

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

# **Poland's National Inventory Report 1989**

Submission under  
the United Nations Framework  
Convention on Climate Change

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## Table of contents

|  |           |
|--|-----------|
| <b>Executive Summary .....</b>   | <b>5</b>  |
| Total national GHG emissions .....   | 5         |
| Carbon dioxide emissions .....   | 5         |
| Methane emissions .....  | 6         |
| Nitrous oxide emissions .....  | 6         |
| <b>1. Introduction .....</b>   | <b>7</b>  |
| 1.1 Background information on greenhouse gas inventories and climate change .....                              | 7         |
| 1.2 A description of institutional arrangement for inventory preparation.....                                  | 7         |
| 1.3 Brief description of the process for inventory preparation .....   | 7         |
| 1.4 General description of methodologies and data sources used.....  | 8         |
| 1.5 Brief description of key source methodologies.....   | 9         |
| 1.6 Information on the QA/QC plan including verification .....   | 9         |
| 1.7 General uncertainty evaluation, including data on the overall uncertainty for the<br>inventory totals..... | 10        |
| 1.8 General assessment of the completeness.....  | 10        |
| <b>2. Greenhouse gas emissions and removals in 1989 .....</b>  | <b>11</b> |
| 2.1 GHG aggregated emissions.....  | 11        |
| 2.2 GHG emissions by gas .....   | 13        |
| 2.3 GHG emissions by category.....   | 16        |
| 2.4 Comparison to base year 1988 .....   | 18        |
| <b>3. Energy (CRF sector 1) .....</b>  | <b>20</b> |
| 3.1 Key categories .....   | 20        |
| 3.2. Methodological issues .....   | 20        |
| <b>4. Industrial Processes (CRF sector 2) .....</b>  | <b>30</b> |
| 4.1. Key categories .....  | 30        |
| 4.2 Methodological issues .....  | 30        |
| <b>5. Solvent and Other Product Use (CRF sector 3) .....</b>   | <b>33</b> |
| 5.1 Key categories .....   | 33        |
| 5.2 Methodological issues .....  | 33        |
| <b>6. Agriculture (CRF sector 4).....</b>  | <b>33</b> |
| 6.1 Key categories .....   | 33        |
| 6.2 Methodological issues .....  | 33        |
| <b>7. Land Use Change and Forestry (CRF sector 5) .....</b>  | <b>40</b> |
| 7.1 Key categories .....   | 40        |
| 7.2 Methodological issues .....  | 40        |
| <b>8. Waste (CRF sector 6) .....</b>   | <b>47</b> |
| 8.1 Key categories .....   | 47        |
| 8.2 Methodological issues .....  | 47        |
| <b>References .....</b>  | <b>51</b> |

|  |              |
|--|--------------|
| <b>Annex 1. Key sources .....</b>                                  | <b>.....</b> |
| <b>Annex 2. Energy balance data for main fuels .....</b>           | <b>.....</b> |
| <b>Annex 3. National energy balance 1989 .....</b>                 | <b>.....</b> |
| <b>Annex 4. National energy balance 1989 - OECD.....</b>           | <b>.....</b> |
| <b>Annex 5. Uncertainty estimation of the 1989 inventory .....</b> | <b>.....</b> |
| <b>Annex 6. Common Reporting Format 1989.....</b>                  | <b>.....</b> |

## Executive Summary

This report - National Inventory Report (NIR) - presents the results of the national emission inventory of greenhouse gases (GHGs) in Poland in 1989. The inventory covers the following GHGs: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O).

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 1989. Totals in tables may not sum due to independent rounding.

### Total national GHG emissions

The GHG emissions in 1988 and 1989, expressed as CO<sub>2</sub> equivalents, are presented in table ES.1 In 1989 the total national emission of GHG were about 569.40 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 1989 emissions have decreased by 3.0%.

Table ES.1 National emissions of greenhouse gases for the years 1988-1989. [Gg CO<sub>2</sub> eq.]

| Pollutant                                     | Base                                 | 1989                                 | (1989-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                           | 436 535.97                           | -0.06            |
| CO <sub>2</sub> – without LUCF.               | 494 885.88                           | 472 028.07                           | -0.05            |
| CH <sub>4</sub>                               | 49 256.41                            | 53 431.54                            | 0.08             |
| N <sub>2</sub> O                              | 42 478.82                            | 43 938.48                            | 0.03             |
| HFCs  | 26.44                                | 0.00                                 | -1.00            |
| PFCs  | 250.18                               | 0.00                                 | -1.00            |
| SF <sub>6</sub>                               | 13.15                                | 0.00                                 | -1.00            |
| <b>TOTAL without CO<sub>2</sub> from LUCF</b> | <b>586 910.88</b>                    | <b>569 398.09</b>                    | <b>-0.03</b>     |
| <b>TOTAL with LUCF</b>                        | <b>553 976.16</b>                    | <b>533 906.00</b>                    | <b>-0.04</b>     |

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

### Carbon dioxide emissions

The CO<sub>2</sub> emissions in 1989 were estimated as 472.03 million tones. This is 4.6% lower than in the base year. CO<sub>2</sub> emission was accounted for 82.9% of total GHG emissions in Poland in 1989. 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 95.31% in 1989. The shares of the main subcategories were as follows: *Energy industries* – 56.3%, *Manufacture Industries and Construction* – 11.6%, *Transport* – 4.9% and *Other Sectors* – 21.2%. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.4% in 1989. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO<sub>2</sub> removal in LUCF sector in 1989, was calculated to be approximately 35.5 million tones. It means that app. 6.6% 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 2 544.36Gg in 1989 i.e. 53.43 million tonnes of CO<sub>2</sub> equivalents.

The contribution of CH<sub>4</sub> to the national total GHG emission was 9.4% in 1989. Three of main CH<sub>4</sub> emission sources include the following categories: *Fugitive Emissions from Fuels*, *Agriculture* and *Waste*. They contributed 39.8%, 37.3% and 21.6% to the national methane emission in 1989, respectively. The emission from the first mentioned sector was covered by emission from Underground Mines (app. 32.3% of total CH<sub>4</sub> emission) and Natural Gas system (app. 7.5% of total CH<sub>4</sub> emission). Waste disposal sites contributed to 8.5% of the methane emission from total CH<sub>4</sub> emission. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 30.8% of total CH<sub>4</sub> emission in 1989.

## **Nitrous oxide emissions**

The nitrous oxide emissions in 1989 were 141.74 Gg i.e. 43.94 million tonnes of CO<sub>2</sub> equivalents. The emission was app. 3.4% higher than the respective figure for the base year. The contribution of N<sub>2</sub>O to the national total GHG emission was 7.7% in 1989. The main N<sub>2</sub>O emission sources and its shares in total N<sub>2</sub>O emission in 1989 are as follow: *Agricultural Soils* – 57.4%, *Manure Management* – 21.5%, *Chemical Industry* – 11.5% and *Fuel Combustion* – 7.0%.

# **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 contained in 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. 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 [IPCC1995].

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<br>in national combustion processes | Steam coal         |                |
|--|--------------------|----------------|
|  | 10 <sup>3</sup> Mg | TJ             |
| <b>In</b>  | <b>180170</b>      | <b>4133358</b> |
| From national sources  | 179244             | 4105900        |
| 1) Indigenous production   | 177633             | 4068685        |
| 2) Transformation output or return                                 | 0                  | 0              |
| 3) Stock decrease  | 1611               | 37215          |
| Import   | 926                | 27458          |
| <b>Out</b>   | <b>180170</b>      | <b>4133358</b> |
| National consumption   | 151221             | 3346416        |
| 1) Transformation input  | 116414             | 2463251        |
| a) input for secondary fuel production                             | 23122              | 674991         |
| b) fuel combustion   | 93292              | 1788260        |



|                                 |               |                |
|---------------------------------|---------------|----------------|
| 2) Direct consumption           | 34807         | 883165         |
| Non-energy use                  | 9             | 305            |
| Combusted directly              | 34798         | 882860         |
| <b>Combusted in Poland</b>      | <b>128090</b> | <b>2671120</b> |
| Stock increase                  | 0             | 0              |
| Export                          | 28943         | 729054         |
| Losses                          | 6             | 132            |
| Statistical differences         |               | 57756          |
| Net Calorific Values            | MJ/kg         | 20.85          |
| CO <sub>2</sub> Emission Factor | kg/GJ         | 96.97          |

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 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

Poland has not yet implemented a formal QA/QC procedure, including verification plan, for the national emission inventory. However, several checks are routinely carried out to eliminate possible errors. The calculated emissions figures for a given year, are compared to the respective figures from entire time series, and outliers are scrutinized in more detail or in other words an extended QA/QC is carried out for doubtful figures.

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. During the following several weeks, extensive checks are done in form of consultations with data providers. The consultations cover both correctness of data and their

proper interpretation. Wherever possible various different datasets are used for comparison purposes. Here the most important institutional sources include: Central Statistical Office, Agency of Energy Market, and a number of collaborating individual experts and institutions. After the checking period is completed, the final CRF is prepared together with the accompanying report.

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

Uncertainty evaluation made for 1989 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 1989 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 *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 1989

### 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 82.9% share (in 1989), while the methane contributes with 9.4% to the national total. Nitrous oxide contribution is 7.7%.

Table 2.1 Greenhouse gas emissions in 1989 in CO<sub>2</sub> eq.

| Pollutant                                     | 1989                                 |              |
|---|--------------------------------------|--------------|
|   | Emission in CO <sub>2</sub> eq. [Gg] | Share [ %]   |
| CO <sub>2</sub> – net emission (with LUCF)    | 436 535.97                           |              |
| CO <sub>2</sub> – without LUCF.               | 472 028.07                           | 82.9         |
| CH <sub>4</sub>                               | 53 431.54                            | 9.4          |
| N <sub>2</sub> O                              | 43 938.48                            | 7.7          |
| HFCs  | 0.00                                 | 0.0          |
| PFCs  | 0.00                                 | 0.0          |
| SF <sub>6</sub>                               | 0.00                                 | 0.0          |
| <b>TOTAL without CO<sub>2</sub> from LUCF</b> | <b>569 398.09</b>                    | <b>100.0</b> |
| <b>TOTAL with LUCF</b>                        | <b>533 906.00</b>                    |              |

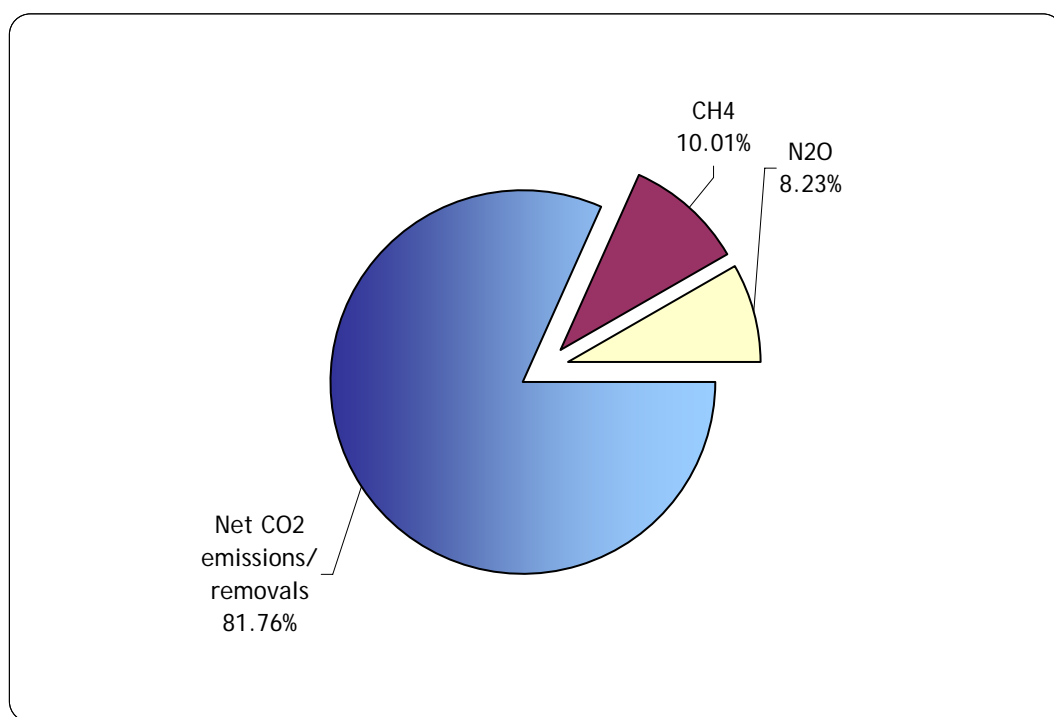


Figure 2.1 Percentage share of greenhouse gases in national total emission total in 1989

Emissions of main GHGs in 1989, 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 1989 [Gg]

| [Gg]   | CO <sub>2</sub>   | CH <sub>4</sub> | N <sub>2</sub> O |
|--|-------------------|-----------------|------------------|
| <b>TOTAL without CO<sub>2</sub> from LUCF</b>    | <b>472 028.07</b> | <b>2 544.17</b> | <b>141.74</b>    |
| <b>1. Energy</b>                                 | <b>449 929.84</b> | <b>1 027.71</b> | <b>9.96</b>      |
| A. Fuel Combustion                               | 449 879.14        | 15.90           | 9.96             |
| 1. Energy Industries                             | 265 783.77        | 3.51            | 3.78             |
| 2. Manufacturing Industries and Construction     | 54 849.95         | 2.35            | 0.86             |
| 3. Transport                                     | 23 351.02         | 6.61            | 1.58             |
| 4. Other Sectors                                 | 100 199.82        | 2.38            | 1.83             |
| 5. Other   | 5 694.59          | 1.04            | 1.91             |
| B. Fugitive Emissions from Fuels                 | 50.70             | 1 011.81        | 0.00             |
| 1. Solid Fuels                                   | 1.84              | 821.13          | 0.00             |
| 2. Oil and Natural Gas                           | 48.86             | 190.68          | 0.00             |
| <b>2. Industrial Processes</b>                   | <b>20 740.79</b>  | <b>16.16</b>    | <b>16.35</b>     |
| A. Mineral Products                              | 10 983.25         | 0.00            | 0.00             |
| B. Chemical Industry                             | 4 044.15          | 12.24           | 16.35            |
| C. Metal Production                              | 5 713.40          | 3.92            | 0.00             |
| D. Other Production                              | 0.00              | 0.00            | 0.00             |
| G. Other   | 0.00              | 0.00            | 0.00             |
| <b>3. Solvent and Other Product Use</b>          | <b>822.14</b>     | <b>0.00</b>     | <b>0.40</b>      |
| <b>4. Agriculture</b>                            | <b>0.00</b>       | <b>950.13</b>   | <b>111.79</b>    |
| A. Enteric Fermentation                          | 0.00              | 783.07          | 0.00             |
| B. Manure Management                             | 0.00              | 165.51          | 30.41            |
| D. Agricultural Soils                            | 0.00              | 0.00            | 81.31            |
| F. Field Burning of Agricultural Residues        | 0.00              | 1.54            | 0.08             |
| <b>5. Land Use, Land-Use Change and Forestry</b> | <b>-35 492.10</b> | <b>0.18</b>     | <b>0.00</b>      |
| A. Forest Land                                   | -43 078.01        | 0.00            | 0.00             |
| B. Cropland                                      | 6 889.89          | 0.00            | 0.00             |
| C. Grassland                                     | 3 823.02          | 0.00            | 0.00             |
| D. Wetlands                                      | 0.00              | 0.00            | 0.00             |
| E. Settlements                                   | -3 127.00         | 0.18            | 0.00             |
| F. Other Land                                    | 0.00              | 0.00            | 0.00             |
| <b>6. Waste</b>                                  | <b>535.29</b>     | <b>550.17</b>   | <b>3.24</b>      |
| A. Solid Waste Disposal on Land                  | 0.00              | 216.29          | 0.00             |
| B. Wastewater Handling                           | 0.00              | 333.88          | 3.18             |
| C. Waste Incineration                            | 535.29            | 0.00            | 0.06             |

As a supplement to the table 2.2, table 2.3 includes percentage contributions of main source sectors to the national totals in 1989 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 1989 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 |
| <b>TOTAL</b>  | <b>100.00</b>                | <b>100.00</b>   | <b>100.00</b>    |
| <b>1. Energy</b>  | <b>95.32</b>                 | <b>40.39</b>    | <b>7.02</b>      |
| A. Fuel Combustion                                      | 95.31                        | 0.62            | 7.02             |
| 1. Energy Industries                                    | 56.31                        | 0.14            | 2.66             |
| 2. Manufacturing Industries and Construction            | 11.62                        | 0.09            | 0.61             |
| 3. Transport  | 4.95                         | 0.26            | 1.11             |
| 4. Other Sectors  | 21.23                        | 0.09            | 1.29             |
| 5. Other  | 1.21                         | 0.04            | 1.35             |
| B. Fugitive Emissions from Fuels                        | 0.01                         | 39.77           | 0.00             |
| 1. Solid Fuels  | 0.00                         | 32.27           | 0.00             |
| 2. Oil and Natural Gas                                  | 0.01                         | 7.49            | 0.00             |
| <b>2. Industrial Processes</b>                          | <b>4.39</b>                  | <b>0.64</b>     | <b>11.53</b>     |
| A. Mineral Products                                     | 2.33                         | 0.00            | 0.00             |
| B. Chemical Industry                                    | 0.86                         | 0.48            | 11.53            |
| C. Metal Production                                     | 1.21                         | 0.15            | 0.00             |
| D. Other Production                                     | 0.00                         | 0.00            | 0.00             |
| G. Other  | 0.00                         | 0.00            | 0.00             |
| <b>3. Solvent and Other Product Use</b>                 | <b>0.17</b>                  | <b>0.00</b>     | <b>0.28</b>      |
| <b>4. Agriculture</b>                                   | <b>0.00</b>                  | <b>37.34</b>    | <b>78.87</b>     |
| A. Enteric Fermentation                                 | 0.00                         | 30.78           | 0.00             |
| B. Manure Management                                    | 0.00                         | 6.51            | 21.45            |
| D. Agricultural Soils                                   | 0.00                         | 0.00            | 57.37            |
| F. Field Burning of Agricultural Residues               | 0.00                         | 0.06            | 0.05             |
| <b>5. Land Use, Land-Use Change and Forestry</b>        |                              | <b>0.01</b>     | <b>0.001</b>     |
| A. Forest Land  |                              | 0.00            | 0.00             |
| B. Cropland   |                              | 0.00            | 0.00             |
| C. Grassland  |                              | 0.00            | 0.00             |
| D. Wetlands   |                              | 0.00            | 0.00             |
| E. Settlements  |                              | 0.01            | 0.001            |
| F. Other Land   |                              | 0.00            | 0.00             |
| <b>6. Waste</b>   | <b>0.11</b>                  | <b>21.62</b>    | <b>2.29</b>      |
| A. Solid Waste Disposal on Land                         | 0.00                         | 8.50            | 0.00             |
| B. Wastewater Handling                                  | 0.00                         | 13.12           | 2.24             |
| C. Waste Incineration                                   | 0.11                         | 0.00            | 0.04             |

## 2.2 GHG emissions by gas

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

In 1989, the net CO<sub>2</sub> emissions (with LULUCF) were estimated as 436.54 million tonnes, while when sector 5. *LUCF* is excluded the figure reaches 472.03 million tones (table 2.1). 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 0.62% in 1989. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 56.3%, *Manufacture Industries and Construction* – 11.6%, *Transport* – 4.9% and *Other Sectors* – 21.2%. Sector 2. *Industrial Processes* contributed to the total CO<sub>2</sub> emission by 4.4% in 1989. *Mineral Products* (especially *Cement Production*) is the main emission source in this sector. The CO<sub>2</sub> emission/removal in LULUCF sector in 1989, was calculated to be approximately 35.5 million tones. It means that app. 6.6% of the total CO<sub>2</sub> emissions are offset by CO<sub>2</sub> uptake by forests.

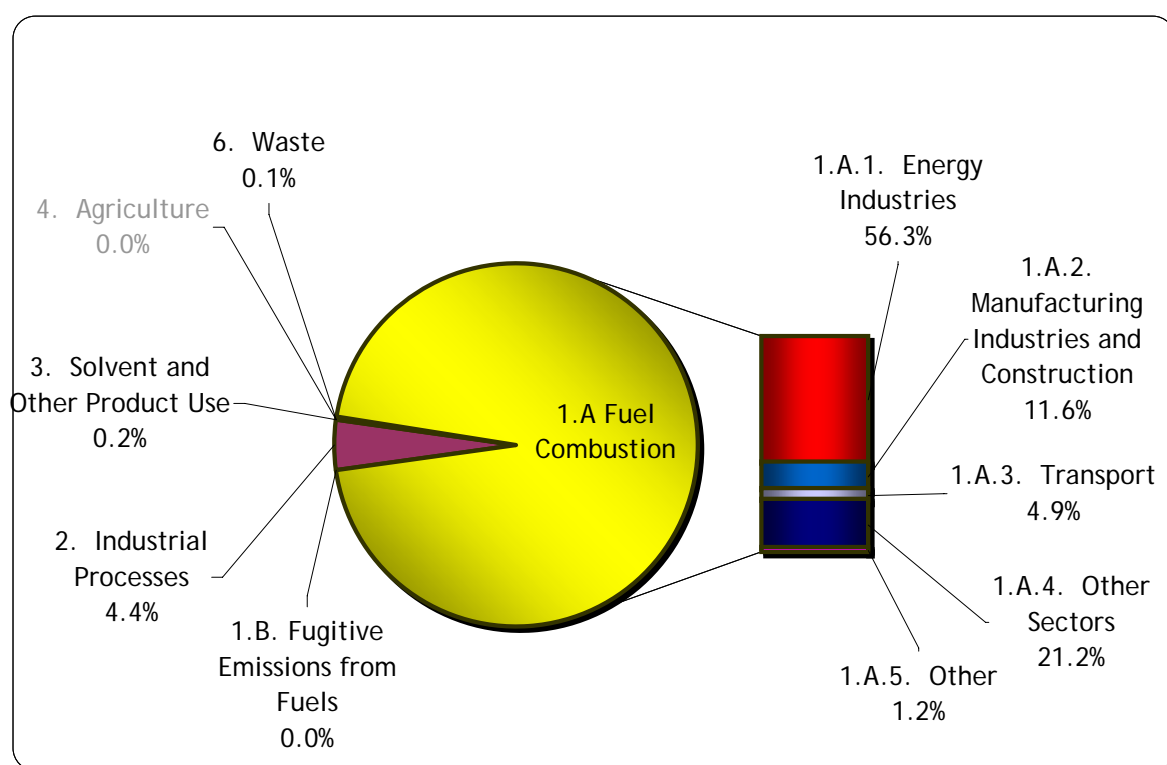


Figure 2.2 Carbon dioxide emission in 1989 by sector

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

The CH<sub>4</sub> emission amounted to 2 544.36Gg in 1989 i.e. 53.43 million tones of CO<sub>2</sub> equivalents (table 2.2). Three of main CH<sub>4</sub> emission sources include the following categories: *Fugitive Emissions from Fuels*, *Agriculture* and *Waste*. They contributed to 39.8%, 37.3% and 21.6% of the national methane emission in 1989 respectively. The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 32.3% of total CH<sub>4</sub> emission) and *Natural Gas* system (about 7.5% of total emission), *Disposal sites* contributed to 8.50% of the methane emission and *Wastewater Handling* contributed to 13.12%. The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 30.8% of total methane emission in 1989.

