep [Activity in 1000 heads, EF in kg/head]	4 159	5.0%		0.17			50.0%			0.70			50.2%		0.00	0.35	0.00
4. Goats [Activity in 1000 heads, EF in kg/head]	179	5.0%		0.12			50.0%			0.02			50.2%		0.00	0.01	0.00
6. Horses [Activity in 1000 heads, EF in kg/head]	941	5.0%		1.39			50.0%			1.31			50.2%		0.00	0.66	0.00
8. Swine [Activity in 1000 heads, EF in kg/head]	19 464	5.0%		5.40			50.0%			105.16			50.2%		0.00	52.84	0.00
9. Poultry [Activity in 1000 heads, EF in kg/head]	228 021	5.0%		0.08			50.0%			17.79			50.2%		0.00	8.94	0.00
11. Liquid Systems [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.001000			150.0%			0.21			150.1%	0.00	0.00	0.32
12. Solid Storage and Dry Lot [Activity in 1000 heads, EF in kg N2O-N/kg N]	0	5.0%			0.020000			150.0%			29.31			150.1%	0.00	0.00	43.99
<b>D. Agricultural Soils</b>											73.75			67.3%	0.00	0.00	49.63
1. Direct Soil Emissions															0.00	0.00	0.00
Synthetic Fertilizers [Activity in kg N, EF in kg N2O-N/kg N]	1 146 600 000	5.0%			0.01			150.0%			16.02			150.1%	0.00	0.00	24.04
Animal Wastes Applied to Soils [Activity in kg N, EF in kg N2O-N/kg N]	823 248 108	5.0%			0.01			150.0%			12.94			150.1%	0.00	0.00	19.42
N-fixing Crops [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	99 000 000	5.0%			0.01			150.0%			1.56			150.1%	0.00	0.00	2.33
Crop Residue [Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass]	199 758 400	5.0%			0.01			150.0%			3.14			150.1%	0.00	0.00	4.71
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]	153 931 303	5.0%			0.02			150.0%			4.84			150.1%	0.00	0.00	7.26
3. Indirect Emissions [Activity in kg N/yr, EF in kg N2O/kg N]	158 186 261	20.0%			1.221027311			150.0%			19.31			151.3%	0.00	0.00	29.23
<b>F. Field Burning of Agricultural Residues</b>										1.48	0.08		21.2%	114.2%	0.00	0.31	0.09
1. Cereals															0.00	0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	9 025 800	30.0%		0.1816	0.0004		20.0%	150.0%		0.16	0.00		36.1%	153.0%	0.00	0.06	0.01
Barley [Activity in t of crop production, EF in kg/t dm]	4 217 000	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]	290 000	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]	2 119 000	30.0%		0.1506	0.0004		20.0%	150.0%		0.03	0.00		36.1%	153.0%	0.00	0.01	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	6 044 000	30.0%		0.2004	0.0004		20.0%	150.0%		0.12	0.00		36.1%	153.0%	0.00	0.04	0.00
Other Cereals [Activity in t of crop production, EF in kg/t dm]	6 318 000	30.0%		0.1592	0.0004		20.0%	150.0%		0.10	0.00		36.1%	153.0%	0.00	0.04	0.00
2 Pulses (Other non-specified)	609 000	30.0%		0.0439	0.0003		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
