CZECH HYDROMETEOROLOGICAL INSTITUTE

Section of the Director - ***Department of Climate Change***
Air Protection Section - ***Department of Emissions and Sources***

NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORT OF THE CZECH REPUBLIC

(REPORTED INVENTORY 2003)

Authors:
Pavel Fott, Jan Pretel, Dušan Vácha (CHMI)
Vladimír Neužil, Jan Bláha (KONEKO Marketing Ltd.)
Miroslav Havránek (CUEC)

The report was prepared in accordance with the UN Framework Convention on Climate Change related to national inventory submission 2005

Prague
May 2005

Content

EXECUTIVE SUMMARY

ES 1. Background Information

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Czech Republic is required to produce and regularly update National Greenhouse Gas Inventories. To date, National Greenhouse Gas Inventories have been produced for 1990 to 2003; nevertheless, data conversion into CRF format for 1991 and 1993 is still missing.

Through adopting decision 3/CP.5, the COP has undertaken to implement the UNFCCC guidelines on reporting and reviewing (FCCC/CP/1999/7). According to this decision, Parties shall submit a National Inventory Report (NIR) containing detailed and complete information on their inventories, in order to ensure the transparency of the inventory. This is the fourth version of the National Inventory Report (NIR) submitted by the Czech Republic; it is an update of the NIR submitted in 2004. This report is based on the figures submitted to the UNFCCC in CRF 2005 submission, which contains data for 2003 and revised data for 1995. These data differ from last year's reported data, as some activity data have been updated or changes in methodology have been made retrospectively, to improve the accuracy of the GHG inventory. In the NIR 2004 version (last reported inventory for 2002), the authors began to apply the updated Reporting Guidelines (FCCC/CP/2008/8) but, because of lack of time, only the general chapters were adapted to the new requirements, while the majority of the sectoral chapters were modified only partially and will be rewritten in the next version of the NIR for 2005 (last reported inventory for 2004).

There is an Executive Summary that gives an overview on the Czech GHG inventory. Chapters 1 and 2 provide general information on the inventory preparation process and summarize the overall trends in emissions. Comprehensive information on the methodologies used for estimating emissions of the national GHG inventory is presented in the Sector Analysis Chapters 3 - 8. Chapter 9 gives an overview of actions planned to further improve the inventory and of changes previously made (recalculations).

References used are also included as well as the underlying emission data for 2003 as included in the CRF tables Submission 2005. Furthermore detailed results from the key source analysis, detailed information on the methodology of emission estimates for the fuel combustion sector, the CO_2 reference approach as well as data from the national energy balance are presented.

It is the intention of the NIR 2005 to help understanding the calculation of the Czech GHG emission data. Those who want to know more details will have to consult the background literature cited in this document, unfortunately, the majority of the background literature is available only in Czech.

The preparation and review of the Czech GHG Inventory as well as the preparation of the NIR 2005 is under the responsibility of Mr. Pavel Fott of the Czech Hydrometeorological Institute, Department of Emission and Sources, as a National GHG Inventory Expert.

Specific responsibilities for the NIR 2003 have been as follows:

Executive Summary	*Jan Pretel, Dusan Vacha*
Chapter 1	*Pavel Fott, Jan Pretel*
Chapter 2	*Dusan Vacha, Jan Pretel*
Chapter 3	*Jan Blaha, Vladimir Neuzil, Pavel Fott*
Chapter 4	*Dusan Vacha, Pavel Fott, Vladimir Neuzil*
Chapter 5	*Vladimir Neuzil*
Chapter 6	*Pavel Fott*
Chapter 7	*Dusan Vacha, Jan Pretel*
Chapter 8	*Miroslav Havranek*
Chapter 9	*Pavel Fott*

The Czech Hydrometeorological Institute expresses its thanks and appreciation for the effort in producing a national methodology and emission inventory of high quality.

ES 2. Summary of National Emission and Removal Related Trends

In 2003, the most important GHG in the Czech Republic was CO_2 contributing 86.0 % to total national GHG emissions and remowals expressed in $CO_{2\ eq.}$, followed by CH_4, 7.1 % and N_2O, 5.7 %. PFCs, HFCs and SF6 contributed for 1.2 % to the overall GHG emissions in the country. The energy sector accounted for 86.1 % of the total GHG emissions followed by Industrial Processes 9.1 %, Agriculture 5.2 % and Waste 2.0 %. Total GHG emissions (without CO_2 from land-use change and forestry) amounted to 147 203 Gg $CO_{2\ eq.}$ and decreased by 23.3 % from 1990 to 2003.

Tab. 1 provides data on emissions by sectors and Tab. 2 by gas from 1990 to 2003.

Tab. 1 Summary of GHG emissions by sector 1990 - 2003 *[Gg $CO_{2\ eq}$]*

	Energy	Industrial Processes	Solvent Use	Agriculture	LUCF	Waste
1990	171 018	4 708	734	12 521	-2 073	2 983
1992	145 150	4 316	671	9 934	-6 511	3 307
1994	135 779	3 849	596	8 459	-4 640	3 186
1995	136 686	3 989	577	8 685	-4 216	3 205
1996	137 909	3 936	662	9 188	-4 437	3 163
1997	142 428	4 323	522	8 681	-4 591	2 878
1998	132 666	4 465	566	7 933	-3 710	2 924
1999	125 274	3 968	551	7 844	-3 346	2 729
2000	132 472	4 336	549	7 542	-3 966	2 731
2001	130 265	6 991	531	7 592	-4 308	2 621
2002	125 303	6 798	531	7 431	-4 435	2 835
2003	123 398	13 017	480	7 409	-3 790	2 839

Tab. 2 Summary of GHG emissions by gas 1990 - 2003 *[Gg $CO_{2\,eq}$]* [1]

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
1990	161 862	16 763	11 266	-	-	-
1992	133 252	14 390	9 227			
1994	125 945	13 008	8 275			
1995	127 148	12 855	8 754	2.2	0.4	167
1996	128 294	12 594	9 211	135	4	183
1997	132 718	12 085	8 811	296	7	323
1998	124 511	11 421	8 390	382	9	132
1999	117 692	10 691	8 111	412	3	111
2000	123 886	10 714	8 175	674	9	206
2001	123 633	10 485	8 291	1 045	14	223
2002	118 566	10 373	8 174	1 092	18	212
2003	123 276	10 210	8 157	1 344	29	339

Over the period 1990 - 2003 CO_2 emissions and removals decreased by 23.8 %[4], mainly by emissions reduction in *Energy* (22.2 %[4]); although CO_2 emissions from *Transport* increased by about 85 % over the same period. CH_4 emissions decreased by 39.1 % during the same period mainly due to lower emissions from *Energy* (41.3 % reduction relative to base year), *Agriculture* (48.1 % reduction) and *Waste* (18.5 % reduction relative to base year); N_2O emissions decreased by 27.5 % over the same period due to emission reduction in *Agriculture* (37.0 % relative to base year); N_2O emissions from *Transport* increased almost 8-times relative to base year. Emissions from HFCs and PFCs increased more than 600-times and 80-times, respectively, whereas SF_6 emissions increased 2-times from the base year (1995) to 2003.

ES 3. Overview of Source and Sink Category Emission Estimates and Trends

In 2003, 123 398 Gg $CO_{2\,eq.}$, that are 83.8 % of national total emissions (excluding land-use change and forestry) arose from *Energy*; 95.3 % of these emissions arise from fuel combustion activities. The most important sub sector of *Fuel Combustion* with 48.3 % of total sectoral emissions in 2003 is *Energy Industries*, M*anufacturing Industries and Construction* responses for 22.5 % and *Transport* for 11.4 % of total sectoral emissions. From 1990 to 2003 emissions from *Energy* decreased by 23.0 %[4].

Industrial Processes is the third largest sector with 8.8 % of total GHG emissions (excluding land-use change and forestry) in 2002 (13 017 Gg $CO_{2\,eq.}$); the largest sub sector is *Metal Production*. From 1990 to 2003 emissions from *Industrial Processes* increased by 0.4 %[4].

Agriculture is the third largest sector in the Czech Republic with 5.0 % of total GHG emissions (excluding land-use change and forestry) in 2003 (7 409 Gg $CO_{2\,eq.}$); about 2 / 3 of emissions is coming from *Enteric Fermentation*. From 1990 to 2003 emissions from *Agriculture* decreased by 40.8 %.

In 2003, 0.3 % of total GHG emissions (excluding land-use change and forestry) in the Czech Republic (480 Gg $CO_{2\,eq.}$) arose from the sector *Solvent and Other Product Use*. From 1990 - 2003 emissions from *Solvent and Other Product Use* decreased by 34.6 %.

1.9 % of the national total GHG emissions (excluding land-use change and forestry) in 2003 arose from *Waste.* Emissions from *Waste* decreased from 1990 to 2003 by 4.8 % to 2 839 Gg $CO_{2\,eq.}$

---

[1] CO_2 emissions excl. LUCF sector

ES 4. Overview of Emission Estimates and Trends of Indirect GHGs and SO_2

Emission estimates of indirect GHGs and SO_2 for the period from 1990 through 2003 are presented in Tab. 3.

Tab. 3 Indirect GHGs and SO_2 for 1990 - 2003 *[Gg]*

	NO_X	CO	NMVOC	SO_2
1990	544	1 257	441	1 881
1991	521	1 179	394	1 780
1992	496	1 170	366	1 543
1993	454	1 103	346	1 424
1994	375	1 125	310	1 275
1995	368	999	292	1 089
1996	366	1 012	293	944
1997	349	944	277	697
1998	321	765	242	438
1999	313	716	234	268
2000	321	648	227	264
2001	332	649	220	251
2002	318	546	203	237
2003	324	603	203	230

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2003: for NO_x by 40 %, for CO by 52 %, for NMVOC by 54 % and for SO_2 by 88 %. The most important emission source for indirect greenhouse gases and SO_2 are fuel combustion activities.

1 Introduction and General Issues

1.1 Background

Annual monitoring of greenhouse gas emissions and removals is one of the obligations following from the *UN Framework Convention on Climate Change*. In addition, as a result of membership in the European Union, the Czech Republic must also fulfill its reporting requirements concerning GHG emissions and removals following from Decision of the European Parliament and Council No. 280/2004/EC.

The *Czech Hydrometeorological Institute* (CHMI) was accredited in 1995 by the Ministry of Environment (ME), which is the founder and supervisor of CHMI. Thereafter CHMI is the official provider of Czech greenhouse gas emission data.

Inventory studies have been gradually elaborated in CHMI for years since 1990: the first study was issued in 1995 for 1990 - 1993 (Fott *et al*, 1995). Following the authorization given by the *Ministry of Environment*, the results of these studies have been submitted in the prescribed format to the *Secretariat of Framework Convention* as official national information. In addition, GHG inventory results compiled by CHMI were summarized in National Communications (*Second National Communication*, 1997; *Third National Communication*, 2001) for the 1990 - 1995 and 1990 - 1999 period, respectively.

This report includes GHG emission inventory in the Czech Republic for 2003 in relation to the preceding period, especially to the reference year 1990. The greatest attention is focused on direct greenhouse gases regulated by the *Kyoto Protocol* - CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. In addition, the precursors of greenhouse gases and aerosols (NO_X, CO, NMVOCs, SO_2) are also monitored. Similar to previous years, inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997; *Good Practice Guidance*, 2000); application of this general methodology on country specific circumstances will be described in following paragraphs.

This version of NIR represents the fourth volume and is also available in English (since the 2002 submission). Previous reports were written only in Czech. The first two English issues were compiled according to the UNFCCC *Reporting Guidelines* (FCCC/CP/1997/7). Last year the authors began to apply the updated *Reporting Guidelines* (FCCC/CP/2002/8) but, because of lack of time, only the general chapters were adapted to the new requirements. The process of implementation of the updated *Reporting Guidelines* is continuing this year and more significant progress is planned for next year.

Since 1998, inventory data have been reported in *Common Reporting Format*. Moreover, data for some previous years (1990, 1992, 1994 and 1995) were also converted to this format. This effort will continue to obtain complete time series in the prescribed CRF.

1.2 Institutional Arrangement for Inventory Preparation

The *Czech Hydrometeorological institute* (CHMI), under the supervision of the *Czech Ministry of Environment* (ME), is responsible for preparation of the national inventory. The national system, as required by the *Kyoto Protocol* (Article 5.1) and by Decision No. 280/2004/EC, which requires allocation of sectoral responsibilities to more specialized and competent co-operating institutions possessing a higher level of sectoral skill and expertise, has not been fully put in place yet and is currently being established in cooperation with ME; it is expected to be in place from 2006. The existing practice in national inventories can be summarized as follows:

CHMI is responsible for inventory management and thus it deals with all general and crosscutting issues including the choice of methods, data processing and data storage and archiving relevant documents. Owing to the lack of suitable sectoral co-operators, it also provides collecting activity data and emissions factors where necessary.

Its main participant is KONEKO MARKETING LTD., which directly participates in the national inventory preparation in Energy, including fugitive emission and also in some industrial processes. The Charles University Environment Center (CUEC) is responsible for compilation of inventories from the Waste sector.

CHMI, as a managing organization, is looking for further co-operators. Preliminarily, the following candidates are considered for future co-operation: IFER for the LUCF sector and CDV for compiling emissions from mobile sources. In addition, a number of external experts from universities and research institutes are also involved in the inventory preparation as consultants.

1.3 Process of Inventory Preparation (data collection, data processing, data storage)

1.3.1 Activity Data Collection

Collection of activity data is based mainly on the official documents of the Czech Statistical Office, which are published annually, where the Czech Statistical Yearbook is the most representative example. However for industrial processes, due to the Czech Act on Statistics, production data are not generally available when there are less than 4 enterprises in the whole country. In such cases, inventory compilers have to rely either on specific statistical materials edited by sectoral associations or, in some cases, inventory experts have to carry out relevant inquiries. In a few cases, the Czech register of individual sources and emissions called REZZO is utilized as source of activity data.

Emissions estimates from Sector 1A - Energy combustion are based on the official Czech Energy Balance, compiled by the Czech Statistical Office. Data from the Czech Energy balance are processed both in the Reference Approach (TPES - primary sources data are used) and in the Sectoral Approach (data for fuel transformations and final consumptions). However, in the latter case, some additional data are required (e.g. transportation statistics data).

1.3.2 Data Processing and Storage

Data Sector 1A - Energy combustion are processed by the system of interconnected spreadsheets, compiled in MS Excel following “Worksheets” presented in IPCC *Guidelines*, Vol. 2. *Workbook.* The system is extended by incorporating sheets with modified energy balance: these sheets represent an input data system.

Also, in the majority of other sectors, data are processed in a similar way - by using a system of joined spreadsheets taken from the *Workbook* and slightly modified in order to respect national circumstances. The following examples of such cases of processing can be mentioned: agriculture, waste, fugitive emissions. On the other hand, in some cases, e.g. for solvent use, such a system is not as efficient and thus it is substituted by spreadsheets inspired by the CORINAIR methodology. For LUCF, a specific spreadsheet system is used, respecting the national methodology. This system was developed in the middle of the 1990s and extended slightly a few years ago by including trees along rivers. All spreadsheets mentioned above are stored electronically.

After calculations, all relevant data are put into the *Common Reporting Format* to be reported and to be stored together with detailed calculation spreadsheets.

1.4 Methodologies and Data Sources

1.4.1 Overview

The IPCC methodology has been prepared for the purpose to compile national inventories of anthropogenic GHG emissions and removals. Its first version was published in 1995. However, it was reviewed soon afterwards, so that the second version has been in use since 1997 (*Revised 1996 IPCC Guidelines*, 1997).

Methodology is related to greenhouse gases with direct radiation absorption effect (CO_2, CH_4, N_2O, substances with increased radiation absorption effect containing fluorine HFCs, PFCs and SF_6, precursors of tropospheric ozone NO_X, NMVOCs, CO, and aerosol precursor SO_2). It highlights CO_2 emissions as the most important greenhouse gas. The only anthropogenic sources according to the IPCC methodology is fossil fuels combustion and, to some extent, also cement production, possibly also limestone and other carbonate minerals decomposition (e.g. melting of glass, liming of soil, lime-based sulfur removal, etc.), unless subsequent sinks compensate these.

The combustion of fossil fuels in stationary and mobile sources usually constitutes the best-known group of sources in most countries. Two IPCC methods are prescribed for the determination of CO_2 emissions from fuel combustion; independent approaches are based to a certain degree on the national energy balance. A simpler procedure (Reference Approach**)**, basically determines the total amount of burned carbon on the basis of the balance calculation of apparent consumption of individual types of fuel (e.g. hard coal, petroleum, petrol, natural gas) for which the inventory is prepared (i.e. mining + imports - exports - change in stocks). This information is expressed in energy units (TJ) in the energy balance. The necessary emission factors for carbon (t C / TJ) for the individual kinds of fuel are listed in the methodical materials and are sufficiently accurate.

The second method (Sectoral Approach**)** is based on the actual fuel consumption in individual categories (e.g. energy production, industry, transportation). The calculation using these two methods requires different items in the energy balance. The Reference Approach is based on primary sources, while the Sectoral Approach is based on transformation processes and final consumption. Both methods also take into account that a smaller part of the fuel is utilized for purposes other than energy production (e.g. lubricating oils, asphalt). For other fuels, it is assumed that almost all the carbon is burned to form carbon dioxide and a small correction is made for unburned carbon. The Reference Approach is very transparent and thus is used especially for control purposes. On the other hand, it does not permit determination of source category of in which the emissions of carbon dioxide are generated and thus the Sectoral Approach has tended to be preferred recently. However, sufficiently reliable energy statistics are required for good quality inventories. The difference in the results for carbon dioxide emissions for the two methods should not exceed 2 %.

Another source, or rather sink of CO_2, is related to Land Use Change and Forestry and it is associated, in particular, with felling or planting forests; the amount of carbon contained in felled trees is considered to correspond to emissions and, to the contrary, the amount of carbon contained in growing wood is considered as a sink. In this approach, any other CO_2 emissions formed, e.g., in burning or aerobic decay of wood or other biomass is not included in the overall emission balance.

Due to character of the most important CH_4 and N_2O sources, like coal mining, animal breeding, landfills and wastewater handling (CH_4), agricultural soils, management of animal waste, production of nitric acid, fluid-bed and local combustion, automobiles with catalyzers (N_2O), the most accurate method to determine emissions (e.g. continuous direct measurement) can be used only exceptionally. Therefore, calculations are based on monitoring of the relevant statistical indicators (coal mining, number of head of farm animals, amount of nitric acid produced, amount of nitrogenous fertilizers employed, etc.) and application of relevant emission factors is a part of emission calculations. Depending on the complexity of the calculation and types of emission factors used (generally recommended - *default*, country-specific, site-specific and technology-specific), the approaches described in the IPCC methodology are separated into three tiers.

The Tier 1 is typically characterized by simpler calculations, based on the basic statistical indicators and on the use of generally recommended emission factors (*default*) of global or continental applicability, tabulated directly in methodical manuals (*Revised 1996 IPCC Guidelines*, 1997; *Good Practice Guidance*, 2000).

The Tier 2 is based on sophisticated calculation and usually requires more detailed and less accessible statistical data. The emission factors (country-specific or technology-specific) are usually derived using calculations based on more complex studies and better knowledge of the source. Even in these cases, it is sometimes possible to find the necessary parameters for the calculation in IPCC manuals. Procedures in the Tier 3 are usually considered to consist in procedures based on the results of direct measurements carried out under local conditions (site-specific and technology-specific emission factors).

Apparently, procedures in higher tiers should be more accurate and should better reflect the reality. However, they are more demanding in all aspects, and especially they are more expensive. Nonetheless, the determination of emissions according to a procedure in the Tier 1 should always be carried out at least for control, because of its higher transparency.

All GHG emissions can be also expressed in terms of total (or aggregated) values, which are calculated as a sum of the emissions of the individual gases multiplied by Global Warming Potential values (GWP). GWP correspond to the factor by which the given gas is more effective in absorption of terrestrial radiation than CO_2 (1 for CO_2, 21 for CH_4 and 310 for N_2O). Total amount of F-gases is relatively small compared to CO_2, CH_4 and N_2O; nevertheless their GWP values are larger by 2-4 orders of magnitude. So, total aggregated emissions to be reduced according to the *Kyoto Protocol* are expressed as the equivalent amount of CO_2 with the same radiation absorption effect as the sum of the individual gases.

1.4.2 **Good Practice Guidance** *and its Implementation in the Czech Inventory*

Increased compliance requirements related to the *Kyoto Protocol* were basis for further improvement of existing IPCC methodology to assure higher level of inventory quality and adequate reduction of inventory uncertainties. Therefore, the new methodological handbook was prepared by the IPCC, entitled as *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (in following text it will be referred as the *Good Practice Guidance*). This methodical handbook is understood as a supplement to the *Revised 1966 IPCC Guidelines*. Its main aim is to assist Parties in preparing their inventories to assure that emission estimates are neither overestimated nor underestimated (wherever possible), and uncertainty in determining of emissions is reduced as much as possible. Implementation of *Good Practice Guidance* in preparation of national inventory improves its transparency, consistency and completeness and it is good basis for an evaluation of levels and trends in uncertainties, verifiability (QC/QA mechanisms) and inventory comparison with other Parties.

In the framework of the *Good Practice Guidance*, rules have also been created for reporting results and documenting procedures in the given category and also enabling effective control and revision of inventories both by the preparing team - QC (Quality Control), and by an independent audit - QA (Quality Assurance).

In relation to general methodological aspects, attention should be made particularly of quantification of uncertainty in the individual year and in the overall trend. Simultaneously, consideration is given to cases of inaccuracies in the individual categories of sources, which is described either by the statistical parameters or at least on the basis of an expert judgment. The uncertainty in the total emissions or its trend can be determined in the Tier 1 using the method of error propagation, based on mathematical statistical relationships for calculation of the scattering of the sum or product from the corresponding scatters of the individual terms. Model methods of the Monte-Carlo type are more sophisticated and can be used for the Tier 2.

From a practical viewpoint, identification of *key sources* is of great importance. These sources contribute to a decisive degree to the total amount of emissions or to its uncertainty, both in the individual year and in terms of trends. Considerably more attention should be paid to *key sources* and their categories, compared to the remaining sources or categories. This means that, where possible, more sophisticated procedures at a higher tier should be used for determining emissions from *key sources*, using site-specific or at least national emission factor values. However, this is often not possible in the absence of expenditure of financial means required to ensure carrying out suitable studies and the relevant measurements. Any means employed to improve the quality of the inventory should be expended in the most effective manner possible and should be preferentially oriented to *key sources*.

One of the most important *Good Practice* issues consists in ensuring consistent time series. In order to achieve this goal, it is necessary to ensure that the entire time series is determined in a methodologically consistent manner. In case of revision of the methodology and its further development, it is sometimes necessary to recalculate the values for previous years if the emission values for these years were determined using an older, obsolete version. Recalculation must sometimes also be carried out when an error is found in earlier calculations or in the use of an unsuitable method.

The Czech national inventory is generally based on the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997). Results determined earlier by older version of IPCC Guidelines from 1995 (*IPCC Guidelines*, 1995) were retained if no methodological change was involved, or had already been recalculated (e.g. CH_4 emissions from coal mining) previously or were recalculated recently (e.g. N_2O emissions, CH_4 emissions from waste). In fact, the latter two revisions reflect *Good Practice Guidance* (recalculation of N_2O emissions for 1991 and 1993 has not yet been completed).

In GHG emission inventories for 2000 - 2003 instructions from *Good Practice Guidance* were gradually implemented. Attention was focused particularly on identification of *key sources,* which will be targeted throughout the entire process. Emphasis is also placed on consistency of the time series.

On the other hand, in preparing this inventory, somewhat less attention was paid to emissions of the precursors NO_X, CO, NMVOCs and SO_2, which are covered primarily by *Convention on Long-Range Transboundary Air Pollution* (CLRTAP) and are not directly related to the Kyoto Protocol. Their inventories are compiled for the purposes of CLRTAP by NFR (*New Format of Reporting*) by another team at CHMI. Since 2001, emissions of precursors in the GHG inventory (CRF) have been fully taken over and transferred from NFR.

It is also necessary to point out that *Good Practice Guidance* for the category Land Use Change and Forestry has only recently prepared approved by COP on December 2003 and so has not been applied yet. At the present time, only the methodical instructions given in (*Revised 1996 IPCC Guidelines*, 1997) have been employed.

As part of the implementation of *Good Practice Guidance* and as a response to review processes performed by UNFCCC, it was decided to re-classify emissions from the production of iron and steel. To date, these emissions have been treated under sub-category 1A2 (to be compatible with the *Reference Approach*); starting with 2001, these emissions are classified under 2C1 (Metal production, Production of iron and steel). Emissions from ammonia production have been re-classified (from 1A2 to 2B1) in a similar way since 2003. However, the corresponding recalculations of the whole time series since the reference year 1990 will not be complete until the end of next year.

In this edition of NIR, uncertainty analysis using Tier 1 approach has been also commenced. This analysis should be considered as only preliminary, because uncertainty data have not been too perfect so far. However, uncertainty data will be gradually improved and as a consequence of this fact quality of uncertainty analysis should be strengthened as well.

1.5 Key Source Categories

The *Good Practice Guidance* provides two tiers of determining these *key sources*. *Key sources* by definition contribute to ninety percent of the overall uncertainty in a level (in emissions per year) or in a trend. The procedure in the Tier 2 follows from this definition, and requires thorough analysis of the uncertainty and use of sophisticated statistical procedures and evaluation of sources in terms of the appropriate characteristics. However, it is more difficult to obtain the necessary data for this approach and this information is not yet available on the national level.

The procedure of the Tier 1 is based on the fact that ninety percent of the overall uncertainty in a level or in a trend is usually caused only by those sources whose contribution to total emissions does not exceed 95 %. This procedure is illustrated in Tab. 1.1 (determined on the basis of the level of emissions, i.e., level assessment) and Tab. 1.2 (determined on the basis of trends, trend assessment). The sources or their categories are for level assessment ordered on the basis of decreasing contribution to total emissions. The *key sources* were considered to be those (denoted in bold) whose cumulative contribution is less than 95 %. For trend assessment, a similar procedure is used; with the difference that here the decisive quantity is defined as the product of the relative contribution to the total emissions (determined in the previous case) and the absolute value of the relative deviation of the individual trends from the total trend.

On the basis of the emission level (Tab. 1.1), a total of 13 *key sources* were established (denoted in bold) for the data of 2003, where trend analysis (Tab. 1.2) led to inclusion of substances containing N_2O from road transport, whose values increased, in contrast to the overall trend. Analogous key source analyses for years 1999, 2000 and 2001 are presented in former NIRs, see (Fott *at al*, 2002; Fott *at al*, 2004). It can be concluded that the key source assessment in the latest years are quite stable.

Tab. 1.1 Determining National Key Source Categories for 2003 (*Tier 1 - Level assessment*)

Sources / categories of sources	Gas	Emission *[Gg $CO_{2\,eq}$]*	Share *[%]*	Cumulative *[%]*
Energy: Stationary Combustion - Solid (CO_2)	**CO_2**	75 098	51.0	51.0
Energy: Stationary Combustion - Gas (CO_2)	**CO_2**	18 648	12.7	63.6
Energy: Mobile Combustion - Road	**CO_2**	12 727	8.6	72.3
Energy: Stationary Combustion - Liquid (CO_2)	**CO_2**	8 013	5.4	77.7
Industrial: Iron and steel (CO_2)	**CO_2**	7 576	5.1	82.9
Energy: Fugitive Emissions - Coal Mining (CH_4)	**CH_4**	4 796	3.3	86.1
Agriculture: Direct Emissions N_2O from Soils	**N_2O**	2 899	2.0	88.1
Industrial: Mineral Products - decarbonizing (CO_2)	**CO_2**	1 980	1.3	89.4
Agriculture: Indirect Emissions N_2O from Agriculture	**N_2O**	1 897	1.3	90.7
Waste: Landfiles (CH_4)	**CH_4**	1 752	1.2	91.9
Indusrtial: Usage of New Gases	**F-gases**	1 712	1.2	93.1
Agriculture: Enteric Fermentation (CH_4)	**CH_4**	1 595	1.1	94.2
Energy: Mobile Combustion - Off Road incl. Waters	**CO_2**	1 492	1.0	95.2
Industrial: Nitric Acid and other chemicals (N_2O)	***N_2O***	972	0.7	95.8
Energy: Stationary Combustion	N_2O	946	0.6	96.5
Industrial: Ammonia (CO_2)	CO_2	706	0.5	96.9
Energy: Mobile Combustion - Aircraft	CO_2	690	0.5	97.4
Waste + Solvent Use: Waste Incineration + SU	CO_2	634	0.4	97.8
Agriculture: Manure Management (CH_4)	CH_4	629	0.4	98.3
Energy: Mobile Combustion - Road	N_2O	617	0.4	98.7
Waste: Wastewater Handling	CH_4	516	0.4	99.0
Energy: Fugitive Emissions - Oil and Gas (CH_4)	CH_4	499	0.3	99.4
Agriculture: Manure Management (N_2O)	N_2O	390	0.3	99.6
Energy: Stationary Combustion	CH_4	239	0.2	99.8
Waste: Wastewater Handling	N_2O	202	0.1	99.9
Energy: Mobile Combustion - Road	CH_4	48	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	N_2O	18	0.0	100.0
Energy: Mobile Combustion - Aircraft	N_2O	6	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	CH_4	6	0.0	100.0
Energy: Mobile Combustion - Aircraft	CH_4	4	0.0	100.0

**) Nitric acid production was evaluated as a key source last years*

Tab. 1.2 Determining National Key Source Categories (*Tier 1 - Trend assessment*)

Sources / categories of sources	Gas	Emiss. 90 *[Gg $CO_{2\,eq.}$]*	Emiss. 03 *[Gg $CO_{2\,eq.}$]*	Level *[%]*	Trend *[%]*	Part *[%]*	Cum. *[%]*
Energy: Stationary Combustion - Solid (CO_2)	**CO_2**	124 441	82 674	56.1	11.2	31.7	31.7
Energy: Stationary Combustion - Gas (CO_2)	**CO_2**	12 933	18 648	12.7	7.8	22.1	53.8
Energy: Mobile Combustion - Road	**CO_2**	5 995	12 727	8.6	7.2	20.5	74.3
Energy: Stationary Combustion - Liquid (CO_2)	**CO_2**	14 407	8 718	5.9	2.0	5.8	80.1
Industrial: Usage of New Gases	**F-gases**	169	1 712	1.2	1.4	4.0	84.1
Energy: Fugitive Emissions - Coal Mining (CH_4)	**CH_4**	7 600	4 796	3.3	0.9	2.6	86.7
Agriculture: Enteric Fermentation (CH_4)	**CH_4**	3 271	1 595	1.1	0.8	2.3	89.0
Energy: Stationary Combustion	**CH_4**	1 174	239	0.2	0.6	1.7	90.6
Industrial: Mineral Products - decarbonizing (CO_2)	**CO_2**	3 380	1 980	1.3	0.5	1.5	92.2
Agriculture: Direct Emissions N_2O from Soils	**N_2O**	4 529	2 899	2.0	0.5	1.4	93.6
Energy: Mobile Combustion - Road	**N_2O**	71	617	0.4	0.5	1.4	95.0
Agriculture: Indirect Emissions N_2O from Agriculture	N_2O	3 041	1 897	1.3	0.4	1.1	96.1
Energy: Mobile Combustion - Off Road incl. Waters	CO_2	2 304	1 492	1.0	0.2	0.7	96.8
Waste: Landfiles (CH_4)	CH_4	1 957	1 752	1.2	0.2	0.6	97.4
Waste + Solvent Use: Waste Incineration + SU	CO2	530	634	0.4	0.2	0.6	98.0
Energy: Mobile Combustion - Aircraft	CO_2	699	690	0.5	0.1	0.4	98.4
Agriculture: Manure Management (CH_4)	CH_4	1 017	629	0.4	0.1	0.4	98.8
Agriculture: Manure Management (N_2O)	N_2O	663	390	0.3	0.1	0.3	99.1
Waste: Wastewater Handling	CH_4	826	516	0.4	0.1	0.3	99.4
Industrial: Nitric Acid and other chemicals (N_2O)	N_2O	1 125	972	0.7	0.1	0.3	99.6
Energy: Stationary Combustion	N_2O	1 321	946	0.6	0.1	0.2	99.8
Waste: Wastewater Handling	N_2O	202	202	0.1	0.0	0.1	99.9
Energy: Fugitive Emissions - Oil and Gas (CH_4)	CH_4	676	499	0.3	0.0	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	CH_4	12	6	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Road	CH_4	59	48	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Aircraft	N_2O	6	6	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	N_2O	25	18	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Aircraft	CH_4	4	4	0.0	0.0	0.0	100.0

1.6 Uncertainty Analysis

Results of uncertainty analysis are given in Tab. 1.3

Uncertainty analysis of Tier 1 is presented for the first time in this volume of NIR. Preparatory work on this task was commenced two years ago, when the relevant calculation sheets were elaborated according to the *Good Practice Guidance*. The correctness of calculations procedures were tested and verified using model calculations for the United Kingdom, because this case is presented directly in the *Good Practice Guidance* as an example for illustration of described calculation procedure.