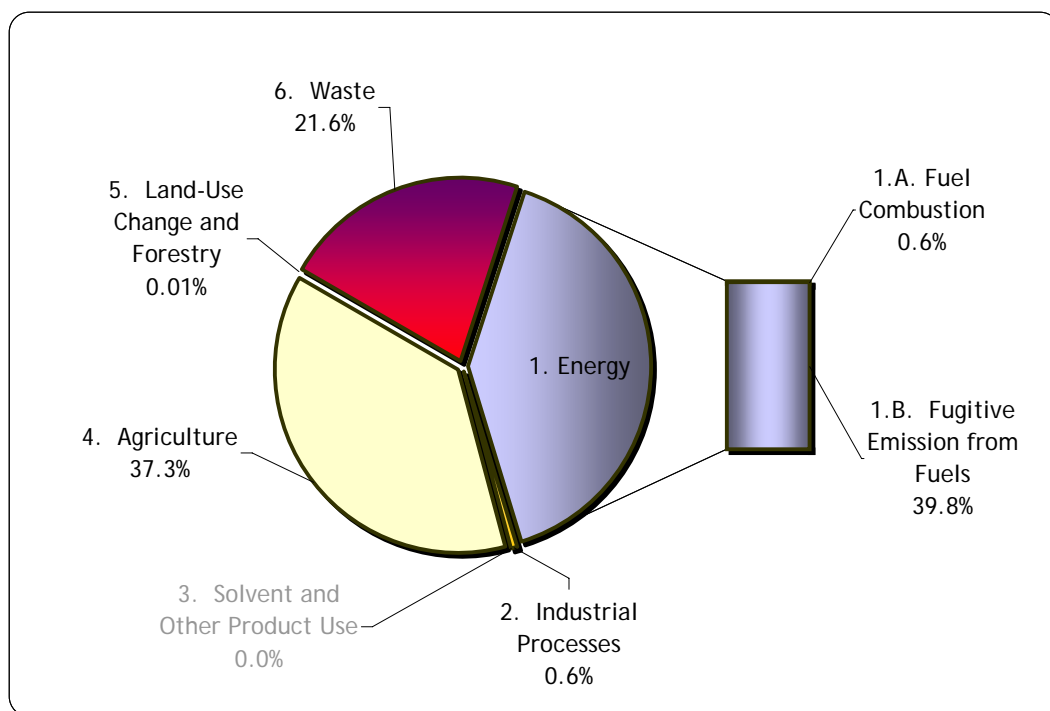


Figure 2.3 Methane emission in 1989 by sector

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

The nitrous oxide emissions in 1989 were 141.74 Gg i.e. 43.94 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 1989 are: *Agricultural Soils* – 57.4%, *Manure Management* – 21.5%, *Chemical Industry* – 11.5% and *Fuel Combustion* – 7.0%.

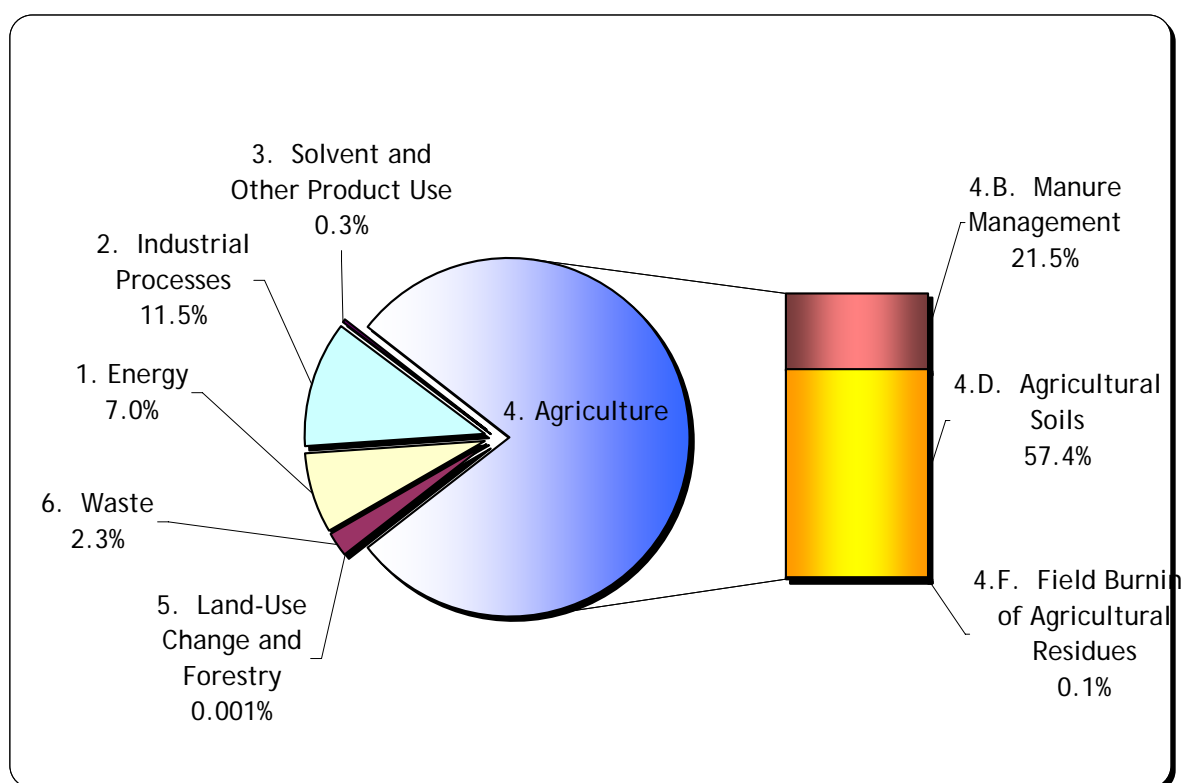


Figure 2.4 Nitrous oxide emission in 1989 by sector

## 2.3 GHG emissions by category

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

### 2.3.1. Energy (IPCC category 1)

The emission of GHGs from *Energy* sector in 1989 was 474.6 million tons of CO<sub>2</sub> equivalent. CO<sub>2</sub> emission share exceeded 94.8% of the total GHG emissions within 1.*Energy* category (table 2.5). 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 1989

| 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 |
| <b>Total Energy</b>                          | <b>474 598.37</b>                     | <b>100.0</b>                              | <b>94.8</b>   | <b>4.5</b>      | <b>0.7</b>       |
| <b>A. Fuel Combustion Activities</b>         | <b>453 299.63</b>                     | <b>95.5</b>                               | <b>94.8</b>   | <b>0.1</b>      | <b>0.7</b>       |
| 1. Energy Industries                         | 267 028.24                            | 56.3                                      | 56.0  | 0.0             | 0.2              |
| 2. Manufacturing Industries and Construction | 55 166.43                             | 11.6                                      | 11.6  | 0.0             | 0.1              |
| 3. Transport                                 | 23 978.32                             | 5.1                                       | 4.9   | 0.0             | 0.1              |
| 4. Other Sectors                             | 100 816.51                            | 21.2                                      | 21.1  | 0.0             | 0.1              |
| 5. Other                                     | 6 310.12                              | 1.3                                       | 1.2   | 0.0             | 0.1              |
| <b>B. Fugitive Emissions from Fuels</b>      | <b>21 298.75</b>                      | <b>4.5</b>                                | <b>0.0</b>  | <b>4.5</b>      | <b>0.0</b>       |
| 1. Solid Fuels                               | 17 245.60                             | 3.6                                       | 0.0   | 3.6             | 0.0              |
| 2. Oil and Natural Gas                       | 4 053.15                              | 0.9                                       | 0.0   | 0.8             | 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 1989. CO<sub>2</sub> is dominating among GHGs – it's contribution exceeds 79.3%. The main GHG emission sources in this category were: production processes of cement, nitric acid and lime.

The emissions of GHG from *Solvent and Other Use* sector includes N<sub>2</sub>O emissions from anaesthesia and CO<sub>2</sub> emissions (recalculated from NMVOC) mostly from category 3.A.*Paint Application* (86.9%) and from 3.B.*Degreasing and Dry Cleaning* (13.1%).

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 1989

| 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 i SF6 |
| <b>Total Industrial Processes</b>          | <b>26 147.88</b>                      | <b>100.0</b>  | <b>79.3</b>   | <b>1.3</b>      | <b>19.4</b>      | <b>0.0</b>     |
| A. Mineral Products                        | 10 983.25                             | 42.0  | 42.0  | 0.0             | 0.0              |                |
| B. Chemical Industry                       | 9 368.87                              | 35.8  | 15.5  | 1.0             | 19.4             |                |
| C. Metal Production                        | 5 795.76                              | 22.2  | 21.9  | 0.3             | 0.0              | 0.0            |
| D. Other Production                        | 0.00                                  | NE  |   |                 |                  |                |
| F. Consumption of Halocarbons and SF6      | 0.00                                  | 0.0   |   |                 |                  | 0.0            |
| G. Other                                   | 0.00                                  | 0.0   |   |                 |                  |                |
| <b>Total Solvent and Other Product Use</b> | <b>946.14</b>                         | <b>100</b>  | <b>86.9</b>   | <b>0.0</b>      | <b>13.1</b>      |                |

### 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 1989 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 1989

| 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 |
| <b>Total Agriculture</b>                  | <b>54 608.40</b>                      | <b>100.0</b>                                   | <b>36.5</b>   | <b>63.5</b>      |
| A. Enteric Fermentation                   | 16 444.54                             | 30.1   | 30.1  | 0.0              |
| B. Manure Management                      | 12 901.96                             | 23.6   | 6.4   | 17.3             |
| D. Agricultural Soils                     | 25 205.66                             | 46.2   | 0.0   | 46.2             |
| F. Field Burning of Agricultural Residues | 56.24                                 | 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 1989 (almost 88.2%). 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 1989

| 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 |
| <b>Total Waste</b>              | <b>13 093.03</b>                      | <b>100</b>                               | <b>4.1</b>  | <b>88.2</b>     | <b>7.7</b>       |
| A. Solid Waste Disposal on Land | 4 542.18                              | 34.7                                     | 0.0   | 34.7            | 0.0              |
| B. Wastewater Handling          | 7 996.17                              | 61.1                                     | 0.0   | 53.6            | 7.5              |
| C. Waste Incineration           | 554.69                                | 4.2                                      | 4.1   | 0.0             | 0.1              |

## 2.4 Comparison to base year 1988

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 1989 with respect to base year 1988/1995

| Pollutant                                     | Base year                            | 1989                                 | 1989/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                           | 436 535.97                           | 94.50              |
| CO <sub>2</sub> – without LUCF.               | 494 885.88                           | 472 028.07                           | 95.38              |
| CH <sub>4</sub>                               | 49 256.41                            | 53 431.54                            | 108.48             |
| N <sub>2</sub> O                              | 42 478.82                            | 43 938.48                            | 103.44             |
| HFCs  | 26.44                                | 0.00                                 | 0.00               |
| PFCs  | 250.18                               | 0.00                                 | 0.00               |
| SF <sub>6</sub>                               | 13.15                                | 0.00                                 | 0.00               |
| <b>TOTAL without CO<sub>2</sub> from LUCF</b> | <b>586 910.88</b>                    | <b>569 398.09</b>                    | <b>97.02</b>       |
| <b>TOTAL with LUCF</b>                        | <b>553 976.16</b>                    | <b>533 906.00</b>                    | <b>96.38</b>       |

\* 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. 4.6% from the base year to 1989.

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

- share in of solid fuels decreased from 85.3% in 1988 to 84.8% in 1989
- share of liquid fuels increased from 11.4% (1988) to 11.7% (1989)
- share of gaseous fuels increased from 3.3% (1988) to 3.4% (1989).

### Methane

CH<sub>4</sub> emission had increased by app. 8.5% from the base year to 1989. The reasons for that are as follow:

- the decrease in emission from *Enteric Fermentation* by 5.0%
- the decrease in *Fugitive Emission* by 13.7%
- the increase in emission from *Waste* by 65.0%.

### Nitrous oxide

The nitrous oxide emissions in 1989 were app. 3.4% higher than the respective figure for the base year. The share in *Manure Management* decreased from 22.0% in 1988 to 21.5% in

1989, in *Agricultural Soils* increased from 55.6% (1988) to 57.4% (1989) and in *Chemical Industry* decreased from 11.8% in 1988 to 11.5% in 1989.

### Emissions of greenhouse gases in 1988/1995 in CO<sub>2</sub> equivalent

Shares of individual GHGs to national total in 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 1989 decreased from 84.3% to 82.9%.

Table 2.10 Emissions of greenhouse gases in 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       |
| <b>TOTAL without CO<sub>2</sub> from LUCF</b> | <b>586 910.88</b>                    | <b>100.0</b> |
| <b>TOTAL with LUCF</b>                        | <b>553 976.16</b>                    |              |

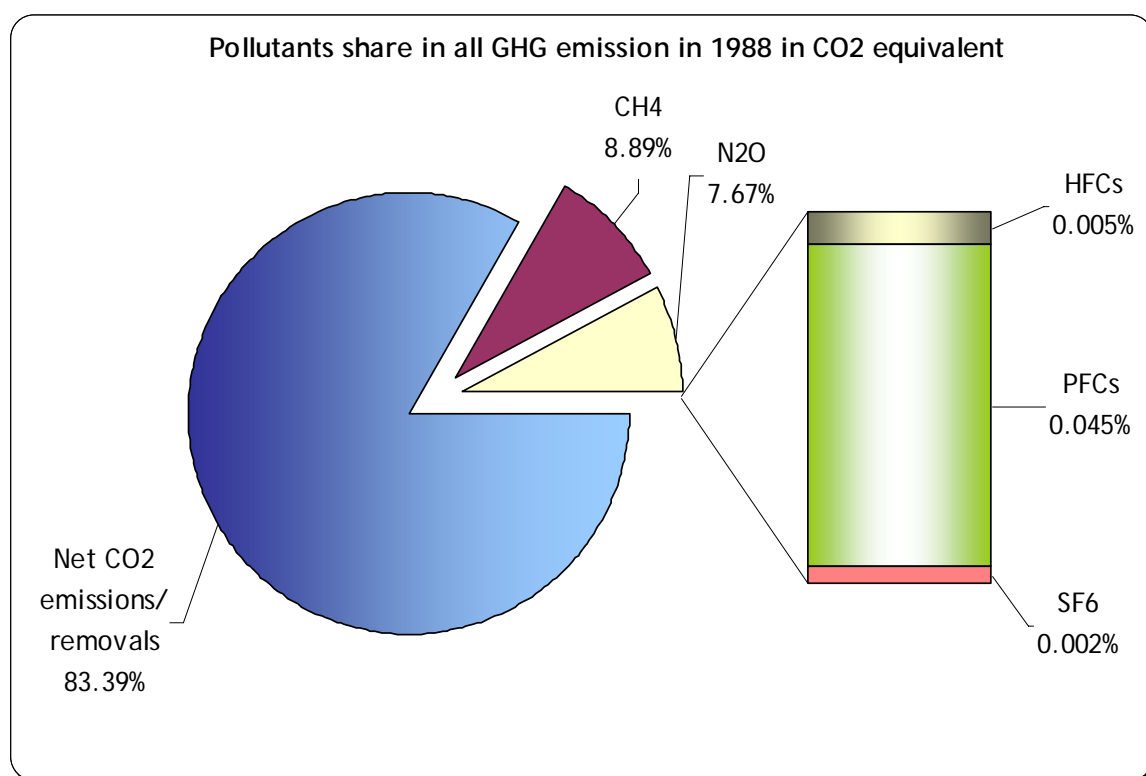


Figure 2.5 Percentage share of national greenhouse gas emissions in 1988 including emission from sector 5.

### 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 74.0%,
- 1.A.3.b - Road Transportation (CO<sub>2</sub> emission), share in total GHG emission 2.9%,
- 1.A.5.b – Other mobile (CO<sub>2</sub> emission), share in total GHG emission 0.9%,
- 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 0.7%.

Share of these categories in total Poland's GHG emissions is 81.5%.

#### 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** of emission is similar to calculation of emission from combustion in the assumed level of detail (*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 domestic methodology of the emission calculation is based on the balance of used fuels in combustion processes on division or groups level.

### *Statistical data*

The Polish statistical yearbooks include, in principle, all the data needed for *Tier 2* method:

1. the data given in the column "transformation input"<sup>1</sup> is divided into two streams:
  - fuel stream for substantial input that is transformed into derived fuel (coking plants, refineries, gas generators, briquetting plants and so on)
  - fuel stream burned in the hearth of installation that produces water vapour, hot water or other heat carrier;
2. the data given in the column "direct consumption" is divided into:
  - fuel use for combustion
  - non-energy use of fuels.

The national methodology introduces as a primary step estimation of the above described two streams of fuels with the use of special spreadsheets, one for each fuel. In the spreadsheet, the final calculation leads to the estimation of aggregated net calorific value (NCV) and calculation of elemental C content in the fuel -  $C_{\max}$ , the maximum emission factor for CO<sub>2</sub> and in the end, the maximum CO<sub>2</sub> emission.

### *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 based 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*

Emission factors for elemental carbon were determined for major fuel types in form of formulae dependent on net calorific values - NCV, obtained with regression analysis. The following formulae were obtained:

the emission factor for elemental carbon from hard coal:

---

<sup>1</sup> Transformation input means the quantities of energy commodities which are subject matter to transformation into other (derived) energy commodities in the technological processes. Energy transformation is a technological process in which one form of energy (usually primary energy commodity e.g. coal is converted into other, derived or secondary form (e.g. electricity, heat, coke, manufactured gas etc.)

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

where:  $C_{hc}$  emission factor for hard coal,  
 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,  
 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:

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

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

the emission factor for elemental carbon from fuel oil:

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

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:

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

where:  $C_{hmng}$  emission factor for high-methane natural gas,  
 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:

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

where:  $C_{cg}$  emission factor for city gas,  
 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:

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

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

Calculation of the  $\text{CO}_2$  emission factor, when the  $C_{\text{max}}$  [ $\text{kg/GJ}$ ] is already known is done with the following formula:

$$\text{EF}_{\text{abc}} = C_{\text{max}} * 44/12 * \text{FO}_{\text{abc}} [\text{kgCO}_2/\text{GJ}]$$

where:  $C_{\text{max}}$  - maximum content of elemental carbon in fuel [ $\text{kgCO}_2/\text{GJ}$ ]  
 $\text{FO}_{\text{abc}}$  - carbon oxidation factor in combustion processes dependent on fuel type and combustion technology

In national emission inventories carried out with "bottom-up" approach, in most cases it is necessary to assess the carbon oxidation factor at the level of aggregated fuel use in combustion processes in groups, sections and individual sub-sectors. Determination of the carbon oxidation factors for individual installations will be needed when domestic and international GHG emission trading will come into force within the framework of UNFCCC. Currently, in the Polish national inventory, it is the expert's estimation which helps to select the suitable value of the carbon oxidation factor.  $\text{CO}_2$  emission factors were calculated for individual fuel types by applying the empirical functions given above. For these formulae, aggregated NCVs were used as well as estimated by experts carbon oxidation factors. The emission factors for the other pollutants:  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ,  $\text{NO}_x$ , CO and NMVOC, were selected from existing sets by taking into account industrial technologies and combustion conditions.

### *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  $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$

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 1991a]
- Energy Balance Poland – OECD [ARE 1991]

Emission factors for stationary combustion in the sectors 1.A.1, 1.A.2 and 1.A.4 are presented in the tables 3.1-3.3. Empty cells for  $\text{CO}_2$  emission factors mean that EF is calculated based on the functions described above. Country specific EFs are estimated based on measurements or based on literature and expert opinion (not calculated based on functions connected with NCV) are marked by italic. The other factors are default values taken from [IPCC 2006].

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

| Type of 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              |
| Crud Oil                       | 73.30              | 0.0030             | 0.0006              |
| Non-energy Products            | 76.50              | 0.0030             | 0.0006              |
| Gaseous and Liquid 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                  |                    | 0.0010             | 0.0001              |
| Blast Furnace 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 3.2. Applied EFs [kg/GJ] for 1.A.2 category

| Type of 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              |
| Crud Oil                       | 73.30              | 0.0030             | 0.0006              |
| Non-energy Products            | 76.50              | 0.0030             | 0.0006              |
| Gaseous and Liquid 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                  |                    | 0.0010             | 0.0001              |
| Blast Furnace Gas              | 44.70              | 0.0010             | 0.0001              |
| Town Gas                       |                    | 0.0010             | 0.0001              |
| Gas Manufactured from Coal     | 116.00             | 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.b and 1.A.4.c categories

| Type of 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              |
| Gaseous and Liquid 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              |



| Type of Fuel               | EF CO <sub>2</sub> | EF CH <sub>4</sub> | EF N <sub>2</sub> O |
|----------------------------|--------------------|--------------------|---------------------|
| SOLID FUELS                |                    |                    |                     |
| Hard Coal                  |                    | 0.0010             | 0.0015              |
| Lignite                    |                    | 0.0010             | 0.0015              |
| Coke                       |                    | 0.0010             | 0.0015              |
| Town Gas                   |                    | 0.0010             | 0.0001              |
| Coke Oven Gas              | 44.70              | 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

| Type of 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              |
| Crud Oil                   | 73.30              | 0.0030             | 0.0006              |
| Non-energy products        | 76.50              | 0.0030             | 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              |

As concerns sector 1.A.3 *Transport*, activity data for road transport were estimated based on fuel use by individual vehicle categories taken for 1988 according to [FEWE 1991] as well as based on relation between 1988/1989 OECD balances for fuel use {ARE 1990, 1991}. CO<sub>2</sub> emissions factors 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. Activity data are as follows:

- ♦ OECD Energy Balance for Poland, [ARE 1991],
- ♦ Questionnaire/Report G-03, [GUS 1991e],
- ♦ Statistical Yearbook of The Republic of Poland 1991 [GUS 1991],
- ♦ unpublished data from Agency of Energy Market

Table 3.5 Emission factors [kg/GJ] for Transport in 1989

| Type of transport                           | Stosowane oznaczenie | Wskaźnik emisji CO <sub>2</sub> | Wskaźnik emisji CH <sub>4</sub> | Wskaźnik emisji 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             | 65.42                           | 0.020                           | 0.0002                           |
|   | 2.i.a.ON             | 73.84                           | 0.002                           | 0.004                            |

| Type of transport  | Stosowane oznaczenie | Wskaźnik emisji CO <sub>2</sub> | Wskaźnik emisji CH <sub>4</sub> | Wskaźnik emisji N <sub>2</sub> O |
|--|----------------------|---------------------------------|---------------------------------|----------------------------------|
|  | 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 statistic for year 1989 does not contain activity data concerning consumption of non-energy products for all economy sectors. For that reason classification is based on total consumption of non-energy products in year 1989 [GUS 1991a] and four-years averages (from years 1996-1999) of shares energy consumption of non-energy products in each sector in proportion to total domestic consumption. Based on these calculations, for each subcategories IPCC, the following shares of energy consumption of non-energy products have been estimated: 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. When comparing the results the difference in energy consumption is 4.1% and in CO<sub>2</sub> emissions –1.7% [Radwański 2006a]. This means that using reference approach CO<sub>2</sub> emissions from fuel combustion were higher by almost 2% comparing to the sectoral approach (“bottom–up”). 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).