3 Tuber and Root															0.00	0.00	0.00
Potatoes [Activity in t of crop production, EF in kg/t dm]	36 313 000	30.0%		0.1796	0.0014		20.0%	150.0%		0.65	0.05		36.1%	153.0%	0.00	0.24	0.08
Sugar Beet [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
Other Tuber and Root [Activity in t of crop production, EF in kg/t dm]	0	30.0%		0.0000	0.0000		20.0%	150.0%		0.00	0.00		36.1%	153.0%	0.00	0.00	0.00
5 Other															0.00	0.00	0.00
Fruits, Veget., Rape, Tobacco, Hop, Hey [Activity in t of crop prod., EF in kg/ t of crop]	33 514 000	30.0%		0.0102	0.0004		20.0%	150.0%		0.34	0.01		36.1%	153.0%	0.00	0.12	0.02
<b>5. Land-Use Change and Forestry</b>									-32725.49	0.17	0.00	62.5%	100.0%	100.0%	0.00	0.00	0.00
<b>A. Forest Land</b>									-40042.52			50.0%			-20437.92	0.17	0.01
<b>B. Cropland</b>									6666.93			50.0%			3333.46	0.00	0.00
<b>C. Grassland</b>									3699.30			50.0%			1849.65	0.00	0.00
<b>D. Wetlands</b>									0.00			50.0%			0.00	0.00	0.00
<b>E. Settlements</b>									-3049.21	0.17	0.0011	50.0%	100.0%	100.0%	-1524.60	0.17	0.001
<b>F. Other Land</b>									0.00	0.00	0.0000	50.0%	100.0%	100.0%	0.00	0.00	0.00
<b>6. Waste</b>									458.68	532.97	3.59	51.0%	65.2%	51.4%	233.88	347.70	1.85
<b>A. Solid Waste Disposal on Land</b>										227.78			102.6%		0.00	233.73	0.00
1 Managed Waste Disposal on Land [Activity in Gg, EF in t/t MSW]							100.0%						100.0%		0.00	0.00	0.00
2 Unmanaged Waste Disposal Sites - deep (>5 m) [Activity in Gg, EF in t/t MSW]															0.00	0.00	0.00
3 Other - Total Waste Disposal on Land (Draft Guidelines 2006) [Activity in Gg, EF in t/t MSW]	11 087.18	23.0%					100.0%			227.78			102.6%		0.00	233.73	0.00
<b>B. Wastewater Handling</b>										305.19	3.54		84.3%	52.2%	0.00	257.42	1.85
Industrial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	2 790.78			0.09			100.0%			251.17			100.0%		0.00	251.17	0.00
Domestic and Commercial Wastewater [Activity in Gg DC(1), EF in kg/kg DC]	239.42	30.0%		0.225643283			100.0%			54.02			104.4%		0.00	56.40	0.00
sewage N produced]	38 183.00	15.0%			0.0000926			50.0%			3.54			52.2%	0.00	0.00	1.85
<b>C. Waste Incineration</b>									458.68		0.05	51.0%			233.88	0.00	0.01
biogenic [Activity in Gg, EF in kg/t waste]		10.0%					50.0%		116.01		0.01	51.0%			59.15	0.00	0.00
plastics and other non-biogenic waste [Activity in Gg, EF in kg/t waste]		10.0%					50.0%		458.68		0.05	51.0%			233.88	0.00	0.01



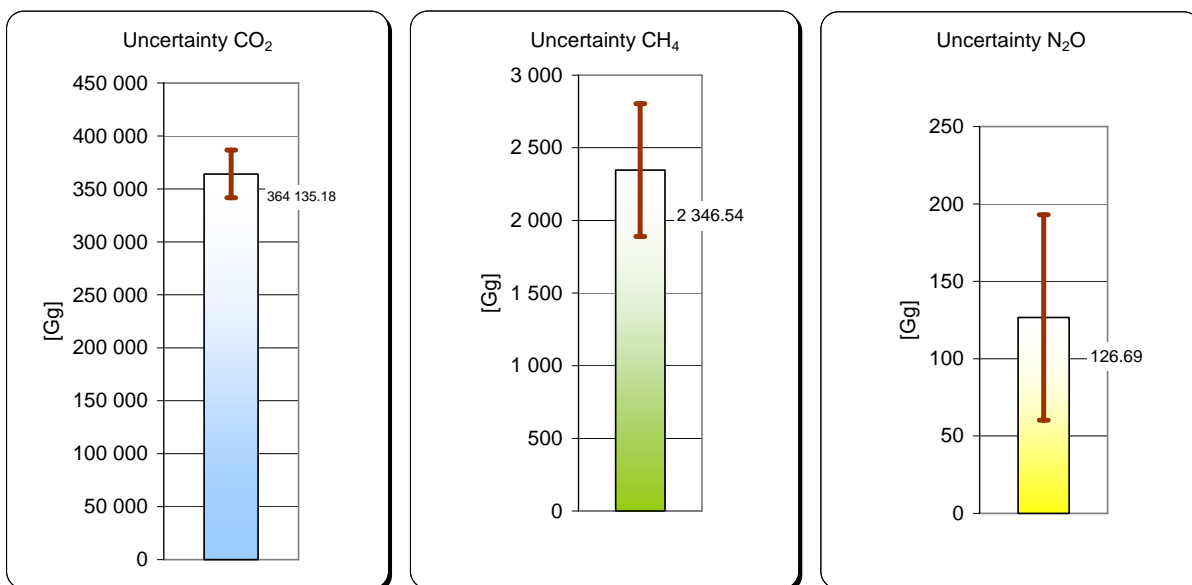
**Results of uncertainty analysis in percents for CO<sub>2</sub> with sectoral split.**



**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.**