In this NIR, spreadsheets prepared earlier have been employed for evaluation of uncertainties in the Czech Republic. So far, rather in-exact results have been available, based only on "default" uncertainty data presented in Good Practice Guidance, combined with uncertainties based on "expert judgment". To achieve more reliable results, it will be necessary to gather more relevant uncertainty data concerning both activity data and emission factors. As soon as more precise uncertainty estimates appear, they will be immediately inserted in the calculation spreadsheet.

Relatively low uncertainty in level (7 %) could be connected with a dominant contribution of CO_2 from fossil fuel combustion, which is usually more accurate compared with other sources. The value of 2.8 % in the trend uncertainty can be considered to be a typical result.

The same source categories used in key sources assessment have also been used even in uncertainty analysis. In this way, the uncertainty analysis result will be used later for Tier 2 key source analysis, which might be more suitable. It should be noted that the "Iron and steel (CO_2)" and "Ammonia production (CO_2)" subcategories are in this uncertainty analysis kept together with "Stationary combustion - Solid (CO_2)" and "Stationary combustion - Liquid (CO_2)", respectively, because of the relevant splitting of the two subcategories is so far available only for data for 2001 and onwards. Uncertainty analysis results for 2003 are very similar to results for 2001, see (Fott *at al*, 2004)

1.7 QA/QC

The Czech Republic has not implemented a general QA/QC or verification plan. Nevertheless, several checks have been formalized. In general terms, these include:

- A stepwise procedure in the preparation of the final national inventory, including recalculation to ensure time series consistency
- Checking of the data and relevant information collected by co-operating institutions (KONEKO MARKETING LTD., CUEC and external experts by experts from CHMI and *vice versa* and follow up of discrepancies)
- Quality control of the emission estimates through comparison with corresponding figures calculated earlier and consistency check for subsequent years.

Sector specific QA/QC procedures are described in the sectoral chapters.

Tab. 1.3 Tier 1 uncertainty analysis in level and trend for year 2003

Input DATA						**Uncertainty in Level**		**Un. in trend**
IPCC Source Category	Gas	Base year emissions (1990)	Year emissions (2003)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Uncertainty introduced into the trend in total national emissions
		[Gg $CO_{2\ eq}$]		*[%]*	*[%]*	*[%]*	*[%]*	*[%]*
1A Energy: Stac. Comb. - Solid, KEY(L,T)	CO_2	124 441	82 674	4.0	4.0	5.66	3.19	2.46
1A Energy: Stac. Comb. - Liquid, KEY(L,T)	CO_2	14 407	8 719	4.0	3.0	5.00	0.30	0.26
1A Energy: Stac. Comb. - Gas, KEY(L,T)	CO_2	12 933	18 648	4.0	3.0	5.00	0.64	0.57
1A Energy: Mob. Comb. - Road, KEY(L,T)	CO_2	5 995	12 727	4.0	3.0	5.00	0.43	0.40
1A Energy: Mob. Comb. - Off Road, KEY (L)	CO_2	2 304	1 492	4.0	3.0	5.00	0.05	0.04
2 Industrial: Mineral Products, KEY(L,T)	CO_2	3 380	1 980	5.0	25.0	25.50	0.34	0.11
3,6 Solvent Use + Waste incineration	CO_2	530	634	20.0	5.0	20.62	0.09	0.09
1A Energy: Stacionary Combustion	CH_4	1 174	239	4.0	50.0	50.16	0.08	0.17
1A Energy: Mob. Comb. - Road	CH_4	59	48	4.0	50.0	50.16	0.02	0.00
1B Energy: Fugitive - Coal Mining, KEY (L,T)	CH_4	7 600	4 796	4.0	40.0	40.20	1.32	0.26
1B Energy: Fugitive - Oil and Gas	CH_4	676	499	4.0	30.0	30.27	0.10	0.02
4 Agriculture: Enteric Ferm., KEY(L,T)	CH_4	3 271	1 595	7.0	40.0	40.61	0.44	0.21
4 Agriculture: Manure Man.	CH_4	1 017	629	7.0	60.0	60.41	0.26	0.06
6 Waste: Landfiles, KEY(L)	CH_4	1 957	1 752	25.0	40.0	47.17	0.56	0.33
6 Waste: Wastewater Handling	CH_4	826	516	50.0	50.0	70.71	0.25	0.19
1A Energy: Stacionary Combustion	N_2O	1 321	946	4.0	80.0	80.10	0.52	0.04
1A Energy: Mob. Comb. - Road, KEY(T)	N_2O	71	618	4.0	80.0	80.10	0.34	0.24
2 Industrial: Nitric Acid, etc., KEY(L)	N_2O	1 125	972	15.0	30.0	33.54	0.22	0.11
4 Agriculture: Direct N2O from Soils, K (L,T)	N_2O	4 529	2 899	15.0	250.0	250.45	4.95	0.81
4 Agriculture: Indirect N2O from Agriculture	N_2O	3 041	1 897	15.0	250.0	250.45	3.24	0.60
4 Agriculture: Manure Man.	N_2O	663	390	7.0	250.0	250.10	0.67	0.15
6 Waste: Wastewater Handling	N_2O	202	202	20.0	50.0	53.85	0.07	0.03
2 Usage of New Gases, KEY (T)	HFCs PFCs SF_6	169	1 712	25.0	1.0	25.02	0.29	0.32
	Total	**191 690**	**146 581**				**7.03**	**2.84**
							Level uncert.	**Trend uncert.**

2 Trend in Total Emissions

According to the Kyoto Protocol, Czech national GHG emissions have to be 8 % below base year emissions during the five-year commitment period from 2008 to 2012. The Czech Republic is in a good direction to meet its goal.

2.1 Emission Trends of Aggregated GHG Emissions

Tab. 2.1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2003 and for years, which have been converted into CFR format. To get a general overview on trends, in Tab. 2.2 are presented all data, including data not converted into CRF by now.

For CO_2, CH_4 and N_2O the base year is 1990; for F-gases the base year is 1995.

Tab. 2.1 GHG emissions from 1990 - 2003 excl. bunkers *[Gg $CO_{2\ eq}$]*

	$CO_{2\ total}$ [2]	$CO_{2\ LUCF}$ [3]	CH_4	N_2O	HFCs	PFCs	SF_6	Total emissions	
								incl. LUCF	excl. LUCF
1990	161 862	-2 128	16 763	11 266	-	-	-	189 891	192 019
1992	133 252	-6 537	14 390	9 227				156 869	163 406
1994	125 945	-4 681	13 008	8 275				147 229	151 910
1995	127 148	-4 250	12 855	8 754	2.2	0.4	166.8	148 926	153 176
1996	128 294	-4 486	12 594	9 211	135	4	183	150 421	154 907
1997	132 718	-4 639	12 085	8 811	296	7	323	154 240	158 879
1998	124 511	-3 757	11 421	8 390	382	9	132	144 844	148 602
1999	117 692	-3 401	10 691	8 111	412	3	111	137 020	140 421
2000	123 886	-4 016	10 714	8 175	674	9	206	143 665	147 681
2001	123 633	-4 363	10 485	8 291	1 045	14	223	143 692	148 056
2002	118 566	-4 492	10 373	8 151	1 092	18	212	138 463	142 955
2003[4]	123 276	-3 848	10 210	8 157	1 344	29	339	143 354	147 203
% [5]	-23.8	80.8	-39.1	-27.6	611-times	73-times	2-times	-24.5	-23.3

Note: Global warming potentials (GWPs) used (100 years time horizon): $CO_2 = 1$; $CH_4 = 21$; $N_2O = 310$; $SF_6 = 23900$; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

---

[2] CO_2 emissions excl. LUCF sector

[3] CO_2 emissions from LUCF sector

[4] For the GHG inventory year 2003 the new approach for CO_2 from the *Industrial Processes – Metal Production* and *Chemical Industry* has been used. Emissions from the iron, steel and chemicals (NH_3) production were removed from the *Energy sector - Manufacturing Industries and Construction* and included into the *Industrial Processes – Metal Production* and *Chemical Industry*. This approach is fully consistent with the 1996 IPCC GL. Based on this approach all time series from 1990 through 2002 will be part of recalculations in the GHG Submission 2006. In order to maintenance of data comparisom, when time development is evaluated emissions from *Metal Production* and *Chemical Industry* are included to Energy.

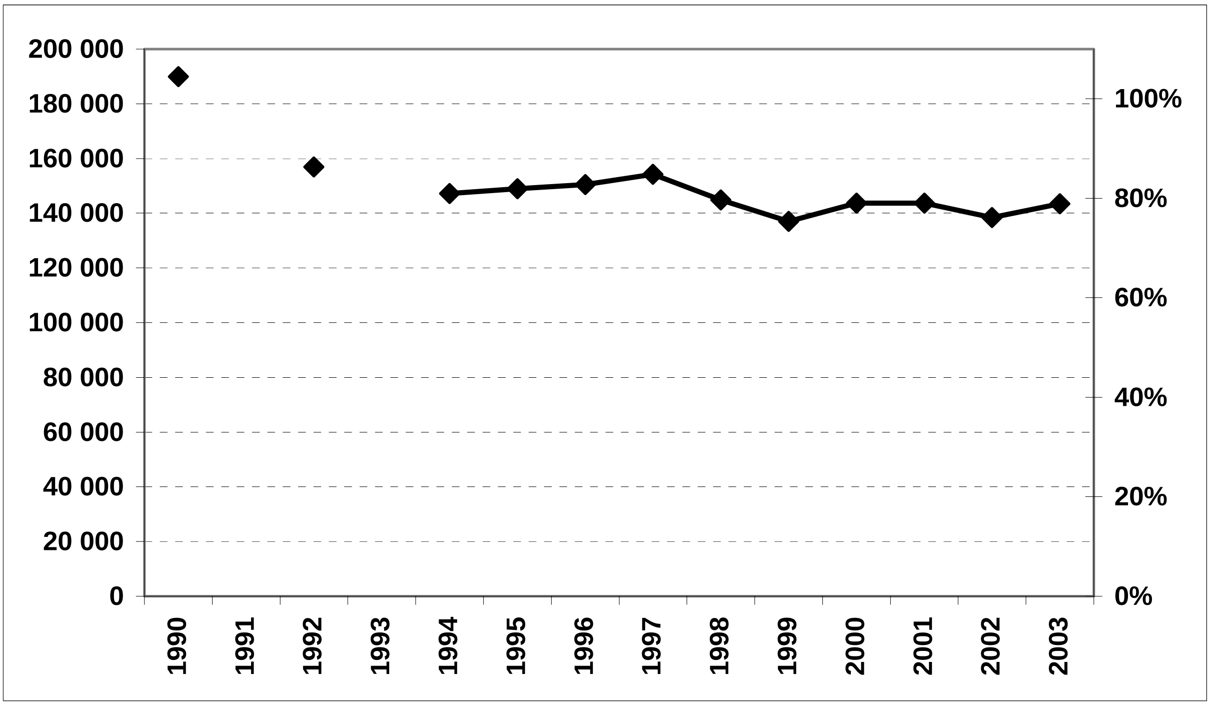
[5] per cent relative to 1990

Tab. 2.2 GHG emissions from 1990 - 2003 incl. bunkers *[Gg $CO_{2\ eq}$]*

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
1990	162 479	16 767	11 272	-	-	-	190 518
1991	148 115	14 926	7 264				170 304
1992	133 727	14 393	9 232				157 352
1993	129 208	13 287	6 573				149 068
1994	126 229	13 010	8 278				147 517
1995	123 362	12 589	6 698	2	0	167	142 819
1996	128 753	12 598	9 211	135	4	183	150 883
1997	133 125	12 088	8 811	296	7	323	154 650
1998	124 735	11 422	8 395	382	9	132	145 075
1999	118 231	10 694	8 116	412	3	111	137 567
2000	124 229	10 716	8 179	674	9	206	144 014
2001	124 072	10 488	8 296	1 045	14	223	144 139
2002	119 063	10 377	8 179	1 092	18	212	138 941
2003	123 873	10 213	8 163	1 344	29	339	143 961

GHG emissions in have been fluctuating since 1993; nevertheless the overall trend in the period of 1990 to 2002 has been decreasing (see Fig. 2.1) by 24.5 %. From 2002 to 2003 the total GHG emissions (incl. LUCF) increased by 3.6 %.

Fig. 2.1 Total GHG emissions (incl. LUCF) for the period from 1990 - 2003 (excl. bunkers) *[Gg $CO_{2\ eq}$]*



As can be seen from Fig. 2.1 there has been a strong decrease in total (incl. LUCF) emissions from 1990 to 1994 (22.5 %), followed by some fluctuations in the following years, but the overall trends has been slightly decreasing (2.6 %) between 1994 and 2003. In the period from 1994 to 2003 emissions fluctuated with maximum in 1997 and 2000 - 2001 and minimum in 1995, 1999 (the lowest emissions since 1990) and 2002. As mentioned above, from 2002 to 2003 emissions increased by 3.6 %, resulting in total emissions of 143 354 Gg $CO_{2\ eq.}$ in 2003 (incl. LUCF). The increas was caused mainly by CO_2 emission increase by 4.0 % and F-gases increase between 2002 and 2003 and also N_2O

and CH_4 reduction by 1.6 % and 0.2 %, resp. The total GHG emissions in 2003 were 24.6 % below the base year level.

2.2 Emission Trends by Gas

Tab. 2.3 presents the GHG emissions of the base year and 2003 and their share in total.

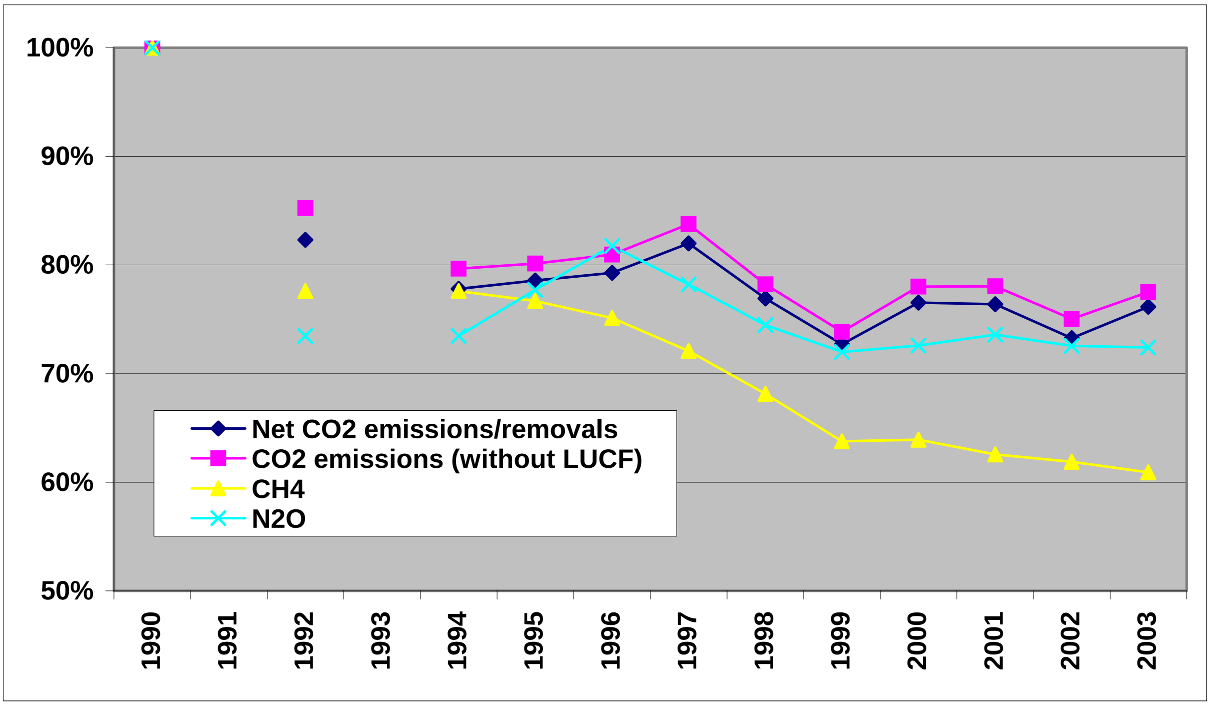
Tab. 2.3 GHG emissions by gas in the base year and in 2003

	Base year	2003	Base year	2003
	[Gg $CO_{2\ eq}$]		*[%]*	
CO_2 emissions	163 990	127 124	86.3	88.7
CO_2 removals	-2 073	-3 790	-1.1	-2.6
CO_2 Total	161 862	123 276	85.2	86.0
CH_4	16 763	10 210	8.8	7.1
N_2O	11 266	8 157	5.9	5.7
F-gases	169	1 712	0.1	1.2
Total (incl. LUCF)	190 061	143 354	100	100

The major greenhouse gas in the Czech Republic is CO_2, which represents 86.0 % of total GHG emissions in 2003, compared to 85.2 % in the base year. It is followed by CH_4 (7.1 % in 2003, 8.8 % in the base year), N_2O (5.7 % in 2003, 5.9 % in the base year) and F-gases (1.2 % in 2003, 0.1 % in the base year).

The trend of individual gas emissions is presented in Fig. 2.2 and 2.3 relative to emissions in the respective base years [6].

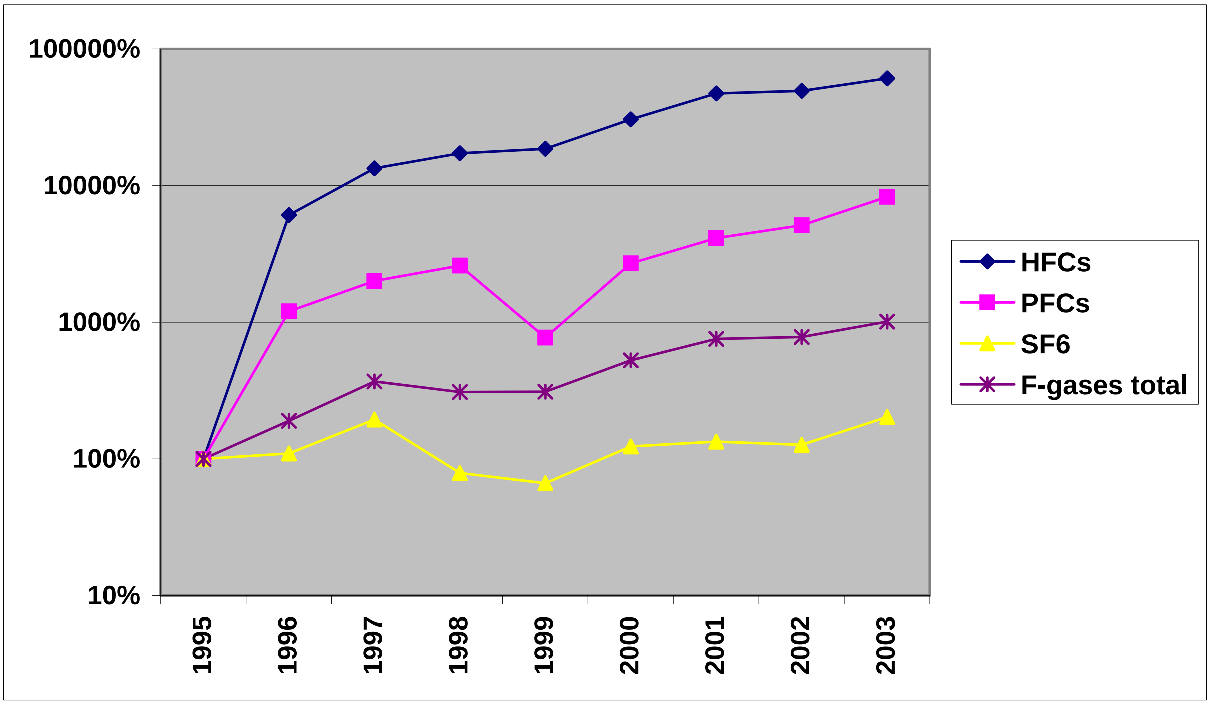
Fig. 2.2 Trend in CO_2, CH_4 and N_2O emissions 1990 - 2003 in index form (base year = 100 %)



---

[6] (index form: 1990 = 100 for CO_2, CH_4 and N_2O and 1995 = 100 for HFCs, PFCs and SF_6)

Fig. 2.3 Trend in HFCs, PFCs and SF_6 emissions 1995 - 2003 in index form (base year = 100 %)



CO_2

CO_2 emissions have been strongly decreasing in the beginning of 90's, followed by small inter-annual fluctuations. Increase in CO_2 emissions (excl. LUCF) from 2002 to 2003 by 3.3 % contributed to a total decrease of 25.0 % from 1990 to 2003 (23.8 % decrease incl. LUCF). Quoting in absolute figures, CO_2 emissions decreased from 163 990 to 127 124 Gg Gg $CO_{2\ eq.}$ (see Tab. 2.3) in the period from 1990 to 2003, mainly due to lower emissions from the *Energy* sector (mainly *Manufacturing Industries & Construction*, *Commercial / Institutional & Residential*).

The main source of CO_2 emissions is fossil fuel combustion; within the *Fuel Combustion* sector, *Energy Industry* and *Manufacturing Industries & Construction* sub sectors are the most important.

CH_4

CH_4 emissions decreased steadily during the period from 1990 to 2003, from 16 763 to 10 210 Gg $CO_{2\ eq.}$ (see Tab. 2.3). In 2003 CH_4 emissions were 39.1 % below the base year level, mainly due to lower contribution of *Fugitive Emissions from Fuels* and emissions from *Agriculture*.

The main sources of CH_4 emissions are *Fugitive Emissions from Fuels* (solid fuel), *Agriculture* (*Enteric Fermentation* and *Manure Management*) and *Waste* (*Landfills* and *Wastewater Handling*).

N_2O

N_2O emissions strongly decreased from 1990 to 1994 by 26.6 % over this period and than fluctuated with maximum value in 1997. N_2O emissions decreased between 1990 and 2003 from 11 266 to 8 157 Gg $CO_{2\ eq.}$ In 2003 N_2O emissions were 27.6 % below the base year level, mainly due to lower emissions from *Agriculture*.

The main source of N_2O emission is agricultural soils (others less important sources are *Fossil Fuel Combustion* and *Industry Processing*).

HFCs

HFCs emissions increased remarkably between 1995 and 2003 from 2 to 1 344 Gg $CO_{2\ eq.}$ In 2005, HFCs emissions are almost 610 times higher than in the base year 1995.

The main sources of HFC emissions are *Refrigeration* and *Air Conditioning Equipment*.

PFCs

PFCs emissions show very similar trend as HFC emissions. They increased remarkably between 1995 and 2003 from 0.35 to 29 Gg $CO_{2\ eq.}$ In 2003, PFCs emissions are more than 80 times higher than in the base year 1995.

The main sources of PFC emissions are *Semiconductor Manufacture* and *Refrigeration*.

SF_6

SF_6 emissions in 1995 amounted for 167 Gg $CO_{2\ eq.}$ Between 1995 and 2003 they inter annually fluctuated with maximum of 339 Gg $CO_{2\ eq.}$ in 2003 and minimum of 111 Gg $CO_{2\ eq.}$ in 1999. They were by 103 % above the base year level.

The main sources of SF_6 emissions are electrical equipment; *Semiconductor Manufacture* and *Filling of Insulate Glasses*.

2.3 Emission Trends by Sources

Tab. 2.4 presents a summary of GHG emissions by sectors for the period from 1990 to 2003:

Sector 1: Energy

Sector 2: Industrial Processes

Sector 3: Solvent and Other Product Use

Sector 4: Agriculture

Sector 5: Land-Use Change and Forestry

Sector 6: Waste

Tab. 2.4 Summary of GHG emissions by sector 1990-2003 *[Gg $CO_{2\ eq}$]*

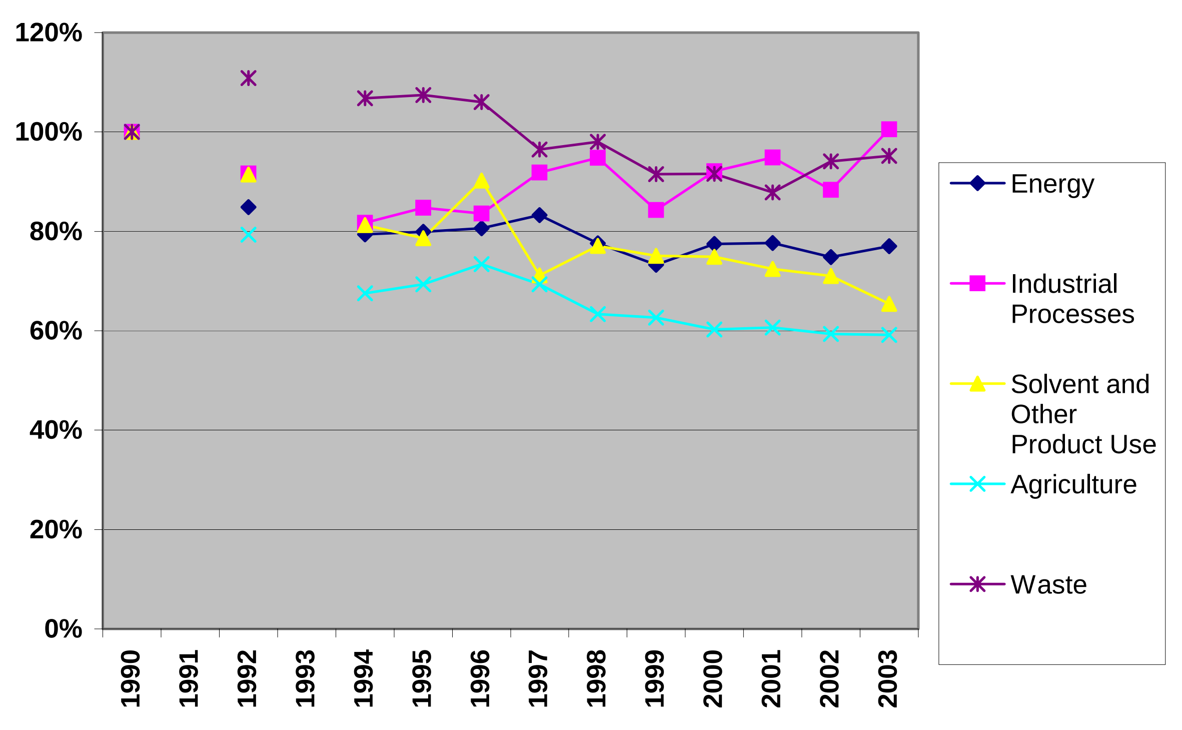
	Energy	Industrial Processes	Solvent Use	Agriculture	LUCF	Waste
1990	171 018	4 708	734	12 521	-2 073	2 983
1992	145 150	4 316	671	9 934	-6 511	3 307
1994	135 779	3 849	596	8 459	-4 640	3 186
1995	136 686	3 989	577	8 685	-4 216	3 205
1996	137 909	3 936	662	9 188	-4 437	3 163
1997	142 428	4 323	522	8 681	-4 591	2 878
1998	132 666	4 465	566	7 933	-3 710	2 924
1999	125 274	3 968	551	7 844	-3 346	2 729
2000	132 472	4 336	549	7 542	-3 966	2 731
2001	130 265	6 991	531	7 592	-4 308	2 621
2002	125 303	6 798	531	7 431	-4 435	2 808
2003	123 398	13 017	480	7 409	-3 790	2 839

The dominant sector is the *Energy* sector, which caused for 86.1 % of total GHG emissions in 2003 (90.1 % in 1990), followed by the sectors *Industrial Processes* and *Agriculture*, which caused for 9.1 % and 5.2 % of total GHG emissions in 2003, resp. (6.6 % and 2.5 % in 1990, resp.) *Waste* sector covered 2.0 %, *Solvent and Other Product Use* 0.3 and *LUCF* - 2.6 % in 2003.