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

#### 3.2.2.1. Fugitive emissions from fuels – coal mining (CRF 1.B1.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. For the year 1999 annual emissions for one of closed mines were estimated what allowed to calculate emission factor from this source relating to coal mined.

The newest emission factors were estimated by [Kwarciański 2005] based on detail data and measurements made in 2003. For the domestic inventory purposes emissions factors were calculated for 1 tone coal mined. The set of Polish emissions factors are presented in table 3.5.

Table 3.5. Methane emission factors analysis

| Emissions sources     | [Gawlik et al. 1994]                     |  | [Gawlik i Grzybek 2001]                  |  | [Kwarciański et al 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                                   |

Finally for the base year inventory (1988) the following data and references for estimating emission factors were used:

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

Table 3.6 contains the data on coal mining as well as methane captured and used for 1988. Emission from de-methane systems stands as a difference between methane capture and use.

Table 3.6. Data relating to coal mining and methane captured and used for 1988

| Coal mining | Methane capture    | Methane use        | Emission from methane capture systems |                     |                    |
|-------------|--------------------|--------------------|---------------------------------------|---------------------|--------------------|
| mln Mg      | mln m <sup>3</sup> | mln m <sup>3</sup> | mln m <sup>3</sup>                    | mln Nm <sup>3</sup> | Gg CH <sub>4</sub> |
| 191.6       | 280.4              | 205.9              | 74.5                                  | 72.04               | 48.27              |

*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, 1990] 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 3.7 have been taken from domestic case study [Steczko 1994]. Activity data come from energy statistics [GUS 1990a].

Table. 3.7. 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 1990a]:

|              |    |       |
|--------------|----|-------|
| production   | PJ | 6.480 |
| distribution | Gg | 14882 |

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. 3.8).

Table 3.8. 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 1990a] and are given in table 3.9.

Table 3.9. Activities for high-methane and nitrified natural gas systems.

| Highmethane gas system        |                     |         |
|-------------------------------|---------------------|---------|
| Gas production                | Gas production [PJ] | 68.405  |
| Gas processing                | Gas use [PJ]        | 351.415 |
| Gas transmission              | Gas use [PJ]        | 351.415 |
| Underground gas storage       | Gas use [PJ]        | 351.415 |
| Gas distribution              | Gas use [PJ]        | 351.415 |
| Nitrified natural gas system: |                     |         |
| Gas production                | Gas production [PJ] | 76.617  |
| Gas processing                | Gas use [PJ]        | 40.872  |
| Gas transmission              | Gas use [PJ]        | 40.872  |
| Gas distribution              | Gas use [PJ]        | 40.872  |

Emission factors for both gas systems were taken from country study [Steczko K. 1994] and are listed in tables 3.10 and 3.11.

Table 3.10. 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 3.11. 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 1.3%,
- 2.B.2 - Nitric Acid Production (N<sub>2</sub>O emission), share in total GHG emission 0.8%,
- 2.C.1 - Iron and Steel Production (CO<sub>2</sub> emission), share in total GHG emission 0.9%.

Share of these categories in total Poland's GHG emissions is 3.0%.

### 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b]. 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 56.63 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b]. 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 1991b] and emission factor is 0.2 kg CH<sub>4</sub> / Mg coke produced [EEA 2004].

#### 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 1991b]. 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 1991b]. 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:

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

where:

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

Additionally, N<sub>2</sub>O emissions from anaesthesiology were estimated in sub-sector 3.D.

## 6. Agriculture (CRF sector 4)

### 6.1 Key categories

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

- 4.A - Enteric Fermentation (CH<sub>4</sub> emission), share in total GHG emission 2.9%,
- 4.B - Manure Management (N<sub>2</sub>O emission), share in total GHG emission 1.7%,
- 4.D.1 - Direct Soil Emissions (N<sub>2</sub>O emission), share in total GHG emission 2.9%,
- 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 8.7%.

### 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 1989

| Livestock                | Population<br>[millions] | GE<br>Gross Energy Intake<br>[MJ/animal/day] | EF<br>Emission Factor<br>[kg CH <sub>4</sub> / animal / year] |
|--------------------------|--------------------------|--|---|
| 4.A Enteric Fermentation | 35.129                   | ---  | ---   |
| 1 Cattle                 | 10.733                   | ---  | ---   |
| a. Dairy cattle          | 4.994                    | 236.805                                      | 93.190  |
| b Non-dairy cattle       | 5.739                    | 104.4373                                     | 41.099  |
| 3 Sheep                  | 4.409                    | 18.128                                       | 7.972   |
| 4 Goats                  | 0.179                    | ---  | 5.000   |
| 6 Horses                 | 0.973                    | ---  | 18.000  |
| 8 Swine                  | 18.835                   | ---  | 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<br>[millions] | Vs<br>Volatile Solids Excreted<br>[kg dm /animal/ day] | EF<br>Emission Factor<br>[kg CH <sub>4</sub> / animal / year] |
|-----------------------|--------------------------|--|---|
| 4.B Manure Management | 301.106                  | ---  | ---   |
| 1 Cattle              | 10.733                   | ---  | ---   |
| a. Dairy cattle       | 4.994                    | 4.865  | 5.915   |
| b Non-dairy cattle    | 5.739                    | 1.750  | 2.598   |
| 3 Sheep               | 4.409                    | 0.362  | 0.168   |
| 4 Goats               | 0.179                    | 0.280  | 0.120   |
| 6 Horses              | 0.973                    | 1.720  | 1.390   |
| 8 Swine               | 18.835                   | 0.500  | 5.214   |
| 9 Poultry             | 265.976                  | 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     | 0.0282        | 0.7518                   | 0.2200                    |
| Non-dairy cattle | 0.0677        | 0.7523                   | 0.1800                    |
| Sheep            | ---           | 0.5000                   | 0.50                      |
| Goats            | ---           | 0.9000                   | 0.10                      |
| Horses           | ---           | 0.9000                   | 0.10                      |
| Swine            | 0.2230        | 0.7770                   | ---                       |
| 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   | 0.0282           | 9858.156   |
| 1.b. Non-dairy cattle | 50.0   | 0.0677           | 19426.515  |
| 3 Sheep               | 16.0   | --               | 0.000  |
| 4 Goats               | 25.0   | --               | 0.000  |
| 6 Horses              | 25.0   | --               | 0.000  |
| 8 Swine               | 20.0   | 0.2230           | 84016.493  |
| 9 Poultry             | 0.6  | 0.2000           | 31917.157  |

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   | 0.7518           | 262814.244                                       |
| 1.b. Non-dairy cattle | 50.0   | 0.7523           | 215872.485                                       |
| 3 Sheep               | 16.0   | 0.5000           | 35272.000  |
| 4 Goats               | 25.0   | 0.9000           | 4034.610   |
| 6 Horses              | 25.0   | 0.9000           | 21892.500  |
| 8 Swine               | 20.0   | 0.7770           | 292683.507                                       |
| 9 Poultry             | 0.6  | 0.8000           | 127668.629                                       |

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

| Animal Waste Management Systems | EF<br>Emission Factor<br>[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 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 study [Myczko 2001].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<br>N <sub>ex</sub><br>[kg/head/yr] | Fraction of manure<br>nitrogen per AWMS<br>[ % / 100 ] | Nitrogen excreted<br>in AWMS<br>[ kg N / year /<br>1000 ] | EF<br>Emission factor<br>for AWMS<br>[kg N <sub>2</sub> O-N/<br>kg N ] |
|-----------------------|---|--|---|--|
| 1.a. Dairy cattle     | 70.0  | 0.22   | 76907.600   |  |
| 1.b. Non-dairy cattle | 50.0  | 0.18   | 51651.000   |  |
| 3 Sheep               | 16.0  | 0.50   | 35272.000   |  |
| 4 Goats               | 25.0  | 0.10   | 448.290   |  |
| 6 Horses              | 25.0  | 0.10   | 2432.500  |  |
| 8 Swine               | --  | --   | --  |  |
| 9 Poultry             | --  | --   | --  |  |
|                       |   | total  | 166711.390  | 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 1989 in Poland. The basic equation for estimating a country's indirect N<sub>2</sub>O emissions:

$$N_{2O_{indirect} \rightarrow N} = N_{2O_{(G)} \rightarrow N} + N_{2O_{(L)} \rightarrow N},$$

where:

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

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

$N_2O_{(L)} \rightarrow N$  –  $N_2O$  produced 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  $N_2O$  formation. According to this methodology the amount of N applied to soils is equal to the total amount of synthetic fertiliser nitrogen applied to soils plus the total amount of animal manure nitrogen excreted in country. Those values have to be multiplied by appropriate volatilisation factors. This sum is then multiplied by an emission factor (table 6.7). Calculations were made according to the following equation:

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

where:

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

$N_{\text{FERT}}$  – 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  $N_2O$  emissions from atmospheric deposition of N on soils and water surfaces, default value.

Table 6.7. Estimation of indirect emissions of  $N_2O$ –N from atmospheric deposition

| $N_{\text{fert}}$<br>[Gg/year] | $\text{Frac}_{\text{GASF}}$<br>[kg N/kg N] | $N_{\text{ex}}$<br>[kg N/year/1000] | $\text{Frac}_{\text{GASM}}$<br>[kg N/kg N] | EF<br>[kg $N_2O$ -N/kg N] | $N_2O_{(G)} \rightarrow N$<br>[Gg $N_2O$ -N] |
|--------------------------------|--|-------------------------------------|--|---------------------------|--|
| 1 520                          | 0.1  | 166 711.39                          | 0.2  | 0.01                      | 1.85   |

#### 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  $N_2O$ . To estimate the amount of applied N that leaches or runs off, the total amount of synthetic fertiliser nitrogen and the total amount of animal N excretion must be summed and then multiplied by a fraction of N input, that is lost through leaching and runoff. Then it must be multiplied by an appropriate emission factor (table 6.8). Calculations were made according to the following equation:

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

where:

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

$N_{FERT}$  – total amount of synthetic nitrogen fertiliser applied to soils, this value is taken from [GUS 1991],

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

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

EF – emission factor for  $N_2O$  emissions for leaching/runoff, default value.

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

Table 6.8. Estimation of indirect emissions of  $N_2O-N$  from nitrogen leaching and run-off

| $N_{fert}$<br>[Gg/year] | $N_{ex}$<br>[kgN/year /1000] | $Frac_{LEACH}$<br>[kg N/kg N] | EF<br>[kgN <sub>2</sub> O-N/kg N] | $N_2O_{(L) \rightarrow N}$<br>[GgN <sub>2</sub> O-N] |
|-------------------------|------------------------------|-------------------------------|-----------------------------------|--|
| 1520                    | 166711.39                    | 0.3                           | 0.025                             | 12.650   |

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

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

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

$CH_4$  and  $N_2O$  emissions from burning of agricultural residues in fields were estimated based on methodology described in [IPCC 1997]. For domestic purposes there were selected 38 crops containing cereals, pulses, tuber and root, oil-bearing plants, vegetables and fruits [Łoboda *et al* 1994] which residues could be burned on fields. Activity data concerning crop production was taken from [GUS 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  $CH_4$  and  $N_2O$  emission estimation from field burning of agriculture residues

| Crops                   | Residue to crop ratio | Dry matter fraction | Fraction burned in fields | Fraction oxidised | Carbon fraction of residue | N / C | Aggregated emission factors |         |
|-------------------------|-----------------------|---------------------|---------------------------|-------------------|----------------------------|-------|-----------------------------|---------|
|                         |                       |                     |                           |                   |                            |       | $CH_4$                      | $N_2O$  |
|                         |                       |                     |                           |                   |                            |       | [Gg/Gg]                     | [Gg/Gg] |
| wheat                   | 1.45                  | 0.86                | 0.005                     | 0.90              | 0.4853                     | 0.014 | 0.0032                      | 0.0001  |
| rye                     | 1.60                  | 0.87                | 0.005                     | 0.90              | 0.4800                     | 0.011 | 0.0032                      | 0.0001  |
| barley                  | 1.25                  | 0.86                | 0.005                     | 0.90              | 0.4567                     | 0.015 | 0.0030                      | 0.0001  |
| oats                    | 1.50                  | 0.89                | 0.004                     | 0.90              | 0.4700                     | 0.016 | 0.0031                      | 0.0001  |
| triticale               | 1.50                  | 0.86                | 0.005                     | 0.90              | 0.4853                     | 0.013 | 0.0032                      | 0.0001  |
| cereal mixed            | 1.40                  | 0.87                | 0.004                     | 0.90              | 0.4730                     | 0.015 | 0.0032                      | 0.0001  |
| buckwheat & millet      | 1.70                  | 0.86                | 0.002                     | 0.90              | 0.4500                     | 0.020 | 0.0030                      | 0.0001  |
| maize                   | 1.30                  | 0.50                | 0.002                     | 0.90              | 0.4709                     | 0.020 | 0.0031                      | 0.0001  |
| edible pulses           | 1.50                  | 0.88                | 0.001                     | 0.90              | 0.4500                     | 0.040 | 0.0030                      | 0.0002  |
| feed pulses             | 2.00                  | 0.85                | 0.001                     | 0.90              | 0.4500                     | 0.045 | 0.0030                      | 0.0002  |
| potatoes                | 0.30                  | 0.25                | 0.100                     | 0.85              | 0.4226                     | 0.048 | 0.0028                      | 0.0002  |
| rape                    | 2.35                  | 0.87                | 0.030                     | 0.90              | 0.4500                     | 0.015 | 0.0030                      | 0.0001  |
| other oil-bearing crops | 3.50                  | 0.87                | 0.030                     | 0.90              | 0.4500                     | 0.015 | 0.0030                      | 0.0001  |

| 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]          |
| 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 1989 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 1989 (and comparing to 1988) 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 1988 and 1989 [IPCC 2003]

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | 1988                                       |                 |                  | 1989                                       |                 |                  |
|---|--|-----------------|------------------|--|-----------------|------------------|
|   | Net CO <sub>2</sub> emissions/<br>removals | CH <sub>4</sub> | N <sub>2</sub> O | Net CO <sub>2</sub> emissions/<br>removals | CH <sub>4</sub> | N <sub>2</sub> O |
|   | (Gg)                                       |                 |                  | (Gg)                                       |                 |                  |
| Table 3.1. 5. Total Land-Use Categories   | -32 934.72                                 | 0.356           | 0.002            | -35 492.10                                 | 0.185           | 0.001            |
| 5A. Forest Land                           | -42 705.20                                 |                 |                  | -43 078.01                                 |                 |                  |
| 1. Forest Land remaining Forest Land      | IE   |                 |                  | IE   |                 |                  |
| 2. Land converted to Forest Land          | 8 165.26                                   |                 |                  | 6 889.89                                   |                 |                  |
| 5B. Cropland                              | IE   |                 |                  | IE   |                 |                  |
| 1. Cropland remaining Cropland            | IE   |                 |                  | IE   |                 |                  |
| Table 3.2. 2. Land converted to Cropland  | 4 530.69                                   |                 |                  | 3 823.02                                   |                 |                  |
| 5C. Grassland                             | IE   |                 |                  | IE   |                 |                  |
| 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             | -2 925.46                                  |                 |                  | -3 127.00                                  |                 |                  |
| 5E. Settlements                           | IE   |                 |                  | IE   |                 |                  |
| 1. Settlements remaining Settlements      | IE   | 0.249           | 0.002            | IE   | 0.129           | 0.001            |
| 2. Land converted to Settlements          | IE   |                 |                  | IE   |                 |                  |
| 5F. Other Land                            | IE   |                 |                  | IE   |                 |                  |
| 1. Other Land remaining Other Land        | IE   | 0.107           | 0.001            | IE   | 0.055           | 0.000            |
| 2. Land converted to Other Land           | NE   | NE              | NE               | NE   | NE              | NE               |
| 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 1988 and 1989 [IPCC 1997]

| Greenhouse gas source and sink categories            | 1988                      |                          |   |                 |                  | 1989                      |                          |   |                 |                  |
|--|---------------------------|--------------------------|---|-----------------|------------------|---------------------------|--------------------------|---|-----------------|------------------|
|  | 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                        |                          |   |                 |                  |
| Table 3.3. 5. Total Land-Use Change and Forestry     | 53 891.01                 | -86 825.73               | -32 934.72                              | 0.356           | 0.002            | 48 956.47                 | -84 448.56               | -35 492.10                              | 0.185           | 0.001            |
| 5A. Changes in Forest and Other Woody Biomass Stocks | 43 380.28                 | -67 089.45               | -23 709.17                              |                 |                  | 40 469.12                 | -67 491.18               | -27 022.07                              |                 |                  |
| 1. Tropical Forests                                  |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| 2. Temperate Forests                                 | 43 380.28                 | -67 089.45               | -23 709.17                              |                 |                  | 40469.12                  | -67491.18                | -27 022.07                              |                 |                  |
| 3. Boreal Forests                                    |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| 4. Grasslands/Tundra                                 |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| 5. Other (please specify)                            |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| Harvested Wood                                       |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| 5B. Forest and Grassland Conversion                  | 114.60                    |                          | 114.60                                  |                 |                  | 74.25                     |                          | 74.25                                   |                 |                  |
| 1. Tropical Forests                                  |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| 2. Temperate Forests                                 | 114.6                     |                          |   | 0.356           | 0.002            | 74.2                      |                          |   | 0.155           | 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 | 10 396.13                 | -19 736.28               | -9 340.15                               |                 |                  | 8 413.10                  | -16 957.38               | -8 544.28                               |                 |                  |
| Cultivation of Mineral Soils                         | 10 396.13                 |                          | 10 396.13                               |                 |                  | 8 413.10                  |                          | 8 413.10                                |                 |                  |
| Cultivation of Organic Soils                         |                           |                          |   |                 |                  |                           |                          |   |                 |                  |
| Liming of Agricultural Soils                         |                           | 2 299.8                  | 2 299.8                                 |                 |                  |                           | 2 299.8                  | 2 299.81                                |                 |                  |
| Forest Soils   |                           | -18 996.03               | -18 996.03                              |                 |                  |                           | -16 055.94               | -16 055.94                              |                 |                  |
| Other Land (please specify)                          |                           | -3 040.06                | -3 040.06                               |                 |                  |                           | -3 201.25                | -3 201.25                               |                 |                  |
| 5E. Other (please specify)                           |                           |                          |   |                 |                  |                           |                          |   |                 |                  |

According to calculation for 1989, Sector 5. Land-Use Change and Forestry, was net CO<sub>2</sub> sink. Removals/emissions balance increased from 32 935 Gg CO<sub>2</sub> in 1988 to 35 492 Gg CO<sub>2</sub> in 1989 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 1989 net CO<sub>2</sub> removals increased to 27 thousand Gg CO<sub>2</sub> from about 24 thousand Gg CO<sub>2</sub> in 1988. This change was caused by harvest of thick decrease (about 1,7 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 1988 this category was a net CO<sub>2</sub> emissions and accounted for about 74 Gg CO<sub>2</sub>. Net emission in year 1989 was lower than in 1988 and it was caused by lessening forest area transmitted into non-forest tasks.

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

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

| Compound         | Ratio |         |             |
|------------------|-------|---------|-------------|
| CH <sub>4</sub>  | 0.012 | default | [IPCC 1997] |
| CO               | 0.060 | default | [IPCC 1997] |
| N <sub>2</sub> O | 0.007 | default | [IPCC 1997] |
| NO <sub>x</sub>  | 0.121 | default | [IPCC 1997] |

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

In this category emission of other than CO<sub>2</sub> GHGs is reported from forest fires only. Assumption is made that woody biomass is not burnt entirely during fires (only canopies and underwood are damaged) so if there is a need for moving out damaged or dead woods it is included into total wood harvest. Controlled burning of forests is not practiced in Poland.

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

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

#### 7.2.4. CO<sub>2</sub> Emissions and Removals from Soil (old CRF 5.D)

GHG balance in this category is a net sink. It is mainly caused by afforestation of agriculture lands. In 1988 net CO<sub>2</sub> sink was about 8 544 Gg CO<sub>2</sub>.

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 1989

| Land-use/ management system | Soil type           | Carbon in soils (Mg C/ha) | Area (Mha) |
|-----------------------------|---------------------|---------------------------|------------|
| Forest management           | High Activity Soils | 3.510                     | 3.515      |
|                             | Low Activity Soils  | 1.684                     | 1.686      |
|                             | Sandy               | 3.297                     | 3.302      |
|                             | Wetland             | 0.372                     | 0.373      |
| Sum                         |                     |                           | 8.876      |
| Grassland/Rangeland         | High Activity Soils | 0.571                     | 0.572      |
|                             | Low Activity Soils  | 1.687                     | 1.690      |
|                             | Sandy               | 1.234                     | 1.236      |
|                             | Wetland             | 0.419                     | 0.419      |
| Sum                         |                     |                           | 3.918      |
| Agricultural crops          | High Activity Soils | 4.145                     | 4.139      |
|                             | Low Activity Soils  | 5.554                     | 5.546      |
|                             | Sandy               | 2.864                     | 2.860      |
|                             | Wetland             | 1.668                     | 1.665      |
| Sum                         |                     |                           | 14.209     |
| Other land                  | High Activity Soils | 0.932                     | 0.933      |
|                             | Low Activity Soils  | 1.751                     | 1.753      |
|                             | Sandy               | 1.101                     | 1.102      |
|                             | Wetland             | 0.478                     | 0.478      |
| Sum                         |                     |                           | 4.266      |
| 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:

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

where:

$M_{\text{limestone}}$  - annual amount of sold calcic limestone [Gg/yr],

$M_{\text{dolomite}}$  - annual amount of sold calcic dolomite [Gg/yr],

$EF_{\text{limestone}}$  - emission factor for limestone – 0.120,

$EF_{\text{dolomite}}$  - emission factor for dolomite – 0.122.

Domestic statistic publications contain only data of use of lime fertilizers in pure nutrient (CaO) [GUS 1989a], that it was necessary to convert these data into actual use of fertilizers [Radwański 2006b]. It was assumed that lime – magnesium fertilizers ( $\text{CaMg}(\text{CO}_3)_2$ ) contains 89,1% of  $\text{CaCO}_3$  and 10,9% of  $\text{MgCO}_3$ . Carbon (C) is converted to carbon-dioxide ( $\text{CO}_2$ ) by the conversion factor 44/12.

## 8. Waste (CRF sector 6)

### 8.1 Key categories

From sector 6 only one category have been identified as key source:

- 6.A - Solid Waste Disposal on Land ( $\text{CH}_4$  emission), share in total GHG emission 0.8%,
- 6.B - Solid Waste Disposal on Land ( $\text{CH}_4$  emission), share in total GHG emission 1.2%.

Share of these categories in total Poland's GHG emissions is 2.0%.

### 8.2 Methodological issues

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

The methane emissions from solid waste disposals in 1988 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  $\text{CH}_4$  is diminished by recapturing of this gas.

The following indicators were used for estimation of  $\text{CH}_4$  emissions:

- DOC – degradable organic carbon in the year of deposition (table 8.1, default value [IPCC 2006])
- $\text{DOC}_f$  – fraction of DOC that can decompose (fraction) (table 8.1, default value [IPCC 2006])
- MCF –  $\text{CH}_4$  correction factor for aerobic decomposition in the year of deposition (table 8.2, default value [IPCC 2006])
- OX – Oxidation Factor reflecting the amount of  $\text{CH}_4$  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  $\text{CH}_4$  by volume, in generated landfill gas (fraction) [Steczko 2001] (table 8.3).
- R – methane recovery was assumed 0 because in 1970-1988 there was no methane recovery.

Table 8.1. DOC and DOC<sub>f</sub> 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 <sub>f</sub>                |           | 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<sub>4</sub> emissions from solid waste disposals contain:

- Population – number of population was taken from [GUS 2003]
- Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. In domestic statistics data were given in dam<sup>3</sup>. To recalculate data into Gg a conversion factor was used. According to GUS this conversion factor is 0.25 t/m<sup>3</sup>.

Table 8.4. Data sources for amount of municipal waste

| year | MSW in Gg | Source        |
|------|-----------|---------------|
| 1970 | 4113.98   | GUS 1987      |
| 1971 | 4624.65   | interpolation |
| 1972 | 5135.31   | interpolation |
| 1973 | 5645.98   | interpolation |
| 1974 | 6156.64   | GUS 1974      |
| 1975 | 6788.96   | GUS 1986      |
| 1976 | 7397.99   | interpolation |
| 1977 | 8007.03   | GUS 1981a     |
| 1978 | 8702.83   | GUS 1981a     |
| 1979 | 9052.63   | GUS 1981a     |
| 1980 | 9868.72   | GUS 1986      |
| 1981 | 10014.42  | GUS 1986      |



|      |          |           |
|------|----------|-----------|
| 1982 | 10329.07 | GUS 1986  |
| 1983 | 10541.91 | GUS 1986  |
| 1984 | 10864.54 | GUS 1986  |
| 1985 | 11086.95 | GUS 1986  |
| 1986 | 11546.86 | GUS 1987  |
| 1987 | 11877.45 | GUS 1989b |
| 1988 | 12084.18 | GUS 1989b |
| 1989 | 12000.95 | GUS 1990d |

RS – GUS Statistical Yearbook

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 – OS 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)

The activity data (wastewater output from individual industry sectors and fraction of treated wastewater) for CH<sub>4</sub> emission estimation were taken from [GUS 1991d]. Methane emission was estimated based on Biochemical Oxygen Demand (BOD) with default values of BOD parameters for all industry sectors. 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-metalic 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 estimated based on methodology [IPCC 1997] and the data on population connected to sewage treatment plants taken from [GUS 1991d]. Organic load in biochemical oxygen demand per person is the default value, which is equal to 60 g BOD/person/day [IPCC 2000]. Fraction of BOD that readily settles and is removed as sludge was taken from [Bernacka 2005] and its value is 0.712. The emission factors calculated in 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

Authors of this study applied default value (0.6 kg CH<sub>4</sub> / kg BOD) of maximum methane producing capacity for estimation of sludge and wastewater emission factors. Fractions of sludge anareobically degraded with and without methane recovery are estimated in [Bernacka 2006]. These value are as follow: fractions of sludge anareobically degraded – 63.9% of which with methane recovery – 23.7%. The same study is the source of data on percentage of wastewater anareobically treated which was estimated as 10%.

N<sub>2</sub>O emission from humane sewage is calculated according to default method [IPCC 1997]. Population of country and value of protein consumption per capita per year are taken from [GUS 1991]. Default values are 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)

CO<sub>2</sub> emission from industrial and medical waste incineration and N<sub>2</sub>O emission from industrial waste incineration were assessed based on the default emission factors [IPCC 2000]. There are no activity data on waste incineration in public statistics for 1989. The activity data for incineration of medical waste was based on expert estimation and number of hospital beds used in 1989 [GUS 1991]. The estimation of the amount of incinerated industrial waste was based on industrial waste production [GUS 1991d]. No municipal waste incineration occurred in 1989.

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## **ANNEXES**

## Annex 1. Key sources

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

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

- Stationary combustion Solid Fuels,
- Stationary combustion Liquid Fuels,
- 1. B. 1. a. Coal Mining and Handling.

Emission from these sources made up 74.3% 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 74.01% of the total GHG emissions. Combustion of solid fuels in stationary sources alone, made up 66.8% of the total GHG emissions.

The most important source categories in level assessment are:

- Stationary combustion Solid Fuels,
- 6.B. Wastewater Handling,
- 4.D.1. Direct Soil Emissions.

Share of these sources in national total made up 70.96%.

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>  | 380499.31             | 0.6683           | 0.67             |
| 2  | 1.A.1, 2, 4, 5.a | Stationary combustion Liquid Fuels    | CO <sub>2</sub>  | 25396.87              | 0.0446           | 0.71             |
| 3  | 1.B.1.a.         | 1. B. 1. a. Coal Mining and Handling  | CH <sub>4</sub>  | 17135.16              | 0.0301           | 0.74             |
| 4  | 1.A.3.b          | 1.A.3.b Transport Road Transportation | CO <sub>2</sub>  | 16711.60              | 0.0293           | 0.77             |
| 5  | 4.D.1            | 4.D.1. Direct Soil Emissions          | N <sub>2</sub> O | 16516.01              | 0.0290           | 0.80             |
| 6  | 4.A              | 4.A. Enteric Fermentation             | CH <sub>4</sub>  | 16444.54              | 0.0289           | 0.83             |
| 7  | 1.A.1, 2, 4, 5.a | Stationary combustion Gaseous Fuels   | CO <sub>2</sub>  | 15507.49              | 0.0272           | 0.86             |
| 8  | 4.B              | 4.B. Manure Management                | N <sub>2</sub> O | 9426.20               | 0.0166           | 0.87             |
| 9  | 2.A.1            | 2.A.1 Cement Production               | CO <sub>2</sub>  | 7212.45               | 0.0127           | 0.89             |
| 10 | 4.D.3            | 4.D.3. Indirect Soil Emissions        | N <sub>2</sub> O | 7065.40               | 0.0124           | 0.90             |
| 11 | 6.B              | 6.B. Wastewater Handling              | CH <sub>4</sub>  | 7011.41               | 0.0123           | 0.91             |
| 12 | 2.C1             | 2.C.1. Iron and Steel Production      | CO <sub>2</sub>  | 5302.87               | 0.0093           | 0.92             |
| 13 | 1.A.5.b          | 1.A.5.b Other Mobile                  | CO <sub>2</sub>  | 5124.45               | 0.0090           | 0.93             |
| 14 | 6.A              | 6.A. Solid Waste Disposal on Land     | CH <sub>4</sub>  | 4542.18               | 0.0080           | 0.94             |
| 15 | 2.B.2            | 2.B.2. Nitric Acid Production         | N <sub>2</sub> O | 4362.60               | 0.0077           | 0.95             |
| 16 | 1.B.2.b.         | 1. B. 2. b. Natural Gas               | CH <sub>4</sub>  | 3995.71               | 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          | 380499.31             | 0.6683           | 0.0150           | 35.2890                   | 0.35             |
| 2  | 6.B              | 6.B. Wastewater Handling              | CH4        | 2170.23            | 7011.41               | 0.0123           | 0.0089           | 20.8803                   | 0.56             |
| 3  | 4.D.1            | 4.D.1. Direct Soil Emissions          | N2O        | 15747.10           | 16516.01              | 0.0290           | 0.0022           | 5.2720                    | 0.61             |
| 4  | 1.A.3.b          | 1.A.3.b Transport Road Transportation | CO2        | 16068.28           | 16711.60              | 0.0293           | 0.0020           | 4.7783                    | 0.66             |
| 5  | 2.C1             | 2.C.1. Iron and Steel Production      | CO2        | 6556.09            | 5302.87               | 0.0093           | 0.0019           | 4.5014                    | 0.71             |
| 6  | 4.D.3            | 4.D.3. Indirect Soil Emissions        | N2O        | 6276.40            | 7065.40               | 0.0124           | 0.0018           | 4.1550                    | 0.75             |
| 7  | 4.A              | 4.A. Enteric Fermentation             | CH4        | 15954.36           | 16444.54              | 0.0289           | 0.0017           | 4.1120                    | 0.79             |
| 8  | 1.B.1.a.         | 1. B. 1. a. Coal Mining and Handling  | CH4        | 18455.82           | 17135.16              | 0.0301           | 0.0014           | 3.2776                    | 0.82             |
| 9  | 1.A.1, 2, 4, 5.a | Stationary combustion Liquid Fuels    | CO2        | 26824.08           | 25396.87              | 0.0446           | 0.0011           | 2.6685                    | 0.85             |
| 10 | 1.A.3.c          | 1.A.3.c Transport Railways            | CO2        | 3355.49            | 2786.79               | 0.0049           | 0.0008           | 1.9944                    | 0.87             |
| 11 | 1.A.1, 2, 4, 5.a | Stationary combustion Gaseous Fuels   | CO2        | 15562.17           | 15507.49              | 0.0272           | 0.0007           | 1.7432                    | 0.89             |
| 12 | 2.A.1            | 2.A.1 Cement Production               | CO2        | 7028.18            | 7212.45               | 0.0127           | 0.0007           | 1.6767                    | 0.90             |
| 13 | 6.A              | 6.A. Solid Waste Disposal on Land     | CH4        | 4284.31            | 4542.18               | 0.0080           | 0.0007           | 1.6415                    | 0.92             |
| 14 | 4.B              | 4.B. Manure Management                | N2O        | 9335.10            | 9426.20               | 0.0166           | 0.0007           | 1.5730                    | 0.94             |
| 15 | 1.A.5.b          | 1.A.5.b Other Mobile                  | CO2        | 5049.93            | 5124.45               | 0.0090           | 0.0004           | 0.9584                    | 0.95             |
| 16 | 2.B.1.           | 2.B.1. Ammonia Production             | CO2        | 3516.60            | 3609.00               | 0.0063           | 0.0004           | 0.8398                    | 0.9536           |



## Annex 2. 1989 Energy balance data for main fuels

Energy balances in 1989 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<br>In national combustion processes | Brown coal         |                |
|--|--------------------|----------------|
|  | 10 <sup>3</sup> Mg | TJ             |
| <b>In</b>  | <b>71 816</b>      | <b>584 364</b> |
| From national sources  | 71 816             | 584 364        |
| 1) Indigenous production   | 71 816             | 584 364        |
| 2) Transformation output or return                                 | 0                  | 0              |
| 3) Stock decrease  | 0                  | 0              |
| Import   | 0                  | 0              |
| <b>Out</b>   | <b>71 816</b>      | <b>584 363</b> |
| National consumption   | 71 807             | 583 606        |
| 1) Transformation input  | 71 565             | 581 291        |
| a) input for secondary fuel production                             | 278                | 2 691          |
| b) fuel combustion   | 71 287             | 578 600        |
| 2) Direct consumption  | 242                | 2 315          |
| Non-energy use   | 4                  | 35             |
| Combusted directly   | 238                | 2 280          |
| <b>Combusted in Poland</b>   | <b>71 525</b>      | <b>580 880</b> |
| Stock increase   | 9                  | 71             |
| Export   | 0                  | 0              |
| Losses   | 0                  | 0              |
| Statistical differences  | 0                  | 686            |
| Net calorific value  | MJ/kg              | 8.12           |
| CO <sub>2</sub> Emission Factor                                    | kg/GJ              | 116.32         |

### Diesel oil consumption

| Evaluation of fuel consumption<br>In national combustion processes | Diesel oil         |                |
|--|--------------------|----------------|
|  | 10 <sup>3</sup> Mg | TJ             |
| <b>In</b>  | <b>6 234</b>       | <b>266 184</b> |
| From national sources  | 4 848              | 207 010        |
| 1) Indigenous production   | 0                  | 0              |
| 2) Transformation output or return                                 | 4 848              | 207 010        |
| 3) Stock decrease  | 0                  | 0              |
| Import   | 1 386              | 59 174         |
| <b>Out</b>   | <b>6 234</b>       | <b>266 183</b> |
| National consumption   | 6 059              | 258 719        |
| 1) Transformation input  | 32                 | 1 346          |
| a) input for secondary fuel production                             | 0                  | 0              |
| b) fuel combustion   | 32                 | 1 346          |
| 2) Direct consumption  | 6 027              | 257 373        |
| Non-energy use   | 7                  | 279            |
| Combusted directly   | 6 020              | 257 094        |
| <b>Combusted in Poland</b>   | <b>6 052</b>       | <b>258 440</b> |
| Stock increase   | 32                 | 1 385          |
| Export   | 140                | 5 957          |
| Losses   | 3                  | 122            |
| 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<br>In national combustion processes | Fuel oil           |                |
|--|--------------------|----------------|
|  | 10 <sup>3</sup> Mg | TJ             |
| <b>In</b>  | <b>4 450</b>       | <b>180 750</b> |
| From national sources  | 3 686              | 149 955        |
| 1) Indigenous production   | 0                  | 0              |
| 2) Transformation output or return                                 | 3 686              | 149 955        |
| 3) Stock decrease  | 0                  | 0              |
| Import   | 764                | 30 795         |
| <b>Out</b>   | <b>4 450</b>       | <b>180 749</b> |
| National consumption   | 4 090              | 165 409        |
| 1) Transformation input  | 1 878              | 76 453         |
| a) input for secondary fuel production                             | 0                  | 0              |
| b) fuel combustion   | 1 878              | 76 453         |
| 2) Direct consumption  | 2 212              | 88 956         |
| Non-energy use   | 61                 | 2 423          |
| Combusted directly   | 2 151              | 86 533         |
| <b>Combusted in Poland</b>   | <b>4 029</b>       | <b>162 986</b> |
| Stock increase   | 30                 | 1 204          |
| Export   | 587                | 23 657         |
| Losses   |                    | 2              |
| Statistical differences  | -257               | -9 523         |
| Net calorific value  | MJ/kg              | 40.45          |
| CO <sub>2</sub> Emission Factor                                    | kg/GJ              | 79.02          |

## High-methane natural gas consumption

| Evaluation of fuel consumption<br>In national combustion processes | High-methane natural gas       |                |
|--|--------------------------------|----------------|
|  | 10 <sup>6</sup> m <sup>3</sup> | TJ             |
| <b>In</b>  | <b>9 976</b>                   | <b>355 826</b> |
| From national sources  | 2 611                          | 89 555         |
| 1) Indigenous production   | 1 735                          | 60 113         |
| 2) Transformation output or return                                 | 876                            | 29 442         |
| 3) Stock decrease  | 0                              | 0              |
| Import   | 7 365                          | 266 271        |
| <b>Out</b>   | <b>9 975</b>                   | <b>355 825</b> |
| National consumption   | 9 353                          | 329 153        |
| 1) Transformation input  | 833                            | 29 403         |
| a) input for secondary fuel production                             | 252                            | 8 913          |
| b) fuel combustion   | 582                            | 20 490         |
| 2) Direct consumption  | 8 520                          | 299 750        |
| Non-energy use   | 2 715                          | 94 842         |
| Combusted directly   | 5 805                          | 204 908        |
| <b>Combusted in Poland</b>   | <b>6 387</b>                   | <b>225 398</b> |
| Stock increase   | 355                            | 12 677         |
| Export   | 1                              | 25             |
| Losses   | 266                            | 7 715          |
| Statistical differences  |                                | 6 255          |
| Net calorific value  | MJ/m <sup>3</sup>              | 35.29          |
| CO <sub>2</sub> Emission Factor                                    | kg/GJ                          | 54.52          |

## Nitrified natural gas consumption

| Evaluation of fuel consumption<br>In national combustion processes | Nitrified natural gas          |               |
|--|--------------------------------|---------------|
|  | 10 <sup>6</sup> m <sup>3</sup> | TJ            |
| <b>In</b>  | <b>3 362</b>                   | <b>80 603</b> |
| From national sources  | 3 362                          | 80 603        |
| 1) Indigenous production   | 3 243                          | 76 617        |
| 2) Transformation output or return                                 | 119                            | 3 986         |
| 3) Stock decrease  | 0                              | 0             |
| Import   | 0                              | 0             |
| <b>Out</b>   | <b>3 363</b>                   | <b>80 604</b> |
| National consumption   | 3 316                          | 83 493        |
| 1) Transformation input  | 1 645                          | 42 037        |
| a) input for secondary fuel production                             | 1 621                          | 41 428        |
| b) fuel combustion   | 24                             | 609           |
| 2) Direct consumption  | 1 671                          | 41 456        |
| Non-energy use   | 0                              | 0             |
| Combusted directly   | 1 671                          | 41 456        |
| <b>Combusted in Poland</b>   | <b>1 695</b>                   | <b>42 065</b> |
| Stock increase   | 0                              | 0             |
| Export   | 0                              | 0             |
| Losses   | 47                             | 1 115         |
| Statistical differences  |                                | -4 004        |
| Net calorific value  | MJ/m <sup>3</sup>              | 24.82         |
| CO <sub>2</sub> Emission Factor                                    | kg/GJ                          | 55            |

## Coke consumption

| Evaluation of fuel consumption<br>In national combustion processes | Coke               |                |
|--|--------------------|----------------|
|  | 10 <sup>3</sup> Mg | TJ             |
| <b>In</b>  | <b>16 885</b>      | <b>467 080</b> |
| From national sources  | 16 885             | 467 080        |
| 1) Indigenous production   | 0                  | 0              |
| 2) Transformation output or return                                 | 16 885             | 467 080        |
| 3) Stock decrease  | 0                  | 0              |
| Import   | 0                  | 0              |
| <b>Out</b>   | <b>16 885</b>      | <b>467 080</b> |
| National consumption   | 13 707             | 373 151        |
| 1) Transformation input  | 3 594              | 100 254        |
| a) input for secondary fuel production                             | 2 769              | 78 719         |
| b) fuel combustion   | 825                | 21 535         |
| 2) Direct consumption  | 10 113             | 272 897        |
| Non-energy use   | 261                | 6 859          |
| Combusted directly   | 9 852              | 266 038        |
| <b>Combusted in Poland</b>   | <b>10 677</b>      | <b>287 573</b> |
| Stock increase   | 27                 | 747            |
| Export   | 3 151              | 84 646         |
| Losses   |                    |                |
| Statistical differences  |                    | 8 536          |
| Net calorific value  | MJ/kg              | 26.93          |
| CO <sub>2</sub> Emission Factor                                    | kg/GJ              | 114.75         |

### Annex 3. National energy balance 1989 [GUS, 1991a]

#### 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<br>MIARY             | POZYSKANIE               | IMPORT  | - W TYM<br>BUNKIER       | EKSPORT | ZMIANA<br>ZAPASÓW |
|----|---|------|--------------------------------|--------------------------|---------|--------------------------|---------|-------------------|
|    | SPECIFICATION   | YEAR | UNIT OF<br>MEASURE             | INDIGENOUS<br>PRODUCTION | IMPORT  | AMONG<br>WHICH<br>BUNKER | EXPORT  | STOCK<br>CHANGE   |
| 1  | ENERGIA OGÓŁEM<br>TOTAL ENERGY                          | 1989 | TJ                             | 4886251                  | 1094097 | 32492                    | 896527  | -33713            |
|    |   | 1990 |                                | 4126157                  | 1059399 | 47648                    | 915781  | 47210             |
| 2  | ENERGIA PIERWOTNA<br>PRIMARY ENERGY                     | 1989 | TJ                             | 4886251                  | 901585  | -                        | 729079  | -38661            |
|    |   | 1990 |                                | 4126157                  | 841867  | -                        | 705930  | 33543             |
| 3  | WĘGIEL KAMIENNY<br>HARD COAL                            | 1989 | tys.ton                        | 177633                   | 926     | -                        | 28943   | -1611             |
|    |   | 1990 | 10 <sup>3</sup> ton            | 147736                   | 560     | -                        | 28065   | 305               |
|    |   | 1989 | TJ                             | 4068685                  | 27458   | -                        | 729054  | -37215            |
|    |   | 1990 |                                | 3390004                  | 16469   | -                        | 704085  | 7051              |
| 4  | WĘGIEL BRUNATNY<br>LIGNITE                              | 1989 | tys.ton                        | 71816                    | -       | -                        | -       | 9                 |
|    |   | 1990 | 10 <sup>3</sup> ton            | 68069                    | -       | -                        | 202     | -                 |
|    |   | 1989 | TJ                             | 584364                   | -       | -                        | -       | 71                |
|    |   | 1990 |                                | 568896                   | -       | -                        | 1814    | -                 |
| 5  | ROPA NAFTOWA<br>CRUDE OIL                               | 1989 | tys.ton                        | 157                      | 14725   | -                        | -       | -344              |
|    |   | 1990 | 10 <sup>3</sup> ton            | 160                      | 13126   | -                        | -       | 440               |
|    |   | 1989 | TJ                             | 6480                     | 607766  | -                        | -       | -14195            |
|    |   | 1990 |                                | 6614                     | 541685  | -                        | -       | 17577             |
| 6  | GAZ ZIEMNY WYSOKOMETANOWY<br>HIGH - METHANE NATURAL GAS | 1989 | mln m <sup>3</sup>             | 2114                     | 7365    | -                        | 1       | 355               |
|    |   | 1990 | 10 <sup>6</sup> m <sup>3</sup> | 1260                     | 7836    | -                        | 1       | 250               |
|    |   | 1989 | TJ                             | 68405                    | 266271  | -                        | 25      | 12677             |
|    |   | 1990 |                                | 38150                    | 283594  | -                        | 32      | 8915              |
| 7  | GAZ ZIEMNY ZAAZOTOWANY<br>NITRIFIED NATURAL GAS         | 1989 | mln m <sup>3</sup>             | 3243                     | -       | -                        | -       | -                 |
|    |   | 1990 | 10 <sup>6</sup> m <sup>3</sup> | 2622                     | -       | -                        | -       | -                 |
|    |   | 1989 | TJ                             | 76617                    | -       | -                        | -       | -                 |
|    |   | 1990 |                                | 61409                    | -       | -                        | -       | -                 |
| 8  | TORF I DREWNO<br>PEAT AND WOOD                          | 1989 | tys. m <sup>3</sup>            | 3508                     | -       | -                        | -       | -                 |
|    |   | 1990 | 10 <sup>3</sup> m <sup>3</sup> | 2325                     | -       | -                        | -       | -                 |
|    |   | 1989 | TJ                             | 33326                    | -       | -                        | -       | -                 |
|    |   | 1990 |                                | 22088                    | -       | -                        | -       | -                 |
| 9  | ENERGIA WODY I WIATRU<br>HYDRO AND WOOD ENERGY          | 1989 | TJ                             | 15089                    | -       | -                        | -       | -                 |
|    |   | 1990 |                                | 12324                    | -       | -                        | -       | -                 |
| 10 | PALIWA ODPADOWE STAŁE<br>SOLID WASTE FUEL               | 1989 | TJ                             | 33285                    | 91      | -                        | -       | -                 |
|    |   | 1990 |                                | 26672                    | 119     | -                        | -       | -                 |
| 11 | ENERGIA POCHODNA<br>DERIVED ENERGY                      | 1989 | TJ                             | -                        | 192513  | 32492                    | 167448  | 4943              |
|    |   | 1990 |                                | -                        | 217533  | 47648                    | 205851  | 13666             |
| 12 | BRYKIETY Z WĘGLA KAMIENNEGO<br>HARD COAL BRIQUETTES     | 1989 | tys.ton                        | -                        | -       | -                        | -       | -                 |
|    |   | 1990 | 10 <sup>3</sup> ton            | -                        | -       | -                        | 1       | -38               |
|    |   | 1989 | TJ                             | -                        | -       | -                        | -       | -                 |
|    |   | 1990 |                                | -                        | -       | -                        | 23      | -884              |
| 13 | BRYKIETY Z WĘGLA BRUNATNEGO<br>LIGNITE BRIQUETTES (BKB) | 1989 | tys.ton                        | -                        | -       | -                        | -       | -                 |
|    |   | 1990 | 10 <sup>3</sup> ton            | -                        | -       | -                        | 25      | -                 |
|    |   | 1989 | TJ                             | -                        | -       | -                        | -       | -                 |
|    |   | 1990 |                                | -                        | -       | -                        | 444     | -                 |
| 14 | KOKS I PÓLKOKS<br>COKE AND SEMI-COKE                    | 1989 | tys.ton                        | -                        | -       | -                        | 3151    | 27                |
|    |   | 1990 | 10 <sup>3</sup> ton            | -                        | -       | -                        | 3662    | -                 |
|    |   | 1989 | TJ                             | -                        | -       | -                        | 84646   | 747               |
|    |   | 1990 |                                | -                        | -       | -                        | 101862  | -                 |
| 15 | GAZ CIEKLY<br>LIPUEFIED PETROLEUM GAS (LPG)             | 1989 | tys.ton                        | -                        | -       | -                        | -       | 0                 |
|    |   | 1990 | 10 <sup>3</sup> ton            | -                        | 2       | -                        | -       | -                 |
|    |   | 1989 | TJ                             | -                        | -       | -                        | -       | 0                 |
|    |   | 1990 |                                | -                        | 104     | -                        | -       | -                 |