Important reason for percentage change (approximately 5 %) is re-categorization of emissions from iron and steals production from the *Energy* sector to *Industrial Processes* category (adopted since the inventory for 2001).

The trend of GHG emissions by sectors is presented in Fig. 2.4 (relative to the base year).

Fig. 2.4 Emission trends in 1990 - 2003[4] by sectors in index form (base year = 100)



Tab. 2.5 GHG emissions by sectors in the base year and in 2003

	Base year	2003	Base year	2003
	[Gg $CO_{2\ eq}$]		*[%]*	
Energy	171 018	123 398	89.0	86.1
Industry	4 878	13 017	2.6	9.1
Solvent	734	480	0.4	0.3
Agriculture	12 521	7 409	6.6	5.2
LUCF	-2 073	-3 790	-1.1	-2.6
Waste	2 983	2 839	1.6	2.0
Total	190 061	143 354	100	100

Energy (IPCC Category 1)

The trend for GHG emissions from *Energy* sector shows decreasing emissions. They strongly decreased from 1990 to 1994 and than fluctuated by 2003. Emissions varied from around 125 000 (in 1999 and 2002) to 142 428 (in 1997) Gg $CO_{2\ eq.}$; nevertheless the overall declining trend could be observed between 1994 and 2003 (total decrease between 1990 and 2003[4] is 23.0 %).

95.3 % of emissions from this sector in 2003 originate from fossil fuel combustion, the rest are fugitive emissions (mainly solid fuels). *Fugitive Emissions* is the largest source for CH_4, which represented 51.9 % of all CH_4 emissions in 2003. 54.7 % of all CH_4 emissions in 2003 originated from *Energy* sector.

CO_2 emission from fossil fuel combustion is the main source of emissions. The most important source in 2003 was the *Energy* sector with a share of 91.4 % in national total emissions (excl. LUCF) or 94.3 % incl. LUCF.

CO_2 contributes for 94.2 % to total GHG emissions from *Energy* sector, CH_4 for 4.5 % and N_2O for 1.3 % in 2003.

Industrial Processes (IPCC Category 2)

GHG emissions from the *Industrial Processes* sector[4] fluctuated during the period 1990 to 2003. Between 1990 and 2003[4] emissnons from this sector slightly increased by 0.6 %. In 2003 emissions amounted for 13 017 Gg $CO_{2\,eq.}$ (4 735 Gg $CO_{2\,eq.}$[4]).

The main sources in the *Industrial Processes* sector are *Metal Production* (58.7 %)*, Mineral Products* (15.2 %), *Consumption of Halocarbons and SF_6* (13.2 %), and *Chemical Industry (*nitric acid and ammonia production*)* (12.9 %) of the sectoral emissions in 2003.

The most important GHG of the *Industrial Processes* sector was CO_2 with 78.8 % of total emissions, followed by HFCs (10.3 %), N_2O (7.5 %), SF_6 (2.6 %), CH_4 (0.5 %) and PFCs (0.2 %).

Solvent and Other Product Use (IPCC Category 3)

In 2003, 0.3 % of total GHG emissions (480.1 Gg $CO_{2\,eq.}$) arose from the *Solvent and Other Product Use* sector. Emissions generally decreased in the period from 1990 to 2003 (in 1990 to 1994 emissions decreased by 18.7 % and then fluctuated and slightly decrease). In 2003 GHG emissions from *Solvent and Other Product Use* were 34.6 % below the base year level. 55.3 % of these emissions were CO_2, N_2O emissions contributed by 44.7 %.

Agriculture (IPCC Category 4)

GHG emissions from the sector *Agriculture* decreased near over the all period from 1990 to 2003; in 2003 emissions were by 40.8 % below the base year level.

They amounted for 7 409 Gg $CO_{2\,eq.}$ in 2003, which corresponds to the 5.2 % of national total. The most important sub sector agricultural soils (N_2O emissions) contributed by 64.7 % to sectoral total in 2003, followed by the enteric fermentation (CH_4 emissions, 21.5 %) and manure management (N_2O and CH_4 emissions, 13.8 %).

Agriculture is the largest source for N_2O and second largest source for CH_4 emissions: 63.6 % of all N_2O emissions and 21.8 % of all CH_4 emissions in 2003 originated from this sector. N_2O emissions amounted for 5 285.3 Gg $CO_{2\,eq.}$, which corresponds to 70.0 % of sectoral emissions, CH_4 contributed by 30.0 % (2 224.1 Gg $CO_{2\,eq.}$).

Land-Use Change and Forestry (IPCC Category 5)

GHG removals from the *Land-Use Change and Forestry* sector fluctuated in the first few years. Over the period from 1994 to 2003 removals are close to 4 000 Gg CO_2; in 2003 removals were 82.8 % above the base year level.

Removals amounted to 3 790 Gg $CO_{2\,eq.}$ in 2003, which corresponds to - 2.6 % to national total emissions and removals. Emissions and removals are calculated from the sub category changes in forest and other woody biomass stocks and on-side burning of cleared forest.

LUCF category is the largest sink for CO_2. CO_2 removals from this sector amounted to 3 848 Gg, CH_4 emissions amounted for 58.0 Gg $CO_{2\,eq.}$, N_2O to 0.7 Gg $CO_{2\,eq.}$

Waste (IPCC Category 6)

GHG emissions from *Waste* category fluctuated during the whole period. In the early 90’, emissions increased with maximum 1992 followed by steady decrease by 2001. In 2003 emissions amounted for 2 839 Gg $CO_{2\,eq.}$, which is 4.8 % below the base year level. The decline of emissions is mainly due to lower emissions from managed waste disposal sites (and also from wastewater handling), which is the most important source as a result of CH_4 recovery systems installed at landfills. The share of this category in total emissions was 2.0 % in 2003.

The main source is solid waste disposal on land, which caused for 61.7 % of sectoral emissions in 2003, followed by wastewater handling (25.2 %) and waste incineration (13.6 %).

79.9 % of all emissions from *Waste* sector are CH_4 emissions; CO_2 contributes by 13.0 % and N_2O by 7.1 %.

2.4 Emission Trends of Indirect GHGs and SO_2

Emission estimates for NO_X, CO, NMVOC and SO_2 are also reported in the CRF. The following chapter summarizes the trends for these gases.

A detailed description of the methodology used to estimate these emissions was provided in the *Czech Informative Inventory Report (IIR) 2003, Submission under the UNECE / CLRTAP Convention*, which was published at May 2005.

Tab. 2.6 presents a summary of emission estimates for indirect GHGs and SO_2 for the period from 1990 to 2003. The National Emission Ceilings (NEC) as set out in the 1999 *Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone*. These reduction targets should be met by 2010 by Parties to the UNECE / CLRTAP Convention signed this Protocol.

Tab. 2.6 Emissions of indirect GHGs and SO_2 1990 - 2003 *[Gg]*

	NO_X	CO	NMVOC	SO_2
1990	544	1 257	441	1 881
1991	521	1 179	394	1 780
1992	496	1 170	366	1 543
1993	454	1 103	346	1 424
1994	375	1 125	310	1 275
1995	368	999	292	1 089
1996	366	1 012	293	944
1997	349	944	277	697
1998	321	765	242	438
1999	313	716	234	268
2000	321	648	227	264
2001	332	649	220	251
2002	318	546	203	237
2003	324	603	203	230
NEC	286	-	220	283

Note: National Emission Ceiling, goal should be met by 2010

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2003 (NMVOCs by 54.0 %, CO by 52.0 % and NO_X by 40.4 %). SO_2 emissions decreased by 87.8 % compared to 1990 level.

NO_X

NO_X emissions decreased from 544 to 324 Gg during the period from 1990 to 2003. In 2003 NO_X emissions were 40.4 % below the 1990 level. Nearly 99 % of NO_X emissions originate from *Energy* (subsectors *Energy Industries* and *Transport*).

CO

CO emissions decreased from 1 257 to 603 Gg during the period from 1990 to 2003. In 2003 CO emissions were 52.0 % below the 1990 level. In 2003, 90.5 % of total CO emissions originated from *Energy* (subsectors *Transport, Manufacturing Industries and Construction* and *Other Sectors (Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries)*), followed by *Metal Production* (5.5 %).

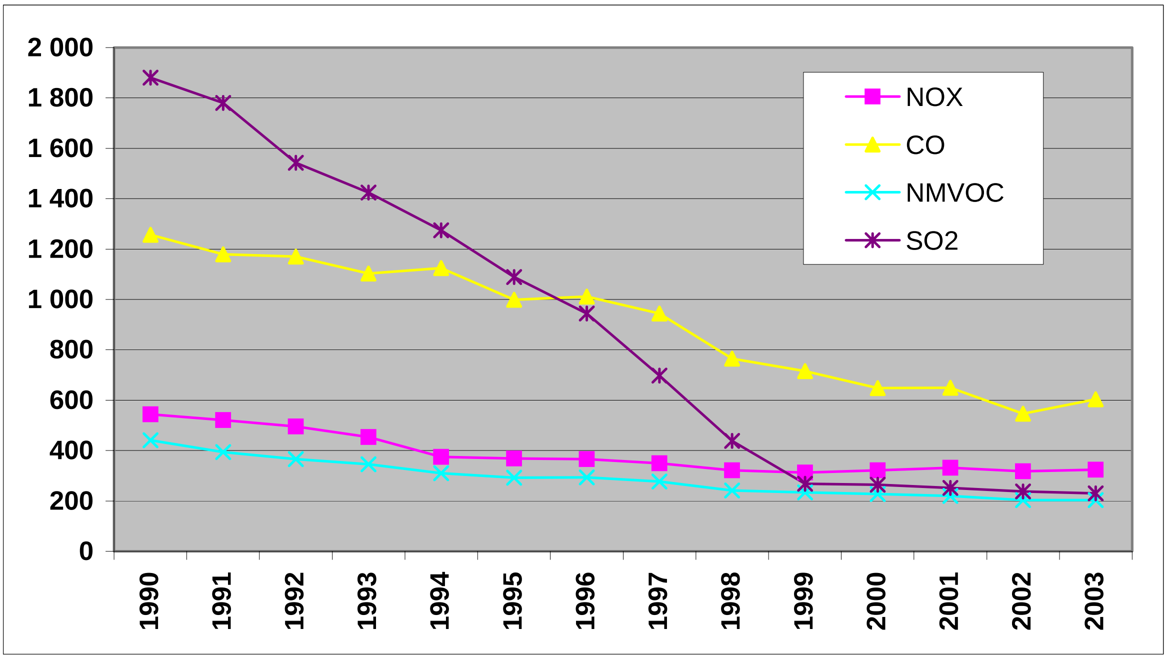
NMVOC

NMVOC emissions decreased from 441 to 203 during the period from 1990 to 2003. In 2003 VOC emissions were 54.0 % below the 1990 level. There are two main emission source, one is *Energy* (subsectors *Transport,* and *Other Sectors* (*Commercial / Institutional, Residential,* *Agriculture / Forestry / Fisheries*)), and second *Solvent Use.* Both of these secrots emit around 50 % of NMVOCs total.

SO_2

SO_2 emissions decreased from 1 881 to 230 Gg during the period from 1990 to 2003. In 2003 SO_2 emissions were 87.8 % below the 1990 level. In 2003, 99 % of total SO_2 emissions originated from *Energy* (subsectors *Energy Industies, Manufacturing Industries and Construction* and *Other Sectors (Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries)*).

Fig. 2.5 Emissions of indirect GHGs and SO_2 1990 - 2003



3 Energy (CRF Sector 1)

3.1 Energy - Combustion processes (CRF Sector 1A)

3.1.1 Sector Characterization

Combustion processes included in category 1A make a decisive contribution to total emissions of greenhouse gases. Almost all emissions of carbon dioxide, with the exception of decomposition of carbonate materials, occurring, e.g., in cement production, are derived from the combustion of fossil fuels in stationary and mobile sources. The role of combustion facilities is apparent from Tab. 1.1 from which it can be seen that 5 of the 13 *key sources* considered correspond to the combustion of fossil fuels in category 1A and, of these, the first four most important contribute approx. 83 % of total emissions.

Consequently, the greatest attention is paid in the *IPCC Guidelines* (*Revised 1996 IPCC Guidelines*, 1997) to inventories of emissions from these processes. In the Czech national inventory a differentiated approach is employed in inventories of emissions of greenhouse gases. Emissions of direct greenhouse gases, i.e. CO_2, CH_4 and N_2O, are calculated on the basis of activity data and emission factors of the fuel combusted. The relevant emission data corresponding to individual source subcategories for NO_X, CO, NMVOC a SO_2 are transferred directly from NFR to CRF.

The results of the inventory, including the activity data, are submitted in the standard CRF format. For direct greenhouse gases, the consumption of fuels and ”implied” emission factors are also given. However, for stationary sources, the fuel consumption is given in the CRF format in aggregated structure, i.e. as solid, liquid and gaseous fuels according to IPCC definition. In relation to the degree of elaboration of the calculation procedures to date, the required CRF tables could be filled out with an exception, when processing industry (1A2) is reported as a whole. The currently available energy production statistics do not provide the necessary activity data for division of this category into the individual branches of industry.

3.1.2 Carbon Dioxide Emissions

According to the IPCC *Good Practice* (*Good Practice Guidance*, 2000), carbon dioxide emissions encompass the following five *key sources* at the primary level:

- stationary combustion of solid fuels,
- stationary combustion of gaseous fuels,
- highway transportation,
- stationary combustion of liquid fuels,
- other transportation.

These *key sources* have a decisive effect on the uncertainty in the absolute levels and trends in CO_2 inventories.

According to IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997), carbon dioxide emissions are calculated in two ways:

1. The **Reference Approach**, i.e. on the basis of total domestic consumption of the individual fuels. This relatively simple method is based on the assumption that almost all the fuel consumed is burned in combustion processes in energy production. It does not require a large amount of input activity data and the basic values of the sources included in the national energy balance and some supplementary data are sufficient. It provides information only on total emissions without any further classification in the consumer sector. The emission factors are related to those kinds of fuel that enter domestic consumption at the level of sources, without regard to specific kinds of fuel burned in the consumer part of the energy balance. Thus, for liquid fuels, this means that the emissions are determined practically only on the basis of domestic petroleum consumption.
2. The **Sectoral Approach**. This method is considerably more demanding in relation to input data and requires information on fuel consumption according to kind in the individual consumer sectors. It has an advantage in the possibility of analyzing the structure of the origin of emissions. As the emission factors employed are specific for each kind of fuel burned, calculations using this method should be more exact. However, it follows from the discussion below that the differences in the overall results from the two methods are not very significant.

3.1.2.1 Reference Approach

The IPCC Reference Approach is based on determining carbon dioxide emissions from domestic consumption of individual fuels. Domestic fuel consumption is calculated in the usual manner as:

extraction + imports - exports - change (increase) in stocks

Extraction includes domestic extraction of petroleum, natural gas (of petroleum or coal origin) and hard and brown coal. The obtaining of other solid fuels, mostly wood for burning, is given in the calculation under the special item solid biomass. In this method, emissions from this fuel are not included in emissions from combustion processes, as they are calculated in the inventory in the forestry category. Imports of fuel include imports of natural gas, petroleum, individual liquid fuels, hard and brown coal, coke and briquettes. Exports and changes in stocks include similar items. The item changes in stocks also includes losses and balance differences that do not entail combustion processes and would distort the results.

Total national consumption is corrected by subtracting non-energy consumption. A substantial portion of non-energy consumption consists in non-energy consumption of petroleum (lubricating and special oils, asphalt and particularly petroleum raw materials used in the production of plastics, etc.). Non-energy products produced from hard coal in coke plants and from brown coal in the production of town gas and energy-production gas (fuel for steam-gas systems) are also important. Some of the intermediate products from the pyrolysis of petrochemical materials are also used directly as heating gases and oils and some of the final products (plastics) are also burned after use. In addition, most lubricating and special oils are finally used as heating oils or are burned during use (the lubricating oils of internal combustion motors). Data on non-energy consumption are taken from the Czech Statistical Office (Balance of Energy Processes in Energy Sector, 2004)

The carbon content is calculated from the corrected domestic consumption of the individual fuels using emission factors and the emissions of carbon dioxide are then calculated by taking into account the efficiency of conversion of carbon in the combustion process. The emission factors determining the carbon content in the individual fuels (in t C / TJ) are taken from the IPCC methodology, as are the recommended values of “oxidation factors” (correction for the unburned carbon residue).

3.1.2.2 Sectoral Approach

This method, which is based on the records of fuel consumption in the individual categories is elaborated in great detail in the IPCC methodology that requires determination of the consumption of the individual kinds of fuel in all the consumption categories.

In relation to the current ability of Czech energy production statistics to determine the corresponding fuel consumption, combustion processes can be divided into only the following basic categories:

1A1 - Energy & Transformation Activities
    Public electricity and heat production
    Petroleum refining
    Manufacture of solid fuels and other energy industries
1A2 - Manufacturing industries and construction (including industrial electricity and heat production)
    Iron and steel
    Non-ferrous metals
    Chemicals
    Pulp, paper and print
    Food processing, beverages and tobacco
    Other (Non metallic minerals, Transport equipment, Machinery, Mining and quarrying, Wood and wood products, Construction, Textile and leather, Non-specified)
1A3 - Transport
    Civil aviation
    Road transportation
    Railway
    Navigation
    Gas and petroleum pipelines transportation
1A4 - Commercial / Institutional
1A5 - Residential
1A6 - Agriculture / Forestry

The consumption in international air transportation is included in the special category *International Bunkers*. Emissions from fuels in this category are not included in the total emissions in the territory of the state, but are summarized directly in global emissions.

Similarly as for the reference method, emission factors, specifying the carbon content in the individual fuels (in t C / TJ) and relevant oxidation factors are taken from the IPCC methodology.

In the inventory, both above mentioned procedures were employed in the structure described in the working manuals (*Revised IPCC Guidelines*, 1997), i.e. including the values of the emission factors of carbon and the standard means of correction for unburned residues.

Emphasis is placed on correct determination of the fraction of unburned (stored) carbon in non-energy use of fossil fuels. Calculation of this amount is based on the assumption that a certain part of the carbon contained in the non-energy material remains fixed for a long time and is not released as CO_2. The fraction of stored carbon in petrochemical materials and oils is standardly considered to equal 50 % and, for tar, 75 %. Practically one hundred percent fixation is assumed for asphalt. To avoid double counting with Sector 6 - Waste, since 2003 emissions from combustion of petrochemical products and lubricants have been reported only in Sector 6.

Similarly, it is necessary to ensure that the carbon, converted to CO_2 in non-energy use, is calculated only once. Carbon dioxide formed in the production of hydrogen used mainly for subsequent synthesis of ammonia is a typical example. Under the conditions in this country, this process consists in gasification of masout (residual fuel oil) using oxygen and steam, with subsequent catalytic conversion. With reference to traditional way of reporting, CO2 from masout used for ammonia production was reported in 1A2 for the whole time series. Since 2003, a rearrangement has been performed and this source has been included in Sector 2 - Industry (2B1). Next year, this rearrangement, which respects the IPCC Good Practice (*Good Practice Guidance*, 2000) will be performed for the whole data series since 1990.

Compared with the Reference Approach, the results of the two methods are very similar and differences are below the precision levels of the input data. From this point of view, the two methods can be considered to be equivalent. The results of inventories carried out by the two procedures differ by less than 2 % for all time period (in accord with the CRF requirement). As in our inventory emissions from consumption of coke in blast furnace are covered under 2C1 (since 2001), it is necessary to add the CO_2 contribution from 2C1 to the emissions from 1A in order to obtain comparable values. A comparison is given in Tab. 3.1.

Tab. 3.1 Comparison of CO_2 emissions calculation from the fossil fuel combustion in 1990, 1992 and in 1994 - 2003

	Reference approach *[Gg CO_2]*	Sectoral approach *) *[Gg CO_2]*	Deviation *[%]*
1990	162 922	160 080	1.8
1992	138 836	135 766	2.3
1994	126 258	127 116	0.7
1995	130 292	128 070	1.7
1996	129 673	129 516	0.1
1997	131 386	133 925	1.9
1998	122 662	124 486	1.5
1999	115 136	117 501	2.0
2000	122 116	124 420	1.9
2001	124 730	124 770	0.0
2002	120 956	120 040	0.8
2003	125 718	123 950	1.4

**) Including the iron and steel industry that has been reported under 2C1 since 2001 and ammonia industry that has been reported under 2B1 since 2003*

The area of production of iron and steel is another difficult area from the standpoint of the potential for reporting CO_2 emissions in several categories. Here, the primary source of emissions is carbon contained in the coke used in blast furnaces in iron production. However, the actual emissions of carbon dioxide from metallurgical coke do not occur in the blast furnace, but in subsequent combustion of blast-furnace gas in energy production. To 2000, all CO_2 emissions from coke have been included in the energy category 1A2, including those from the metallurgical process itself (oxidation of carbon from pig iron during steel production). The calculation procedure is based on the amount of carbon in the coke as a reducing agent that is used in metallurgical processes. Beginning in 2001, the CO_2 emissions from the iron and steel industry are reported under 2C1 (Industrial processes) in accordance with the *Good Practice Guidance*.

Since 2003, CO_2 emissions from the whole amount of coke used in metallurgy have been reported under 2C1. At the same time, CO_2 emissions from non-energy use of fuels (masout) used for ammonia production, have been transferred to 2B1. This rearrangement of CO_2 emissions for the last three years is illustrated in Tab. 3.2.

Recalculation for the whole time series will be performed in 2005.

Tab. 3.2 Transfer of CO_2 emissions from category 1A to category 2B and 2C in 2001 - 2003 *[Gg CO_2]*

	Original value 1A	New value 1A	Transfer to 2B *) and 2C
2001	124 770	122 246	2 524
2002	120 040	117 426	2 614
2003	123 950	115 668	8 282

**) since 2003*

Comparison with 1990 indicates a marked decrease in the level of emissions of carbon dioxide, corresponding to the decrease in the domestic consumption of primary fossil fuels. This is a consequence of the lower consumption of coal and its partial replacement by natural gas. Tab. 3.3

gives the decrease in this consumption over the past decade. There has been only a small decrease in the consumption of liquid fuels (with the exception of the sudden decrease at the beginning of the nineties), but there has been a marked change in the structure of consumption. In 1990, the fraction of heating oils in the consumption of liquid fuels equalled 37 %, while this figure equalled only 7 % in 2003. There was a substantial increase in consumption of natural gas.

Tab. 3.3 Total primary energy sources in 1990, 1992 and in 1994 - 2003 *[PJ]*

	Total Primary Energy Supply	Of which Coal
1990	2 069.6	1 326.8
1992	1 788.2	1 099.0
1994	1 683.1	963.7
1995	1 748.3	983.9
1996	1 823.1	993.1
1997	1 744.1	951.7
1998	1 658.3	856.7
1999	1 617.6	797.0
2000	1 657.0	877.9
2001	1 706.2	887.3
2002	1 694.9	854.6
2003	1 814.0	875.5
Decrease in consumption 1990 - 2003	255.6	451.3

The Sectoral Approach, in contrast to the Reference Approach, permits analysis of the structure of the source of the emissions. It is then possible to determine that there was a change in the sectoral structure of the origin of emissions of carbon dioxide in years 1990, 1992 and 1994 - 2003, as can be seen in Tab. 3.4. Comparison with all years from period 1990 - 1995 is not possible, as inventory calculations in period of 1990 to 1995 were carried out using a slightly different method (*IPCC Guidelines*, 1995) - the data for 1990, 1992, 1994 and 1995 were recently revised.

Tab. 3.4 Share of individual categories on the CO_2 emissions in 1990, 1992 and in 1994 - 2003$^{*)}$ *[%]*

	Energy Industry	Manufacturing Industry	Transport	Commercial, services	Residential	Agriculture
1990	37.0	37.1	4.5	6.0	13.0	2.4
1992	38.7	37.7	5.5	5.1	11.1	1.9
1994	43.8	34.8	6.0	4.6	9.2	1.6
1995	45.3	32.5	7.4	4.5	9.0	1.3
1996	44.7	33.9	7.5	4.1	8.5	1.3
1997	44.2	32.4	8.4	4.8	8.8	1.4
1998	47.2	28.4	8.6	4.7	9.7	1.4
1999	45.9	29.2	10.0	4.8	8.7	1.4
2000	48.4	29.1	8.9	4.4	7.9	1.3
2001	48.4	29.3	9.7	3.4	8.0	1.2
2002	48.7	27.3	10.4	3.8	8.4	1.4
2003	47.5	28.9	10.8	3.6	7.7	1.4

***)** *Including the iron and steel industry that has been reported under 2C1 since 2001 and ammonia industry that has been reported under 2B1 since 2003*

The fraction of emissions from the processing industry and households decreased as a consequence of the marked decrease in consumption, especially of coal. On the other hand, there was a significant increase in emissions from transport as a consequence of increasing consumption of liquid fuels in highway transport. There was a relative increase in the fraction of emissions from the energy-production industry because, for lower total emissions, the absolute values of emissions from energy-production in 2003 are practically at the same level as in 1990.

Allocation of the individual categories (sub-sectors) has been changed somewhat after the above-mentioned rearrangement (transfer of CO_2 emissions to 2C and CO_2 from ammonia to 2B) as presented in Tab. 3.5. The contribution of the "Manufacturing industry" is decreased compared to the other sub-sectors

Tab. 3.5 Share of individual categories on the CO_2 emissions from 1A in 2001 - 2003*) *[%]*

	Energy Industry	Manufacturing Industry	Transport	Commercial, services	Residential	Agriculture
2001	48.7	28.5	9.9	3.5	8.1	1.3
2002	49.2	26.4	10.6	3.9	8.5	1.4
2003	50.9	23.8	11.6	3.8	8.3	1.5

***)** *Excluding the iron and steel industry since 2001 and ammonia industry since 2003*

According to the IPCC Methodology (*Revised 1996 IPCC Guidelines*,1997), emissions from international air transport are not reported as part of national emissions, but are reported separately, because they are summarized directly in global emissions. The calculation is based on the amount of fuel tanked into the aircraft in the particular country of origin. Those data are taken over from (*Supply of Basic Final Refinery Products*, 2004). The contribution of the Czech Republic to international air transport varies around a value of 0.6 Mt CO_2 p.a.

3.1.3 Methane Emissions

Methane emissions from fuel combustion from stationary and mobile sources do not constitute *key sources*. Relatively the largest contribution comes from fuel combustion in local heating units.

The means of determining methane emissions is similar in many respects to the method of the individual consumption categories for carbon dioxide emissions. The simplest level (Tier 1) (*Revised 1996 IPCC Guidelines*,1997) includes only summary fuel categories:

- coal-type solid fuels
- gaseous fuels
- liquid fuels
- wood fuel (biomass)
- charcoal
- other biomass.

Only the first four categories were filled with active data in the inventory. These data were aggregated directly from the connected working sheets for the calculation of carbon dioxide by the consumption sector method.

CH_4 emissions were calculated based on default emission factors recommended by IPCC Methodology (*Revised 1996 IPCC Guidelines*,1997). In the process of calculation CH_4 emissions from transport category should be pointed out that individual fuel consumption in the given category is considered as activity data. This is related particularly to gasoline, diesel oil, jet kerosene, natural gas, and propane-butane (LPG) consumption.

3.1.4 Nitrous Oxide Emissions

Although N_2O emissions from combustion processes are not amongst *key sources* in the Czech Republic, these emissions from both stationary and mobile sources represent a somewhat more important contribution than that made by CH_4 emissions.

N_2O emissions were calculated by a similar method as CH_4 emissions, directly using the emission coefficients lying within the recommended intervals given in the revised *IPCC Guidelines* (*Revised 1996 IPCC Guidelines*,1997) .The emission factors for combustion from stationary sources were taken from (Markvart and Bernauer, 1999). The data lacking for the combustion of brown coal were taken from study (Svoboda, 1996).

It should be pointed out that the emission factors used are not contradictory to the values given in the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997) and reflect the following facts:

- the emissions factors for combustion of pulverized coal in granulation furnaces have the smallest values,
- the values used for grate furnaces are only slightly higher,
- the emission factors for fluid-bed furnaces are highest, especially those for hard coal and lower relative furnace outputs (compared to nominal outputs), manifested in a lower temperature of combustion.

In calculation of N_2O emissions from mobile sources, the most important source according to the IPCC methodology seems to be passenger automobile transport, especially passenger cars with catalyzers. The emissions factors for N_2O for vehicles with diesel motors and for vehicles with gasoline motors without catalyzers are not very high and were taken in the standard manner from the methodical instructions (IPCC default values). The situation is more complex for vehicles with gasoline motors equipped with three-way catalyzers. The IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997) gives three pairs of emission factors for passenger cars with catalyzers (for new and deactivated catalyzers). The value for a deactivated catalyzer is approximately three times that for a new catalyzer. The pair of values recommended on the basis of Canadian research was selected because of the lack of domestic data; in addition, American and French coefficients are presented in the Reference Manual, Box 3 (*Revised 1996 IPCC Guidelines*, 1997). The arithmetic mean of the values for new and older used catalyzers was taken as the final emission factor for passenger cars with catalyzers.

The calculation was based on the consumption of petrol and diesel fuel by the main types of vehicles. Here, the consumption of petrol must be divided into the part burned in vehicles equipped with three-way catalyzers and other vehicles. The calculation was based on an estimate following from the study of the *Transport Research Centre* (CDV) prepared annually for *Ministry of Environment*, estimating the fraction of gasoline-propelled vehicles equipped with three-way catalyzers (Adamec *et al*, 2002). According this study, the fraction of petrol-propelled vehicles equipped with three-way catalyzers was recently equalled 32 %. Similar to previous years, we assume that newer vehicles emit larger amounts and again express this by a coefficient of 1.5. The result of this calculation is that not quite 48 % of gasoline is combusted in vehicles with catalyzers.

A partial increase in N_2O emissions can be expected in this category in connection with the growing fraction of vehicles equipped with three-way catalyzers, or the expected increase in the number of fluid-bed combustion units.