| ZUŻYCIE<br>GLOBALNE<br>LUB<br>SALDO WYM.         | UZYSK<br>Z PRZEMIAN<br>LUB<br>ODZYSK         | ZUŻYCIE<br>OGÓŁEM    | ZUŻYCIE<br>NA WSAD<br>PRZEMIAN | ZUŻYCIE<br>BEZPOŚREDNIE | - W TYM<br>ZUŻYCIE<br>NIEENERGETY-<br>CZNE | STRATY<br>TRANSPORTU<br>I MAGA-<br>ZYNOWANIA | RÓŻNICE<br>BILANSOWE      | LP |
|--|--|----------------------|--------------------------------|-------------------------|--|--|---------------------------|----|
| GLOBAL<br>CONSUMPTION<br>OR EXCHANGE<br>BALANCES | TRANSFORMA-<br>TIONS OUTPUT<br>OR<br>RETURNS | TOTAL<br>CONSUMPTION | TRANSFORMA-<br>TIONS INPUT     | DIRECT<br>CONSUMPTION   | AMONG WHICH<br>NON-ENERGY<br>USE           | LOSSES<br>OF TRANSPORT<br>AND STORAGE        | STATISTICAL<br>DIFFERENCE |    |
| 5117535  | 2784309                                      | x                    | 4054273                        | 3727521                 | 133658                                     | 59368  | 60683                     | 1  |
| 4222565  | 2465179                                      | x                    | 3627725                        | 3025963                 | 110139                                     | 48326  | -14270                    |    |
| 5097418  | 33428  | x                    | 3784017                        | 1277175                 | 102881                                     | 8961   | 60693                     | 2  |
| 4228550  | 30338  | x                    | 3392553                        | 863664                  | 85906                                      | 8713   | -6042                     |    |
| 151227   | -  | 151227               | 116414                         | 34807                   | 9  | 6  | 0                         | 3  |
| 119926   | -  | 119926               | 100829                         | 19098                   | 14   | -  | 0                         |    |
| 3404303  | -  | 3404303              | 2463251                        | 883165                  | 305  | 132  | 57756                     |    |
| 2695338  | -  | 2695338              | 2201559                        | 506220                  | 453  | -  | -12442                    |    |
| 71807  | -  | 71807                | 71565                          | 242                     | 4  | -  | 0                         | 4  |
| 67867  | -  | 67867                | 67302                          | 566                     | 1  | -  | 0                         |    |
| 584293   | -  | 584293               | 581291                         | 2315                    | 35   | -  | 686                       |    |
| 567082   | -  | 567082               | 559135                         | 5526                    | 7  | -  | 2421                      |    |
| 15226  | -  | 15226                | 15226                          | -                       | -  | -  | 0                         | 5  |
| 12846  | -  | 12846                | 12846                          | 0                       | -  | -  | 0                         |    |
| 628441   | -  | 628441               | 628441                         | -                       | -  | -  | 0                         |    |
| 530722   | -  | 530722               | 530721                         | 1                       | -  | -  | 0                         |    |
| 9123   | 876  | 9999                 | 963                            | 8769                    | 2715                                       | 266  | 0                         | 6  |
| 8845   | 689  | 9534                 | 1068                           | 8229                    | 2298                                       | 238  | 0                         |    |
| 321974   | 29442  | 351415               | 32205                          | 305240                  | 94842                                      | 7715   | 6255                      |    |
| 312796   | 23212  | 336008               | 35714                          | 287584                  | 80552                                      | 6586   | 6124                      |    |
| 3243   | 119  | 3362                 | 1645                           | 1671                    | -  | 47   | 0                         | 7  |
| 2622   | 208  | 2829                 | 1272                           | 1469                    | 16   | 88   | 0                         |    |
| 76617  | 3986   | 80603                | 42037                          | 41456                   | -  | 1115   | -4004                     |    |
| 61409  | 7126   | 68535                | 32596                          | 35950                   | 393  | 2127   | -2137                     |    |
| 3508   | -  | 3508                 | 63                             | 3445                    | -  | -  | 0                         | 8  |
| 2325   | -  | 2325                 | 72                             | 2253                    | -  | -  | 0                         |    |
| 33326  | -  | 33326                | 597                            | 32729                   | -  | -  | 0                         |    |
| 22088  | -  | 22088                | 682                            | 21406                   | -  | -  | -                         |    |
| 15089  | -  | 15089                | 15089                          | -                       | -  | -  | 0                         | 9  |
| 12324  | -  | 12324                | 12324                          | -                       | -  | -  | -                         |    |
| 33375  | -  | 33375                | 21106                          | 12270                   | 7699                                       | -  | 0                         | 10 |
| 26791  | -  | 26791                | 19822                          | 6977                    | 4502                                       | -  | -9                        |    |
| 20117  | 2750881                                      | x                    | 258058                         | 2462543                 | 17051                                      | 50407  | -10                       | 11 |
| 5985   | 2434841                                      | x                    | 223666                         | 2173805                 | 13020                                      | 39613  | -8228                     |    |
| -  | 496  | 496                  | 194                            | 302                     | -  | -  | 0                         | 12 |
| 37   | 77   | 114                  | 104                            | 11                      | -  | -  | 0                         |    |
| -  | 11364  | 11364                | 4340                           | 7024                    | -  | -  | 0                         |    |
| 862  | 1759   | 2621                 | 2374                           | 247                     | -  | -  | 0                         |    |
| -  | 136  | 136                  | 18                             | 118                     | -  | -  | 0                         | 13 |
| -25  | 122  | 97                   | 8                              | 89                      | -  | -  | -                         |    |
| -  | 2396   | 2396                 | 323                            | 2073                    | -  | -  | 0                         |    |
| -444   | 2174   | 1730                 | 149                            | 1582                    | -  | -  | 0                         |    |
| -3178  | 16885  | 13707                | 3594                           | 10113                   | 261  | -  | 0                         | 14 |
| -3622  | 13671  | 10009                | 2984                           | 7024                    | 249  | -  | 0                         |    |
| -85393   | 467080                                       | 381687               | 100254                         | 272897                  | 6859                                       | -  | 8536                      |    |
| -101862  | 380642                                       | 278780               | 83423                          | 193948                  | 6425                                       | -  | 1409                      |    |
| 0  | 280  | 280                  | 12                             | 268                     | 99   | 0  | 0                         | 15 |
| 2  | 141  | 143                  | 11                             | 132                     | 88   | 0  | 0                         |    |
| 0  | 12823  | 12824                | 527                            | 12255                   | 4525                                       | 3  | 38                        |    |
| 104  | 6413   | 6516                 | 504                            | 6010                    | 4047                                       | 2  | 0                         |    |

| LP | NAZWA NOŚNIKA ENERGII  | ROK         | JEDNOSTKA<br>MIARY             | POZYSKANIE                       | IMPORT        | - W TYM<br>BUNKIER                | EKSPORT       | ZMIANA<br>ZAPASÓW       |
|----|--|-------------|--------------------------------|----------------------------------|---------------|-----------------------------------|---------------|-------------------------|
|    | <i>SPECIFICATION</i>   | <i>YEAR</i> | <i>UNIT OF<br/>MEASURE</i>     | <i>INDIGENOUS<br/>PRODUCTION</i> | <i>IMPORT</i> | <i>AMONG<br/>WHICH<br/>BUNKER</i> | <i>EXPORT</i> | <i>STOCK<br/>CHANGE</i> |
| 16 | BENZYNY<br><i>GASOLINE</i>   | 1989        | tys. ton                       | -                                | 1271          | 153                               | 24            | 39                      |
|    |  | 1990        | 10 <sup>3</sup> ton            | -                                | 1579          | 146                               | 30            | 190                     |
|    |  | 1989        | TJ                             | -                                | 55034         | 6606                              | 1021          | 1689                    |
|    |  | 1990        | -                              | -                                | 68377         | 6322                              | 1311          | 8232                    |
| 17 | OLEJE NAPĘDOWE<br><i>DIESEL OIL</i>                                    | 1989        | tys. ton                       | -                                | 1386          | 100                               | 140           | 32                      |
|    |  | 1990        | 10 <sup>3</sup> ton            | -                                | 1694          | 203                               | 200           | 171                     |
|    |  | 1989        | TJ                             | -                                | 59174         | 4267                              | 5957          | 1385                    |
|    |  | 1990        | -                              | -                                | 72340         | 8655                              | 8557          | 7304                    |
| 18 | OLEJE OPAŁOWE<br><i>FUEL OIL</i>                                       | 1989        | tys. ton                       | -                                | 764           | 536                               | 587           | 30                      |
|    |  | 1990        | 10 <sup>3</sup> ton            | -                                | 912           | 811                               | 983           | 0                       |
|    |  | 1989        | TJ                             | -                                | 30795         | 21620                             | 23657         | 1204                    |
|    |  | 1990        | -                              | -                                | 36769         | 32671                             | 39600         | 0                       |
| 19 | PRODUKTY NIEENERGETYCZNE<br><i>NON-ENERGY PRODUCTS</i>                 | 1989        | TJ                             | -                                | 3914          | -                                 | 15202         | -78                     |
|    |  | 1990        | -                              | -                                | 2184          | -                                 | 16735         | -985                    |
| 20 | GAZ RAFINERYJNY<br><i>REFINERY GAS</i>                                 | 1989        | tys. ton                       | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | 10 <sup>3</sup> ton            | -                                | -             | -                                 | -             | -                       |
|    |  | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 21 | GAZ KOKSOWNICZY<br><i>COKE OVEN GAS</i>                                | 1989        | mln m <sup>3</sup>             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | 10 <sup>6</sup> m <sup>3</sup> | -                                | -             | -                                 | -             | -                       |
|    |  | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 22 | GAZ MIEJSKI<br><i>TOWN GAS</i>   | 1989        | mln m <sup>3</sup>             | -                                | 12            | -                                 | -             | -                       |
|    |  | 1990        | 10 <sup>6</sup> m <sup>3</sup> | -                                | 12            | -                                 | -             | -                       |
|    |  | 1989        | TJ                             | -                                | 184           | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | 186           | -                                 | -             | -                       |
| 23 | GAZ CZADNICOWY I WYTLEWNY<br><i>BLAST FURNACE GAS</i>                  | 1989        | mln m <sup>3</sup>             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | 10 <sup>6</sup> m <sup>3</sup> | -                                | -             | -                                 | -             | -                       |
|    |  | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 24 | GAZ WIELKOPIECOWY<br><i>GAS MANUFACTURED FROM COAL</i>                 | 1989        | mln m <sup>3</sup>             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | 10 <sup>6</sup> m <sup>3</sup> | -                                | -             | -                                 | -             | -                       |
|    |  | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 25 | ENERGIA ELEKTRYCZNA<br><i>ELECTRICITY</i>                              | 1989        | GWh                            | -                                | 12059         | -                                 | 10268         | -                       |
|    |  | 1990        | -                              | -                                | 10437         | -                                 | 11478         | -                       |
|    |  | 1989        | TJ                             | -                                | 43413         | -                                 | 36965         | -                       |
|    |  | 1990        | -                              | -                                | 37574         | -                                 | 41319         | -                       |
| 26 | CIEPŁO<br>HEAT   | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 27 | <b>ENERGIA Z ODZYSKU</b><br><i>ENERGY FROM RETURNS</i>                 | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 28 | PALIWA ODPAD. CIEKŁE I GAZOWE<br><i>LIQUID AND GASEOUS WASTE FUELS</i> | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |
| 29 | CIEPŁO Z ODZYSKU<br><i>HEAT FROM RETURNS</i>                           | 1989        | TJ                             | -                                | -             | -                                 | -             | -                       |
|    |  | 1990        | -                              | -                                | -             | -                                 | -             | -                       |

| ZUŻYCIE<br>GLOBALNE<br>LUB<br>SALDO WYM.                   | UZYSK<br>Z PRZEMIAN<br>LUB<br>ODZYSK                   | ZUŻYCIE<br>OGÓŁEM            | ZUŻYCIE<br>NA WSAD<br>PRZEMIAN     | ZUŻYCIE<br>BEZPOŚREDNIE       | - W TYM<br>ZUŻYCIE<br>NIEENERGETY-<br>CZNE | STRATY<br>TRANSPORTU<br>I MAGA-<br>ZYNOWANIA   | RÓŻNICE<br>BILANSOWE              | LP |
|--|--|------------------------------|------------------------------------|-------------------------------|--|--|-----------------------------------|----|
| <i>GLOBAL<br/>CONSUMPTION<br/>OR EXCHANGE<br/>BALANCES</i> | <i>TRANSFORMA-<br/>TIONS OUTPUT<br/>OR<br/>RETURNS</i> | <i>TOTAL<br/>CONSUMPTION</i> | <i>TRANSFORMA-<br/>TIONS INPUT</i> | <i>DIRECT<br/>CONSUMPTION</i> | <i>AMONG WHICH<br/>NON-ENERGY<br/>USE</i>  | <i>LOSSES<br/>OF TRANSPORT<br/>AND STORAGE</i> | <i>STATISTICAL<br/>DIFFERENCE</i> |    |
| 1208   | 2974   | 4183                         | 341                                | 3837                          | 21   | 5  | 0                                 | 16 |
| 1359   | 2414   | 3773                         | 191                                | 3575                          | 18   | 7  | 0                                 |    |
| 52324  | 128791   | 181115                       | 14765                              | 166127                        | 896  | 224  | 0                                 |    |
| 58834  | 104531   | 163365                       | 8283                               | 154777                        | 764  | 305  | 0                                 |    |
| 1214   | 4848   | 6062                         | 32                                 | 6027                          | 7  | 3  | 0                                 | 17 |
| 1323   | 3974   | 5297                         | 27                                 | 5267                          | 6  | 3  | 0                                 |    |
| 51831  | 207010   | 258842                       | 1346                               | 257373                        | 279  | 122  | 0                                 |    |
| 56479  | 169702   | 226181                       | 1145                               | 224913                        | 254  | 123  | 0                                 |    |
| 147  | 3686   | 3833                         | 1878                               | 2212                          | 61   | 0  | -257                              | 18 |
| -70  | 3631   | 3561                         | 1910                               | 1895                          | 23   | 0  | -245                              |    |
| 5933   | 149955   | 155888                       | 76453                              | 88956                         | 2423                                       | 2  | -9523                             |    |
| -2831  | 146138   | 143307                       | 77154                              | 76143                         | 922  | 2  | -9992                             |    |
| -11210   | 157425   | 146215                       | 2178                               | 144005                        | -  | 32   | 0                                 | 19 |
| -13567   | 129300   | 115734                       | 1237                               | 114395                        | -  | 52   | 0                                 |    |
| -  | 251  | 251                          | 24                                 | 228                           | -  |  | 0                                 | 20 |
| -  | 179  | 179                          | 20                                 | 159                           | -  |  | 0                                 |    |
| -  | 14099  | 14099                        | 1327                               | 12772                         | -  |  | 0                                 |    |
| -  | 9475   | 9475                         | 1036                               | 8439                          | -  | -  | 0                                 |    |
| -  | 6752   | 6752                         | 462                                | 6104                          | 120  | 186  | 0                                 | 21 |
| -  | 5784   | 5784                         | 473                                | 5249                          | 32   | 63   | 0                                 |    |
| -  | 118472   | 118472                       | 8072                               | 106358                        | 2069                                       | 3266   | 775                               |    |
| -  | 101735   | 101735                       | 8319                               | 91485                         | 610  | 1113   | 818                               |    |
| 12   | 245  | 257                          | 1                                  | 248                           | -  | 8  | 0                                 | 22 |
| 12   | 165  | 177                          | 2                                  | 211                           | -  | -  | -36                               |    |
| 184  | 4292   | 4476                         | 24                                 | 4141                          | -  | 133  | 178                               |    |
| 186  | 2902   | 3088                         | 39                                 | 3510                          | -  | -  | -461                              |    |
| -  | 1555   | 1555                         | 88                                 | 1467                          | -  | -  | 0                                 | 23 |
| -  | 1106   | 1106                         | 31                                 | 1075                          | -  | -  | 0                                 |    |
| -  | 9082   | 9082                         | 613                                | 8484                          | -  | -  | -14                               |    |
| -  | 6509   | 6509                         | 205                                | 6306                          | -  | -  | -3                                |    |
| -  | 18702  | 18702                        | 6985                               | 11717                         | -  | -  | 0                                 | 24 |
| -  | 16949  | 16949                        | 6056                               | 10892                         | -  | -  | 0                                 |    |
| -  | 71785  | 71785                        | 26890                              | 44895                         | -  | -  | 0                                 |    |
| -  | 62969  | 62969                        | 22490                              | 40480                         | -  | -  | 0                                 |    |
| 1791   | 145467   | 147258                       | 2922                               | 131385                        | -  | 12951  | 0                                 | 25 |
| -1040  | 136311   | 135271                       | 2614                               | 122097                        | -  | 10560  | 0                                 |    |
| 6448   | 523682   | 530130                       | 10520                              | 472986                        | -  | 46624  | 0                                 |    |
| -3745  | 490721   | 486976                       | 9411                               | 439550                        | -  | 38015  | 0                                 |    |
| -  | 872625   | 872625                       | 10426                              | 862199                        | -  | -  | 0                                 | 26 |
| -  | 819869   | 819869                       | 7847                               | 812022                        | -  | -  | 0                                 |    |
| -  | 103581   | x                            | 12197                              | 91383                         | 13726                                      | -  | 0                                 | 27 |
| -  | 91761  | x                            | 11506                              | 80256                         | 11212                                      | -  | 0                                 |    |
| -  | 52824  | 52824                        | 12197                              | 40627                         | 13726                                      | -  | 0                                 | 28 |
| -  | 42405  | 42405                        | 11506                              | 30899                         | 11212                                      | -  | 0                                 |    |
| -  | 50757  | 50757                        | -                                  | 50757                         | -  | -  | -                                 | 29 |
| -  | 49357  | 49357                        | -                                  | 49357                         | -  | -  | -                                 |    |

## Annex 4. National energy balance 1989 – OECD

### Poland : 1989

| PRODUCTION<br>AND<br>USES OF ENERGY | Coal (TJ)        |                 |                              |                |               |                |                                      | Gas (TJ)        |                     |
|-------------------------------------|------------------|-----------------|------------------------------|----------------|---------------|----------------|--------------------------------------|-----------------|---------------------|
|                                     | Hard<br>Coal     | Brown<br>Coal   | Oven Coke<br>and<br>Gas Coke | Patent<br>Fuel | BKB           | Fuel<br>Wood   | Other<br>Non-<br>commercial<br>Fuels | Natural<br>Gas  | Gas<br>Works<br>Gas |
| Indigenous Production               | 4062554.5        | 584364.0        | 462795.4                     | 11364.0        | 2396.0        | 33326.0        | 32271.2                              | 150234.7        | 12226.3             |
| From Other Sources                  | 6129.4           |                 | 4284.6                       |                |               |                |                                      | 9289.5          | 483.8               |
| Imports                             | 27458.0          |                 |                              |                |               |                |                                      | 292898.1        | 202.0               |
| Exports                             | 729054.0         |                 | 84646.0                      |                |               |                |                                      | 27.5            |                     |
| International Marine Bunkers        |                  |                 |                              |                |               |                |                                      |                 |                     |
| Stock Changes                       | 37215.0          | -71.0           | -747.0                       |                |               |                |                                      | -13945.0        |                     |
| <b>DOMESTIC SUPPLY</b>              | <b>3404302.9</b> | <b>584293.0</b> | <b>381687.0</b>              | <b>11364.0</b> | <b>2396.0</b> | <b>33326.0</b> | <b>32271.2</b>                       | <b>438449.8</b> | <b>12912.1</b>      |
| Returns to Supply                   |                  |                 |                              |                |               |                | 44725.5                              |                 |                     |
| Transfers                           |                  |                 |                              |                |               |                |                                      | -1918.0         | 2001.2              |
| Total Requirements                  | 3404302.9        | 584293.0        | 381687.0                     | 11364.0        | 2396.0        | 33326.0        | 76996.7                              | 436531.8        | 14913.3             |
| Statistical Difference              | 57756.0          | 688.0           | 8535.9                       | 0.0            | 0.0           | 0.0            | 0.0                                  | 2476.0          | 180.0               |
| <b>TRANSFORMATION SECTOR</b>        | <b>2350020.5</b> | <b>579418.8</b> | <b>91340.4</b>               | <b>3810.9</b>  | <b>224.7</b>  | <b>0.0</b>     | <b>15181.9</b>                       | <b>28615.0</b>  | <b>637.0</b>        |
| Patent Fuel Plants                  | 10537.5          | 2433.4          |                              |                |               |                |                                      |                 |                     |
| Coke Ovens                          | 639139.6         |                 | 5770.2                       |                |               |                | 2.1                                  | 1362.4          |                     |
| Gas Works                           | 25314.1          | 257.8           | 1163.8                       |                |               |                |                                      | 3910.6          |                     |
| Blast Furnaces                      |                  |                 | 71784.8                      |                |               |                |                                      |                 |                     |
| Oil Refineries                      |                  |                 |                              |                |               |                |                                      |                 |                     |
| Autoproducers of Electricity        | 308922.9         | 1851.2          |                              |                |               |                | 4520.0                               | 2176.6          | 446.8               |
| Public Plants for CHP               | 977123.8         | 571023.2        |                              |                |               |                | 61.5                                 | 179.0           |                     |
| Heating Plants                      | 388982.6         | 3853.2          | 12621.6                      | 3810.9         | 224.7         |                | 10598.3                              | 20986.4         | 190.2               |
| Non-Specified                       |                  |                 |                              |                |               |                |                                      |                 |                     |
| <b>ENERGY SECTOR</b>                | <b>10902.0</b>   | <b>59.0</b>     | <b>893.0</b>                 | <b>0.9</b>     | <b>24.0</b>   | <b>1.1</b>     | <b>19916.7</b>                       | <b>17623.0</b>  | <b>8.4</b>          |
| Coal Mines                          | 5003.6           | 59.0            | 143.6                        |                | 23.9          |                | 1.1                                  | 585.0           |                     |
| Oil and Gas Extraction              | 49.4             |                 | 11.7                         |                |               |                |                                      | 11989.0         |                     |
| Patent Fuel Plants                  | 283.5            |                 |                              |                |               |                |                                      |                 |                     |
| Coke Ovens                          |                  |                 |                              |                |               |                | 120.1                                |                 |                     |
| Gas Works                           | 211.1            |                 | 640.2                        |                |               |                |                                      | 2411.0          | 8.4                 |
| Oil Refineries                      | 42.0             |                 | 1.2                          |                |               |                | 19795.5                              | 2636.3          |                     |
| Electric Plants                     |                  |                 |                              |                |               |                |                                      |                 |                     |
| Pumped Storage                      |                  |                 |                              |                |               |                |                                      |                 |                     |
| Non-Specified                       | 5312.4           |                 | 96.3                         | 0.9            | 0.1           | 1.1            |                                      | 1.7             |                     |
| Distribution Losses                 | 132.0            |                 |                              |                |               |                |                                      | 9713.0          | 146.3               |
| <b>FINAL CONSUMPTION</b>            | <b>985492.4</b>  | <b>4127.2</b>   | <b>280917.7</b>              | <b>7552.2</b>  | <b>2147.3</b> | <b>33324.9</b> | <b>41898.1</b>                       | <b>378104.8</b> | <b>13941.6</b>      |
| <b>INDUSTRY SECTOR</b>              | <b>192875.4</b>  | <b>987.3</b>    | <b>164452.6</b>              | <b>173.6</b>   | <b>92.2</b>   | <b>726.2</b>   | <b>16623.3</b>                       | <b>140277.1</b> | <b>9255.2</b>       |
| Iron and Steel                      | 1376.5           |                 | 111960.0                     |                |               |                | 3345.2                               | 69685.0         | 3542.0              |
| Chemical                            | 8895.9           | 39.9            | 4160.1                       | 4.4            |               | 2.4            | 2996.6                               | 6870.2          |                     |
| <i>of which: Petrochemical</i>      | 0.7              |                 | 2.5                          |                |               |                |                                      |                 |                     |
| Non-Ferrous Metals                  | 1303.7           |                 | 8322.3                       |                |               |                | 718.9                                | 6018.1          | 374.1               |
| Non-Metallic Minerals               | 100764.0         | 174.3           | 18247.6                      | 11.0           | 21.6          | 134.4          | 2235.8                               | 30927.6         | 4138.0              |
| Transport Equipment                 | 4448.6           | 3.2             | 1577.9                       | 3.5            |               | 4.9            | 10.2                                 | 3663.0          | 34.0                |
| Machinery                           | 15557.3          | 44.2            | 10806.9                      | 57.9           | 2.5           | 57.0           | 30.4                                 | 13352.9         | 1057.0              |
| Mining and Quarrying                | 4493.1           | 2.2             | 1741.3                       | 0.1            | 52.9          | 0.9            | 873.2                                | 6901.4          | 54.0                |
| Food and Tobacco                    | 31759.3          | 100.6           | 3569.3                       | 17.5           | 1.5           | 99.1           | 8.7                                  | 2102.1          | 36.0                |
| Paper, Pulp and Print               | 1834.0           | 2.5             | 251.5                        | 3.1            |               | 0.5            | 203.9                                | 178.2           | 3.0                 |
| Wood and Wood Products              | 6064.4           | 136.2           | 457.1                        | 19.5           | 11.1          | 293.4          | 5852.8                               | 123.2           |                     |
| Constructions                       | 7595.4           | 22.0            | 2629.1                       | 52.2           | 1.1           | 95.7           | 65.2                                 | 224.4           | 8.0                 |
| Textiles and Leather                | 7970.6           | 461.0           | 461.6                        | 2.2            |               | 37.4           | 147.1                                | 199.1           | 6.1                 |
| Non-specified                       | 812.6            | 1.2             | 267.9                        | 2.2            | 1.5           | 0.5            | 135.3                                | 31.9            | 3.0                 |
| <b>TRANSPORT SECTOR</b>             | <b>18593.3</b>   | <b>25.3</b>     | <b>3890.4</b>                | <b>458.6</b>   | <b>41.7</b>   | <b>8.6</b>     | <b>2.4</b>                           | <b>91.3</b>     | <b>13.1</b>         |
| Air Transport                       | 16.4             |                 |                              |                |               |                |                                      |                 |                     |
| Road Transport                      | 2694.9           | 14.5            | 917.0                        | 25.6           | 2.4           | 8.4            | 0.0                                  | 38.5            | 6.4                 |
| Railways                            | 15773.4          | 10.8            | 2874.9                       | 433.0          | 39.3          |                |                                      | 52.8            | 6.1                 |
| Internal Navigation                 | 108.6            |                 | 98.5                         |                |               | 0.2            | 2.4                                  |                 | 0.6                 |
| <b>OTHER SECTORS</b>                | <b>773718.6</b>  | <b>3079.6</b>   | <b>105716.2</b>              | <b>6920.0</b>  | <b>2013.4</b> | <b>32590.1</b> | <b>3847.4</b>                        | <b>133410.9</b> | <b>4673.3</b>       |
| Agriculture                         | 29590.0          | 1220.0          | 1667.9                       | 522.3          | 99.5          | 83.9           | 29.7                                 | 489.5           | 2.0                 |
| Commerce and Public                 |                  |                 |                              |                |               |                |                                      |                 |                     |
| Residential                         |                  |                 |                              |                |               |                |                                      | 118415.0        | 4068.0              |
| Non-Specified                       | 744128.6         | 1859.6          | 104048.3                     | 6397.7         | 1913.9        | 32506.2        | 3817.7                               | 14506.4         | 603.3               |
| <b>NON-ENERGY USE</b>               | <b>305.1</b>     | <b>35.0</b>     | <b>6858.5</b>                |                |               |                | <b>21425.0</b>                       | <b>104325.5</b> |                     |
| in Industry                         | 305.1            | 35.0            | 6848.1                       |                |               |                | 15789.2                              | 104325.5        |                     |



| PRODUCTION<br>AND<br>USES OF ENERGY | Gas (TJ)            |                         |             |                   |          | Gas (TJ)                                    |                       | Oil (TJ)        |                 |                 |
|-------------------------------------|---------------------|-------------------------|-------------|-------------------|----------|---|-----------------------|-----------------|-----------------|-----------------|
|                                     | Coke<br>Oven<br>Gas | Blast<br>Furnace<br>Gas | Electricity |                   | Heat     | Crude Oil<br>+ Feedstocks<br>+ Other Inputs | Crude Oil<br>+<br>NGL | Feed-<br>stocks | Other<br>Inputs | Refinery<br>Gas |
|                                     |                     |                         | Total       | of which<br>Hydro |          |   |                       |                 |                 |                 |
| Indigenous Production               | 125751.9            | 71784.8                 | 516028.3    | 5871.6            | 781318.0 | 7496.9                                      | 6480.0                |                 | 1016.9          | 12085.2         |
| From Other Sources                  | 3112.7              |                         | 7653.6      | 7653.6            | 3989.3   |   |                       |                 |                 |                 |
| Imports                             |                     |                         | 43412.4     |                   |          | 621329.7                                    | 607766.0              | 13471.2         | 92.4            |                 |
| Exports                             |                     |                         | 36964.8     |                   |          |   |                       |                 |                 |                 |
| International Marine Bunkers        |                     |                         |             |                   |          |   |                       |                 |                 |                 |
| Stock Changes                       |                     |                         |             |                   |          | 14195.0                                     | 14195.0               |                 |                 |                 |
| DOMESTIC SUPPLY                     | 128864.6            | 71784.8                 | 530129.5    | 13525.2           | 785307.3 | 643021.6                                    | 628441.0              | 13471.2         | 1109.3          | 12085.2         |
| Returns to Supply                   |                     |                         |             |                   | 50757.0  | 8584.2                                      |                       | 8584.2          |                 |                 |
| Transfers                           | -83.2               |                         |             |                   |          |   |                       |                 |                 |                 |
| Total Requirements                  | 128781.4            | 71784.8                 | 530129.5    | 13525.2           | 836064.3 | 651605.8                                    | 628441.0              | 22055.4         | 1109.3          | 12085.2         |
| Statistical Difference              | 853.1               | 0.0                     | 0.0         | 13525.2           | 0.0      |   |                       |                 |                 | 0.0             |
| TRANSFORMATION SECTOR               | 7222.9              | 26891.0                 | 0.0         | 0.0               | 10255.3  | 651605.8                                    | 628441.0              | 22055.4         | 1109.3          | 1155.6          |
| Patent Fuel Plants                  |                     |                         |             |                   |          |   |                       |                 |                 |                 |
| Coke Ovens                          |                     | 152.0                   |             |                   |          |   |                       |                 |                 |                 |
| Gas Works                           |                     |                         |             |                   |          |   |                       |                 |                 |                 |
| Blast Furnaces                      |                     |                         |             |                   |          |   |                       |                 |                 |                 |
| Oil Refineries                      |                     |                         |             |                   |          | 651605.8                                    | 628441.0              | 22055.4         | 1109.3          |                 |
| Autoproducers of Electricity        | 5393.3              | 24201.9                 |             |                   | 9046.2   |   |                       |                 |                 | 1155.6          |
| Public Plants for CHP               | 3.0                 |                         |             |                   | 854.3    |   |                       |                 |                 |                 |
| Heating Plants                      | 1826.6              | 2537.1                  |             |                   | 354.8    |   |                       |                 |                 |                 |
| Non-Specified                       |                     |                         |             |                   |          |   |                       |                 |                 |                 |
| ENERGY SECTOR                       | 56054.0             | 4441.2                  | 109583.5    | 0.0               | 105825.2 | 0.0   | 0.0                   | 0.0             | 0.0             | 9051.9          |
| Coal Mines                          | 10.5                |                         | 37633.7     |                   | 21477.6  |   |                       |                 |                 |                 |
| Oil and Gas Extraction              |                     |                         | 823.7       |                   | 231.7    |   |                       |                 |                 |                 |
| Patent Fuel Plants                  |                     |                         | 31.3        |                   | 621.4    |   |                       |                 |                 |                 |
| Coke Ovens                          | 55944.5             | 4441.2                  | 2964.7      |                   | 20183.2  |   |                       |                 |                 |                 |
| Gas Works                           | 93.8                |                         | 182.2       |                   | 1776.1   |   |                       |                 |                 |                 |
| Oil Refineries                      |                     |                         | 1628.6      |                   | 36922.9  |   |                       |                 |                 | 9051.9          |
| Electric Plants                     |                     |                         | 36656.3     |                   | 5446.7   |   |                       |                 |                 |                 |
| Pumped Storage                      |                     |                         | 10519.6     |                   |          |   |                       |                 |                 |                 |
| Non-Specified                       | 5.2                 |                         | 19143.4     |                   | 19165.6  |   |                       |                 |                 |                 |
| Distribution Losses                 | 3592.6              |                         | 46623.6     |                   |          |   |                       |                 |                 |                 |
| FINAL CONSUMPTION                   | 61058.8             | 40452.6                 | 373922.4    |                   | 719983.8 | 0.0   | 0.0                   | 0.0             | 0.0             | 1877.7          |
| INDUSTRY SECTOR                     | 39782.2             | 40452.6                 | 177881.5    | 0.0               | 456666.4 | 0.0   | 0.0                   | 0.0             | 0.0             | 1877.8          |
| Iron and Steel                      | 34106.1             | 40198.6                 | 29013.5     |                   | 45472.4  |   |                       |                 |                 |                 |
| Chemical                            |                     | 136.0                   | 43718.8     |                   | 147478.7 |   |                       |                 |                 | 1877.8          |
| of which: Petrochemical             |                     |                         | 3437.6      |                   | 29898.0  |   |                       |                 |                 |                 |
| Non-Ferrous Metals                  | 481.0               |                         | 8781.5      |                   | 4025.4   |   |                       |                 |                 |                 |
| Non-Metallic Minerals               | 2466.0              | 118.0                   | 13882.3     |                   | 14191.5  |   |                       |                 |                 |                 |
| Transport Equipment                 | 86.0                |                         | 6664.3      |                   | 15574.7  |   |                       |                 |                 |                 |
| Machinery                           | 2470.1              |                         | 23407.6     |                   | 36245.4  |   |                       |                 |                 |                 |
| Mining and Quarrying                | 8.0                 |                         | 13016.2     |                   | 41779.7  |   |                       |                 |                 |                 |
| Food and Tobacco                    | 132.0               |                         | 11160.0     |                   | 57764.6  |   |                       |                 |                 |                 |
| Paper, Pulp and Print               | 3.0                 |                         | 8091.7      |                   | 33524.5  |   |                       |                 |                 |                 |
| Wood and Wood Products              |                     |                         | 5002.2      |                   | 11523.7  |   |                       |                 |                 |                 |
| Constructions                       | 10.0                |                         | 4676.0      |                   | 16683.0  |   |                       |                 |                 |                 |
| Textiles and Leather                | 18.0                |                         | 9899.3      |                   | 31098.4  |   |                       |                 |                 |                 |
| Non-specified                       | 2.0                 |                         | 568.1       |                   | 1304.4   |   |                       |                 |                 |                 |
| TRANSPORT SECTOR                    | 5.6                 | 0.0                     | 25405.3     | 0.0               | 6376.4   | 0.0   | 0.0                   | 0.0             | 0.0             | 0.0             |
| Air Transport                       |                     |                         | 14.8        |                   | 108.2    |   |                       |                 |                 |                 |

# Poland : 1989

| PRODUCTION<br>AND<br>USES OF ENERGY | Oil (TJ)                        |                   | Petroleum Products (TJ) |                |              |                   |                      |                |                                |
|-------------------------------------|---------------------------------|-------------------|-------------------------|----------------|--------------|-------------------|----------------------|----------------|--------------------------------|
|                                     | Liquified<br>Petroleum<br>Gases | Motor<br>Gasoline | Aviation<br>Gasoline    | Jet<br>Fuel    | Kerosene     | Gas/Diesel<br>Oil | Residual<br>Fuel Oil | Naphta         | Other<br>Petroleum<br>Products |
| Indigenous Production               | 13247.0                         | 123779.0          |                         | 8561.2         | 131.3        | 209950.2          | 148152.4             | 48833.8        | 76045.7                        |
| From Other Sources                  |                                 |                   |                         |                |              |                   |                      |                |                                |
| Imports                             |                                 | 27058.5           | 851.2                   | 7936.9         |              | 55726.7           | 9164.1               |                | 3697.8                         |
| Exports                             |                                 | 179.2             |                         |                |              | 5243.3            | 21825.0              | 5040.9         | 10128.7                        |
| International Marine Bunkers        |                                 |                   |                         | 847.2          |              | 11353.4           | 20739.5              |                |                                |
| Stock Changes                       |                                 | -1164.8           | 313.6                   | -891.8         | 131.3        | -1386.7           | -1205.8              |                |                                |
| <b>DOMESTIC SUPPLY</b>              | <b>13247.0</b>                  | <b>149493.5</b>   | <b>1164.8</b>           | <b>14759.1</b> | <b>262.6</b> | <b>247693.6</b>   | <b>113546.2</b>      | <b>43792.9</b> | <b>69614.8</b>                 |
| Returns to Supply                   |                                 |                   |                         |                |              |                   |                      |                |                                |
| Transfers                           |                                 | 537.6             | -313.6                  | -178.4         | 87.5         | 130.0             |                      |                | -241.2                         |
| Total Requirements                  | 13247.0                         | 150031.1          | 851.2                   | 14580.7        | 350.1        | 247823.6          | 113546.2             | 43792.9        | 69373.6                        |
| Statistical Difference              | 0.0                             | 0.0               | 0.0                     | 0.0            |              | 0.0               | -11897.2             |                | 0.0                            |
| <b>TRANSFORMATION SECTOR</b>        | <b>567.7</b>                    | <b>0.0</b>        | <b>0.0</b>              | <b>0.0</b>     | <b>0.0</b>   | <b>866.6</b>      | <b>71142.1</b>       | <b>0.0</b>     | <b>0.0</b>                     |
| Patent Fuel Plants                  |                                 |                   |                         |                |              |                   |                      |                |                                |
| Coke Ovens                          |                                 |                   |                         |                |              |                   |                      |                |                                |
| Gas Works                           | 567.7                           |                   |                         |                |              |                   |                      |                |                                |
| Blast Furnaces                      |                                 |                   |                         |                |              |                   |                      |                |                                |
| Oil Refineries                      |                                 |                   |                         |                |              | 130.0             |                      |                |                                |
| Autoproducers of Electricity        |                                 |                   |                         |                |              | 173.3             | 45860.5              |                |                                |
| Public Plants for CHP               |                                 |                   |                         |                |              | 130.0             | 7676.9               |                |                                |
| Heating Plants                      |                                 |                   |                         |                |              | 433.3             | 17604.7              |                |                                |
| Non-Specified                       |                                 |                   |                         |                |              |                   |                      |                |                                |
| <b>ENERGY SECTOR</b>                | <b>94.6</b>                     | <b>89.6</b>       | <b>0.0</b>              | <b>0.0</b>     | <b>0.0</b>   | <b>1906.7</b>     | <b>13906.9</b>       | <b>0.0</b>     | <b>0.0</b>                     |
| Coal Mines                          |                                 | 44.8              |                         |                |              | 1430.0            |                      |                |                                |
| Oil and Gas Extraction              |                                 |                   |                         |                |              | 216.7             |                      |                |                                |
| Patent Fuel Plants                  |                                 |                   |                         |                |              |                   |                      |                |                                |
| Coke Ovens                          |                                 |                   |                         |                |              |                   |                      |                |                                |
| Gas Works                           |                                 |                   |                         |                |              | 43.3              |                      |                |                                |
| Oil Refineries                      | 94.6                            |                   |                         |                |              |                   | 13866.7              |                |                                |
| Electric Plants                     |                                 |                   |                         |                |              |                   |                      |                |                                |
| Pumped Storage                      |                                 |                   |                         |                |              |                   |                      |                |                                |
| Non-Specified                       |                                 | 44.8              |                         |                |              | 216.7             | 40.2                 |                |                                |
| Distribution Losses                 |                                 | 224.0             |                         |                |              | 130.0             |                      |                | 40.2                           |
| <b>FINAL CONSUMPTION</b>            | <b>12584.7</b>                  | <b>149717.5</b>   | <b>851.2</b>            | <b>14580.7</b> | <b>350.1</b> | <b>244920.3</b>   | <b>40394.4</b>       | <b>43792.9</b> | <b>69333.4</b>                 |
| <b>INDUSTRY SECTOR</b>              | <b>236.5</b>                    | <b>1792.0</b>     | <b>0.0</b>              | <b>0.0</b>     | <b>0.0</b>   | <b>17506.8</b>    | <b>32757.6</b>       | <b>0.0</b>     | <b>0.0</b>                     |
| Iron and Steel                      |                                 |                   |                         |                |              | 130.0             | 15474.4              |                |                                |
| Chemical                            |                                 | 44.8              |                         |                |              | 1386.7            | 3697.8               |                |                                |
| <i>of which: Petrochemical</i>      |                                 |                   |                         |                |              |                   | 643.1                |                |                                |
| Non-Ferrous Metals                  |                                 |                   |                         |                |              | 43.3              | 763.7                |                |                                |
| Non-Metallic Minerals               |                                 |                   |                         |                |              | 1126.7            | 6752.5               |                |                                |
| Transport Equipment                 | 47.3                            | 179.2             |                         |                |              | 866.7             | 321.5                |                |                                |
| Machinery                           | 94.6                            | 224.0             |                         |                |              | 1516.7            | 120.6                |                |                                |
| Mining and Quarrying                |                                 | 44.8              |                         |                |              | 1603.3            | 803.9                |                |                                |
| Food and Tobacco                    | 47.3                            | 268.8             |                         |                |              | 1560.0            | 1647.9               |                |                                |
| Paper, Pulp and Print               | 47.3                            |                   |                         |                |              | 86.7              | 1165.6               |                |                                |
| Wood and Wood Products              |                                 |                   |                         |                |              | 130.0             | 1768.5               |                |                                |
| Constructions                       |                                 | 940.8             |                         |                |              | 8536.7            | 241.2                |                |                                |
| Textiles and Leather                |                                 | 44.8              |                         |                |              | 216.7             |                      |                |                                |
| Non-specified                       |                                 | 44.8              |                         |                |              | 303.3             |                      |                |                                |
| <b>TRANSPORT SECTOR</b>             | <b>0.0</b>                      | <b>146984.7</b>   | <b>851.2</b>            | <b>14580.7</b> | <b>0.0</b>   | <b>174243.5</b>   | <b>2572.4</b>        | <b>0.0</b>     | <b>0.0</b>                     |
| Air Transport                       |                                 |                   | 851.2                   | 14580.7        |              |                   |                      |                |                                |
| Road Transport                      |                                 | 146895.1          |                         |                |              | 151840.2          |                      |                |                                |
| Railways                            |                                 | 89.6              |                         |                |              | 21970.0           |                      |                |                                |
| Internal Navigation                 |                                 |                   |                         |                |              | 433.3             | 2572.4               |                |                                |
| <b>OTHER SECTORS</b>                | <b>7664.4</b>                   | <b>0.0</b>        | <b>0.0</b>              | <b>0.0</b>     | <b>0.1</b>   | <b>52866.7</b>    | <b>2612.6</b>        | <b>0.0</b>     | <b>0.0</b>                     |
| Agriculture                         |                                 |                   |                         |                |              | 52866.7           | 2612.6               |                |                                |
| Commerce and Public                 |                                 |                   |                         |                |              |                   |                      |                |                                |
| Residential                         | 7569.7                          |                   |                         |                |              |                   |                      |                |                                |
| Non-Specified                       | 94.7                            | 0.0               | 0.0                     |                | 0.1          | 0.0               | 0.0                  | 0.0            | 0.0                            |
| <b>NON-ENERGY USE</b>               | <b>4683.8</b>                   | <b>940.8</b>      |                         |                | <b>350.0</b> | <b>303.3</b>      | <b>2451.8</b>        | <b>43792.9</b> | <b>69333.4</b>                 |
| in Industry                         | 4683.8                          | 940.8             |                         |                | 350.0        | 303.3             | 2451.8               | 43792.9        | 69333.4                        |

## Annex 5. Uncertainty estimation of the 1989 inventory

Uncertainty analysis for the year 1989 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> – 5.6%

CH<sub>4</sub> – 18.9%

N<sub>2</sub>O - 50.6%

#### Activities

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

#### CO<sub>2</sub> emission factors

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

Low level of uncertainty of national total of CO<sub>2</sub> (5.6%) 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. 18.9% which is result of share of agriculture and waste sectors in national totals – emission factors in those sectors have high uncertainty.