3.1.5 Activity Data

Determination of the activity data on fuel consumption was based on the preliminary energy balance, prepared by KONEKO Marketing Ltd., on the basis of the material published to date by the *Czech Statistical Office* (CSO) and other organizations on trends in energy management in 2003. For these purposes, it is often necessary to use preliminary information, as CSO does not issue final data until the first quarter of the second year following the year in question (data for 2003 are issued in 2005). The preliminary energy balance for 2003 was prepared using the method of the *International Energy Agency*. Such a balance permits filling of the basic categories of the IPCC method with activity data. At the time, when the preliminary balances are prepared, usually only basic data is available on extraction of fuels, imports, exports and production of the main energy commodities (petroleum, natural gas, electricity). In addition, detailed information is lacking on the imports and exports of the individual fuels, on changes in stocks and particularly almost all data on consumption.

Determination of the activity data for revision of 1995 was based on the total CSO balance for that year. While definitive data is given here, only information on the source part may be used without difficulties. However, data on energy consumption are not entirely sufficient for application of the *Sectoral method* even in the final energy balance.

Consequently, drawing up of the energy balance in the IEA (*International Energy Agency*) method from available data requires the use of a number of specialized procedures in both the source and especially in the consumption parts. In the source part, this is especially true of expression of production of heat in centralized systems, which includes only public sources in the IEA method and, for industrial sources, only that part sold to other entities. Drawing up the necessary categorization of the energy balance in the consumption part is connected with considerable difficulties.

In order to classify consumption in the transport category in the individual subcategories, a specialized model of the MAED transport type was employed. This is one of a series of models of the *International Atomic Energy Agency*. These models are used in predicting consumption of all kinds of energy in the entire national economy. The necessary data on the individual segments of transport cannot be obtained directly, as they are not monitored in this classification. Using the MAED model, consumptions of gasoline and diesel oil can be determined for the following transport sub-categories:

- road transport - goods transport
- road transport - public passenger transport
- road transport - individual passenger transport
- rail transport - goods transport
- road transport - passenger transport
- inland waterway transport of goods
- public transit in towns

Relevant transport capacities (outputs) for these sub-categories are taken from CSO (*Statistical Yearbook*, 2004).

For similar reasons, another specialized model, again of the MAED type, was used to determine energy consumption in the household category. In both cases, calculations for 2003 took into account the results of the statistical study "Energy consumption in households", carried out in 1997 by CSO on the basis of the PHARE / EUROSTAT method. All of categories 1A1 to 1A6 were filled with data on consumption of the individual solid, liquid and gaseous fuels, including non-energy consumption (petrochemical materials, lubricating oils).

Because of the considerable importance of emissions of greenhouse gases from combustion processes, there has been an increase in demands for transparency and controllability of activity data used for inventory calculations, especially in connection with trading in respect to carbon dioxide. Consequently, the energy balance for 2003 and for 1995 (in the *IEA* methodology and following modification according to IPCC requirements) was prepared as part of a set for calculation of emissions of greenhouse gases from combustion processes. This guarantees an unambiguous connection between the balance and emission values.

3.1.6 Direct GHG Emissions - Overview

Combustion processes in energy management are a source of emissions of a decisive fraction of greenhouse gases. Emissions of carbon dioxide from combustion processes contribute to almost 98 % of total emissions of this gas and encompass five *key sources*. Activity data (data on consumption of individual fuels) were determined using the above-described preliminary energy balance. The results of the inventory including activity data are processed in the CRF format, which also includes back-control of the calculation of the “implied” emission factors. Because of the degree of elaboration of the calculation procedures used to date, it was possible to fill out the required CRF tables, with one exception, where the processing industry (1A2) is reported as a whole. The current energy statistics do not provide sufficient data for classification into the individual branches of industry.

Comparison of the results of the inventory for 2003 with the initial year of 1990 indicates a significant decrease in level of emissions of direct greenhouse gases, which basically corresponds to the decrease in domestic consumption of primary fossil fuel sources in this period, as a consequence of a substantial decrease in coal consumption.

Inventory calculations are accompanied by a certain uncertainty. The first uncertainty follows from the use of the preliminary energy balance. The deviation from the total balance may be as large as 5 % in the individual balanced years, but usually does not exceed 2 %.

Another uncertainty follows from the deriving of emissions from fuel consumption, expressed in energy units. The precision of the determination of the heat capacity plays a decisive role here, especially for coal. Thus the use of specific emission coefficients corresponding to the specific kind of coal, in place of the current *default* factors, could lead to an improvement. However, it follows from the study (Fott, 1999) that large differences between *default* and country-specific or site-specific cannot emission factors are not expected.

3.1.7 Precursor Emissions

Inventory of ozone precursors (CO, NO_X and NMVOCs) and aerosol precursor (SO_2) in CRF do not require stating of emission factors. Emission precursors estimates for the relevant subcategories (starting with the emission data for 2001) have thus been transferred from NFR to CRF. As was already stated previously, the NFR format has recently been implemented for reporting emissions of traditional pollutants under CLRTAP, while the national emission database called REZZO was used as the primary data source. The REZZO - NFR - CRF data transmission enables enhancement of harmonization of all the Czech inventories dealing with some air quality pollutants as GHG precursors.

3.1.8 QA/QC Procedures

Activity data required for emissions calculation using the IPCC methodology were determined on the basis of the preliminary energy balance published by CSO in August 2004. The data in this balance were verified on the basis of individual data from the following organizations:

- fuel extraction: Czech Mining Authority, Employers Federation of the Mining and Petroleum Industry, Miners' Association,
- liquid fuel consumption: Czech Association of the Petroleum Industry and Trade (CAPPO),
- production and consumption of natural gas: Annual Report of Distribution Companies of the Gas Industry, Transgas Balance.

Data from transport and household subcategories of were verified and supplemented using specialized models, as described in Subchapter 3.1.5.

Formal control of the correctness and completeness of the data entered in CRF tables was carried out by CHMI. This control was carried out at random.

3.1.9 Survey of Present State and Expected Improvements

- Emission inventories for 1996 - 2003 were compiled in a consistent manner using the *Revised IPCC Guidelines*
- The former, not entirely consistent data for 1990, 1992, 1994 and now 1995, were recently revised including incorporating data into CRF. The revised data are now consistent with the 1996 - 2003 period. It will be necessary to also complete this revision for 1991 and 1993 in next years.
- Since 2001, emissions from iron and steel (specifically coming from coke input to blast furnaces) are covered under 2C1, but for the 1990 - 2000 period are still covered under 1A2. It will be necessary to complete all backward rearrangement (reallocation) since 1990.
- Emissions of N_2O from road traffic were found not to be comparable with other European states and so thus it is planned that they will be recalculated using the *Good Practice Guidelines*.

3.2 Energy - Fugitive Emissions (Sector CRF 1B)

3.2.1 Sector Characterization

Mining, treatment and all handling of fossil fuels are sources of fugitive emissions. They consist mainly of emissions of methane and volatile organic compounds NMVOCs (petroleum extraction and processing). In the Czech Republic, CH_4 emissions from deep mining of hard coal are significant, while emissions from surface mining of brown coal and emissions from landfills and gas distribution are also important. On the other hand, emissions from petroleum extraction and processing are less important. Other industrial activities included in this category are of marginal importance, in respect to both CH_4 and NMVOC emissions. Category 1B also includes CO_2 emissions from removal of SO_2 from combustion products using limestone.

CH_4 emissions are primarily derived from deep mining of hard coal in the Ostrava-Karviná area. A lesser source consists in brown coal mining by surface methods and post-mining treatment of hard and brown coal. Approximately 10 % of emissions are formed in the Czech Republic from gas industry in extraction, storage, transport and distribution of natural gas and in its final use. Petroleum extraction and refining processes are less important. NMVOC emissions are formed primarily from petroleum refining and in storage and handling of petroleum products.

National emission factors (Takla and Nováček, 1997) were used in calculating methane emissions in deep hard coal mining; emission factors according to the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997) were used for the emission factors for emissions from the surface mining of brown coal and post-extraction treatment. Methane emissions from the gas industry were determined using national emission factors based on the specific emission factors for the individual parts of the gas industry system (*Gas and Environment*, 1997, Alfeld, 1998) Determination of methane emissions from the processes of refining of petroleum is based on the recommended (default) emission factors according to the IPCC methodology.

In Fugitive Emissions category, only Coal Mining and Handling was evaluated as key source (Tab. 3.6).

Tab. 3.6 Share of CH_4 emissions from individual sub-categories on the overall aggregated emissions

	Character of source	Gas	% of total
Fugitive Emissions from Coal Mining and Handling	Key source	CH_4	3.3
Fugitive Emissions from Oil & Gas operations		CH_4	0.3

3.2.2 Methane Emissions from Mining and Post-mining Coal Treatment

Coal mining (in particular hard coal mining) is accompanied by an occurrence of methane. Methane, as a product of the coal-formation process is physically bonded to the coal mass or is present as the free gas in pores and cracks in the coal and in the surrounding rocks. In deep hard coal mining, CH_4 is released from the coal mass and from the surrounding rocks into the mine air and must be removed to the surface to prevent formation of dangerous concentrations in the mine. The mine ventilation must be calculated according to the amounts of gas released. At the end of 1950's mine gas removal systems were introduced in opening new mines and levels in the Ostrava-Karviná coal-mining area, which permitted separate exhaustion of partial methane released in the mining activity in the mixture containing the mine air. The total amount of methane emitted can be balanced quite accurately from the methane concentrations in the mine air and their total annual volume. The ratio between mining and the volume of methane emissions is given in Tab. 3.7, see (Takla and Nováček, 1997).

As it is a key source, the determined national emission factor has been used to calculate methane emissions since 1996 (calculation at the level of Tier 3), i.e. 18.3 m^3 CH_4 / t. It should be pointed out that an emission factor of 23.9 m^3 CH_4 / t, taken from the IPCC Methodology (*IPCC Guidelines,* 1995), was used up to 1996; this was much higher than the emission factor used in Poland. This emission factor was also used to recalculate the curves for emissions of methane in this category from 1990 to 1995. The activity data are taken from (*Mining Yearbook*, 1994 - 2003)

The use of the emission factor for 1996 - 2003 can be considered satisfactory from the standpoint of (*Good Practice Guidance*, 2000) as the ratio NG / HC (m^3 / t) between natural gas of coal origin (NG - natural gas) and hard coal mining (HC - Hard Coal) did not change significantly in this period Tab. 3.8.

Tab. 3.7 Coal mining and CH_4 emissions in the Ostrava - Karvina coal-mining area

	Coal mining *[mil. t / year]*	CH_4 emissions		Emission factors	
		[mil. m^3 / year]	*[Gg / year]*	*[m^3 / t]*	*[kg / t]*
1960	20.90	348.9	250.3	16.7	12.0
1970	23.90	589.5	422.9	24.7	17.7
1975	24.11	523.9	375.8	21.7	15.6
1980	24.69	505.3	362.5	20.5	14.7
1985	22.95	479.9	344.3	20.9	15.0
1990	20.06	381.1	273.4	19.0	13.6
1995	15.60	270.7	194.2	17.4	12.4
1996	15.10	276.0	198.0	18.3	13.1
Total	**167.31**	**3 375.3**	**2 421.3**	**20.2**	**14.5**
1990 till 1996	50.76	927.8	665.6	18.3	13.1

Tab. 3.8 Trends of mined natural gas of coal origin (NG) and its ratio to hard coal (HC) mining

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
NG *[mil. m^3]*	127.1	124.4	151.3	139.8	139.6	154	146.9
Ratio NG / HC	6.3	7.2	8.8	8.5	8.8	9.8	9.7
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NG *[mil. m^3]*	128	126.5	118.1	98.7	115.6	112.8	117.9
Ratio NG / HC	8.6	8.7	8.8	7.1	8.1	7.9	8.7

Other areas of deep mining in the Czech Republic are not important for methane emissions. The mines located in the Kladno mining area, in which less than 1 / 10 of domestic production was mined to 2001, where classified by State Mining Administration as the non-gaseous mines. Consequently, the amount of methane emitted in this location is not monitored. As Tier 2 calculation is permissible for key sources, the lower limit of the recommended emission factors for mining and post-mining treatment, related to the activity data on mining in the Kladno area, was used for CH_4 emission calculation in this location. ČMD Company, a. s., which was mining bituminous coal in the former mines in Kladno mining areas, has stopped the mining here on 30th June 2002 from the safety and economical reasons - CH_4 emissions were not already reported in year 2003 in this mining area.

During surface mining, methane escaping is not related to specific flow of air and thus it is far more difficult to monitor the amount of methane escaping into the air. Consequently, default IPCC emission factors are employed to calculate methane emissions from surface mining and from post-mining treatment (*Revised 1996 IPCC Guidelines*, 1997). However, it would be useful to carry out a study that would determine the ratio between methane produced and brown coal obtained by surface mining, in order to chose an emission factor that would correspond to the national specific characteristics. Research has indicated that no such studies or analyses have so far been carried out.

3.2.3 Methane Emissions from Gas Extraction, Storage, Transit, Transport and Distribution

In the 1990's, the gas industry was one of the most dynamically evolving industrial categories in the Czech Republic. Natural gas is an important trade commodity and consequently its consumption, transport, distribution, storage and supplementary extraction in the territory of the Czech Republic is monitored carefully. As a result, activity data for the methane emission balance are available with high precision in this category.

Methane emissions in this category are basically formed in several ways:

- through poor seals in the flanges and joints, fittings, probes in mining and storage fields and other parts of the pipeline system,
- through pipeline perforation,
- through technical discharge of gas into the air,
- through accidents.

Escapes in the distribution network and household distribution pipes can be considered to constitute the most serious source of emissions. In the 1990's, the distribution network was newly constructed almost entirely from welded plastics and the old pipeline was reconstructed to a major degree in the same manner. Household distribution pipes are subject to strict standards and any poor seals can be identified by the characteristic smell. In addition to safety aspects, all escapes also have an economic impact both for the distribution company and for the end user, so this aspect is carefully monitored and, where possible, immediately remedied. As a whole, the gas distribution is at a high technical level and it can be stated that all escapes are carefully sought out and eliminated.

As a method was developed in the last few years for determining methane emissions in the gas industry using specific emission factors, this sophisticated method of calculation continues to be used, although, from the standpoint of ref. (*Good Practice Guidance*, 2000), calculation using default values would probably suffice.

Qualified estimation of methane emissions is thus carried out using specific emission factors for the individual parts of the gas distribution system (Alfeld, 1998, *Gas and Environment*, 2000). The total emission value given corresponds to about 0.3 % of the total consumption of natural gas in the Czech Republic. The detailed calculation given corresponds to Tier 2.

In conclusion, it should be pointed out that, since 1997, this chapter does not include transport and distribution of town gas, whose production was terminated in 1996, when the entire gas system was converted to natural gas. The factory for production of energy-production gas in the pressure gas plant of Vřesová (Sokolovská uhelná, a.s.) was reconstructed as an integrated steam-gas facility. However, from the standpoint of the overall balance, the importance of this source of fugitive emissions lies below the borderline of the precision of the other professional estimates.

3.2.4 Methane Emissions from Petroleum Extraction, Refining and Storage

As the fraction of this category makes a minority contribution to overall methane emissions in the category Fugitive emissions from operations connected with petroleum and gas, this chapter is limited to a brief commentary.

Calculation of methane emissions in domestic petroleum production was carried out using the emission factor based on data from ref. (*UNIPETROL and Environment*, 1999), and currently has a value of 5.287 kg / PJ of extracted petroleum. This emission factor is somewhat higher than the maximum value recommended by IPCC: 4.670 kg / PJ (*Revised 1996 IPCC Guidelines*, 1997); however, it is the same order of magnitude. The calculation corresponds to Tier 2.

In the recent past, Czech refineries have undergone a quite extensive process of innovation and reconstruction, to decrease technical losses of raw materials and final products. Comprehensive verification has been carried out of the seals of the individual fittings, pumps and all the technical equipment. This entire process, which was carried out mainly for economic reasons, also led to a decrease in overall emissions, especially of NMVOCs. Consequently, the emission factors taken from (*Revised 1996 IPCC Guidelines*, 1997) can be considered to correspond to the current technical condition of refineries in this country. In this connection, it should be pointed out that fugitive emissions from refinery technology couldn't be determined by direct measurements, as they are not connected with specific air outlets or chimneys. Thus, they can be determined only on the basis of professional estimates from balance losses or using emission factors. The resultant emissions of the individual substances were compared with the data in the national emission database and are of the same order of magnitude.

As, according to the literature, methane constitutes about 10 % of total VOC emissions, it can be stated that the emission factor for methane would correspond to a level of about 0.07 kg / t of processed petroleum, which is the upper limit given in (*Revised 1996 IPCC Guidelines*, 1997).

Technical progress in the past has permitted reduction of emissions by about 30 %. Consequently, an emission factor value of 1.150 kg / PJ is used to calculate methane emissions from petroleum refining. The emission factor for storage of petroleum was found by a similar method as being at the level of 250 kg / PJ. Petroleum products practically do not contain methane and thus emissions from storage and handling of petroleum products are not calculated.

Because of the uncertainty, it is necessary to evaluate methane emissions in this subcategory at the level of Tier 1. However, the uncertainty entailed cannot significantly affect the overall balance.

3.2.5 Activity Data and Emission Factors

Activity data on the extraction of the individual energy carriers (coal, petroleum, gas) and on batches of petroleum in the petrochemical industry are available in yearbooks (*Mining Yearbook*, 1994 - 2003, *Statisical Yearbook*, 2004) and, since 1998, in the periodical publication Energy Management in the Czech Republic in Numbers (*Energy Economy*, 1999 - 2003). Data on the gas distribution system are monitored and collected by TRANSGAS a.s. and by the Czech Gas Association. All the activity data employed can be considered to have a relatively high level of precision (± 5 %).

Methane emissions were calculated using national emission factors determined in previous years from various sources given in the literature survey, with the assistance of professionals for the individual categories of sources. In relation to expected future developments, it will, however, be necessary to regularly refine the emission factors values employed. All the required information on activity data could be entered in tables in CRF format because of the high validation and in relation to the complexity of the procedures used to calculate the emissions to date.

Tab. 3.9 and 3.10 illustrate the calculation of fugitive emissions of methane from solid, liquid and gaseous fuels.

Tab. 3.9 Calculation of CH_4 emissions from coal mining in 2003

	A	B	C	D	E
	Ammount of Coal Produced	*Emission Factor*	*Methane Emissions*	*Conversion Factors*	*Methane Emissions*
	[mil. t]	*[m^3 CH_4 / t]*	*[mil. m^3]*	*[Gg CH_4 / $10^6 m^3$]*	*[Gg CH_4]*
			C=A*B		E=C*D
Mining (I - III)	13.643	18.1	250	0.67	167.3
*OKR** (Tier 3)	13.643	18.3	250	0.67	167.3
Other(Kladno -Tier 1*)*	**0.000**	10.0	**0**	0.67	**0.0**
Post-Mining (Tier 1)	13.643	2.45	33	0.67	22.4
*OKR** (Tier 1)	13.643	2.45	33	0.67	22.4
Other(Kladno -Tier 1*)*	**0.000**	0.9	**0**	0.67	**0.0**
Mining (Tier 1)	46.240	1.15	53	0.67	35.6
Post-Mining (Tier 1)	46.240	0.1	5	0.67	3.1
				Total	**228.40**

** Ostrava-Karviná coal-mining area*

Tab. 3.10 Calculation of CH_4 emissions from oil and natural gas in 2003

	Tier	A	B	C	D
		Activity	Emission Factors	CH_4 Emissions	Emissions CH_4
				[kg CH_4]	*[Gg CH_4]*
				C = (A x B)	D = (C / 10^6)
Production	***OIL***	*PJ oil produced*	*kg CH_4 / PJ*		
(domestic production)	3	13.25	5 287	70 064	0.070
Refining		*PJ oil refined*	*kg CH_4 / PJ*		
	1 - 2	283.5	1 150	325 995	0.326
Storage		*PJ oil refined*	*kg CH_4 / PJ*		
	1	283.5	250	70 868	0.071
				CH_4 from oil	**0.467**
Production / Processing	***GAS***	*PJ gas produced*	*kg CH_4 / PJ*		
(domestic production NG)	2	6.83	88 572	604 508	0.605
Transmission & Distribution		*PJ gas consumed*	*kg CH_4 / PJ*		
(transit transport, high and low pressure pipeline)	2	1 320	16 115	21 271 975	21.272
Other Leakage		*PJ gas consumed*	*kg CH_4 / PJ*		
Underground storage	3	96.84	14 762	1 429 613	1.430
				CH_4 from gas	**23.306**

Relatively low value of the implied emission factor for *Transmission/Processing* is caused by the fact that an international transit of natural gas represents a considerable part of the activity value.

3.2.6 Emission Trends

Determination of the consistency of time trends is one of the requirements of the Good Practice Guidance. For methane emissions from the main key category - Mining and post-mining treatment of coal - the time series after recalculating data after 1996 is consistent and corresponds to the trends in coal mining in this country. The original data in the following table (Tier 1) were replaced by data at the Tier 3 level.

Tab. 3.11 Trend of CH_4 emissions from coal mining and post-mining activities *[Gg CH_4]*

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Original value	427.0	381.0	363.0	353.0	338.0	367.0								
Present value	361.9	321.0	306.0	298.0	282.0	276.6	268.5	263.5	253.1	229.0	239.0	244.7	237.5	228.2

The time series for the category of methane emissions from petroleum processing and from the gas industry are also sufficiently consistent and their decreasing trend in the second half of the 90's is a result of modernization of technology in these branches.

Tab. 3.12 Trend of CH_4 emissions from oil and natural gas activities *[Gg CH_4]*

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Oil and natural gas	32.20	35.40	35.90	35.30	34.60	38.00	32.00
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Oil and natural gas	35.00	28.20	28.80	28.77	22.89	23.14	23.77

For conversion into CRF format, data for 1992 were newly recalculated on the basis of the refined emission data and specific process emissions. In a number of cases, the results submitted in this report can exhibit certain deviations from the original data presented in previous years; this is also true of data given in the Second National Communication.

3.2.7 Precursor Emissions

Ozone precursors (NO_X, CO, NMVOCs) and aerosols (SO_2) from this category are generated primarily in the processes of treatment of petroleum and in its storage, and also in other handling of petroleum and petroleum products. Emission data for precursors (since 2001) have been inserted into CRF format by conversion from corresponding subcategories of the NFR format, similarly as in the other categories.

3.2.8 QA/QC Procedures

The application of control mechanisms in inventory of fugitive CH_4 emissions is an important element of data correctness verification and uncertainty evaluation. The very nature of fugitive emissions leads to needs for internal and external controls, as these emissions are not related to specific outlets and consequently cannot be measured directly. Thus, it is necessary to employ other data than those provided, e.g., by analysis of combustion products from furnaces or waste air from technical facilities. Accordingly, determination of emission factors is a very complex matter. On the basis of the collected data, emission factors were determined for the individual segments of category 1B and compared with the default values (Tier 1); these values were then used to calculate fugitive emissions. The newly determined emission factors for deep mining were also used to correct CH_4 emissions for GHG inventories 1990 to 1995.

3.2.8.1 Internal Quality Control

For the purposes of internal quality control, the calculations were based on basic requirements that are defined as follows:

- routine control of consistency to ensure data integrity and their correctness and completeness;
- identification and correction of errors and omissions;
- documentation and archiving of all material used for the inventory preparation and QC activities.

Control of quality of the processed by national expert team is carried out both on the basis of the emission factors and activity data used. The consistency of activity data is controlled on the basis of the following sources:

- fuel extraction: Czech Mining Authority, Employers Federation of the Mining and Petroleum Industry, Miners' Association:
- extraction of domestic petroleum: Employers Federation of the Mining and Petroleum Industry, Miners' Association, Moravian Petroleum Mines;
- production and consumption of natural gas: Annual Report of Distribution Companies of the Gas Industry, Transgas Balance.

These sources have been also used in other parts of GHG emission inventory, e.g. in *Combustion Processes*, resulting in cross-control within the working team. The emissions calculated from the emission factors are then compared with previous years and a check is made to ensure that no sudden changes have occurred. All data (source and calculated) are stored by the national expert team.

4 Industrial Processes (CRF Sector 2)

4.1 Sector Characterization

This category includes only emissions from actual processes and not from fuel combustion used to supply energy for carrying out these processes. For example, in the production of cement, consideration is given only to emissions derived from the thermal decomposition of mineral raw materials (specifically CO_2 emissions from the decomposition of limestone) and not from fuel used to heat the rotary kiln (considered in category 1A2). It should also be borne in mind that emissions occurring during petroleum refining belong in category 1B (fugitive emissions).

In respect to emissions of direct greenhouse gases, these consist only in emissions of CO_2 in the production of mineral products (cement, glass). This source can be considered a *key source* according to the IPCC *Good Practice* (*Good Practice Guidance*, 2000), although it is far less significant compared to combustion of fossil fuels. The production of nitric acid, which leads to emissions of N_2O, can be considered to be a source lying on the borderline between key and non-*key sources*. Tab. 4.1 gives a summary of sources of direct greenhouse gases in category 2 excluding use of F-gases. This subcategory (2F) will be dealt with in section 4.6

Tab. 4.1 Overview of the most important sources from this category

	Character of source	Gas	% of total
Minerals production (decarbonization)	Key source	CO_2	1.6
Iron and steel	Key source	CO_2	6.0
HNO_3 production	-	N_2O	0.7
NH_3 production	-	CO_2	0.6

Other sources of direct greenhouse gases are minor, except of CO_2 emissions from iron and steel production, which have so far been reported in the energy category 1A2. In the 2001 inventory, these emissions were already re-classified as emissions from Industrial processes, 2C1. Naturally, this constitutes a quite important key source under Industrial processes. In this way, the relevant rearrangements will be applied on the whole data series.

Emissions from ammonia production (including hydrogen production by steam gasification followed by the shift reaction) should also be reported in the Industrial processes category. However, they were two reasons to include these emissions currently under Energy (1A2) - to respect existing continuity, and due to some difficulties in identification of the amount of gasified fuel (residual oil).

These difficulties could be overcome for the data for 2003 and the technically specific emission factor of 2.41 Gg CO_2 / Gg NH_3 was determined on the basis of operating data, so that the CO_2 emissions from ammonia production are appropriately reported in sector 2B1. In this way, the relevant rearrangements will be employed for the whole data series.

According to the IPCC categorization of sources, this category also includes emissions from production and use of HFCs, PFCs and SF_6. It is no production of these gases in the Czech Republic. Emissions related to their usage are presented at the end of this chapter.

4.2 Carbon Dioxide Emissions

4.2.1 Mineral Products

Cement production (2A1) is one of the traditional anthropogenic sources of carbon dioxide included in inventories; however, its importance is incomparably smaller than the combustion of fossil fuels. Process-related CO_2 is emitted during the production of clinker (calcination process) when calcium carbonate ($CaCO_3$) is heated in a cement kiln up to temperatures of about 1300 °C. During this process, calcium carbonate is converted into lime (CaO - calcium oxide) and CO_2. CO_2 emissions from combustion processes taking place in the cement industry (especially heating of rotary kilns) have been reported in IPCC Category 1A2.

In principle, carbon dioxide emissions can be calculated according to the IPCC methodology from the production of clinker or cement. The latter approach has been so far employed in this inventory, because statistical information on cement production is available in the Czech Republic. The *default* emission from the IPCC Methodology (*Revised 1996 IPCC Guidelines*, 1997) i.e. 0.4985 t CO_2 / t cement, was used for estimating emissions from cement throughout the nineteen nineties. In 2003, CO_2 emissions decreased nearly twice compared to 1990 and are equal 1 782 Gg CO_2 (it represents 56 % of the value in 1990). Process-related emissions from cement production for the whole 1990 - 2003 period are presented in Tab. 4.2

Tab. 4.2 Activity data and CO_2 emissions from cement and lime production in 1990 - 2003

	Cement produced *[t / year]*	Process-specific CO_2 emissions *[Gg]*	Lime produced *[t / year]*
1990	6 434	3 207	1 490
1991	5 610	2 797	1 391
1992	6 145	3 063	1 337
1993	5 393	2 688	1 147
1994	5 252	2 618	1 212
1995	4 831	2 408	1 186
1996	4 973	2 479	1 176
1997	5 011	2 498	1 217
1998	4 874	2 430	1 151
1999	4 241	2 114	1 142
2000	4 093	2 040	1 202
2001	3 591	1 790	1 312
2002	3 249	1 604	1 258
2003	3 502	1 746	1 262

Data on cement production were taken from the official Czech statistics, see ref. (*Statistical Yearbook*, 2005)

Emissions from lime production (2A2) were calculated as the sum of CO_2 emissions from lime production and CO_2 removals from the atmosphere. It has been approximately assumed so far that emissions and removals are identical. This means that overall emissions from lime production are considered to be 0.

CO_2 is emitted during the calcination step of lime production. Calcium carbonate ($CaCO_3$) in limestone and calcium / magnesium carbonates in dolomite rock ($CaCO_3$•$MgCO_3$) are decomposed to form CO_2 and quicklime (CaO) or dolomite quicklime (CaO•MgO) respectively. On the other hand, the use of hydrated lime (e.g. building industry - hardening of mortar, water softening, sugar production) mostly results in the reaction of CO_2 with lime to form calcium carbonate.

Only CO_2 emissions generated in the process of calcination step of lime treatment are considered under Category 2A2. CO_2 emissions from combustion processes (heating of kills and furnaces) are reported under Category 1A2. Tab. 4.2 presents sum of quick, slaked and hydraulic lime production (taken from the official Czech statistics, see ref. (*Statistical Yearbook*, 2004))

As can be seen in Tab. 4.2, the overall trend for lime production decreased slightly in the 1990 - 2003 period; in 2003, lime production was 16 % lower than in 1990.

In the 2004, a study was performed in an attempt to obtain more precise data for cement and lime production and to propose changes in the methodology (Tier 2 methodology for cement production based on clinker production, for lime production review of the relationship between emissions and removals). More details are given in Chapter 4.4 Recalculations, QA/QC and Plans for Improvement.

Glass production is not too important source, where CO_2 emissions (198 Gg) are derived particularly from the decomposition of alkaline carbonates added to glass-making sand. The emission factor value of 0.14 t CO_2 / t glass was taken from the new version of the guidebook (EMEP / CORINAIR Atmospheric Emission Inventory Guidebook, 1999).