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

Most uncertain values for N<sub>2</sub>O emission factors were assigned in sector *4.B.11 and 4.B.12 Manure management* (150%), *4.D Agricultural Soils* (150%) and in *4.F Agriculture/Field Burning of Agricultural Residues* (150%), most precise values were for Natural gas combustion in *1.A.3 Transport* (2.3%) and *1.A Fuel Combustion* (3.8%).

Highest value of uncertainty of national total occurred in N<sub>2</sub>O (50.9%) 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 1989 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.

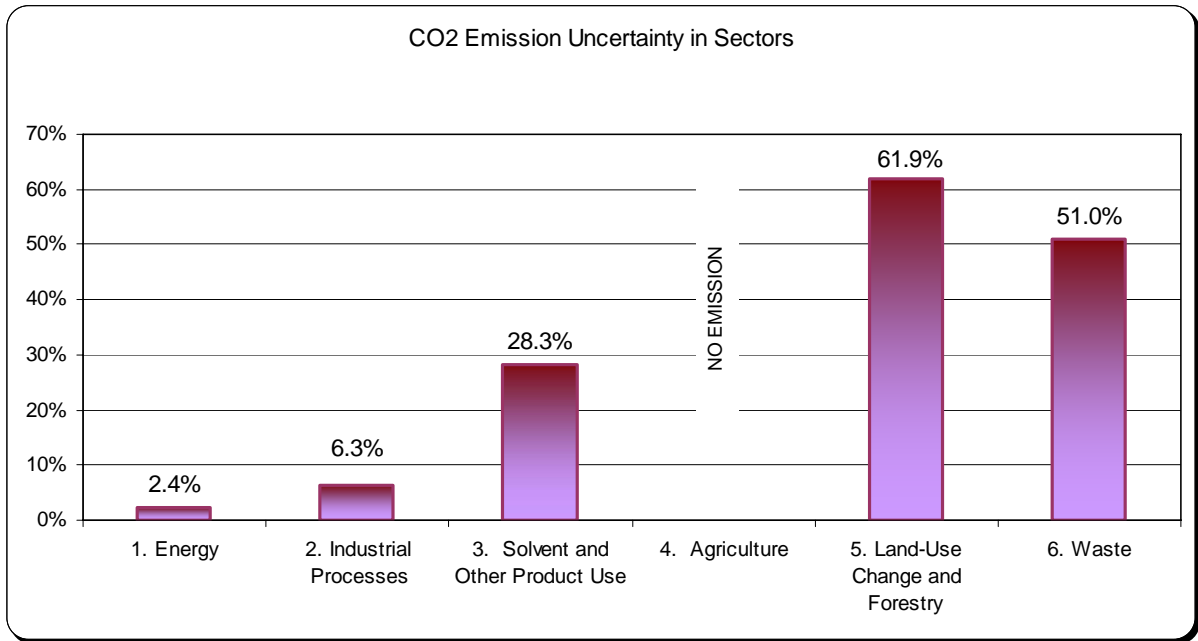
Sector *3. Solvents and Other Products Use* was included in calculations with high sectoral uncertainty 28.3%. Emission from this sector is small compared to total CO<sub>2</sub> and high uncertainty have very little influence on uncertainty of values of total national CO<sub>2</sub> emission.

# GHG inventory 1989 – Uncertainty analysis, part 1, sectors 1-2

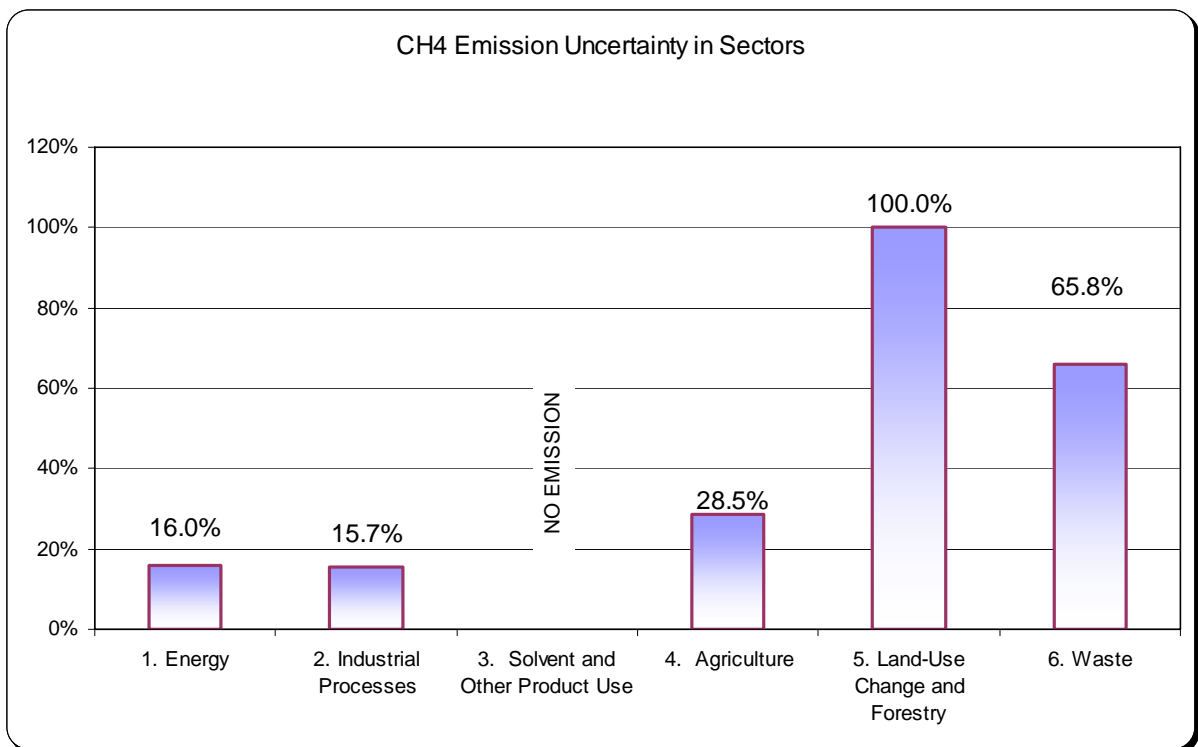
| 1989  | Activity [TJ] | Activity uncertainty [%] | EF CO2 [t/TJ] | EF CH4 [kg/TJ] | EF N2O [kg/TJ] | EF CO2 Uncertainty [%] | EF CH4 Uncertainty [%] | EF N2O Uncertainty [%] | CO2 [Gg]          | CH4 [Gg]       | N2O [Gg]     | CO2 Emission uncertainty [%] | CH4 Emission uncertainty [%] | N2O Emission uncertainty [%] | CO2 Emission absolute uncertainty [Gg] | CH4 Emission absolute uncertainty [Gg] | N2O Emission absolute uncertainty [Gg] |
|---|---------------|--------------------------|---------------|----------------|----------------|------------------------|------------------------|------------------------|-------------------|----------------|--------------|------------------------------|------------------------------|------------------------------|--|--|--|
| TOTAL   |               |                          |               |                |                |                        |                        |                        | 436 535.97        | 2 544.36       | 141.74       | 5.6%                         | 18.9%                        | 50.6%                        | 24 430.53                              | 481.07                                 | 71.77                                  |
| <b>1. Energy</b>  |               |                          |               |                |                |                        |                        |                        | <b>449 929.84</b> | <b>1027.71</b> | <b>9.96</b>  | <b>2.4%</b>                  | <b>16.0%</b>                 | <b>2.7%</b>                  | <b>10635.09</b>                        | <b>164.19</b>                          | <b>0.27</b>                            |
| <b>A. Fuel Combustion</b>   |               |                          |               |                |                |                        |                        |                        | <b>449 879.14</b> | <b>15.90</b>   | <b>9.96</b>  | <b>2.4%</b>                  | <b>9.0%</b>                  | <b>2.7%</b>                  | <b>10635.09</b>                        | <b>1.43</b>                            | <b>0.27</b>                            |
| 1. Energy Industries  |               |                          |               |                |                |                        |                        |                        | 265 783.77        | 3.51           | 3.78         | 3.4%                         | 13.0%                        | 3.5%                         | 9151.95                                | 0.46                                   | 0.13                                   |
| Liquid Fuels  | 145 310       | 3.0%                     | 72.14         | 2.56           | 0.54           | 1.0%                   | 41.8%                  | 3.8%                   | 10 482.89         | 0.37           | 0.08         | 3.2%                         | 41.9%                        | 3.2%                         | 331.50                                 | 0.16                                   | 0.00                                   |
| Solid Fuels   | 2 511 978     | 3.0%                     | 100.98        | 1.23           | 1.47           | 2.0%                   | 13.5%                  | 11.7%                  | 253 657.41        | 3.09           | 3.69         | 3.2%                         | 13.8%                        | 3.6%                         | 9145.75                                | 0.43                                   | 0.13                                   |
| Gaseous Fuels   | 29 538        | 3.0%                     | 55.64         | 1.00           | 0.10           | 2.0%                   | 17.0%                  | 20.0%                  | 1 643.48          | 0.03           | 0.00         | 3.6%                         | 17.3%                        | 3.6%                         | 59.26                                  | 0.01                                   | 0.00                                   |
| Biomass   | 597           | 3.0%                     |               |                |                | 0.0%                   | 24.0%                  | 37.0%                  | 66.92             | 0.02           | 0.00         | 3.0%                         | 24.2%                        | 3.0%                         |  | 0.00                                   | 0.00                                   |
| 2. Manufacturing Industries and Construction                        |               |                          |               |                |                |                        |                        |                        | 54 849.95         | 2.35           | 0.86         | 4.1%                         | 12.9%                        | 7.0%                         | 2232.29                                | 0.30                                   | 0.06                                   |
| Liquid Fuels  | 96 796.79     | 5.0%                     | 75.32         | 3.01           | 4.37           | 1.0%                   | 41.8%                  | 3.8%                   | 7 290.47          | 0.29           | 0.42         | 5.1%                         | 42.1%                        | 6.3%                         | 371.74                                 | 0.12                                   | 0.03                                   |
| Solid Fuels   | 367 866.26    | 5.0%                     | 112.35        | 5.35           | 1.19           | 2.0%                   | 13.5%                  | 11.7%                  | 40 207.04         | 1.91           | 0.42         | 5.4%                         | 14.4%                        | 12.7%                        | 2165.22                                | 0.28                                   | 0.05                                   |
| Gaseous Fuels   | 131 565.56    | 5.0%                     | 55.88         | 1.00           | 0.10           | 2.0%                   | 17.0%                  | 20.0%                  | 7 352.44          | 0.13           | 0.01         | 5.4%                         | 17.7%                        | 20.6%                        | 395.94                                 | 0.02                                   | 0.00                                   |
| Biomass   | 336.00        | 5.0%                     | 112.00        | 30.00          | 4.00           | 0.0%                   | 24.0%                  | 37.0%                  | 37.63             | 0.01           | 0.00         | 5.0%                         | 24.5%                        | 37.3%                        |  | 0.00                                   | 0.00                                   |
| 3. Transport  |               |                          |               |                |                |                        |                        |                        | 23 351.02         | 6.61           | 1.58         | 6.7%                         | 11.2%                        | 5.4%                         | 1569.75                                | 0.74                                   | 0.09                                   |
| Liquid Fuels  | 301 537.79    | 5.0%                     | 73.52         | 21.62          | 5.12           | 5.0%                   | 10.2%                  | 2.3%                   | 22 168.04         | 6.52           | 1.54         | 7.1%                         | 11.4%                        | 5.5%                         | 1567.52                                | 0.74                                   | 0.08                                   |
| Solid Fuels   | 15 773.00     | 5.0%                     | 75.00         | 6.00           | NE             | 5.0%                   | 13.5%                  | 11.7%                  | 1 182.98          | 0.05           | 0.03         | 7.1%                         | 14.4%                        | 12.7%                        | 83.65                                  | 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  |               |                          |               |                |                |                        |                        |                        | 100 199.82        | 2.38           | 1.83         | 4.7%                         | 13.3%                        | 9.7%                         | 4671.94                                | 0.32                                   | 0.18                                   |
| Liquid Fuels  | 101 149.04    | 5.0%                     | 73.87         | 3.80           | 3.57           | 1.0%                   | 41.8%                  | 3.8%                   | 7 471.75          | 0.38           | 0.36         | 5.1%                         | 42.1%                        | 6.3%                         | 380.99                                 | 0.16                                   | 0.02                                   |
| Solid Fuels   | 902 218.70    | 5.0%                     | 95.57         | 1.00           | 1.47           | 2.0%                   | 13.5%                  | 11.7%                  | 86 221.63         | 0.90           | 1.32         | 5.4%                         | 14.4%                        | 12.7%                        | 4643.18                                | 0.13                                   | 0.17                                   |
| Gaseous Fuels   | 120 450.50    | 5.0%                     | 54.02         | 1.00           | 0.10           | 2.0%                   | 17.0%                  | 20.0%                  | 6 506.44          | 0.12           | 0.01         | 5.4%                         | 17.7%                        | 20.6%                        | 350.38                                 | 0.02                                   | 0.00                                   |
| Biomass   | 32 439.90     | 5.0%                     | 112.00        | 30.00          | 4.00           |                        | 24.0%                  | 37.0%                  | 3 633.27          | 0.97           | 0.13         | 5.0%                         | 24.5%                        | 37.3%                        |  | 0.24                                   | 0.05                                   |
| 5. Other  |               |                          |               |                |                |                        |                        |                        | 5 694.59          | 1.04           | 1.91         | 4.7%                         | 99.7%                        | 6.3%                         | 269.95                                 | 1.04                                   | 0.12                                   |
| Liquid Fuels  | 72 361.53     | 5.0%                     | 72.91         | 14.37          | 26.38          | 1.0%                   | 100.0%                 | 3.8%                   | 5 276.22          | 1.04           | 1.91         | 5.1%                         | 100.1%                       | 6.3%                         | 269.04                                 | 1.04                                   | 0.12                                   |
| Solid Fuels   | 3 850.00      | 5.0%                     | 107.33        | 1.01           | 1.50           | 2.0%                   | 80.0%                  | 11.7%                  | 41 323            | 0.00           | 0.01         | 5.4%                         | 80.2%                        | 12.7%                        | 22.25                                  | 0.00                                   | 0.00                                   |
| Gaseous Fuels   | 93.00         | 5.0%                     | 55.24         | 1.00           | 0.10           | 2.0%                   | 90.0%                  | 20.0%                  | 5.14              | 0.00           | 0.00         | 5.4%                         | 90.1%                        | 20.6%                        | 0.28                                   | 0.00                                   | 0.00                                   |
| Biomass   | 2.00          | 5.0%                     | 112.00        | 30.00          | 4.00           | 0.0%                   | 95.0%                  | 37.0%                  | 0.22              | 0.00           | 0.00         | 5.0%                         | 95.1%                        | 37.3%                        |  | 0.00                                   | 0.00                                   |
| <b>B. Fugitive Emissions from Fuels</b>                             |               |                          |               |                |                |                        |                        |                        | <b>50.70</b>      | <b>1011.81</b> | <b>0.00</b>  | <b>5.4%</b>                  | <b>16.2%</b>                 |                              | <b>2.76</b>                            | <b>164.19</b>                          | <b>0.00</b>                            |
| 1. Solid Fuels  |               |                          |               |                |                |                        |                        |                        | 1.84              | 821.13         | 0.00         | 6.6%                         | 20.0%                        |                              | 0.12                                   | 163.82                                 | 0.00                                   |
| 1. B. 1. a. Coal Mining and Handling                                |               |                          |               |                |                |                        |                        |                        |                   |                |              |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| i. Underground Mines [Activity in Mt, EF in kg/t]                   | 175.90        | 2.0%                     |               | 4.63356        |                |                        | 20.0%                  |                        |                   | 815.04         |              |                              | 20.1%                        |                              | 0.00                                   | 163.82                                 | 0.00                                   |
| ii. Surface Mines [Activity in Mt, EF in kg/t]                      | 72.00         | 2.0%                     |               | 0.01273        |                |                        | 20.0%                  |                        |                   | 0.92           |              |                              | 20.1%                        |                              | 0.00                                   | 0.18                                   | 0.00                                   |
| 1. B. 1. c. Other [CO2 Emission from Coking Gas Subsystem]          | 0.89          | 2.0%                     | 2 060 765     | 5 791 695.00   |                |                        | 20.0%                  |                        | 1.84              | 5.17           |              | 6.6%                         | 15.0%                        |                              | 0.12                                   | 0.78                                   |  |
| 2. Oil and Natural Gas  |               |                          |               |                |                |                        |                        |                        | 48.86             | 190.68         | 0.00         | 5.6%                         | 5.7%                         |                              | 2.76                                   | 10.94                                  | 0.00                                   |
| 1. B. 2. a. Oil   |               |                          |               |                |                |                        |                        |                        |                   |                |              |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| ii. Production [Activity in PJ, EFs in kg/PJ]                       | 6.48          | 0.5%                     | 6 315 000     | 61 800.00      |                | 6.6%                   | 8.1%                   |                        | 40.92             | 0.40           |              | 6.6%                         | 8.1%                         |                              | 2.71                                   | 0.03                                   | 0.00                                   |
| iii. Transport [Activity in Gg]                                     | 14 882.00     | 0.5%                     | NE            | NE             |                | 6.6%                   | 8.1%                   |                        | 0.09              | 0.01           |              | 6.6%                         | 8.1%                         |                              | 0.01                                   | 0.00                                   | 0.00                                   |
| 1. B. 2. b. Natural Gas   |               |                          |               |                |                |                        |                        |                        |                   |                |              |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| i. Production / Processing [Activity in PJ, EFs in kg/PJ]           | 145.02        | 0.5%                     | 49 501.72     | 94 232.62      |                | 6.6%                   | 8.1%                   |                        | 7.18              | 13.67          |              | 6.6%                         | 8.1%                         |                              | 0.48                                   | 1.11                                   | 0.00                                   |
| ii. Transmission [Activity in PJ, EFs in kg/PJ]                     | 392.29        | 0.5%                     | 519.87        | 136 988.91     |                | 6.6%                   | 8.1%                   |                        | 0.20              | 53.74          |              | 6.6%                         | 8.1%                         |                              | 0.01                                   | 4.36                                   | 0.00                                   |
| ii. Distribution [Activity in PJ, EFs in kg/PJ]                     | 392.29        | 0.5%                     | 1 173.42      | 313 206.28     |                | 6.6%                   | 8.1%                   |                        | 0.46              | 122.87         |              | 6.6%                         | 8.1%                         |                              | 0.03                                   | 9.97                                   | 0.00                                   |
| <b>2. Industrial Processes</b>                                      |               |                          |               |                |                |                        |                        |                        | <b>20740.79</b>   | <b>16.16</b>   | <b>16.35</b> | <b>6.3%</b>                  | <b>15.7%</b>                 | <b>25.9%</b>                 | <b>1312.29</b>                         | <b>2.53</b>                            | <b>4.24</b>                            |
| <b>A. Mineral Products</b>  |               |                          |               |                |                |                        |                        |                        | 10983.25          |                | 0            | 11.3%                        |                              |                              | 1241.88                                | 0.00                                   | 0.00                                   |
| 1. Cement Production [Activity in kt, EF in t/t]                    | 13 738.00     | 5.0%                     | 0.525         |                |                | 15.0%                  |                        |                        | 7212.45           |                |              | 15.8%                        |                              |                              | 1140.39                                | 0.00                                   | 0.00                                   |
| 2. Lime Production [Activity in kt, EF in t/t]                      | 4 421.00      | 10.0%                    | 0.785         |                |                | 10.0%                  |                        |                        | 3470.49           |                |              | 14.1%                        |                              |                              | 490.80                                 | 0.00                                   | 0.00                                   |
| 4. Soda Ash (production) [Activity in kt, EF in t/t]                | 723.65        | 10.0%                    | 0.415         |                |                | 0.0%                   |                        |                        | 300.32            |                |              | 10.0%                        |                              |                              | 30.03                                  | 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>   |               |                          |               |                |                |                        |                        |                        | 4044.15           | 12.24          | 16.35        | 6.4%                         | 19.9%                        | 25.9%                        | 257.04                                 | 2.43                                   | 4.24                                   |
| 1. Ammonia Production [Activity in kt, EF in t/t]                   | 2 406.00      | 5.0%                     | 1.5           | 0.0049         |                | 5.0%                   | 20.0%                  |                        | 3609.00           | 11.79          |              | 7.1%                         | 20.6%                        |                              | 255.19                                 | 2.43                                   | 0.00                                   |
| 2. Nitric Acid Production [Activity in kt, EF in t/t]               | 2 175.10      | 2.0%                     |               |                | 0.01           |                        |                        | 30.0%                  |                   |                | 14.07        |                              |                              | 30.1%                        | 0.00                                   |  | 4.23                                   |
| 3. Adipic Acid Production [Activity in kt, EF in t/t]               | 6.00          | 5.0%                     |               |                | 0.00           |                        |                        | 10.0%                  | NE                |                | 1.80         |                              |                              | 11.2%                        |  |  |  |
| 4. Carbide Production (calcium carbide) [Activity in kt, EF in t/t] | 395.50        | 5.0%                     | 1.1           |                |                | 5.0%                   |                        |                        | 435.05            |                |              | 7.1%                         |                              |                              | 30.76                                  | 0.00                                   | 0.00                                   |
| 5. Other (Carbon Black) [Activity in kt, EF in t/t]                 | 45.20         | 5.0%                     |               | 0.01           |                |                        | 20.0%                  |                        |                   | 0.45           |              |                              | 20.6%                        |                              | 0.00                                   | 0.09                                   | 0.00                                   |
| 5. Other (Ethylene) [Activity in kt, EF in t/t]                     | 322.06        | 5.0%                     | 0.0003        |                |                | 5.0%                   |                        |                        | 0.10              |                |              | 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]              | 1 021.20      | 5.0%                     | 0             |                |                | 5.0%                   |                        |                        |                   |                |              | 7.1%                         |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| 5. Other (Caprolactam) [Activity in kt, EF in t/t]                  | 100.08        | 5.0%                     |               |                | 0.0047         |                        |                        | 20.0%                  |                   |                | 0.47         |                              |                              | 20.6%                        | 0.00                                   | 0.00                                   | 0.10                                   |
| <b>C. Metal Production</b>  |               |                          |               |                |                |                        |                        |                        | 5713.40           | 3.92           | 0            | 5.9%                         | 17.9%                        |                              | 337.30                                 | 0.70                                   | 0.00                                   |
| 1. Iron and Steel Production  |               |                          |               |                |                |                        |                        |                        |                   |                |              |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| Sinter [Activity in kt, EF in t/t]                                  | 12 992.47     | 5.0%                     | 0.06          |                |                | 10.0%                  |                        |                        | 735.76            |                |              | 11.2%                        |                              |                              | 82.25                                  | 0.00                                   | 0.00                                   |
| Coke [Activity in kt, EF in t/t]                                    | 16 886.14     | 5.0%                     | 0.12          | 0.000200       |                | 10.0%                  | 20.0%                  |                        | 2104.58           | 3.38           |              | 11.2%                        | 20.6%                        |                              | 235.30                                 | 0.70                                   | 0.00                                   |
| Open-heart Steel [Activity in kt, EF in t/t]                        | 5 386.50      | 5.0%                     | 0.052         |                |                | 10.0%                  |                        |                        | 280.10            |                |              | 11.2%                        |                              | NE                           |  |  |  |
| Electric Furnace Steel [Activity in kt, EF in t/t]                  | 2 480.00      | 5.0%                     | 0.00430       | 0.000120       |                | 10.0%                  | 20.0%                  |                        | 10.65             | 0.30           |              | 11.2%                        | 20.6%                        |                              | 1.19                                   | 0.06                                   | 0.00                                   |
| Pig Iron [Activity in kt, EF in t/t]                                | 9 487.62      | 5.0%                     | 0.21067       |                |                | 10.0%                  |                        |                        | 1998.73           |                |              | 11.2%                        |                              |                              | 223.46                                 | 0.00                                   | 0.00                                   |
| Iron Cast [Activity in kt, EF in t/t]                               | 1 236.90      | 5.0%                     | 0.061         | 0.000200       |                | 10.0%                  | 20.0%                  |                        | 75.45             | 0.25           |              | 11.2%                        | 20.6%                        |                              | 8.44                                   | 0.05                                   | 0.00                                   |
| Steel Cast [Activity in kt, EF in t/t]                              | 264.20        | 5.0%                     | 0.062         |                |                | 10.0%                  |                        |                        | 16.38             |                |              | 11.2%                        |                              |                              | 1.83                                   | 0.00                                   | 0.00                                   |
| Basic Oxygen Furnace Steel [Activity in kt, EF in t/t]              | 7 212.30      | 5.0%                     | 0.01126       |                |                | 10.0%                  |                        |                        | 81.21             |                |              | 11.2%                        |                              |                              | 9.08                                   | 0.00                                   | 0.00                                   |
| 2. Ferroalloys Production [Activity in kt, EF in t/t]               | 83.20         | 5.0%                     | 3.9           |                |                | 5.0%                   |                        |                        | 324.48            |                |              | 7.1%                         |                              |                              | 22.94                                  | 0.00                                   | 0.00                                   |
| 3. Aluminium Production [Activity in kt, EF in t/t]                 | 47.80         | 5.0%                     | 1.8           |                |                | 5.0%                   |                        |                        | 86.04             |                |              | 7.1%                         |                              |                              | 6.08                                   | 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 1989 – Uncertainty analysis, part 2, sector 3-6

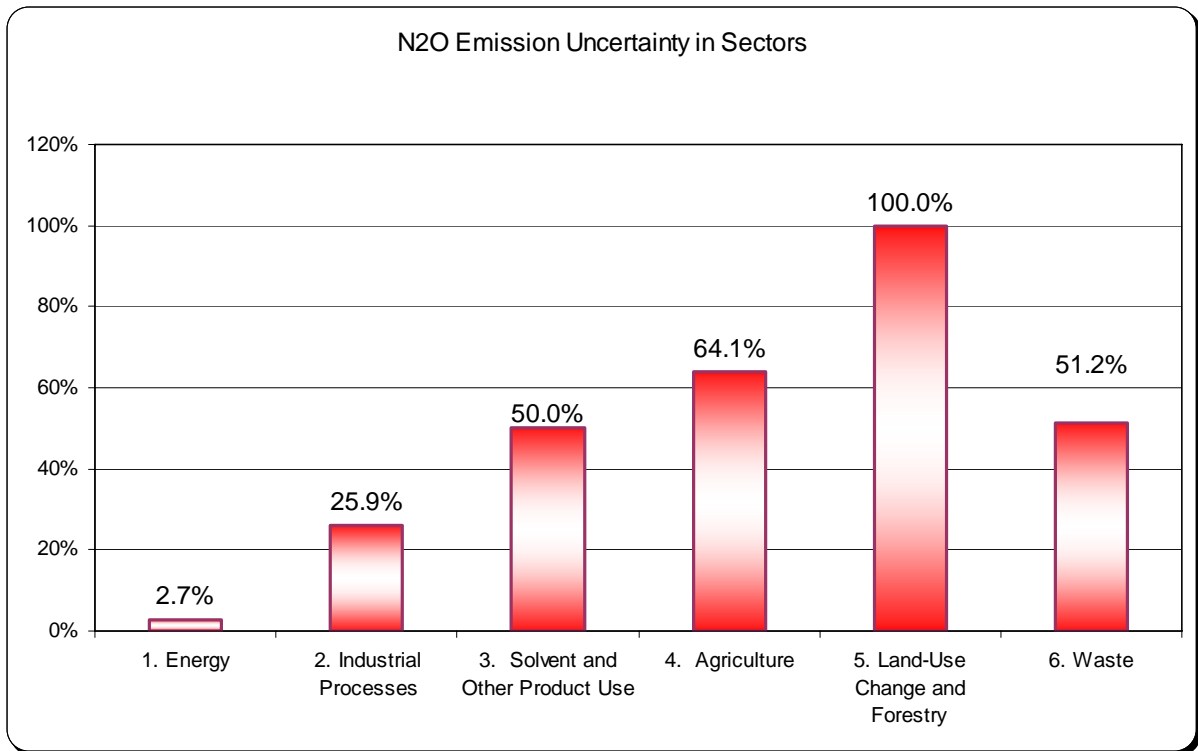
| 1989  | Activity [TJ] | Activity uncertainty [%] | EF CO2 [t/TJ] | EF CH4 [kg/TJ] | EF N2O [kg/TJ] | EF CO2 Uncertainty [%] | EF CH4 Uncertainty [%] | EF N2O Uncertainty [%] | CO2 [Gg]  | CH4 [Gg] | N2O [Gg] | CO2 Emission uncertainty [%] | CH4 Emission uncertainty [%] | N2O Emission uncertainty [%] | CO2 Emission absolute uncertainty [Gg] | CH4 Emission absolute uncertainty [Gg] | N2O Emission absolute uncertainty [Gg] |
|---|---------------|--------------------------|---------------|----------------|----------------|------------------------|------------------------|------------------------|-----------|----------|----------|------------------------------|------------------------------|------------------------------|--|--|--|
| 3. Solvent and Other Product Use  | 258.52        |                          | NA            |                |                |                        |                        |                        | 822.14    |          | 0.40     | 28.3%                        |                              | 50.0%                        | 232.67                                 | 0.00                                   | 0.20                                   |
| 4. Agriculture  |               |                          |               |                |                |                        |                        |                        |           | 950.13   | 111.79   |                              | 28.5%                        | 64.1%                        | 0.00                                   | 271.12                                 | 71.63                                  |
| A. Enteric Fermentation   |               |                          |               |                |                |                        |                        |                        |           | 783.07   |          |                              | 33.6%                        |                              | 0.00                                   | 263.30                                 | 0.00                                   |
| 1. Cattle   |               |                          |               |                |                |                        |                        |                        |           |          |          |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| Dairy Cattle (Activity in 1000 heads, EF in kg/head)  | 4 994.0       | 5.0%                     |               | 93.19          |                |                        | 50.0%                  |                        |           | 465.39   |          |                              | 50.2%                        |                              | 0.00                                   | 233.86                                 | 0.00                                   |
| Non-Dairy Cattle (Activity in 1000 heads, EF in kg/head)  | 5 739.0       | 5.0%                     |               | 41.10          |                |                        | 50.0%                  |                        |           | 235.87   |          |                              | 50.2%                        |                              | 0.00                                   | 119.52                                 | 0.00                                   |
| 3. Sheep (Activity in 1000 heads, EF in kg/head)  | 4 409.0       | 5.0%                     |               | 7.97           |                |                        | 50.0%                  |                        |           | 35.15    |          |                              | 50.2%                        |                              | 0.00                                   | 17.66                                  | 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)   | 973.0         | 5.0%                     |               | 18.00          |                |                        | 50.0%                  |                        |           | 17.51    |          |                              | 50.2%                        |                              | 0.00                                   | 8.80                                   | 0.00                                   |
| 8. Swine (Activity in 1000 heads, EF in kg/head)  | 18 835.0      | 5.0%                     |               | 1.50           |                |                        | 50.0%                  |                        |           | 28.25    |          |                              | 50.2%                        |                              | 0.00                                   | 14.20                                  | 0.00                                   |
| 9. Poultry (Activity in 1000 heads, EF in kg/head)  | 265 976.3     | 5.0%                     |               | 0.00           |                |                        | 50.0%                  |                        |           | 0.00     |          |                              | 50.2%                        |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| B. Manure Management  |               |                          |               |                |                |                        |                        |                        |           | 165.51   | 30.41    |                              | 39.1%                        | 149.0%                       | 0.00                                   | 64.65                                  | 45.29                                  |
| 1. Cattle   |               |                          |               |                |                |                        |                        |                        |           |          |          |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| Dairy Cattle (Activity in 1000 heads, EF in kg/head)  | 4 994         | 5.0%                     |               | 5.92           |                |                        | 50.0%                  |                        |           | 29.54    |          |                              | 50.2%                        |                              | 0.00                                   | 14.84                                  | 0.00                                   |
| Non-Dairy Cattle (Activity in 1000 heads, EF in kg/head)  | 5 739         | 5.0%                     |               | 2.60           |                |                        | 50.0%                  |                        |           | 14.91    |          |                              | 50.2%                        |                              | 0.00                                   | 7.49                                   | 0.00                                   |
| 3. Sheep (Activity in 1000 heads, EF in kg/head)  | 4 409         | 5.0%                     |               | 0.17           |                |                        | 50.0%                  |                        |           | 0.74     |          |                              | 50.2%                        |                              | 0.00                                   | 0.37                                   | 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)   | 973           | 5.0%                     |               | 1.39           |                |                        | 50.0%                  |                        |           | 1.35     |          |                              | 50.2%                        |                              | 0.00                                   | 0.68                                   | 0.00                                   |
| 8. Swine (Activity in 1000 heads, EF in kg/head)  | 18 835        | 5.0%                     |               | 5.21           |                |                        | 50.0%                  |                        |           | 98.20    |          |                              | 50.2%                        |                              | 0.00                                   | 49.34                                  | 0.00                                   |
| 9. Poultry (Activity in 1000 heads, EF in kg/head)  | 265 976       | 5.0%                     |               | 0.08           |                |                        | 50.0%                  |                        |           | 20.75    |          |                              | 50.2%                        |                              | 0.00                                   | 10.42                                  | 0.00                                   |
| 11. Liquid Systems (Activity in 1000 heads, EF in kg N2O-N/kg N)                                | 0             | 5.0%                     |               |                | 0.001000       |                        |                        | 150.0%                 |           |          | 0.23     |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 0.34                                   |
| 12. Solid Storage and Dry Lot (Activity in 1000 heads, EF in kg N2O-N/kg N)                     | 0             | 5.0%                     |               |                | 0.020000       |                        |                        | 150.0%                 |           |          | 30.18    |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 45.29                                  |
| D. Agricultural Soils   |               |                          |               |                |                |                        |                        |                        |           |          | 81.31    |                              |                              | 68.2%                        | 0.00                                   | 0.00                                   | 55.49                                  |
| 1. Direct Soil Emissions  |               |                          |               |                |                |                        |                        |                        |           |          |          |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| Synthetic Fertilizers (Activity in kg N, EF in kg N2O-N/kg N)                                   | 1 368 000 000 | 5.0%                     |               |                | 0.01           |                        |                        | 150.0%                 |           |          | 19.11    |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 28.68                                  |
| Animal Wastes Applied to Soils (Activity in kg N, EF in kg N2O-N/kg N)                          | 851 022 759   | 5.0%                     |               |                | 0.01           |                        |                        | 150.0%                 |           |          | 13.37    |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 20.07                                  |
| N-fixing Crops (Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass)                      | 108 630 000   | 5.0%                     |               |                | 0.01           |                        |                        | 150.0%                 |           |          | 1.71     |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 2.56                                   |
| Crop Residue (Activity in kg dry biomass, EF in kg N2O-N/kg dry biomass)                        | 199 530 400   | 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)                                    | 166 711 390   | 5.0%                     |               |                | 0.02           |                        |                        | 150.0%                 |           |          | 5.24     |                              |                              | 150.1%                       | 0.00                                   | 0.00                                   | 7.86                                   |
| 3. Indirect Emissions (Activity in kg N/yr, EF in kg N2O/kg N)                                  | 185 342 278   | 20.0%                    |               |                | 1.229704322    |                        |                        | 150.0%                 |           |          | 22.79    |                              |                              | 151.3%                       | 0.00                                   | 0.00                                   | 34.49                                  |
| F. Field Burning of Agricultural Residues   |               |                          |               |                |                |                        |                        |                        |           | 1.54     | 0.08     |                              | 20.8%                        | 108.9%                       | 0.00                                   | 0.32                                   | 0.08                                   |
| 1. Cereals  |               |                          |               |                |                |                        |                        |                        |           |          |          |                              |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| Wheat (Activity in t of crop production, EF in kg/t dm)   | 8 462 000     | 30.0%                    |               | 0.1816         | 0.0004         |                        | 20.0%                  | 150.0%                 |           | 0.15     | 0.00     |                              | 36.1%                        | 153.0%                       | 0.00                                   | 0.06                                   | 0.01                                   |
| Barley (Activity in t of crop production, EF in kg/t dm)  | 3 909 000     | 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)   | 244 000       | 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)  | 2 185 000     | 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)   | 6 216 000     | 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)                                 | 5 942 000     | 30.0%                    |               | 0.1576         | 0.0004         |                        | 20.0%                  | 150.0%                 |           | 0.09     | 0.00     |                              | 36.1%                        | 153.0%                       | 0.00                                   | 0.03                                   | 0.00                                   |
| 2. Pulses (Other non-specified)   | 615 000       | 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)                                      | 34 390 000    | 30.0%                    |               | 0.1796         | 0.0014         |                        | 20.0%                  | 150.0%                 |           | 0.62     | 0.05     |                              | 36.1%                        | 153.0%                       | 0.00                                   | 0.22                                   | 0.07                                   |
| 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)      | 33 923 000    | 30.0%                    |               | 0.0136         | 0.0005         |                        | 20.0%                  | 150.0%                 |           | 0.46     | 0.02     |                              | 36.1%                        | 153.0%                       | 0.00                                   | 0.17                                   | 0.03                                   |
|   |               |                          |               |                |                |                        |                        |                        |           |          |          |                              | 0.0%                         | 0.0%                         | 0.00                                   | 0.00                                   | 0.00                                   |
| 5. Land-Use Change and Forestry   |               |                          |               |                |                |                        |                        |                        | -35492.10 | 0.18     | 0.00     | 61.9%                        | 100.0%                       | 100.0%                       | -21952.10                              | 0.18                                   | 0.00                                   |
| A. Forest Land  |               |                          |               |                |                |                        |                        |                        | -43078.01 |          |          | 50.0%                        |                              |                              | -21539.01                              | 0.00                                   | 0.00                                   |
| B. Cropland   |               |                          |               |                |                |                        |                        |                        | 6889.89   |          |          | 50.0%                        |                              |                              | 3444.95                                | 0.00                                   | 0.00                                   |
| C. Grassland  |               |                          |               |                |                |                        |                        |                        | 3823.02   |          |          | 50.0%                        |                              |                              | 1911.51                                | 0.00                                   | 0.00                                   |
| D. Wetlands   |               |                          |               |                |                |                        |                        |                        | 0.00      |          |          | 50.0%                        |                              |                              | 0.00                                   | 0.00                                   | 0.00                                   |
| E. Settlements  |               |                          |               |                |                |                        |                        |                        | -3127.00  | 0.18     | 0.0013   | 50.0%                        | 100.0%                       | 100.0%                       | -1563.50                               | 0.18                                   | 0.00                                   |
| F. Other Land   |               |                          |               |                |                |                        |                        |                        | 0.00      | 0.00     | 0.0000   | 50.0%                        | 100.0%                       | 100.0%                       | 0.00                                   | 0.00                                   | 0.00                                   |
| 6. Waste  |               |                          |               |                |                |                        |                        |                        | 535.29    | 550.17   | 3.24     | 51.0%                        | 65.8%                        | 51.2%                        | 272.95                                 | 361.88                                 | 1.66                                   |
| A. Solid Waste Disposal on Land   |               |                          |               |                |                |                        |                        |                        |           | 216.29   |          |                              | 102.6%                       |                              | 0.00                                   | 221.94                                 | 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) | 11 988.95     | 23.0%                    |               |                |                |                        | 100.0%                 |                        |           | 216.29   | 3.18     |                              | 102.6%                       |                              | 0.00                                   | 221.94                                 | 0.00                                   |
| B. Wastewater Handling  |               |                          |               |                |                |                        |                        |                        |           | 333.88   |          |                              | 85.6%                        | 52.2%                        | 0.00                                   | 285.83                                 | 1.66                                   |
| Industrial Wastewater (Activity in Gg DC(1), EF in kg/kg DC)                                    | 3 114.54      |                          |               | 0.09           |                |                        | 100.0%                 |                        |           | 280.31   |          |                              | 100.0%                       |                              | 0.00                                   | 280.31                                 | 0.00                                   |
| Domestic and Commercial Wastewater (Activity in Gg DC(1), EF in kg/kg DC)                       | 237.48        | 30.0%                    |               | 0.225565873    |                |                        | 100.0%                 |                        |           | 53.57    |          |                              | 104.4%                       |                              | 0.00                                   | 55.93                                  | 0.00                                   |
| sewage N produced   | 38 038.00     | 15.0%                    |               |                | 0.0000835      |                        |                        | 50.0%                  |           |          | 3.18     |                              |                              | 52.2%                        | 0.00                                   | 0.00                                   | 1.66                                   |
| C. Waste Incineration   |               |                          |               |                |                |                        |                        |                        |           | 535.29   | 0.06     | 51.0%                        |                              |                              | 272.95                                 | 0.00                                   | 0.02                                   |
| biogenic (Activity in Gg, EF in kg/t waste)   |               | 10.0%                    |               |                |                | 50.0%                  |                        |                        |           | 123.52   | 0.01     | 51.0%                        |                              | 30.0%                        | 62.98                                  | 0.00                                   | 0.00                                   |
| plastics and other non-biogenic waste (Activity in Gg, EF in kg/t waste)                        |               | 10.0%                    |               |                |                | 50.0%                  |                        |                        |           | 535.29   | 0.06     | 51.0%                        |                              | 30.0%                        | 272.95                                 | 0.00                                   | 0.02                                   |



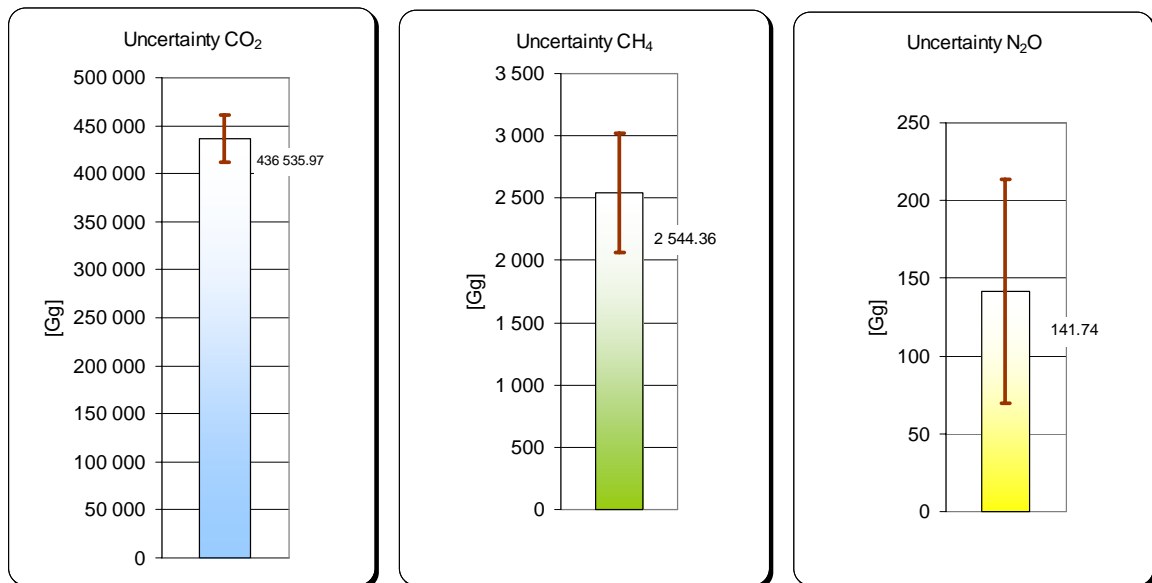
**Results of uncertainty analysis in percents for CO<sub>2</sub> with sectoral split.**



**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.**