From the chemical standpoint, sulfur removal from combustion products in coal combustion, using limestone, is a related source of CO_2 emissions, although it is not of great importance. Here, it holds that one mole of SO_2 removed releases one mole of CO_2 without regard to the sulfur-removal technology employed and the stoichiometric excess. However, this source is reported in category 1B. These amounts have, understandably, increased somewhat in the last three years, to a value of about 0.56 Mt CO_2 as a consequence of the extensive introduction of sulfur removal, especially in power plants. However, this figure is not expected to increase further.

4.2.2 Iron and Steel Production

In accordance to the IPCC *Good Practice* (*Good Practice Guidance*, 2000) starting with GHG emission inventory 2001, recategorization of the CO_2 emissions formed in the metallurgy industry in the process of production of iron and steel was carried out. These emissions, which are connected with the actual metallurgical process, were previously included in category 1A2. For 2001 and 2002, these emissions, equaling 2 524 Gg CO_2 and 2 614 Gg CO_2 respectively, were transposed to category 2C1. Obviously, they constitute a new key source in category 2.

CO_2 emissions were determined for subcategory 2C1 using a procedure corresponding to Tier 1 of the *Good Practice Guidance* for 2C1. This calculation was based on the amount of coke burned in blast furnaces, as stated by the Energy Balance for the Czech Republic for 2001 (*Energy balance of the Czech Republic*, 2003), equal to 23 811 TJ (829 Gg) and for 2002 equal to 24 658 TJ (858 Gg). The calculation was carried out using the carbon emission factor for coke, 29.5 t C / TJ, which is the *default* value according to (*Revised 1996 IPCC Guidelines*, 1997). As the final products in metallurgical processes are mostly steel and iron with very low carbon contents, the relevant correction for the amount of carbon remaining in the steel or iron was taken into account by using factor 0.98, i.e. the same factor that is standardly used for combustion of solid fuels (the oxidation factor). The major part of CO_2 emissions calculated in this manner, is emitted in combustion of blast-furnace gas, while a smaller part is derived from heat treatment (improvement) of pig iron.

In the calculation, first the emissions derived from total coke were determined, and a proportional amount derived from the batches of metallurgical coke added to blast furnaces was then (from 2001) transferred from category 1A to category 2C1. Thus, the total emissions of carbon dioxide are not affected in this approach by a potential uncertainty in determination of the amount of metallurgical coke added to blast furnaces. In application of the QA/QC mechanism, it was found that the amount of metallurgical coke was underestimated in 2001 and 2002. Consequently, for 2003, emissions corresponding to the production of iron and steel were calculated from the entire annual addition of metallurgical coke of 2 499 t (71 468 TJ) for blast furnaces. This led to final emissions of CO_2 of 7 576 Gg as mentioned in Chapter 3.1. In the next submission, the entire time series from 1990 will be rearranged in this way to ensure temporal consistency.

4.2.3 Ammonia production

Similarly, emissions of CO_2 corresponding to the production of ammonia have been determined since 2003 by first determining the emissions corresponding to the overall consumption of residual fuel oil. Then the emissions derived from the corresponding amount of ammonia produced are determined using the technically specific emission factor 2.41 Gg CO_2 / Gg NH_3. Thus, also in this case, a potential uncertainty in the emission factor for ammonia would not influence the total sum of CO_2 emissions. In 2003, emissions from production of ammonia equalled 705.84 Gg CO_2. In the next submission, the entire time series from 1990 will be rearranged in this way to ensure temporal consistency.

4.3 Methane and Nitrous Oxide Emissions

Nitrous oxide emissions in this category are derived mainly from the production of nitric acid. Nitrous oxide is generated as a by-product in the catalytic process of oxidation of ammonia. It follows from domestic studies (Markvart and Bernauer, 1999, 2000, 2003) that the resulting emission factor depends on the technology employed: higher emission factor values are usually given for the process carried out at normal pressure, while lower values are usually given for the medium-pressure process. Two types of processes are carried out in this country, at pressures of 0.1 MPa and 0.4 MPa. The amount of nitrous oxide in the exit gases is also affected by the type of process employed to remove nitrogen oxides, NO_X (i.e. NO and NO_2). In this country, the process of Selective Catalytic Reduction (SCR) is mostly used, which slightly increases the amount of N_2O, and also to a certain degree NonSelective Catalytic Reduction (NSCR), which also removes N_2O to a considerable degree. The final value of aggregated emissions for 2003 is equal 5.72 kg N_2O / t HNO_3 (taken as 100 % HNO_3), see ref. (Markvart and Bernauer, 2003, 2004). The emission factor for 2003 is somewhat lower than that for 2002 (EF = 6,57 kg N_2O / t HNO_3), caused by starting up of a new higher-pressure production line.

Studies (Markvart and Bernauer, 2000, 2003) recommend the following emission factors for various types of production technology and removal processes:

Tab. 4.4 Emission factors for N_2O recommended by (Markvart and Bernauer, 2000)

Pressure in HNO_3 production	0,1 MPa			0,4 MPa		
Technology RENOX	--	SCR	NSCR	--	SCR	NSCR
Emission factors N_2O *[kg N_2O / t HNO_3]*	9.05	9.20	1.80	5.43	5.58	1.09

The emission factors corresponding to the technologies in operation in this country are given in Tab. 4.4. The emission factors for the basic process (without RENOX technology) are in accord with the principles given in the above-cited IPCC methodology. The effect of the NO_X removal technology on the emission factor for N_2O was evaluated on the basis of the balance calculations presented in studies (Markvart and Bernauer, 1999, 2000, 2003)

Collection of activity data for HNO_3 production is more difficult than for cement production because of the present legislation, which complicates the releasing of statistical data on manufactured products where the number of producers is smaller than (or equal to) three. Therefore, it was necessary to obtain them by questioning all three producers in the Czech Republic, see (Markvart and Bernauer, 1999, 2000, 2003, 2004)

Studuis (Markvart and Bernauer, 1999, 2000, 2003, 2004) also gives the value of N_2O emissions from the production of caprolactam starting this year: 0.3 Gg N_2O per annum. However, this amount is small compared with other sources. Adipic acid, which is considered to be a significant source of N_2O on a global scale, has not been manufactured in the Czech Republic for some time. Further potential sources of N_2O from other nitration processes in chemical technology should be negligible.

Tab. 4.5 gives the emissions of N_2O from production of nitric acid including production values. Emissions from the production of nitric acid did not decrease and tended to fluctuate around a value of 3.25.

Calculations of N_2O emissions from nitric acid based on study (Markvart and Bernauer, 1999) were firstly used to obtain emission estimates in 1998. This approach, resulting in emission factor values lying in the range 6.5 - 6.9, was also employed for revised data for 1990, 1992, 1994 and 1995; years 1991 and 1993 will be revised soon.

Industrial processes emit only 3.40 Gg of methane (in 2003), of which approximately one half corresponds to escape of carbonization gas in coke production. Emission estimates of precursors for the relevant subcategories (starting with inventory 2001) have been transferred from NFR to CRF, as described in previous chapters.

Tab. 4.5 Emission trends for HNO_3 production

	Production of HNO_3, *[Gg HNO_3 (100 %)]*	Emissions of N_2O *[Gg N_2O]* from HNO_3 production
1990	530.0	3.63
1992	439.4	2.98
1994	439.8	2.94
1996	438.0	3.33
1997	483.1	3.60
1998	532.5	3.59
1999	455.0	2.95
2000	505.0	3.36
2001	505.1	3.32
2002	437.1	2.87
2003	500.6	2.86

4.4 Recalculations, QA/QC and Plans for Improvement

In 2004, a study was peformed and proposed new methodology for cement production, based on clinker production. This study also compares the activity data obtained from the Czech Statistical Office and the Czech Cement Association, which associates all Czech cement producers. Data from CSO differ from those provided by CCA, mainly due to inclusion of clinker imports and exports. The CCA data was considered to be more accurate. The emission factor was derived from the parameters for the limestone used in 1990, 1996, 1998 - 2001 (the value of EF was extrapolated for the other years). EF fluctuates from 0.5267 to 0.5534 t CO_2 / t clinker. This value is in accordance with GPG defaults EF. Tab. 4.6 gives a comparison of the results of the Tier 1 (cement) and 2 (clinker) methods.

Tab. 4.6 Tier 1 and Tier 2 methods results comparison for 1990 - 2003 *[Gg CO_2]*

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Tier 1	3 149	2 746	3 008	2 640	2 571	2 365	2 455	2 386	2 254	2 076	2 004	1 758	1 590	1 696
Tier 2	2 489	2 309	2 468	2 194	2 209	2 005	2 116	2 083	2 068	1 963	1 937	1 629	1 404	

Recalculation of emissions from lime production was focused on the ratio between emissions and removals in lime production and use. All lime producers were asked to estimate the fraction of their production used in the various sectors of iron and steel production, production of chemicals, export, environmental protection, building materials, construction, agriculture and unspecified. It is assumed that 35 % of emissions are removed by lime use. CSO monitors lime production as a single category and doesn't distinguish between quick, slaked and hydraulic lime. In cooperation with the Czech Lime Association lime production data was obtained from the individual producers. Tab. 4.7. gives the results of the recalculations.

Following implementation of QA/QC procedures emission recalculation from cement and lime production will be incorporated into the national inventory.

Tab. 4.7 Lime production, emissions and removal from lime production from 1990 - 2003 *[t and Gg CO_2]*

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Lime production	1 823	1 152	1 134	1 062	1 100	1 115	1 133	1 163	1 087	1 074	1 130	1 128	1 112	1 102
CO_2 emissions	869	549	541	506	524	531	540	554	518	512	539	538	530	525

Above-mentioned results of data recalculations must be considered as preliminary. New methodology will be checked for omissions and compatibility with IPCC methodology and also will continue discussion if data sources are the most suitable and reliable.

No recalculations of CO_2 emissions from cement production have been made so far. The above-described changes in reallocation of CO_2 emissions from iron and steel from 1A2 to 2C1 since 2001 must be followed by the relevant changes in the whole time series since 1990. The CO_2 series from ammonia synthesis will be rearranged in a similar way.

Recalculations concerning N_2O were described in previous paragraphs.

Other activity data available in the official CSO materials related to QA/QC were independently determined by experts from CHMI and KONEKO Marketing Ltd. and were mutually compared. Experts of CHMI, and vice versa additionally controlled most of the calculations carried out by experts of KONEKO Marketing Ltd.

As regards planned improvement in “Mineral products”: in the area of cement production (key source), the national inventory team plans to replace the existing Tier 1 approach, based on using the default EF for cement, by the Tier 2 approach based on clinker production, which will include use of more detailed bottom-up data obtained directly from cement producers. Similarly, it is intended to obtain more precise data on lime production. Moreover, an attempt will be made to quantify the removal / emission ratio (so far it has been approximated by one) by analyzing means of lime utilization.

4.5 Production of Halocarbons and SF_6 (CRF Sector 2.E)

Halocarbons and SF_6 are not produced in Czech Republic.

4.6 Consumption of Halocarbons and SF_6 (CRF Sector 2.F)

4.6.1 Source Category Description

HFC, PFC and SF_6 (for short: F-gases) emissions are in the Czech Republic on the relatively low level due to absence of large industrial sources of the F-gas emissions. As mentioned above, F-gases are not produced in Czech Republic and therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (HCFCs, etc.) that could lead to by-product F-gas emissions and it does not exist any aluminum and magnesium industry in the Czech Republic.

F-gases emissions from national sources are coming only from their consumption in applications as follows:

1. SF_6 used in electrical equipment,
2. SF_6 used in sound proof windows production,
3. HFCs, PFCs and SF_6 used in semiconductor manufacturing,
4. HFCs and PFCs used as refrigerants in refrigeration and air conditioning equipment,
5. HFCs used as propellants in aerosols,
6. HFCs used as blowing agents,
7. HFCs used as extinguishing agents in fixed fire fighting systems.

No official statistics, which would allow disaggregated reporting and / or use of higher tier methodology, is available in the Czech Republic at this moment.

For the source consumption of F-gas emissions increased from 169.4 Gg $CO_{2\ eq.}$ in 1995 to 1 712.1 Gg $CO_{2\ eq.}$ in 2003. This significant increase could be explained mainly due to strong increase of HFCs usage.

Tab. 4.6 HFCs, PFCs and SF_6 potential emissions in 1995 - 2003 *[Gg $CO_{2\ eq}$]*

	1995	1996	1997	1998	1999	2000	2001	2002	2003
HFCs	2.2	134.1	295.6	381.8	411.9	674.3	1 045.2	1 092.4	1 343.9
PFCs	0.4	4.2	7.0	9.1	2.7	9.4	14.5	17.9	28.6
SF_6	166.8	183.1	323.1	131.7	110.9	205.9	223.2	211.9	339.3
Total	169.4	321.4	625.7	522.6	525.5	889.8	1 282.9	1 322.1	1 711.8

4.6.2 Methodological Issues

At present, the national F-gases inventory is based on the potential emissions method, supplemented by the specific individual data collection on F-gases usage in individual industrial users. At this moment current national statistics does not allow inventory preparation based on actual emission.

According to (*Revised 1996 IPCC Guidelines*, 1997), potential emissions have been calculated from the consumption of F-gases (sum of domestic production and import minus export and environmentally sound disposal). Due to short time of F-gases usage it has been supposed that disposed amount is insignificant and F-gases production is negligible. The applied method assumes that actual emissions should not exceed potential emissions.

As these substances are not nationally produced, import and export information coming from official customs authorities are of the key importance. Individual F-gases do not have a separate custom codes in the customs tariff list as individual chemical substances. SF_6 is listed as a part of cluster of non-metal halogenides and oxides, HFCs and PFCs are listed as total in the cluster of halogen derivatives of acyclic hydrocarbons. In order to determine the exact amounts of these substances, it is essential to get information from the customs statistics and from individual importers and exporters, about (a) imported and exported amounts and (b) kinds of substances (or their mixtures) and possibly also (c) areas of usage, for that reason all importers and exporters are additionally requested to complete the specific questionnaire on F-gases export, import and to support questionnaire by additional information on quantity, composition and their usage. More detailed description of the methodology is available under the separate document (Řeháček and Michálek, 2004) which also contents all relevant information for emission calculations.

4.6.3 Uncertainty, Consistency, QA/QC, Recalculations and Planned Improvement

No uncertainty analysis has been made for the time being.

The time series is not fully consistent as no detailed information on exporters and importers for the period 1997 to 1999 was available; only data on total amount of substances imported in the certain cluster of substances under the corporate customs code was affordable. The calculation has been made using the identical approaches as for 1996. The calculation for 1999 was additionally checked and improved by informal questionnaires, which were sent to the assumed importers and users.

Verification has been carried out by data comparison received from customs office and from submitted questionnaires. The QC system is still under the development.

In 2004, preparations were made for a study to discuss the potential for the use of Tier 2 methodology and also to obtain more precise data for 1997 - 1999. However, some problematic issues related mainly to historical data still remain in this study (e.g. use of SF_6 before 1995). An attempt will be made this year to satisfactorily resolve all problematic aspects, so that recalculation of the entire data series for 1995 - 2004 will be part of the 2006 submission.

5 Solvent and Other Product Use (CRF Sector 3)

This category includes particularly emissions of NMVOC (ozone precursor) from the use of solvents, which are simultaneously considered to be a source of CO_2 emissions (these solvents are mostly obtained from fossil fuels), as their gradual oxidation in the atmosphere is also a factor. However, the use of solvents is not an important source of CO_2 emissions - in 2003, CO_2 emissions were calculated at the level of 0.29 Mt CO_2.

This category (Solvent and Other Product Use) also includes N_2O emissions from its use in the food industry and in health care. These not very significant emissions corresponding to 0.69 Gg N_2O were derived from production in the Czech Republic.

The IPCC methodology (Revised 1996 IPCC Guidelines, 1997) uses the CORINAIR methodology (EMEP / CORINAIR Guidelines, 1999) for processing NMVOC emissions in this category. This manual also gives the following conversions for the relevant activities, which can be used in conversion of data from the CORINAIR (i.e. SNAP) structure to the IPCC classification.

Tab. 5.1 Conversion from SNAP into IPCC nomenclature

SNAP	SOLVENT AND OTHER PRODUCT USE	IPCC	
06 01	Paint application Items 06.01.01 to 06.01.09	3A	Paint application
06 02	Degreasing, dry cleaning and electronic Items 06.02.01 to 06.02.04	3B	Degreasing and dry cleaning
06 03	Chemical products manufacturing or processing. Items 06.03.01 to 06.03.14	3C	Chemical products
06 04	Other use of solvents + related activities Items 06.04.01 to 06.04.12	3D	Other
06 05	Use of N_2O Items 06.06.01 to 06.06.02	3D	Other

Inventory of NMVOC emissions for 2003 for this sector is based on a study prepared by SVÚOM s.r.o. Prague (*Commentary on the emission inventory NMVOC*, 2004). This study is elaborated annually for the UNECE / CLRTAP inventory in NFR and is also adopted for the National GHG inventory.

Solvent Use chapter is based on the following sources of information:

- statistical information on producers and imports from the Czech Statistical Office,
- REZZO data,
- annual reports of the Association of Coatings Producers and Association of Industrial Distilleries,
- information from the Customs Administration.

6 Agriculture (CRF Sector 4)

6.1 Sector Characterization

GHG emissions from agriculture category under national conditions consist mainly of emissions of methane and nitrous oxide.

Methane emissions are derived from animal breeding. These are derived primarily from enteric fermentation (digestive processes), which is manifested most for ungulate animals (in this country, mostly cattle). Other emissions are derived from fertilizer management, where methane is formed under anaerobic conditions (with simultaneous formation of ammonia which, however, is not monitored in the framework of greenhouse gas inventories).

Nitrous oxide emissions are formed mainly in denitrification processes in soils, mainly under anaerobic conditions. The anthropogenic contribution that is determined in the national inventory of greenhouse gases is caused by nitrogenous substances derived from inorganic nitrogen-containing fertilizers, manure from animal breeding and nitrogen contained in parts of agricultural crops that are returned to the soil (for example, in the form of straw together with manure, or that are ploughed into the soil). In addition, emissions are also included from stables and fertilizer management and indirect emissions derived from atmospheric deposition and from nitrogenous substances flushed into water courses and reservoirs.

For Agriculture, three from five sources (categories of sources) were evaluated according to the IPCC *Good Practice* (*Good Practice Guidance*, 2000) as *key sources*. According to this approach, sources are related to the given pollutant. Overview of sources, including their contribution to aggregated emissions, is given in Tab. 6.1.

Tab. 6.1 Overview of the most important sources from Agriculture

	Character of source	Gas	% of total
Direct emissions of N_2O from agriculture soils	Key source	N_2O	2.0
Indirect emissions of N_2O from agriculture activities	Key source	N_2O	1.3
Enteric fermentation	Key source	CH_4	1.1
Manure management	-	CH_4	0.4
Manure management	-	N_2O	0.3

6.2 Methane Emissions

As mentioned above, methane emissions from the breeding of farm animals are caused both by enteric fermentation and also by the decomposition of animal excrements (manure). Determination of these emissions was prepared at the level of both Tier 1 and Tier 2. If enteric fermentation is considered according to Tab. 7.1 to constitute a *key source*, preference should be given to determination in Tier 2. This calculation arose in 1994 in connection with the historical inventory (Dolejš, 1994) and was reviewed by (Jelínek *et al* in 1996), where only minimal adjustments were made to the emission factors. In principle, emissions from animal excrements could be calculated according to Tier 1 (this is not a *key source*); however, due to tradition and consistency of the time series, the final values were also calculated according to Tier 2 using the emission factors from studies (Dolejš, 1994; Jelínek, 1996). The number of animals required for the calculation was taken from the Statistical Yearbook (*Statistical Yearbook*, 2003)

6.2.1 Tier 1

In deciding on the relevant emission factors in the area of animal production, the *IPCC Guidelines* [1, 2] permits a choice between developed and undeveloped countries or between the countries of Western and Eastern Europe. Because of the tradition of intensive agriculture in the Czech Republic and the cultural similarity to Western Europe, values for developed countries or Western Europe were used. For comparison, calculation was also carried out for an Eastern European country. For emissions from animal manure, a further parameter is the temperature zone (cool, temperate, warm). As the average annual temperature in the Czech Republic does not exceed 10 ^{o}C, the values for a cooler climate (< 15 ^{o}C) were selected. Determination in Tier 1 was carried out mainly for the purposes of control, while the final sums were drawn up on the basis of emissions determined according to Tier 2.

6.2.2 Tier 2

The emission factor for methane from fermentation (EF) in kg p.a. according to (*Revised 1996 IPCC Guidelines*, 1997) is proportional to the daily food intake and the conversion factor. It thus holds that

$$EF = 365 / 55.65 * \text{daily food intake} * Y,$$

where the daily food intake (MJ / day) is taken as the mean feed ration for the given type of farm animal (there are several subcategories for cattle) and Y is the conversion, which also differs according to the kind of farm animal (usually 0.06 to 0.08 for cattle). The conversion factor of 55.65 has dimensions of MJ / kg CH_4. Parameters for calculations in earlier inventories for years 1990 - 1995 were taken from the domestic data at that time (Dolejš, 1994), which are given in Tab. 7.2. The accepted conversion value of 0.08 for cattle is somewhat higher than the usual value given for Western Europe of 0.06 (*Revised 1996 IPCC Guidelines*, 1997). For cattle other than dairy cattle, the number of head in the individual subcategories (e.g. calves) is also given for 1990, so that it is possible to calculate the aggregated emission factor for the entire category of other (non-dairy) cattle.

Tab. 6.2 Input data for original calculation of CH_4 emissions from livestock according to Tier 2 (Dolejš, 1994)

Livestock (data from 1994)	Stock *[thous. pcs]*	Intake *[MJ / day]*	Y	VS *[kg / day]*	Bo *[m^3 / kg]*	MCF
Dairy cows	1 195	128	0.08	5.6	0.24	0.01
Other cattle	2 165			3.6	0.17	0.01
Cows	350	104	0.08			
Breeding bulls	1	95	0.08			
Pre-weaning calves	60	10	0.08			
Increscent bulls and heifers	626	21	0.08			
Young bulls and heifers	1 128	45	0.08			
Pigs	4 589	26	0.02	0.8	0.45	0.10
Poultry	33 278	1	0.01	0.03	0.32	0.01
Horses	25	90	0.08	4.5	0.33	0.01
Sheep	430	15	0.08	0.7	0.19	0.01
Goats	42	10	0.07	0.5	0.17	0.01

The emission factors for methane from animal manure are calculated for each kind of farm animals according to the equation (*Revised 1996 IPCC Guidelines*, 1997)

$$EF = VS * 365 * Bo * 0.67 * MCF,$$

where EF is the emission factor [kg p.a.], VS is the daily excretion (production of decomposing organic substances in the manure) [kg / day], Bo is the maximum methane production in the excretion [m^3 / kg_{VS}] and MCF is the conversion factor for the given system of manure storage (deposition). The values of VS, Bo and MCF employed are given in Tab. 6.2. Values of VS presented in this table differ somewhat from the default values presented in (*Revised 1996 IPCC Guidelines*, 1997). The Bo and MCF values were taken from (*Revised 1996 IPCC Guidelines*, 1997), factor MCF = 0.01 corresponds to open deposition of manure (in the cold temperature zone), the value 0.1 for pigs corresponds to the usual manner of storing liquid pig manure (slurry). The emission factors for methane emissions from the breeding of livestock according to Tier 2 were in 1996 up-dated by domestic agricultural specialists, (Jelínek *et al*, 1996). The emission factors were calculated using zoo-technical data from 1995. The original and updated data are given in Tab. 6.3.

Tab. 6.3 Emission factors of CH_4 from livestock (Tier 2)

	Emission factors *[kg CH_4 / pcs.year]*			
	Original value (Dolejš, 1994)		Present value (Jelínek, 1996)	
	Fermentation	Manure	Fermentation	Manure
1 Cattle				
a) Dairy cows	67.16	3.29	68.20	3.29
b) Other cattle	24.48	1.50	23.61	1.01
3 Sheep	7.87	0.33	5.01	0.23
4 Goats	4.59	0.21	4.13	0.19
6 Horses	47.22	3.63	47.20	3.63
8 Pigs	3.41	8.80	3.41	7.87
9 Poultry	0.07	0.02	0.07	0.02

It is apparent from Tab. 6.3 that there are only minimal differences between the former and newly updated emission factors. Tab. 6.4 gives a comparison of the emissions of methane from agriculture calculated for Tier 1 and 2 and for Western Europe (WE) and Eastern Europe (EE).

Tab. 6.4 Comparison of CH_4 emissions results in 1997 calculated by various methods *[Gg]*

	Dairy cow	Other cattle	Pigs	Other animals	Total
Tier 1 (WE)	80	63	18	4	165
Fermentation	*70*	*56*	*6*	*2*	*134*
Manure	*10*	*7*	*12*	*2*	*31*
Tier 1 (EE)	61	70	22	4	157
Fermentation	*57*	*65*	*6*	*2*	*130*
Manure	*4*	*5*	*16*	*2*	*27*
Tier 2 (J)	50	29	46	4	129
Fermentation	*48*	*27*	*14*	*4*	*93*
Manure	*2*	*1*	*32*	*1*	*36*

It is apparent from Tab. 6.4 that the results of the calculation do not greatly differ for Western and Eastern Europe. For enteric fermentation, the results calculated according to Tier 2 (Dolejš, 1994; Jelínek, 1996) are about one third lower than the corresponding values calculated for Tier 1, for both Eastern and Western Europe. In contrast, for emissions from manure, the resultant values are similar for Tier 1 and 2; however, according to Tier 2, they are caused especially by emissions from pig manure. A cattle breeding does not make a significant contribution to emissions from enteric fermentation. The final sums for methane emissions were drawn up using data calculated at Tier 2, taking into account national zoo-technical data. Nonetheless, the difference in emissions of methane from enteric fermentation calculated for Tier 1 and 2 somewhat exceed the usual expected error of ≤ 30 % in determining methane emissions from enteric fermentation (*Good Practice Guidance*, 2000).

Recent international inspections (reviews) organized by the Secretariat of UNFCCC have revealed that Czech CH_4 emission estimates based on older Tier 2 calculations (Dolejš, 1994; Jelínek, 1996) are not comparable to other European countries and thus complete recalculations are necessary. It should be taken into account that both above-mentioned studies were prepared prior to publishing of the *Good Practice Guidance* and that the first study was prepared even prior to publishing of the first version of the IPCC methodology (*IPCC Guidelines*, 1995), when only a preliminary draft of these guidelines was available.

6.3 Nitrous Oxide Emissions

The previous greenhouse gas inventories (for data 1990 to 1995), in accord with the older version of the *IPCC* methodology (*IPCC Guidelines*, 1995), considered only emissions from agricultural soils, where the usual (*default*) mean emission factor was taken as the value 0.0036 kg N-N_2O / kg N. According to the older manner of calculation, which also did not clearly specify how to determine the necessary data on the amount of organic and biologically bonded nitrogen in soils from standard statistical data for the calculation, the resultant emissions for the Czech Republic were about 2 Gg N_2O.

On the basis of more recent studies, a complex methodology was prepared for calculation of emissions from agriculture which, in addition to the formerly considered emissions from agricultural soils, also includes emissions from animal stables and manure management and also indirect emissions derived from atmospheric deposition and from nitrogenous substances flushed into water courses and reservoirs. Simultaneously, there was a significant increase in the emission factor for determining N_2O emissions from agricultural soils to the usual mean value of 0.0125 kg N-N_2O / kg N, which should lie within the confidence interval (0.0025 to 0.0225) (*Revised 1996 IPCC Guideline*s, 1997).

A set of interconnected spreadsheets in EXCEL format were prepared in CHMI for this approach according to the (*Revised 1996 IPCC Guideline*s, 1997), which has been used for national GHG inventories for data since 1996. The standard calculation of Tier 1 required the following input information:

- the number of head of farm animals (FAO statistics) (dairy cows, other cattle, pigs, sheep, poultry, horses and goats),
- the annual amount of nitrogen applied in the form of industrial fertilizers,
- the annual harvest of cereals and legumes.

All these data were taken from the Statistical Yearbook of the Czech Republic.

Other input data consists in the mass fraction $X_{i,j}$ of animal excrement in animal category i (i = dairy cows, other cattle, pigs, ...) for various types of excrement management (AWMS - Animal Waste Management System) j (j = anaerobic lagoons, liquid manure, solid manure, pasturage, daily spreading in fields, other). Here, it holds that $X_{i,1} + X_{i,2} + ... + X_{i,6} = 1$. For Tier 1, (*Revised 1996 IPCC Guideline*s, 1997) gives only the values of matrix X for typical means of management of animal excrement in Eastern and Western Europe. As we are aware that agricultural farming in the Czech Republic cannot be classified according to this system, we carried out the calculation for both characteristics types of management. The results are given in Tab. 6.5.

Tab. 6.5 Comparison of N_2O emissions results in 1997 calculated for various AWMS *[Gg N_2O]*

	Western Europe	Eastern Europe
Manure management	1.52	2.56
Agriculture soils (direct emissions)	8.48	7.89
Grazing animals	2.83	2.30
Indirect emissions (atmospheric deposition)	1.12	0.97
Indirect emissions (leaching)	5.30	4.76
Total N_2O	19.26	18.49

It is apparent from Tab. 6.5 that differences in the calculation of N_2O for countries in Western and Eastern Europe are not large in relation to the expected error. Nonetheless, we will attempt to find an input matrix X (AWMS) that is characteristics for farming in the Czech Republic; however, this information is not currently available. The results of calculation with the AWMS outputs for tables derived for Western Europe, which we consider to be close to the conditions in this country, are listed in the final tables. Other outputs (number of head of animals, application of nitrogen in industrial fertilizers) were, of course, taken from statistical data for the Czech Republic (*Statistical yearbook*, 2003).

It is apparent from the table that the greatest contribution is that from agricultural soils. The complete results for the agricultural category are given in the tabular annex.

6.4 Emission Trends

The trend series seems consistent for methane, where the decrease in emissions for enteric fermentation since 1990 is connected with the decrease in the numbers of animals, especially cattle, while the decrease in emissions derived from manure (especially pig manure) is not as great, as there has been a smaller decrease in the number of head of pigs. It would seem that conditions have stabilized somewhat in agriculture since 1994.

Tab. 6.6 CH_4 and N2O emission trends in Agriculture

	CH_4 emissions *[Gg $CO_{2\ eq}$]*		N_2O emissions *[Gg $CO_{2\ eq}$]*	
	Enteric fermentation *Key source*	Manure management	Direct emissions (soil + manure) *Key source*	Indirect emissions *Key source*
1990	3 293	1 016	5 192	3 042
1992	2 539	873	4 114	2 409
1994	2 081	733	3 590	2 056
1995	2 055	755	3 712	2 163
1996	2 054	756	4 213	2 164
1997	1 951	762	3 980	1 990
1998	1 802	741	3 441	1 950
1999	1 789	741	3 382	1 931
2000	1 701	688	3 290	1 862
2001	1 699	672	3 308	1 912
2002	1 587	626	3 329	1 889
2003	1 595	629	3 289	1 897

6.5 OA/QC, Recalculations and Plans for Improvement

In the process of implementation of the *Good Practice Guidance*, increased attention was firstly paid to enteric fermentation, which has led to the decision to revise the existing determination of methane emissions. It was stated that the cooperation with specialized agricultural experts is crucial to achieve new consistent and comparable data of proper quality.

Consequently, it was decided to revise the entire procedure for calculation of methane emissions from animal breeding in accordance with the *Good Practice Guidance*. Recently, such an approach has been employed for recalculating enteric fermentation of cattle in a study by the authors (Kolar, Havlikova and Fott, 2004), who have compiled new emission estimates for the whole 1990 - 2002 period using nationally specific data collected by our external experts (Hons and Mudrik, 2003). Innovated calculations for cattle are based on Czech zoo-technical data (milk production, weight, weight gain for growing animals, type of stabling, etc.) and also on statistical data for more detailed classification of cattle, which are available in the Czech Republic. Recalculations will be presented in CRF and NIR as soon as all the QA/QC procedures are in place. Study on enteric fermentation should be followed in 2005 by a similar study of emissions from manure management; however, this constitutes a less important source of methane emissions.

Definitive recalculation of the entire emission series is expected only after thorough verification of all calculation procedures. These verification procedures should be accomplished by the end of 2005. The existing procedure and results will still be used until all the values are properly verified.

In relation to the consistency of the emission series for N_2O, it should be repeated that the emission estimates have been calculated in a consistent manner since 1996 according to the default methodology from (*Revised 1996 IPCC Guidelines*, 1997). The recalculated values for 1990, 1992, 1994 and were obtained in years; the data for 1991 and 2003 were recalculated this year.

7 Land Use Change and Forestry (CRF Sector 5)

7.1 Source Category Description

As forests in the Czech Republic are mostly employed for economic purposes and, except of very limited areas, they do not constitute "primary" forest, carbon balance was calculated for the category of managed forests of the temperate zone. The areas under tree species has slowly increased since 1990 and equalled 2562 thous. ha in 2003, corresponding to 33.4 per cent of the area of the country. 75.8 per cent of forest stands consist of conifers (spruce, pine, larch, fir) and the remaining 24.2 per cent consist of broad-leaved species (oak, beech, birch). In afforestation, emphasis has recently been placed on attempts to increase the fraction of broad-leaved species rather than conifers. The overall stand stock of wood in the forests of the country has constantly increased since 1990 (564 mil. m^3) to 650 mil. m^3 in 2003 and trend continues.

Estimate of carbon dioxide balance, in according to *1995 IPCC Guidelines for National Greenhouse Gas Inventories,* has been based on the difference between total annual augmentation and total annual timber harvest, additionally supported by several expert judgments and analysis given by national forestry experts in 1994 - 1995. Some conversion and expansion factors recommended by *1995 IPCC Guidelines* are specified and slightly modified to better reflect current national forest management conditions.

Estimate was replenished by an estimate of contributions coming from afforestation of agricultural land (annually updated information), and timber harvest of trees growing along watercourses and from larger groups of non-forestry trees (annual update is not available; an assumption of constant contribution over years is applied)[7].

The methodology used for 2003 estimate is fully consistent with procedures previously used for inventory years 1990, 1992 and 1994 to 2003; estimate for inventory year 1995 have been recalculated in this submission.

7.2 Methodological Issues

Methodology is based on national statistic data on timber harvest, increments in wood mass and share of reforestation and afforestation as listed in Tab. 7.1.

The following assumptions, which suitably reflect national forest management conditions, was included into calculation model used:

- amount of biomass remaining in forest after timber harvest is approximately constant and all phases of decomposition are presented in the same amount;
- decomposition of humus and subterranean biomass after timber harvest is continuously compensated by new biomass production (decomposition mechanisms is not taken into account);
- broadleaf tree species are harvested mainly in winter after leaves loss and it does not lead to increased carbon release;
- reforested areas are equal to areas deforested by extraordinary harvest (calamity harvest, etc.);
- carbon production by annual loss of the assimilation organs equals to annual removals in new assimilation organs.

---

[7] non-forestry trees cover about 2 per cent of the total sectoral balance in emissions and removals coming from LUCF sector.

Tab. 7.1 List of annual statistical data used for carbon balance estimate

	unit
Areas under tree species	*thous. ha*
Total timber harvest without bark - coniferous	*mil.* m^3
Total timber harvest without bark - non-coniferous	*mil.* m^3
Looses in timber harvest	*per cent*
Total augmentation	*mil.* m^3
Cleaning and sniping total	*thous. ha*
Reforestation after timber harvest	*ha*
Share of coniferous on timber harvest	*per cent*
Share of coniferous in forests	*per cent*
Afforestation of agriculture land	*ha*
Destroyed by forest fires	*ha*
Natural regeneration	*ha*

Tab. 7.2 Conversion factors used for carbon balance estimate

parameter		factor
Conversion factor for mass of timber[8] without bark to mass of timber with bark		1.1
Conversion factor for content of wood with bark to dry mass	standard timber harvest clearing timber harvest	0.465 t / m^3 0.41 t / m^3 [9]
Conversion factor for content of wood with bark to dry mass	non-coniferous coniferous	0.65 t dry mass / m^3 0.45 t dry mass / m^3
Conversion factor for top-wood mass to mass of timber with bark	thinning clearing timber harvest average	0.1782 0.0686 0.1003
Conversion factor for stump mass to mass of timber with bark		0.018
Average mass of coniferous assimilatory organ dry dry mass		18 t / ha
Carbon content in dry dry mass		0.45 t C / t dry mass
Average timber harvest in clearing		3 m^3 / ha
Share of clearing on total mass		15 %

Conversion factors as in Tab. 7.2 were used for carbon balance estimate (timber with bark, top-wood and assimilatory organ biomass calculations, etc.). Balance has been replenished by carbon balance from top-wood, stump, bark and assimilatory organ biomass from clearing.

Estimate of carbon removals by biomass augmentation, incl. an additional input of stump and top-wood biomass, was based on detailed national inventory of wood-biomass reserve. Generally growing age of forests increase of afforested areas and gradual and slowly improving of forest health condition give an increase of removals. Input data for calculation from afforestation of agriculture land are based on national statistics on area of afforested land and related rendered subsidies, prepared by the Ministry of Agriculture. Area of afforested land has been multiplied by related conversion factors (7,5 t dry mass / ha for non-coniferous, 5,5 t dry mass / ha for coniferous and factor 0,45 tC / t dry mass).

According to national statistics it is assumed that about 7 % of clearing timber harvest is burned in open land. The amount of related emitted gases is not significant and it is added only for the sake of

---

[8] mass of timber means stem-wood, which is defined as that fraction of trees (i.e. trunk and branches) with diameter of the trunk with bark at a height of 130 cm above the ground exceeds 7 cm

[9] value is lower than generally recommended as during pollution type of timber harvest also dead and withered trees are harvested

completeness. *1995 IPCC Guidelines* methodology and emission factors have been used for CH_4, CO and NO_X estimates.

Pursuant to requirements of revision and review of national inventory, an estimate of carbon dioxide emissions from liming has been newly provided for inventory years 2001 and 2002. To avoid inconsistencies in time-series, the relevant values have not been included into CRFs for submissions 2003 - 2005. According to national statistics 29 212 t of dolomite in the forest management and 201 000 t of lime or limy material in agriculture were applied in 2002. Emission factors for dolomite (130 t C / Gg) and for lime (120 t C / Gg) were applied. Total emissions from liming for 2002 can be estimated as 102,4 Gg CO_2. It is supposable that emissions from limining is in 2003 are similar as in 2002.

7.3 Uncertainties and Time-series

The inventory from the LUCF category in 2003 was prepared using the identical methodology, without any change in the calculation system compared to previous years. Data on CO_2 emissions and removals estimate in 1990, 1992, 1994 - 2003 are given in Tab. 7.3, and data on other gas emissions from on-site biomass combustion from wood removal in Tab. 7.4 for the same period. Uncertainty of emissions / sinks estimates is not available yet; estimates should be presented after implementation of the *IPCC GPG2003*.

Tab. 7.3 CO_2 emissions and removals from LUCF category *[Gg CO_2]*

Year	CO_2 emissions			CO_2 removals				**total CO_2 balance**
	from forestry	from other vegetation	***total***	from forestry	from afforestation of agriculture land	from other vegetation growth	***total***	
1990	15 132	371	***15 503***	17 161	6	464	***17 631***	**-2 128**
1992	11 329	371	***11 701***	17 168	6	464	***18 238***	**-6 537**
1994	13 486	371	***13 857***	18 071	3	464	***18 538***	**-4 681**
1995	14 021	371	***14 392***	18 172	6	464	***18 642***	**-4 250**
1996	13 796	371	***14 167***	18 182	7	464	***18 653***	**-4 486**
1997	13 833	371	***14 204***	18 374	5	464	***18 843***	**-4 639**
1998	14 916	371	***15 287***	18 576	4	464	***19 044***	**-3 757**
1999	15 677	371	***16 048***	18 980	5	464	***19 449***	**-3 401**
2000	16 070	371	***16 441***	19 984	10	464	***20 458***	**-4 016**
2001	15 932	371	***16 304***	20 191	12	464	***20 667***	**-4 363**
2002	16 006	371	***16 378***	20 393	13	464	***20 870***	**-4 492**
2003	16 648	371	***17 019***	20 393	10	464	***20 867***	**-3 848**

7.4 Source-specific QA/QC and Verification

All the related data (activity data, emission data) before entering into calculation spreadsheets and CRF were verified and formally checked. Source category data and inventory submission 2005 as a whole, were per-reviewed by an independent expert and approved by the Ministry of Environment in December 2004.

7.5 Source-specific Recalculations

All data for 1995 have been recalculated using the identical methodology as in previous years and included into CRF.

Tab. 7.4 Other gas emissions from on-site biomass combustion from wood removal *[t]*

	CH_4	CO	N_2O	NO_X
1990	2 364	20 688	2	43
1992	1 264	11 062	1	23
1994	1 913	16 738	1	35
1995	1 619	14 170	1	29
1996	2 310	20 210	2	42
1997	2 250	19 650	2	41
1998	2 250	19 650	2	41
1999	2 580	22 560	2	47
2000	2 360	20 687	2	43
2001	2 587	22 635	2	47
2002	2 676	23 419	2	49
2003	2 764	24 186	2	50

7.6 Source-specific Planned Improvements

The Czech Republic has a formal plan to develop and implement a revised methodology for the LUCF sector following the *IPCC GPG2003*. The revision is an explicit element of the contract between the Czech Hydrometeorological Institute and the Ministry of Environment, and it is planned for its completion gradually in 2004 - 2006. Appropriate forestry and agriculture experts have already been identified.

The revised approach will consider all categories within the LUCF sector, including those currently not reported. If the same activity data are used as in the present methodology, national inventory team intends to develop a formal process for incorporating final versions of the activity data in its submissions, using recalculations if necessary. An improvement should be mainly focused on inconsistencies stated in *FCCC/WEB/IRI/2004/CZE,* Chapter LUCF. There is also an intention to improve the NIR structure under recommendations given by the UNFCCC reporting guidelines (*FCCC/CP/2002/8*).

8 Waste (CFR Sector 6)

8.1 Sector Characterization

Emissions of greenhouse gases from waste in the Czech Republic consist mainly of methane emissions from municipal waste landfills and methane emissions from wastewater treatment (industrial and municipal). This category also includes CO_2 emissions from waste incineration and nitrous oxide emissions from wastewater. Part of the wastewater management sub-sector was recently revised in accordance with the IPCC *Good Practice* (*Good Practice Guidance*, 2000). The next revision, concerning methane emissions from landfills (application of the Tier 2 approach) is currently being elaborated.

CHMI cooperated in compilation of emission inventory from this sector with professional workplaces, in particular with the *Institute for Environmental Science of the Faculty of Sciences at Charles University in Prague* (PřFUK) (Havránek, 2001), the *University of Chemical Technology* (VŠCHT) (Dohanyos and Zábranská, 2000; Zábranská, 2002; Zábranská, 2004) and *Institute for Research and Use of Fuels in Prague Běchovice* (ÚVVP) (Straka, 2001). In the framework of this cooperation, all the emission inventories in this category were recalculated for the entire time series from the reference year of 1990 to the present. At the present time, this sector is managed by the *Charles University Environment Center* (CUEC).

Of the individual subcategories in the category 6, only methane from landfills belongs in the category of *key sources*. The contributions to the aggregate emissions are given in Tab. 8.1.

Tab. 8.1 Overview of the most important sources from category 6

	Character of source	Gas	% of total
CH_4 emissions from landfilling	Key source	CH_4	1.2
CH_4 emissions from wastewater handling	-	CH_4	0.4
N_2O emissions from wastewater handling	-	N_2O	0.1
CO_2 emissions from waste incineration	-	CO_2	0.2

8.2 Emissions from Solid Waste Landfills

This category belongs amongst *key sources* and the IPCC methodology recommends placing increased emphasis on this source. The main greenhouse gas in this category is methane, which is formed in landfills as part of landfill gas from the anaerobic decomposition of biologically degradable carbon. A certain amount of initial data is required to determine emissions. It is necessary to know the amount of waste deposited in the landfill, the portion of biologically degradable carbon in the waste and other parameters specified for the formation of methane in this country. Similarly to last year, this year's calculations are again based on the national study (Straka *et al*, 1997), which can be considered as a Tier 3 approach that, however, does not take into account time trends in national parameters. A new study (Straka, 2001) includes this trend. Both studies and data from the *Czech Environmental Institute* were employed as a basis for a more complex study (Havránek, 2001), which forms the basis for the following text.

In order to determine emissions in this category of sources, it is necessary to select a suitable method for calculation of emissions. The IPCC method distinguishes two methodical tiers. These are the basic method - Tier 1 - and the FOD (First Order Decay) method - Tier 2, which includes first-order kinetics. Both methods are based on knowledge of the amount of biologically degradable carbon deposited on the landfill, where the basic method is based on the assumption that the landfill is at steady state. The FOD method should be preferable from the standpoint of determining the emissions in the individual years. At the present time, only the basic method (Tier 1) is used for the inventory in the Czech Republic because of lack of necessary data.

According to Tier 1, the amount of methane emitted from municipal landfills is given by the equation:

$$\textbf{Methane emissions (Gg CH}_4\textbf{)} = [(MSW_T \times MSW_F \times L_0) - R] \times (1 - OX)$$

where

$$\mathbf{L_0}\ \textbf{(Gg CH}_4\textbf{ / kg waste)} = MCF \times DOC \times DOC_F \times F \times 16 / 12$$

where MSW_T is the total amount of municipal waste generated in the given year, MSW_F is its fraction deposited in the landfill, MCF is the correction factor for methane (=1 for a managed landfill), DOC and DOC_F are the fraction of degradable carbon and the part thereof that is actually degraded, F is the CH_4 content in the landfill gas, R denotes the methane removed by targeted oxidation (recovered), 16 / 12 is the weight ratio of methane / carbon and OX is the oxidation factor.

Municipal waste in defined as all wastes generated on the territory of the municipality, that originate in the activities of natural persons, with the exception of wastes formed on the premises of legal persons or natural persons authorized to operate a business. The activity data constitute the output of the Waste Management Information System (WMIS) operated for the Ministry of Environment by the Water Research Institute - Centre of Waste Management. Date on waste for the years in question were obtained from the waste records provided by the individual district authorities in CR in accord with ME Decree No. 338 / 1997 Coll., on details of waste management, and the Methodical Instruction of the Waste Department of ME CR on keeping records of waste and reporting of waste. Relevant values for Tier 1 calculations are given in Tab. 8.2. Illustration of present waste management practices in the Czech Republic in shown in Tab. 8.3 (*Environmental Statistical Yearbook*, 2003, 2005). The calculation also took into account the fact that a certain amount of the biogas produced is burned or destroyed by targeted bio-oxidation. The detailed procedure is described in studies (Straka, 2001; Havránek, 2001), where the factors employed is taken from the IPCC methodology [3, 8] in relation to the nationally specific factors as given in refs. (Straka, 2001; Havránek, 2001). A survey of the parameters required for the calculation is given in Tab. 8.4.

Tab. 8.2 Municipal solid waste (MSW) production in CR for 1990 -2003 *[thous. t MSW]*

	MSW	Landfilling
1990	3 764	2 371
1991	3 853	2 388
1992	3 944	2 484
1993	4 037	2 543
1994	4 132	2 561
1995	4 229	2 621
1996	4 329	2 683
1997	4 431	2 739
1998	4 535	2 804
1999	4 195	2 632
2000	4 508	2 803
2001	4 294	2 575
2002	4 747	2 826
2003	4 639	2 924

Tab. 8.3 Municipal waste utilization and disposal practices in the Czech Republic in 2003 *[Gg]*

Total production	Utilisation of waste as a fuel (R1)	Recovery of organic substances (incl. composting) (R3)	Recycling of inorganic matter (R4-R5)	Use of waste for reclaiming landscape (N1)	Deposition under ground (Landfilling) (D1)	Biological treatment (D8)	Treatment by soil processes (D2)	Combustion on land (D10)	Physical-chemical treatment (D9)	Other
4 639	219	153	69	176	2924	132	18	222	8	718
100 %	4.7 %	3.3 %	1.5 %	3.8 %	63.0 %	2.8 %	0.4 %	4.8 %	0.2 %	15.5 %

Tab. 8.4 Overview of parameters for calculation of CH_4 emissions from municipal waste landfills

	Revised 1996 IPCC Guidelines	IPCC Good Practice	National specific value*
Waste deposition *[kg / person / day]*	0.54 -1.14	-	0.63 - 0.74
DOC	0.19 - 0.08	-	0.096 -0.08
DOC_F	0.77	0.50 - 0.60	0.60
F	0.5	0.4 -0.6	0.61
MCF	0.4 - 1.0		1.0
OX	0	0-10	0.15

*Source: Straka, 2001; Havránek, 2001

Tab. 8.5 CH_4 emissions from landfills in 1990 - 2003 *[Gg CH_4]*

	Gross Annual Methane Generation	Oxidized (OX)	CH_4 recovered	Net Annual Methane Emissions
1990	112.9	16.4	3.3	93.2
1991	113.7	16.6	3.3	93.9
1992	116.4	16.9	3.5	96.0
1993	111.7	16.2	3.5	92.0
1994	112.5	16.4	3.5	92.7
1995	115.1	16.7	3.5	94.9
1996	117.8	16.8	6.0	95.0
1997	106.9	14.3	11.8	80.9
1998	109.5	14.5	13.1	81.9
1999	102.8	13.4	13.4	76.0
2000	109.4	14.5	13.4	81.7
2001	100.5	13.0	14.1	73.5
2002	110.3	14.2	15.5	80.6
2003	114.1	14.7	16.0	83.4

Tab. 8.5 gives an overall survey of emissions in 1990 - 2003 and also includes recovery (R) and oxidation (OX) of methane. If we use parameters in tables above a model calculation for year 2003 can be expressed as follows:

$$\text{Gg } CH_4 = [(MSW_T \times MSW_F \times L_0) - R] \times (1 - OX)$$

$$\text{Gg } CH_4 = [(4639 \times 0.63 \times L_0) - 16.0] \times (1 - 0.15)$$

where

$$L_0 = MCF \times DOC \times DOCF \times F \times 16 / 12$$

$$L_0 = 1.0 \times 0.08 \times 0.60 \times 0.61 \times 1.33$$

Net methane emissions in 2003 = 83.4 Gg CH_4

8.3 Emissions from Wastewater Handling

The basic factor for determining methane emissions from wastewater handling is the content of organic pollution in the water. The content of organic pollution in municipal water and sludge is given as BOD5 (the biochemical oxygen demand). BOD is a group method of determination of organic substances and expresses the amount of oxygen consumed in the biochemical oxidation, and is thus a measure of biologically degradable substances. In contrast, COD (chemical oxygen demand) is the amount of oxygen required for chemical oxidation and includes both biologically degradable and biologically non-degradable substances. COD is used according to (*Revised 1996 IPCC Guidelines*, 1997) for calculation of methane emissions from industrial wastewater and is always greater than BOD.

The current IPCC methodology employs BOD for evaluation of municipal wastewater and sludge and COD for industrial wastewater. The new method is also extended to include determination of emissions from sludge that are primarily the products of various methods of treatment of wastewater and, under anaerobic conditions, may contribute to methane production and methane emissions.

In the estimation of methane emissions from wastewater and sludge, it is necessary to determine the total amount of organic substances contained in them and to determine (estimate) the emission factors for the individual means of wastewater treatment. For this purpose, professional cooperation was undertaken with the *University of Chemical Technology* and a study was carried out (Havránek, 2001), supplementing an earlier study (Zábranská, 2002) and related to a new study (Zábranská, 2004)

8.3.1 Emissions from Municipal Wastewater

The basic input data for determining emissions from municipal wastewater are as follows:

- the number of inhabitants
- the pollution produced per inhabitant
- the conditions under which the wastewater is treated.

Calculations for conditions in this country are based on pollution production per inhabitant of 18.25 kg BOD p.a. (*Revised 1996 IPCC Guidelines*, 1997), of which approx. 33 % is present in the form of insoluble substances, i.e. is separated as sludge. This factor was changed somewhat last year mainly due to increased savings in water use (approx. 10 - 20 %) and the quite dry year. The total amount of organic pollution is constant, but the density is higher and, for 2003, it was assumed that 40 % of BOD is separated as sludge (Zábranská, 2004).

Another data entering the calculation are also the number of inhabitants connected to the sewers and the percent of treated wastewater collected in the sewers. Tab. 8.6 gives shows amount for the time series. Decrease in wastewater treatment in year 2002 was caused by disastrous floods which more or less disrupted wastewater treatment in central and northern parts of the Czech Republic for a several weeks.

According to the IPCC *Good Practice* (*Good Practice Guidance*, 2000), the maximum theoretical methane production B_0 equals 0.25 kg CH_4 / kg COD, corresponding to 0.6 kg CH_4 / kg BOD. This data is used to determine the emission factors for municipal wastewater and sludge. In determining the emission factor for sludge, it is necessary to evaluate the technology used to treat the particular sludge and to assign a conversion factor to it - MCF - Methane Conversion Factor - giving the part of the organic material that will be transformed as methane (the remainder to CO_2). Refs. (Dohanyos and Zábranská, 2000; Zábranská, 2004) give a survey of the nationally specific factors for the ratio of aerobic and anaerobic technologies for the 1990 - 2003, given in Tab. 8.7. There is also a certain fraction of wastewater that does not enter the sewer system and is treated on site. For this situation, the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997; *Good Practice Guidance*, 2000) recommends that separation into wastewater and sludge not be carried out (this corresponds to latrines, septic tanks, cesspools, etc.). The residual wastewater in the Czech Republic which does not enter the sewer system is considered to be treated on site. All methane generated in anaerobic processes for sludge is considered to be removed (recovered for energy purposes or flared). Remaining methane is considered to be emitted. This assumption is based on Czech national standards (to certain degree similar to ISO standards) CSN 385502, CSN 105190 and CSN 756415. On the basis of these standards, every wastewater treatment facility is obliged to maintain safety and abate gas emission. Leakage might occur only during accidents, but the amount of methane emitted seems to be insignificant (the estimate by expert judgment is less than 1 % of the total amount) (Zábranská, 2003).

Tab. 8.6 Population sewer connection and wastewater treatment in 1990 - 2003

	Total population *[thous. pers.]*	**Sewer connection** *[%]*	**Water treated** *[%]*
1990	10 362	72.6	73.0
1991	10 308	72.3	69.6
1992	10 317	72.7	77.8
1993	10 330	72.8	78.9
1994	10 336	73.0	82.2
1995	10 330	73.2	89.5
1996	10 315	73.3	90.3
1997	10 303	73.5	90.9
1998	10 294	74.4	91.3
1999	10 282	74.6	95.0
2000	10 272	74.8	94.8
2001	10 224	74.9	95.5
2002	10 201	77.4	92.6
2003	10 202	77.7	94.5

Tab. 8.7 Used methane conversion factors (MCF) and share of individual technologies in 1990 - 2003 *[%]*

	MCF	**1990**	**1993**	**1996**	**1999**	**2003**
On-site treatment	0.15	100	100	100	100	100
Discharged into rivers	0.05	27	21	10	5	5
Aerobic treatment of water	0.05	48	54	65	70	72
Anaerobic treatment of water	0.50	25	25	25	25	23
Aerobic treatment of sludge	0.10	45	40	35	30	15
Anaerobic treatment of sludge	0.50	55	60	65	70	85

The amount of methane emitted from municipal wastewater treatment is given by the equation:

$$\textbf{Total Gg CH}_4\textbf{ p.a. = Gg CH}_{4\,(tos)}\textbf{ + Gg CH4}_{(wwt)}\textbf{ + Gg CH}_{4\,(sld)}\textbf{ - R}$$

Where *tos* is part of water treated on site, *wwt* is part treated as wastewater and *sld* is part treated as sludge. R is methane recovered (flared or used as gas fuel).

Calculation example for 2003

Treatment on site:

Emission factor $_{(tos)}$ = 0.15 × 0.60 = 0.09 CH_4 / kg BOD

BOD$_{(tos)}$ = 10 202 × 0.223 × 18250 = 42.518 Gg BOD / year

Total$_{(tos)}$ = 42.518 × 0.09 = 3.74 Gg CH_4

Watewater:

Emission factor $_{(wwt)}$ = Maximum meth.capacity ×(aerobic MCF + septic tanks MCF + non-treated MCF))

Emission factor $_{(wwt)}$ = 0.6 × ((0.715 × 0.05) + (0.230 × 0.5) + (0.055×0.05)) = 0.0921 CH_4 / kg BOD

BOD $_{(wwt)}$ = 10 202 × 0.777 × (1-0.40) = 86.797 Gg BOD / year

Total $_{(wwt)}$ = 86.797 × 0.0921 = 7.99 Gg CH_4

Sludge:

Emission factor $_{(sld)}$ = Emission factor $_{(sld)}$ (aerobic) + Emission factor $_{(sld)}$ (anaerobic)

Emission factor $_{(sld)}$ = 0.6 × ((0.85 × 0.5) + (0.15 × 0.1)) = 0.264 CH_4 / kg BOD

BOD $_{(sld)}$ =10 202 × 0.777 × 0.40 = 57.864 Gg BOD / year

Total $_{(sld)}$ =57.864 × 0.264 = 15.28 Gg CH_4

R (recovered CH_4) = 0.6 × (0.85 × 0.5) × 57.864 = 14.86 Gg CH_4

Methane emissions from municipal wastewater in 2001=

3.74 + 7.99 + 15.28 - 14.86 = **12.25 Gg CH_4**

8.3.2 Emissions from Treatment of Industrial Wastewater

The main activity data for estimation of methane emission from this subcategory is determination of the amount of degradable pollution in industrial wastewater. In this inventory we use specific production of pollution - the amount of pollution per production unit - kg COD / kg product and then we multiply it by the production, or from the overall amounts of industrial wastewater and from a qualified estimate of their concentrations (in kg COD / m^3). We use the procedure from the IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997; *Good Practice Guidance*, 2000). The necessary activity data were taken from the material of CSO (*Czech Statistical Office*) (*Statistical Yearbook*, 2003, 2004) and the other parameters required for the calculation were taken from the IPCC *Good Practice* (*Good Practice Guidance*, 2000). On the basis of information on the total amount of industrial wastewater of 217 mil.m^3 (actually only 203 mil.m^3 were treated) (*Environmental Statistical Yearbook*, 2003, 2005), it was also possible to determine "unidentified" amount of wastewater (36 mil.m^3), which were assigned an average concentration of 3 kg COD / m^3. In addition, it was estimated, in accordance with (*Revised 1996 IPCC Guidelines*, 1997), that the amount of sludge equals 10 % of the total pollution in industrial water (more was reported in some branches) (Dohanyos and Zábranská, 2000; Zábranská, 2002; Zábranská, 2004), see Tab. 8.8.

Tab. 8.8 Estimation of COD generated by individual sub-categories 2003

	Production *[Gg / year]*	COD / m^3 *[kg / m^3]*	Wastewater / t *[m^3 / t]*	Share of sludge *[%]*	COD of sludge *[t]*	COD of wastewater *[t]*
Alcohol Refining	56	11.00	24.00	0.10	1 466	13 193
Dairy Products	871	2.70	7.00	0.10	1 646	14 814
Malt & Beer	2 458	2.90	6.30	0.10	4 490	40 410
Meat & Poultry	653	4.10	13.00	0.25	8 703	26 108
Organic Chemicals	197	3.00	67.00	0.10	3 954	35 586
Pet. ref. / Petrochemicals	3 537	1.00	0.60	0.10	212	1 910
Plastics and Resins	819	3.70	0.60	0.10	182	1 637
Pulp & Paper	671	9.00	162.00	0.25	244 678	734 034
Soap and Detergents	62	0.85	3.00	0.10	16	141
Starch production	67	10.00	9.00	0.10	600	5 398
Sugar Refining	517	3.20	9.00	0.10	1 489	13 401
Textiles(natural)	82	0.90	172.00	0.10	1 270	11 432
Vegetable Oils	101	0.85	3.10	0.10	27	239
Vegetables, Fruits & Juices	131	5.00	20.00	0.25	3 271	9 813
Wine & Vinegar	87	1.50	23.00	0.10	300	2 698
Unidentified wastewater	25 581	3.00	1.00	0.10	7 674	69 068
Total					279 977	979 880

In accord with (*Good Practice Guidance*, 2000), the maximum theoretical methane production B_0 was considered to equal 0.25 kg CH_4 / kg COD. This value is in accordance with national factors presented in (Dohanyos and Zábranská, 2000).

The calculation of the emission factor for wastewater is based on a qualified estimate of the ratio of the use of individual technologies during the entire recalculated time series. In the future, this ratio will shift towards anaerobic treatment of wastewater and sludge because of the energy advantages of this means of treating wastewater. Tab. 8.9 describes this trend. The conversion factor for anaerobic treatment is 0.06 and, for aerobic treatment, 0.7. There is a significant increase in production in Pulp & Paper sector from 2002.

In contrast to a quite stable for technologies for treating wastewater, ratio used for sludge keeps shifting in favour to anaerobic treatment. This is mostly due its economic efficiency. The calculation of the emission factor for sludge was based on the assumption that 27 % is treated anaerobically with a conversion factor of 0.3 and the remaining 73 % by other, especially aerobic methods with a conversion factor of 0.1. Similarly as in the previous case, it is assumed that all the methane from the anaerobic processes is burned (mostly usefully in cogeneration units, as flaring is used less and less and cogeneration technology seems to be economically effective); however, in contrast to municipal water, methane from anaerobic sludge and wastewater is included. This assumption is based on national standards and regulations presented in subchapter above (Zábranská, 2004). For the calculation of the methane emissions is sufficient to consider only aerobic processes (where the methane is not oxidized to biological CO_2). Experts at the *University of Chemical Technology* recommended the conversion factors and other parameters given in this part, see (Dohanyos and Zábranská, 2000; Zábranská, 2004).

Tab. 8.9 Parameters for CH_4 emissions calculation from industrial wastewater

	MCF	1990	1993	1996	1999	2003
Non-treated	0.05	29 %	18 %	13 %	12 %	7 %
Aerobic treatment of water	0.06	67 %	73 %	70 %	66 %	65 %
Anaerobic treatment of water	0.70	4 %	8 %	17 %	22 %	28 %
Aerobic treatment of sludge	0.10	40 %	40 %	40 %	40 %	27 %
Anaerobic treatment of sludge	0.30	60 %	60 %	60 %	60 %	73 %

The amount of methane emitted from municipal wastewater treatment is given by the equation:

$$\textbf{Total Gg } \mathbf{CH_4} = \textbf{Gg CH4}_{\mathbf{(wwt)}} + \textbf{Gg } \mathbf{CH_{4\,(sld)}} - \mathbf{R}$$

Where *wwt* is part treated as wastewater, *sld* is part treated as sludge and R is methane recovered (flared or used as gas fuel).

Calculation example for 2003

Wastewater:

$$\text{Emission factor}_{(wwt)} = \text{methane capacity} \times (\text{aerobic MCF} + \text{anaerobic MCF}) + \text{non-treated MCF}))$$
$$\text{Emission factor}_{(wwt)} = 0.25 \times ((0.65 \times 0.06)+(0.28 \times 0.70)+(0.07 \times 0.05)) = 0.0593\ CH_4 / \text{kg BOD}$$
$$\text{COD}_{(wwt)} = \text{Table 8.8} = 980 \text{ Gg COD / year}$$
$$\text{Total}_{(wwt)} = 0.0597 \times 980 = 58.12 \text{ Gg } CH_4$$

Sludge:

$$\text{Emission factor}_{(sld)} = \text{Emission factor}_{(sld)} \text{ (aerobic)} + \text{Emission factor}_{(sld)} \text{ (anaerobic)}$$
$$\text{Emission factor}_{(sld)} = 0.25 \times ((0.73 \times 0.3)+(0.27 \times 0.1)) = 0.0615\ CH_4 / \text{kg BOD}$$
$$\text{COD}_{(sld)} = \text{Table 8.8} = 280 \text{ Gg COD / year}$$
$$\text{Total}_{(sld)} = 0.0615 \times 279 = 17.22 \text{ Gg } CH_4$$

$$\text{R (recovered } CH_4) = 0.25 \times ((0.73 \times 0.3 \times 279) + (0.28 \times 0.7 \times 979)) = 63.03 \text{ Gg } CH_4$$

Methane emissions for industrial wastewater in 2003 =
58.12 + 17.20 - 63.03 = **12.32 Gg CH_4 / year**

Tab. 8.10 CH_4 emissions from municipal and industrial wastewater in 1990 - 2003 *[Gg]*

	1990	1994	1996	1997	1998	1999	2000	2001	2002	2003
Municipal wastewater										
CH_4 production	22.34	22.84	23.37	23.36	23.42	23.97	23.95	24.96	25.18	27.00
Oxidized CH_4	7.47	8.18	8.88	8.89	8.99	9.70	9.69	11.06	11.41	14.76
Total CH_4 emissions	14.86	14.67	14.49	14.47	14.43	14.27	14.26	13.90	13.77	12.25
Industrial wastewater										
CH_4 production	49.76	46.67	55.81	58.42	63.33	60.10	63.51	66.42	77.36	75.35
Oxidized CH_4	25.31	23.86	41.28	43.25	47.00	46.90	50.29	55.47	64.50	63.03
Total CH_4 emissions	24.45	17.81	14.53	15.16	16.34	13.17	13.26	10.94	12.87	12.32

8.3.3 Emissions of CO_2 from waste incineration

Incineration of municipal solid waste does not have a long tradition in the Czech Republic. The first incinerator plant was built in 1989 in Brno (SAKO a.s.). Since then, two other incinerators have been built - one in Liberec (TERMIZO) and the newest one in Prague (Pražské služby a.s.) in 1998. The total capacity of municipal waste incinerators in the Czech Republic is given in Tab. 8.11.

Tab. 8.11 Capacity of municipal waste incineration plants in the Czech Republic in 2003 *[Gg]*

Incinerator	**Capacity**
TERMIZO	96
Pražské služby a.s.	310
SAKO a.s.	240

Estimation of CO_2 emission from waste incineration is based on the tier 1 approach (*Good Practice Guidance*, 2000). It assumes that total fossil carbon dioxide emissions are dependent on the amount of carbon in waste, on the fraction of fossil carbon and on the combustion efficiency of waste incineration. As no country-specific data were available for the necessary parameters, we employed the IPCC Good Practice default data (*Good Practice Guidance*, 2000) in our calculation, see Tab. 8.12. The data for 2003 are given in Tab. 8.12 and the model equation for the category of municipal waste is given in a box below the table.

Tab. 8.12 Default data used for emission of CO_2 from waste incineration (*Good Practice Guidance,* 2000)

	Amount of carbon fraction	Fossil carbon fraction	Combust efficiency
Municipal Solid Waste	0.4	0.4	0.95
Clinical Waste	0.6	0.4	0.95
Hazardous Waste	0.5	0.9	0.995
Sludge Waste	0.3	0	0.95

Tab. 8.13 Various waste type incineration in the Czech Republic, 2003 (*Production, use and disposal,* 2004; *Environmental Statistical Yearbook of the Czech Republic,* 2003, 2005)

	Gg of waste
Municipal Solid Waste	441.0
Clinical Waste	2.8
Hazardous Waste	73.2
Sludge Waste	n.a.

Calculation example for 2003

$$\text{Total emission (Gg)} = EF_{(MSW)} \times MSW + EF_{(CW)} \times CW + EF_{(HW)} \times HW$$
$$EF_{(i)} = TC_{(i)} \times FC_{(i)} \times CE_{(i)} \times CO_2 / C$$

where

EF means emission factor of waste type *i* (Municipal Solid Waste - *MSW*, Clinical Waste - *CW* or Hazardous Waste - *HW*). MSW, CW and HW mean amount of waste type in Gg. *TC* means total carbon fraction in waste, *FC* means fossil carbon fraction, *CE* is combustion efficiency and CO_2 / C is carbon dioxide - carbon weight ratio (44 / 12). Based on Tab. 8.12 and 8.13 we get:

$$EF_{(MSW)} = 0.4 \times 0.4 \times 0.95 \times 3.66 = 0.557$$
$$EF_{(CW)} = 0.6 \times 0.4 \times 0.95 \times 3.66 = 0.836$$
$$EF_{(HW)} = 0.5 \times 0.9 \times 0.995 \times 3.66 = 1.643$$

Total emission (Gg) = 0.557 × 441 + 0.836 × 2.8 + 1.643 × 73.2 = **368.31 Gg CO_2**

8.3.4 *Emissions of N_2O from Municipal Wastewater*

Determination of N_2O emissions from municipal wastewater is part of a broader complex of calculations, concerned particularly with the area of agriculture. Tier 1 calculation is based on the number of inhabitants and estimation of the average annual protein consumption. The N_2O emissions according to (*Revised 1996 IPCC Guidelines*, 1997) would then equal

N_2O emissions = 10 202 000 × 25 × 0.16 × 0.01 × 44 / 28 / 1 000 000 = 0.641 Gg p.a.

The values of 0.16 kg N / kg protein and 0.01 kg N_2O-N / kg N correspond to the mass fraction and standard recommended emission factor.

8.3.5 *Emissions of N_2O from Municipal Waste Incineration*

We estimated N_2O emissions from waste incineration in the Czech Republic on the basis of the suggested range of emission factors (*Good Practice Guidance*, 2000, Waste Chapter). The suggested emission factor range for grate furnace incineration of waste is between 5.5- 66 kg of N_2O per Gg of incinerated MSW. We used an average value of 35 kg of N_2O per Gg of waste. The data for incinerated waste were taken from Tab. 8.12.

N_2O emissions = MSW × EF / 1000 000 = 441 × 35 / 1000000 = **0.02 Gg of N_2O**

By using GWP of 310 for N_2O **0.02 Gg** equals **4.78 Gg** of $CO_{2\,eq.}$

8.4 Changes in Inventory and Recalculations

IPCC *Good Practice* (*Good Practice Guidelines*, 2000) has been used for inventory. Adopted principles emphasize particularly the consistency of the time series, *key sources* and the transparency of the calculation. Since inventory year 2000 this has led to a number of basic changes in determining the methane emissions from wastes, which then led to recalculation of the entire time series of emissions from this category. Tab. 8.5 and 8.10 give the recalculated time series.

Changes in the inventory of **methane emissions from landfills** compared to previous years can be summarized as follows:

- Recalculation of the entire time series using the Tier 1 of the IPCC method, taking into account newly refined values of the national parameters,
- Refining of activity data in relation to the amount of waste landfilled,
- Classification as recovered methane and methane that is intentionally oxidized using biofilters.

Changes in the inventory of **methane emissions from wastewater** consist particularly in:

- For the biological oxygen demand, the value of 0.6 kg CH_4 / kg BOD is used for maximum methane production, i.e. factor B_0; this is more than the former value of $B_0 = 0.25$ CH_4 / kg BOD, used before recalculation of the whole data series; however, this value (0.25) is valid for COD, which is always larger than the corresponding BOD value.
- Refining of the calculation for the area of management of industrial wastewater. In place of the formerly used, less accurate values of the average concentration for industrial wastewater, total COD is now determined on the basis of the production of the individual branches generating wastewater.
- Determination of emissions for the part of the population that is not connected to the public sewer system is now being prepared separately in relation to the different conditions (treatment on site).

Changes in the inventory of **greenhouse gases emissions from waste incineration** consist particularly in:

- Adopting default IPCC parameters,
- Refining of activity data in relation to the amount of waste incinerated.

8.5 QA/QC and Plans for Improvement of Inventory Quality

The last year, the Czech greenhouse gas inventory underwent the in-country review by UNFCCC. Results and recommendation were presented to the inventory team and some of the most serious gaps will be reflected in future work. The primary effort will be to transfer calculation of methane emissions from landfills (as a key source) to Tier 2. The present Tier 1 is insufficient and it gives uncertain results for Czech Republic, mainly methodical flaws in subtracting actually recovered methane from theoretical full-life emissions. This should be carried out in the next year and will be part of NIR 2004, including recalculation of the entire time series and implementation Good Practice in calculation. We will use software model LandGEM developed by USEPA (based on first order decay approach) in to which we adopt national specific parameters. We expect some changes in landfill sector. We also plan to recalculate emission from waste incineration. This is mainly because of lack of transparency of previous equation. We do not expect however results will differ significantly.

Increased transparency of all equations is another aspect that needs to be addressed. This will be done by filling in of older years in CRF and by providing a broader survey in next NIR report.

Data quality and uncertainties in inventory is the last, but not least, issue that needs to be addressed. We plan to include the newest relevant data in our calculation (e.g. measurement of waste composition) to decrease the uncertainties caused by inaccurate data. Default IPCC factors used in calculation has their own uncertainty mainly as big as range of suggested parameters.

Activity data are taken from official channels (Czech statistical office, Ministry of Environment). Quality assurance of the activity data is guaranteed by the data provider. For the Czech Statistical Office, use of standardized comprehensive methodology harmonized with EU is guaranteed.

9 Recalculations

9.1 History of Czech Inventories

The first attempt of compilation of a complete Czech GHG Inventory was done in 1994 as a part of the "Country study project" supported by the U. S. Government. This Inventory was based on an older version of the IPCC Methodology and was prepared by non-governmental organization SEVEn in co-operation with CHMI (Tichý *et al*, 1995).

The first version of the Czech GHG Inventory compiled by CHMI under the supervision of the Ministry of Environment was prepared in 1995 and 1996 for 1990 - 93 and 1994 - 1995 periods, respectively (Fott et al, 1995, 1996). Both inventories were based on the former version of the IPCC Methodology and were considerably inspired by the "Country study", in both the positive and the negative sense. Relevant emissions / removals estimates for the 1990 - 1995 period were also summarized in the *Second National Communication* in 1997.

Older results presented before 1997 were distorted by some imperfections and gaps due to application of the older version of the IPCC guidelines and application of obsolete national studies concerning agriculture and waste sectors. The chief imperfections can be characterized in this way:

A) All N_2O emission were completely distorted: while N_2O emission from fuel combustion were significantly overestimated by using EFs based on the obsolete CORINAIR90 guidebook, emissions from agriculture were, on the contrary significantly underestimated using the older version of the IPCC Guidelines (as is explained in Chapter 6).

B) Methane emissions from agriculture based on the older national study issued even before the first version of the IPCC methodology (only the draft version was available) appear out-of-date at the present time. Emission estimates based on this study are rather underestimated in comparison with other European countries. This case is analyzed in detail in Chapter 6. In contrast to N_2O, where the relevant methodology was changed for data after 1996, updating of the CH_4 method for enteric fermentation is still in progress.

Other imperfections were of less importance but not negligible, so that they had to be addressed. Some examples are listed bellow:

1. The former estimates of CH_4 from the waste sector, using activity data based mainly on expert judgment rather than on more rigorous statistics, was later found not to be in accordance with the (*Good Practice Guidance*, 2000)
2. More relevant country specific data were obtained for CH_4 emissions from deep coal mining in 1997, resulting in somewhat lower estimates
3. It was found after editing the (*Revised 1996 IPCC Guidelines*, 1997) that the Sectoral approach for CO_2 used for the 1990 - 1995 period is not quite perfect and in accordance with the Revised Guidelines. On the other hand, the Reference approach was used properly.

The editing the *Revised 1966 IPCC Guidelines* in 1997 formed a good basis for analyzing imperfections in inventories. Subsequently, specifically topics A), 2) 3) and 4), occurring in the first GHG inventories for 1990 - 1995 data, were immediately revised and employed in inventories for data after 1996. Revision of data for CH_4 from Waste (topic 1) was carried out later.

The relevant recalculations were carried out later (see the following table).

9.2 Overview of Recalculations

A survey of the most important recalculations carried out so far is given in the following table.

Tab. 9.1 Survey of recalculations

Year of recalculation	Recalculated years	Recalculated category	Reason of recalculation	Reporting of recalculated results
1997	1990 - 95	CH_4 from coal mining, 1B1	National EFs were evaluated (see topic 2 from the previous page)	3rd National Communication, 1999 Submission 2002 for UNFCCC Explained in NIR
2001	1995 - 1998	HFC, PFC, SF_6	Identified gaps in import data	3rd National Communication, 2001 Submission 2002 for UNFCCC
2002	1990 - 2000	CH_4 from Waste	Application of Good Practice (see topic 1 from the previous page)	Submission 2002- 2004 for UNFCCC Explained in NIR
2002-2004	1990, 1994, 1992	N_2O from all sources	Application of Revised IPCC Guidelines (see topic A from the previous page)	Submissions 2002 - 2004 for UNFCCC Explained in NIR
2002-2004	1990, 1994, 1992	CO_2 from Energy	Sectoral Approach from Revised Guidelines applied (see topic 3 from previous page)	Submissions 2002 - 2004 for UNFCCC Explained in NIR

Cases of recalculations summarized above and other recalculations are explained in a more detail in Chapters 3 - 8.

Summary of the planned recalculation for next year:

On the basis of the results of the QA/QC procedures to date and in connection with the conclusions of the international review organized by UNFCCC, the Czech team is planning the following recalculation or rearrangement of the subsectors:

- Rearrangement of emissions from non-energy use of fuels (production of iron and steel, production of ammonia) from category 1A (Combustion processes) to category 2 (Industrial processes, specifically 2C1 and 2B1)
- Recalculation of emissions of N_2O from road transportation
- Recalculation of emissions of methane from enteric fermentation using the procedures described in the *Good Practice Guidance* at the level of tier 2
- Recalculation of emissions of methane from landfills on the basic of the procedure for tier 2 based on the kinetic model.

10 References

Adamec V., Dufek J., Jedlička J.: *Study of trends in transport in 2002 from the standpoint of the environment,* Transport Research Centre, Brno, May 2002 (in Czech)

Alfeld, K.: *Methane Emissions Produced by the Gas Industry Worldwide*, IGU Study Group 8.1: Methane emissions, Essen, January 1998

Balance of Energy Processes in Energy Sector, Czech Statistical Office, Prague 2004

Commentary on the emission inventory of NMVOC for 2002 in the sector "Solvent use and applications - 060000", SVÚOM, s.r.o., Prague, October 2004 (in Czech)

Dohányos M., Zábranská J.: *Proposals for refining the calculation of methane emissions from municipal and industrial wastewater*; Report for CHMI, Prague 2000 (in Czech)

Dolejš: *Emissions of greenhouse gases in agriculture in the Czech Republic,* Report for PROINCOM Pardubice, Research Institure of Animal Production, Uhříněves, Prague 1994 (in Czech)

EMEP / CORINAIR *Atmospheric Emission Inventory Guidebook*, UN ECE - EMEP 1999

Energy Economy - the Czech Republic in numbers in 1994 - 1997, 1994 - 1998, 1995 - 1999 and 1996 - 2000; KONEKO Marketing Ltd. Prague, December 1998, November 1999, November 2000, November 2001

Environmental Statistical Yearbook of the Czech Republic 2003. ME CR, Prague 2004 (in Czech)

F. Straka: *Calculation of emissions from landfills in CR,* Institute for Research and Use of Fuels, Prague February 2001 (in Czech)

Fott P., Bláha J., Pecka K.: *Inventories of greenhouse gases in 1990 - 1993*, CHMI, "Global Climate Change" Project , Environmental Project No. 49/14/1/95, Prague 1995 (in Czech)

Fott P., Pretel J., Bláha J., Pecka K.: *Inventories of greenhouse gases in 1994 - 1995*, CHMI, "Global Climate Change II" Project , Environmental Project No. 310/1/96, Prague 1996 (in Czech)

Fott P., Pretel J., Bláha J., Neužil V.: *National GHG Inventory Report of the Czech Republic* (NIR), last year 2000, CHMI, Prague 2002

Fott P., Pretel J., Vácha D., Bláha J., Neužil V.: *National GHG Inventory Report of the Czech Republic* (NIR), last year 2001, CHMI, Prague 2003

Fott P., Pretel J., Vácha D., Bláha J., Neužil V., Havránek M.: *National GHG Inventory Report of the Czech Republic* (NIR), last year 2002, CHMI, Prague 2004

Fott, P.: *Carbon emission factors of coal and lignite: Analysis of Czech coal data and comparison with European values*. Environmental Science and Policy (Elsevier), **2**, 1999, p. 347 - 354

Gas and the Environment, 20th World Gas Conference, Copenhagen 1997

Gas and the Environment, 21th World Gas Conference, Nice 2000

Good Practice Guidance and Uncertainty Management in National GHG Inventories, IPCC 2000

Report about forest and forestry conditions in the Czech Republic (Green Report), Forest Management Institute, Ministry of Agriculture, Prague 2004 (in Czech)

Havránek V: *Emissions of greenhouse gases from the waste sector in CR,* Thesis. Institute of the Environment, Faculty of Sciences, Charles University and CHMI, Prague 2001 (in Czech)

Henžlík, V., Zatloukal, V., et al.: *Estimate of overall emissions of greenhouse gases in forest management in the Czech Republic,* Ministry of Agriculture of CR, Prague 1994 (in Czech)

Henžlík, V.: *Activity data for the forest management sector for 2003 according to information from IEMF* (communication of October, 2004) (in Czech)

Hons P., Mudřík Z.: *Czech country-specific data for estimation of methane emissions from enteric fermentation of cattle*. AGROBIO report for CHMI, Prague 2003 (in Czech)

IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-3, IPCC / OECD / IEA, 1995

Jelínek A, Plíva P., Vostoupal B.: *Determining VOC emissions from agricultural activities in the Czech Republic,* Report for CHMI, Research Institute of Agricultural Technology, Prague, 1996 (in Czech)

Kolář F, Havlíková M., Fott P.: *Recalculation of emission series of methane from enteric fermentation of cattle*. Report of CHMI, Prague 2004 (in Czech)

Markvart M., Bernauer B.: *Emission factors for nitrous oxide from combustion processes, chemical technology and mobile sources,* Kateko Report for CHMI, Prague 1999 (in Czech)

Markvart M., Bernauer B.: *Emission trends in nitrous oxide from industrial processes in the nineteen nineties,* Report for CHMI, Prague 2000. (in Czech)

Markvart M., Bernauer B.: *Nitrogen industry as a source of nitrous oxide emissions in the Czech rep*ublic, Report for CHMI, Prague 2003 (in Czech)

Markvart M., Bernauer B.: *Emissions of nitrous in the Czech republic in years 2000 - 2003*, Report for CHMI, Prague 2004 (in Czech)

Mining Yearbook, 1994 - 2003 (in Czech)

Production of selected products in industry in CR (in selected specific units) for January to December 2002, Department of Statistics of Industry, Construction and Energy Production, Czech Statistical Office, Prague 2003 (in Czech)

Production, use and disposal of waste in year 2003, Czech Statistical Office, Prague 2004 (in Czech)

Řeháček V., Michálek L.: Information on emissions of greenhouse gases containing fluorine in CR in 2003, Report for CHMI, Prague 2004 (in Czech)

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-3, IPCC 1997

Second National Communication of the Czech Republic on the UN Framework Convention on Climate Change, ME CR, Prague 1997

Statistical Yearbook of the Czech Republic, Czech Statistical Office, Prague 2003

Statistical Yearbook of the Czech Republic, Czech Statistical Office, Prague 2004

Straka F., Musilová M., Crha J., Pavlas M.: *Emissions of greenhouse gases from wastes in the territory of CR in 1996*, Institute for Research and Use of Fuels, Prague-Běchovice for CHMI, Prague 1997 (in Czech)

Supply of Basic Final Refinery Products in the CR, Czech Statistical Office, Prague 2004

Svoboda K.: *Emission factors for nitrous oxide from coal combustion in stationary sources, Report for CHMI,* Prague 1996 (in Czech)

Takla G., Nováček P.: *Emissions of mine gases in the Ostrava-Karviná coal-mining area and potential for minimization,* Proceedings from the conference Emissions of natural gas - economic and environmental impacts, Czech Gas Association, May 1997 (in Czech)

Takla, G.: *Methane emissions from deep coal mining*, national conference "Natural Gas Emissions - New Clean Air Act and international reliability of the methane emission inventory in the Czech Republic", Czech Gas Association, 2002 (in Czech)

Third National Communication of the Czech Republic on the UN Framework Convention on Climate Change, ME CR, Prague 2001

Tichý M., Voráčková Z., Dvořák P.: *Inventory of emissions of greenhouse gases in the Czech Republic in 1990*, SEVEn, Prague 1995 (in Czech)

UNIPETROL and the environment - *Report on the environmental impacts of the Unipetrol Group in 1998,* UNIPETROL 1999 (in Czech)

Zábranská J.: *Proposals for refining the calculation of methane emissions from municipal and industrial wastewater (data for years 2000 and 2001)* Report for CHMI, Prague 2002 (in Czech)

Zábranská J.: *Proposals for update of the calculation of methane emissions from municipal and industrial wastewater,* Report for CUEC, Prague 2003 (in Czech)

Zábranská J.: *Proposals for update of the calculation of methane emissions from municipal and industrial wastewater in 2002 - 2003*; University of Chemical Technology*,* Report for CUEC, Prague 2004 (in Czech)

Abbreviations

APL	*Association of Industrial Distilleries (Asociace průmyslových lihovarů)*
AVNH	*Association of Coatings Producers (Asociace výrobců nátěrových hmot)*
CCA	*Czech Cement Association*
CDV	*Transport Research Centre (Centrum dopravního výzkumu)*
CHMI	*Czech Hydrometeorological Institute (Český hydrometeorologický ústav)*
CSO	*Czech Statistical Office (Český statistický úřad)*
CUEC	*Charles University Environment Center (Centrum pro otázky životního prostředí Univerzity Karlovy)*
EEA	*European Environmental Agency*
IEA	*International Energy Agency*
IFER	*Institute of Forest Ecosystem Research (Ústav pro výzkum lesních ekosystémů)*
IGU	*International Gas Union*
ME (CR)	*Ministry of Environment of (CR) (Ministerstvo životního prostředí (ČR))*
MSW	*Municipal solid waste*
REZZO	*Register of Emissions and Sources of Air Pollution (Registr emisí a zdrojů znečišťování ovzduší)*
SEVEn	*The Energy Efficiency Center (Středisko pro efektivní využívání energie)*
ÚHÚL	*Forest Management Institute (Ústav pro hospodářskou úpravu lesů)*
VŠCHT	*Institute of Chemical Technology (Vysoká škola chemicko technologická)*
ÚVVP	*Institute for Research and Use of Fuels (Ústav pro výzkum a využití paliv)*

Appendix I

EMISSION INVENTORY

2003

TABLE 1 SECTORAL REPORT FOR ENERGY
(Sheet 1 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
				(Gg)			
Total Energy	**116 227.95**	**266.13**	**5.10**	**318.74**	**545.35**	**102.27**	**228.33**
A. Fuel Combustion Activities (Sectoral Approach)	**115 667.91**	**13.96**	**5.10**	**318.19**	**543.63**	**100.79**	**227.68**
1. Energy Industries	**58 924.31**	**0.73**	**2.14**	**103.92**	**11.66**	**7.11**	**142.67**
a. Public Electricity and Heat Production	56 537.85	0.64	2.10	96.89	8.87	6.35	132.59
b. Petroleum Refining	1 188.53	0.05	0.00	0.06	0.05	0.00	1.03
c. Manufacture of Solid Fuels and Other Energy Industries	1 197.93	0.04	0.03	6.97	2.74	0.75	9.05
2. Manufacturing Industries and Construction	**27 556.12**	**1.10**	**0.71**	**33.86**	**119.87**	**4.27**	**39.81**
a. Iron and Steel	3 248.09	0.10	0.08	IE	IE	IE	IE
b. Non-Ferrous Metals	248.49	0.01	0.01	IE	IE	IE	IE
c. Chemicals	7 064.94	0.22	0.27	IE	IE	IE	IE
d. Pulp, Paper and Print	1 321.01	0.23	0.05	IE	IE	IE	IE
e. Food Processing, Beverages and Tobacco	2 756.27	0.08	0.05	IE	IE	IE	IE
f. Other *(please specify)*	12 917.31	0.46	0.26	33.86	119.87	4.27	39.81
Only total of a-e available, treated as f				33.86	119.87	4.27	39.81
3. Transport	**13 430.76**	**2.32**	**2.01**	**101.17**	**230.40**	**45.53**	**2.17**
a. Civil Aviation	93.30	0.00	0.00	0.02	0.00	0.00	0.00
b. Road Transportation	12 726.80	2.30	1.99	92.83	224.75	44.43	2.01
c. Railways	242.49	0.02	0.01	7.40	5.10	1.00	0.15
d. Navigation	19.36	0.00	0.00	0.70	0.50	0.10	0.01
e. Other Transportation *(please specify)*	348.82	0.00	0.00	0.21	0.05	0.00	0.00
Gas pipelines transportation				0.21	0.05	0.00	0.00

TABLE 1 SECTORAL REPORT FOR ENERGY
(Sheet 2 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(Gg)						
4. Other Sectors	**14 526.27**	**9.55**	**0.20**	**21.63**	**119.17**	**27.35**	**39.98**
a. Commercial/Institutional	4 419.75	0.72	0.03	4.22	4.25	1.04	5.07
b. Residential	9 571.16	8.25	0.15	16.61	112.70	25.91	33.29
c. Agriculture/Forestry/Fisheries	535.36	0.58	0.01	0.79	2.21	0.40	1.62
5. Other *(please specify)* [1]	**1 230.46**	**0.26**	**0.05**	**57.62**	**62.53**	**16.53**	**3.06**
a. Stationary	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IE	IE	IE	IE	IE	IE	IE
b. Mobile	1 230.46	0.26	0.05	57.62	62.53	16.53	3.06
Mobile sources from the Agriculture/Forestry/Fishing Sector are treated here.	1 230.46	0.26	0.05	57.62	62.53	16.53	3.06
B. Fugitive Emissions from Fuels	**560.04**	**252.17**	**0.00**	**0.55**	**1.72**	**1.48**	**0.65**
1. Solid Fuels	**560.04**	**228.40**	**0.00**	**0.43**	**1.57**	**0.17**	**0.21**
a. Coal Mining	0.00	228.40	NE	NE	NE	NE	
b. Solid Fuel Transformation	IE	IE	IE	0.43	1.57	0.17	0.21
c. Other *(please specify)*	560.04	0.00	0.00	0.00	0.00	0.00	0.00
2. Oil and Natural Gas	**0.00**	**23.77**	**0.00**	**0.12**	**0.15**	**1.31**	**0.43**
a. Oil	0.00	0.47		0.12	0.15	1.31	0.43
b. Natural Gas	0.00	23.31				NE	NE
c. Venting and Flaring	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Venting	0.00	0.00				NE	NE
Flaring	0.00	0.00	0.00	NE	NE	NE	NE
d. Other *(please specify)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items: [2]							
International Bunkers	**596.86**	**0.18**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**
Aviation	596.86	0.18	0.02	IE	IE	IE	IE
Marine	0.00	0.00	0.00	NO	NO	NO	NO
Multilateral Operations	0.00	0.00	0.00	NO	NO	NO	NO
CO_2 Emissions from Biomass	**2 900.24**						

[1] Include military fuel use under this category.

[2] Please do not include in energy totals.

TABLE 2(I) SECTORAL REPORT FOR INDUSTRIAL PROCESSES
(Sheet 1 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total Industrial Processes	**10 262.06**	**3.40**	**3.13**	**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**	**4.27**	**33.01**	**2.05**	**2.02**
A. Mineral Products	**1 980.22**	**0.01**	**0.00**							**0.06**	**0.26**	**0.29**	**0.01**
1. Cement Production	1 781.98												0.01
2. Lime Production	0.00												
3. Limestone and Dolomite Use	NE												
4. Soda Ash Production and Use	0.00												
5. Asphalt Roofing	NE										0.00	NE	
6. Road Paving with Asphalt	0.00									0.00	0.12	0.00	0.00
7. Other *(please specify)*	198.24	0.01	0.00							0.06	0.14	0.28	0.00
Glass production										0.06	0.14	0.28	0.00
B. Chemical Industry	**705.84**	**0.39**	**3.13**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.30**	**0.37**	**0.24**	**0.88**
1. Ammonia Production	705.84	NE								0.62	0.37	0.01	NE
2. Nitric Acid Production			2.86							0.03			
3. Adipic Acid Production			NO							NO	NO	NO	
4. Carbide Production	0.00	0.00									NO	NO	NO
5. Other *(please specify)*	0.00	0.39	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.22	0.88
Sum of other nonspecified items										0.64	0.00	0.22	0.88
C. Metal Production	**7 576.00**	**3.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.82**	**31.89**	**1.46**	**0.48**
1. Iron and Steel Production	7 576.00	2.56								1.82	31.89	1.34	0.48
2. Ferroalloys Production	NE	0.00								0.00	0.00	0.12	0.00
3. Aluminium Production	NO	NO					0.00			NO	NO	NO	NO
4. SF_6 Used in Aluminium and Magnesium Foundries									0.00				
5. Other *(please specify)*	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of other nonspecified items													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines. A = Actual emissions based on Tier 2 approach of the IPCC Guidelines. This only applies in sectors where methods exist for both tiers.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

TABLE 2(I) SECTORAL REPORT FOR INDUSTRIAL PROCESSES
(Sheet 2 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
D. Other Production	**0.00**									**1.09**	**0.48**	**0.06**	**0.65**
1. Pulp and Paper										1.09	0.48	0.00	0.65
2. Food and Drink[2]	0.00											0.06	
E. Production of Halocarbons and SF_6					**0.00**		**0.00**		**0.00**				
1. By-product Emissions					0.00		0.00		0.00				
Production of HCFC-22					0.00								
Other					0.00		0.00		0.00				
2. Fugitive Emissions					0.00		0.00		0.00				
3. Other *(please specify)*					0.00		0.00		0.00				
F. Consumption of Halocarbons and SF_6				**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**				
1. Refrigeration and Air Conditioning Equipment				1 280.47	0.00	26.62	0.00	0.00	0.00				
2. Foam Blowing				5.62	0.00	0.00	0.00	0.00	0.00				
3. Fire Extinguishers				35.45	0.00	0.00	0.00	0.00	0.00				
4. Aerosols/ Metered Dose Inhalers				22.38	0.00	0.00	0.00	0.00	0.00				
5. Solvents				0.00	0.00	0.00	0.00	0.00	0.00				
6. Semiconductor Manufacture				0.00	0.00	2.02	0.00	16.73	0.00				
7. Electrical Equipment				0.00	0.00	0.00	0.00	169.86	0.00				
8. Other *(please specify)*				0.00	0.00	0.00	0.00	152.67	0.00				
Other - nonspecified				0.00	0.00	0.00	0.00	152.67	0.00				
G. Other *(please specify)*													

[2] CO_2 from Food and Drink Production (e.g. gasification of water) can be of biogenic or non-biogenic origin. Only information on CO_2 emissions of non-biogenic origin should be reported.

TABLE 3 SECTORAL REPORT FOR SOLVENT AND OTHER PRODUCT USE
(Sheet 1 of 1)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2**	**N_2O**	**NMVOC**
		(Gg)	
Total Solvent and Other Product Use	**265.59**	**0.69**	**98.87**
A. Paint Application	**121.44**	**NA**	**38.64**
B. Degreasing and Dry Cleaning	**62.39**	**NA**	**19.86**
C. Chemical Products, Manufacture and Processing			**14.36**
D. Other *(please specify)*	**81.76**	**0.69**	**26.02**
(Use of N_2O for Anaesthesia)	NA	0.35	NA
(N_2O from Fire Extinguishers)	NA	0.00	NA
(N_2O from Aerosol Cans)	NA	0.35	NA
(Other Use of N_2O)	NA	0.00	NA
Other solvent use (SNAP 0604)	81.76	NA	26.02

Please account for the quantity of carbon released in the form of NMVOC in both the NMVOC and the CO_2 columns.

Note: The IPCC Guidelines do not provide methodologies for the calculation of emissions of N_2O from Solvent and Other Product Use. If reporting such data, Parties should provide additional information (activity data and emission factors) used to make these estimates in the documentation box to Table 3.A-D.

TABLE 4 SECTORAL REPORT FOR AGRICULTURE
(Sheet 1 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
	(Gg)				
Total Agriculture	**105.91**	**16.73**	**0.00**	**0.00**	**0.00**
A. Enteric Fermentation	**75.97**				
1. Cattle	61.11				
Dairy Cattle	40.24				
Non-Dairy Cattle	20.87				
2. Buffalo	NO				
3. Sheep	0.52				
4. Goats	0.05				
5. Camels and Llamas	NO				
6. Horses	0.94				
7. Mules and Asses	NO				
8. Swine	11.47				
9. Poultry	1.88				
10. Other *(please specify)*	0.00				
B. Manure Management	**29.94**	**1.26**			**0.00**
1. Cattle	2.83				
Dairy Cattle	1.94				
Non-Dairy Cattle	0.89				
2. Buffalo	NO				
3. Sheep	0.02				
4. Goats	0.00				
5. Camels and Llamas	NO				
6. Horses	0.07				
7. Mules and Asses	NO				
8. Swine	26.47				
9. Poultry	0.54				

TABLE 4 SECTORAL REPORT FOR AGRICULTURE
(Sheet 2 of 2)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
	(Gg)				
B. Manure Management (continued)					
10. Anaerobic Lagoons		0.00			NE
11. Liquid Systems		0.18			NE
12. Solid Storage and Dry Lot		0.92			NE
13. Other *(please specify)*		0.16			0.00
		0.16			
C. Rice Cultivation	0.00				**0.00**
1. Irrigated	0.00				NO
2. Rainfed	0.00				NO
3. Deep Water	0.00				NO
4. Other *(please specify)*	0.00				0.00
D. Agricultural Soils (1)	**0.00**	**15.47**			**0.00**
1. Direct Soil Emissions	NE	8.47			NE
2. Animal Production	NE	0.88			NE
3. Indirect Emissions	NE	6.12			NE
4. Other *(please specify)*	0.00	0.00			0.00
E. Prescribed Burning of Savannas	**0.00**	**0.00**			
F. Field Burning of Agricultural Residues	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1 . Cereals	0.00	0.00	NO	NO	NO
2. Pulse	0.00	0.00	NO	NO	NO
3 . Tuber and Root	0.00	0.00	NO	NO	NO
4 . Sugar Cane	0.00	0.00	NO	NO	NO
5 . Other *(please specify)*	0.00	0.00	0.00	0.00	0.00
G. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

(1) See footnote 4 to Summary 1.A of this common reporting format. Parties which choose to report CO_2 emissions and removals from agricultural soils under 4.D. Agricultural Soils category of the sector Agriculture should indicate the amount [Gg] of these emissions or removals in the documentation box to Table 4.D. Additional information (activity data, implied emissions factors) should also be provided using the relevant documentation box to Table 4.D. This table is not modified for reporting the CO_2 emissions and removals for the sake of consistency with the IPCC tables (i.e. IPCC Sectoral Report for Agriculture).

Note: The IPCC Guidelines do not provide methodologies for the calculation of CH_4 emissions, CH_4 and N_2O removals from agricultural soils, or CO_2 emissions from savanna burning or agricultural residues burning. If you have reported such data, you should provide additional information (activity data and emission factors) used to make these estimates using the relevant documentation boxes of the Sectoral background data tables.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY
(Sheet 1 of 1)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	NO_x	CO
	(Gg)						
Total Land-Use Change and Forestry	**17 018.92**	**-20 867.15**	**-3 848.23**	**2.76**	**0.00**	**0.05**	**24.19**
A. Changes in Forest and Other Woody Biomass Stocks	**17 018.92**	**-20 867.15**	**-3 848.23**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	17 018.92	-20 867.15	-3 848.23				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other *(please specify)*	0.00	0.00	0.00				
Harvested Wood [1]			0.00				
	0.00			**0.00**	**0.00**	**0.00**	**0.00**
B. Forest and Grassland Conversion [2]	NO			NO	NO	NO	NO
1. Tropical Forests	NE			NE	NE	NE	NE
2. Temperate Forests	NO			NO	NO	NO	NO
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	0.00			0.00	0.00	0.00	0.00
5. Other *(please specify)*	NE			NE	NE	NE	NE
	0.00	**0.00**	**0.00**				
C. Abandonment of Managed Lands	NO	NO	0.00				
1. Tropical Forests	NE	NE	0.00				
2. Temperate Forests	NO	NO	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	0.00	0.00	0.00				
5. Other *(please specify)*			0.00				
	0.00	**0.00**	**0.00**				
D. CO_2 Emissions and Removals from Soil	NE	NE	0.00				
Cultivation of Mineral Soils	NE	NE	0.00				
Cultivation of Organic Soils	NE	NE	0.00				
Liming of Agricultural Soils	NE	NE	0.00				
Forest Soils	0.00	0.00	0.00				
Other *(please specify)* [3]			0.00				
	0.00	**0.00**	**0.00**	**2.76**	**0.00**	**0.05**	**24.19**
E. Other *(please specify)*	IE	0.00	0.00	2.76	0.00	0.05	24.19
On-side burning of Cleared Forest (4)	**17 018.92**	**-20 867.15**	**-3 848.23**	**2.76**	**0.00**	**0.05**	**24.19**

[1] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).

[2] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.

[3] Include emissions from soils not reported under sections A, B and C.

[4] CO_2 emissions included in A2

Note: See footnote 4 to Summary 1.A of this common reporting format.

TABLE 6 SECTORAL REPORT FOR WASTE
(Sheet 1 of 1)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2(1)	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(Gg)						
Total Waste	**368.31**	**107.98**	**0.66**	**0.63**	**0.05**	**0.03**	**0.05**
A. Solid Waste Disposal on Land	**0.00**	**83.41**		**0.00**	**0.00**	**0.00**	
1. Managed Waste Disposal on Land	NA	83.41		NE	NE	NE	
2. Unmanaged Waste Disposal Sites	0.00	0.00		NE	NE	NE	
3. Other *(please specify)*	0.00	0.00		0.00	0.00	0.00	
B. Wastewater Handling		**24.57**	**0.64**	**0.00**	**0.00**	**0.02**	
1. Industrial Wastewater		12.32	NE	NE	NE	NE	
2. Domestic and Commercial Wastewater		8.51	0.64	NE	NE	NE	
3. Other *(please specify)*		3.74	0.00	0.00	0.00	0.00	
C. Waste Incineration	**368.31**	**0.00**	**0.02**	0.63	0.05	0.01	0.05
D. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

(1) Note that CO_2 from Waste Disposal and Incineration source categories should only be included if it stems from non-biological or inorganic waste sources.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 3)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**127 123.92**	**-3 848.23**	**486.18**	**26.31**	**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**	**323.68**	**602.60**	**203.22**	**230.40**
1. Energy	**116 227.95**		**266.13**	**5.10**							**318.74**	**545.35**	**102.27**	**228.33**
A. Fuel Combustion	125 718.50													
	115 667.91		13.96	5.10							318.19	543.63	100.79	227.68
1. Energy Industries	58 924.31		0.73	2.14							103.92	11.66	7.11	142.67
2. Manufacturing Industries and Construction	27 556.12		1.10	0.71							33.86	119.87	4.27	39.81
3. Transport	13 430.76		2.32	2.01							101.17	230.40	45.53	2.17
4. Other Sectors	14 526.27		9.55	0.20							21.63	119.17	27.35	39.98
5. Other	1 230.46		0.26	0.05							57.62	62.53	16.53	3.06
B. Fugitive Emissions from Fuels	560.04		252.17	0.00							0.55	1.72	1.48	0.65
1. Solid Fuels	560.04		228.40	0.00							0.43	1.57	0.17	0.21
2. Oil and Natural Gas	0.00		23.77	0.00							0.12	0.15	1.31	0.43
2. Industrial Processes	**10 262.06**		**3.40**	**3.13**	**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**	**4.27**	**33.01**	**2.05**	**2.02**
A. Mineral Products	1 980.22		0.01	0.00							0.06	0.26	0.29	0.01
B. Chemical Industry	705.84		0.39	3.13	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.37	0.24	0.88
C. Metal Production	7 576.00		3.00	0.00				0.00		0.00	1.82	31.89	1.46	0.48
D. Other Production[3]	0.00										1.09	0.48	0.06	0.65
E. Production of Halocarbons and SF_6						0.00		0.00		0.00				
F. Consumption of Halocarbons and SF_6					1 343.92	0.00	28.64	0.00	339.26	0.00				
G. Other	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines.

A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach. Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] Other Production includes Pulp and Paper and Food and Drink Production.

Note: The numbering of footnotes to all tables containing more than one sheet continue to the next sheet. Common footnotes are given only once at the first point of reference.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 3)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs [1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	**265.59**			**0.69**							**0.00**	**0.00**	**98.87**	0.00
4. Agriculture	**0.00**	**0.00**	**105.91**	**16.73**							0.00	0.00	0.00	0.00
A. Enteric Fermentation			75.97											
B. Manure Management			29.94	1.26									0.00	
C. Rice Cultivation			0.00										0.00	
D. Agricultural Soils	[4]	[4]	0.00	15.47									0.00	
E. Prescribed Burning of Savannas			0.00	0.00							0.00	0.00	0.00	
F. Field Burning of Agricultural Residues			0.00	0.00							0.00	0.00	0.00	
G. Other			0.00	0.00							0.00	0.00	0.00	NO
5. Land-Use Change and Forestry	[5] **0.00**	[5] **-3 848.23**	**2.76**	**0.00**							**0.05**	**24.19**	**0.00**	**0.00**
A. Changes in Forest and Other Woody Biomass Stocks	[5] 0.00	[5] -3 848.23												
B. Forest and Grassland Conversion	0.00		0.00	0.00							0.00	0.00	NO	
C. Abandonment of Managed Lands	[5] 0.00	[5] 0.00												
D. CO_2 Emissions and Removals from Soil	[5] 0.00	[5] 0.00												
E. Other	[5] 0.00	[5] 0.00	2.76	0.00							0.05	24.19	NE	NE
6. Waste	**368.31**		**107.98**	**0.66**							**0.63**	**0.05**	**0.03**	**0.05**
A. Solid Waste Disposal on Land	[6] 0.00		83.41									0.00	0.00	
B. Wastewater Handling			24.57	0.64							0.00	0.00	0.02	
C. Waste Incineration	[6] 368.31		0.00	0.02							0.63	0.05	0.01	0.05
D. Other	0.00		0.00	0.00							0.00	0.00	0.00	0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

[4] According to the IPCC Guidelines (Volume 3. Reference Manual, pp. 4.2, 4.87), CO_2 emissions from agricultural soils are to be included under Land-Use Change and Forestry (LUCF). At the same time, the Summary Report 7A (Volume 1. Reporting Instructions, Tables.27) allows for reporting CO_2 emissions or removals from agricultural soils, either in the Agriculture sector, under D. Agricultural Soils or in the Land-Use Change and Forestry sector under D. Emissions and Removals from Soil. Parties may choose either way to report emissions or removals from this source in the common reporting format, but the way they have chosen to report should be clearly indicated, by inserting explanatory comments to the corresponding cells of Summary 1.A and Summary 1.B. Double-counting of these emissions or removals should be avoided. Parties should include these emissions or removals consistently in Table8(a) (Recalculation - Recalculated data) and Table10 (Emission trends).

[5] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[6] Note that CO_2 from Waste Disposal and Incineration source categories should only be included if it stems from non-biogenic or inorganic waste streams.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A) (Sheet 3 of 3)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Memo Items: [(7)]														
International Bunkers	**596.86**		**0.18**	**0.02**							**0.00**	**0.00**	**0.00**	**0.00**
Aviation	596.86		0.18	0.02							IE	IE	IE	IE
Marine	0.00		0.00	0.00							NO	NO	NO	NO
Multilateral Operations	**0.00**		**0.00**	**0.00**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**2 900.24**													

(7) Memo Items are not included in the national totals.

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B) (Sheet 1 of 1)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs(1)		PFCs(1)		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals		**127 123.92**	**-3 848.23**	**486.18**	**26.31**	**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**	**323.68**	**-3 848.23**	**486.18**	**26.31**
1. Energy		**117 977.66**	**266.13**	**5.10**							**318.74**		**266.13**	**5.10**	**233.12**
A. Fuel Combustion	Reference Approach(2)	120 955.74													
	Sectoral Approach(2)	117 426.28	13.96	5.10							318.19		13.96	5.10	230.59
B. Fugitive Emissions from Fuels		560.04		252.17	0.00							0.55		252.17	0.00
2. Industrial Processes		**4 406.53**	**3.40**	**3.13**	**1 343.92**	**0.00**	**28.64**	**0.00**	**339.26**	**0.00**	**4.27**		**3.40**	**3.13**	**4.11**
3. Solvent and Other Product Use		**265.59**			**0.69**							**0.00**			**0.69**
4. Agriculture (3)		**0.00**	**0.00** **105.91**	**16.73**							**0.00**	**0.00**	**105.91**	**16.73**	**0.00**
5. Land-Use Change and Forestry		**(4) 0.00**	**(4) -3 848.23**	**2.76**	**0.00**							**0.05**	**-3 848.23**	**2.76**	**0.00**
6. Waste		**368.31**	**107.98**	**0.66**							**0.63**		**107.98**	**0.66**	**0.15**
7. Other		**0.00**	**0.00** **0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Memo Items:															
International Bunkers		**596.86**	**0.18**	**0.02**							**0.00**		**0.18**	**0.02**	**0.00**
Aviation		596.86	0.18	0.02							IE		0.18	0.02	IE
Marine		0.00	0.00	0.00							NO		0.00	0.00	NO
Multilateral Operations		**0.00**	**0.00**	**0.00**							**NO**		**0.00**	**0.00**	**0.00**
CO_2 Emissions from Biomass		**2 815.05**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines. A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

(1) The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

(2) For verification purposes. countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible. the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

(3) See footnote 4 to Summary 1.A.

(4) Please do not provide an estimate of both CO_2 emissions and CO_2 removals. “Net” emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column. as appropriate. Please note that for the purposes of reporting. the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**123 275.69**	**10 209.72**	**8 157.19**	**1 343.92**	**28.64**	**339.26**	**143 354.42**
1. Energy	**116 227.95**	**5 588.64**	**1 581.50**				**123 398.10**
A. Fuel Combustion (Sectoral Approach)	115 667.91	293.06	1 581.50				117 542.47
1. Energy Industries	58 924.31	15.23	662.68				59 602.21
2. Manufacturing Industries and Construction	27 556.12	23.06	221.34				27 800.52
3. Transport	13 430.76	48.78	621.67				14 101.21
4. Other Sectors	14 526.27	200.57	60.85				14 787.69
5. Other	1 230.46	5.42	14.97				1 250.84
B. Fugitive Emissions from Fuels	560.04	5 295.59	0.00				5 855.63
1. Solid Fuels	560.04	4 796.35	0.00				5 356.40
2. Oil and Natural Gas	0.00	499.23	0.00				499.23
2. Industrial Processes	**10 262.06**	**71.41**	**971.59**	**0.00**	**0.00**	**0.00**	**11 305.07**
A. Mineral Products	1 980.22	0.20	0.00				1 980.42
B. Chemical Industry	705.84	8.19	971.59	0.00	0.00	0.00	1 685.62
C. Metal Production	7 576.00	63.02	0.00		0.00	0.00	7 639.02
D. Other Production	0.00						0.00
E. Production of Halocarbons and SF_6				0.00	0.00	0.00	0.00
F. Consumption of Halocarbons and SF_6				0.00	0.00	0.00	0.00
G. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Solvent and Other Product Use	**265.59**		**214.52**				**480.11**
4. Agriculture	**0.00**	**2 224.09**	**5 185.34**				**7 409.43**
A. Enteric Fermentation		1 595.41					1 595.41
B. Manure Management		628.68	390.14				1 018.81
C. Rice Cultivation		0.00					0.00
D. Agricultural Soils(2)		0.00	4 795.20				4 795.20
E. Prescribed Burning of Savannas		0.00	0.00				0.00
F. Field Burning of Agricultural Residues		0.00	0.00				0.00
G. Other		0.00	0.00				0.00
5. Land-Use Change and Forestry(1)	**-3 848.23**	**58.05**	**0.66**				**-3 789.52**
6. Waste	**368.31**	**2 267.53**	**203.57**				2 839.42
A. Solid Waste Disposal on Land	0.00	1 751.51					1 751.51
B. Wastewater Handling		516.03	198.79				714.81
C. Waste Incineration	368.31	0.00	4.78				373.10
D. Other	0.00	0.00	0.00				0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**1 343.92**	**28.64**	**339.26**	**1 711.82**
Consumption of HFCs. PFCs and SF6 (Tier 1)				1 343.92	28.64	339.26	1 711.82
Memo Items:							
International Bunkers	**596.86**	**3.72**	**6.01**				**606.59**
Aviation	596.86	3.72	6.01				606.59
Marine	0.00	0.00	0.00				0.00
Multilateral Operations	**0.00**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**2 900.24**						**2 900.24**

---

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting. the signs for uptake are always (-) and for emissions (+).
(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES Land-Use Change and Forestry	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	17 018.92	-20 867.15	-3 848.23			-3 848.23
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	0.00	0.00	0.00			0.00
E. Other	0.00	0.00	0.00	58.05	0.66	58.71
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	17 018.92	-20 867.15	-3 848.23	58.05	0.66	-3 789.52

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry (a)	147 143.94
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry (a)	143 354.42

(a) The information in these rows is requested to facilitate comparison of data. since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

Appendix II

EMISSION INVENTORY OVERVIEW

FOR 1990 - 2003*

* except 1991. 1993 and 1995. HFCs. PFCs. SF_6 data for 1995 - 2003

TABLE 10 EMISSIONS TRENDS (CO_2)
(Sheet 1 of 5)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)											
1. Energy	**160 080**	**135 766**	**127 116**	**128 070**	**129 592**	**134 166**	**124 903**	**118 038**	**124 960**	**122 798**	**117 978**	**116 228**
A. Fuel Combustion (Sectoral Approach)	160 080	135 766	127 116	128 070	129 516	133 925	124 486	117 501	124 420	122 246	117 426	115 668
1. Energy Industries	59 171	52 550	55 768	58 059	57 818	59 180	58 706	53 848	60 160	59 538	57 729	58 924
2. Manufacturing Industries and Construction	59 457	51 207	44 199	41 591	43 867	43 341	35 376	34 156	36 130	34 879	30 968	27 556
3. Transport	7 275	7 453	7 605	9 502	9 896	11 392	10 779	12 016	11 110	12 061	12 428	13 431
4. Other Sectors	34 177	24 555	19 544	18 918	17 936	20 013	19 624	17 481	17 019	15 769	16 301	15 757
5. Other												
B. Fugitive Emissions from Fuels	0	0	0	0	76	241	417	537	540	551	551	560
1. Solid Fuels			0	0	76	241	417	537	540	551	551	560
2. Oil and Natural Gas												
2. Industrial Processes	**3 380**	**3 210**	**2 772**	**2 609**	**2 479**	**2 498**	**2 661**	**2 362**	**2 251**	**4 524**	**4 407**	**10 262**
A. Mineral Products	3 380	3 210	2 772	2 609	2 479	2 498	2 661	2 362	2 251	2 000	1 793	1 980
B. Chemical Industry												706
C. Metal Production		IE								2 524	2 614	7 576
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use	**530**	**457**	**382**	**362**	**352**	**336**	**347**	**336**	**335**	**317**	**317**	**266**
4. Agriculture	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
A. Enteric Fermentation												
B. Manure Management												
C. Rice Cultivation												
D. Agricultural Soils (2)												
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry (3)	**-2 128**	**-6 537**	**-4 681**	**-4 250**	**-4 486**	**-4 639**	**-3 757**	**-3 401**	**-4 016**	**-4 363**	**-4 492**	**-3 848**
A. Changes in Forest and Other Woody Biomass Stocks	-2 128	-6 537	-4 681	-4 250	-4 486	-4 639	-3 757	-3 401	-4 016	-4 363	-4 492	-3 848
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other												
6. Waste	**0**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**368**
A. Solid Waste Disposal on Land												
B. Waste-water Handling												
C. Waste Incineration		357	357	357	357	357	357	357	357	357	357	368
D. Other												
7. Other *(please specify)*	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Emissions/Removals with LUCF (4)	**161 862**	**133 252**	**125 945**	**127 148**	**128 294**	**132 718**	**124 511**	**117 692**	**123 886**	**123 633**	**118 566**	**123 276**
Total Emissions without LUCF(4)	**163 990**	**139 789**	**130 626**	**131 398**	**132 780**	**137 357**	**128 268**	**121 093**	**127 902**	**127 996**	**123 058**	**127 124**
Memo Items:												
International Bunkers	**617**	**476**	**283**	**371**	**459**	**407**	**225**	**539**	**343**	**439**	**497**	**597**
Aviation	617	476	283	371	459	407	225	539	343	439	497	597
Marine												
Multilateral Operations												
CO_2 Emissions from Biomass												

(1) Fill in the base year adopted by the Party under the Convention. if different from 1990.
(2) See footnote 4 to Summary 1.A of this common reporting format.
(3) Take the net emissions as reported in Summary 1.A of this common reporting format. Please note that for the purposes of reporting. the signs for uptake are always (-) and for emissions (+).
(4) The information in these rows is requested to facilitate comparison of data. since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

TABLE 10 EMISSIONS TRENDS (CH_4)
(Sheet 2 of 5)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)											
Total Emissions	**798.26**	**685.25**	**619.44**	**612.15**	**599.72**	**575.50**	**543.83**	**509.10**	**510.21**	**499.30**	**493.97**	**486.18**
1. Energy	**453.38**	**385.83**	**354.48**	**346.80**	**334.63**	**329.72**	**303.75**	**278.68**	**287.18**	**282.07**	**275.24**	**266.13**
A. Fuel Combustion (Sectoral Approach)	59.31	42.18	34.92	32.14	33.95	31.27	22.51	20.95	19.41	14.06	14.62	13.96
1. Energy Industries	7.10	7.01	6.72	5.13	2.57	2.26	2.24	1.66	1.27	0.68	0.66	0.73
2. Manufacturing Industries and Construction	1.23	1.70	1.50	2.41	1.03	1.51	1.21	1.28	1.16	0.89	0.79	1.10
3. Transport	3.07	1.25	1.02	1.34	3.51	4.29	1.86	1.90	1.92	2.04	2.21	2.32
4. Other Sectors	47.91	32.22	25.69	23.26	26.83	23.22	17.19	16.12	15.06	10.46	10.97	9.81
5. Other												
B. Fugitive Emissions from Fuels	394.07	343.65	319.56	314.66	300.68	298.45	281.23	257.73	267.77	268.00	260.62	252.17
1. Solid Fuels	361.90	305.97	281.99	276.61	268.42	263.47	253.05	228.96	239.00	244.74	237.48	228.40
2. Oil and Natural Gas	32.17	37.69	37.56	38.05	32.26	34.98	28.18	28.77	28.77	23.27	23.14	23.77
2. Industrial Processes	**5.60**	**4.78**	**3.93**	**3.83**	**4.90**	**3.91**	**4.02**	**3.92**	**3.40**	**3.40**	**3.40**	**3.40**
A. Mineral Products		0.01	0.01	0.01	0.16	0.01	0.00	0.00	0.01	0.01	0.01	0.01
B. Chemical Industry	0.40	0.40	0.39	0.40	0.39	0.39	0.39	0.40	0.39	0.39	0.39	0.39
C. Metal Production	5.20	4.37	3.53	3.41	4.34	3.51	3.63	3.52	3.00	3.00	3.00	3.00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use												
4. Agriculture	**204.19**	**162.44**	**133.97**	**133.83**	**133.83**	**129.11**	**121.13**	**120.50**	**113.76**	**112.92**	**105.38**	**105.91**
A. Enteric Fermentation	155.78	120.88	99.09	97.83	97.83	92.86	85.83	85.16	81.01	80.89	75.56	75.97
B. Manure Management	48.41	41.56	34.88	35.99	35.99	36.25	35.30	35.34	32.75	32.04	29.82	29.94
C. Rice Cultivation												
D. Agricultural Soils												
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry	**2.58**	**1.26**	**1.91**	**1.62**	**2.31**	**2.25**	**2.25**	**2.58**	**2.36**	**2.59**	**2.68**	**2.76**
A. Changes in Forest and Other Woody Biomass Stocks												
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other	2.58	1.26	1.91	1.62	2.31	2.25	2.25	2.58	2.36	2.59	2.68	2.76
6. Waste	**132.51**	**130.94**	**125.15**	**126.07**	**124.06**	**110.51**	**112.70**	**103.42**	**103.51**	**98.32**	**107.27**	**107.98**
A. Solid Waste Disposal on Land	93.20	95.98	92.67	94.91	95.04	80.87	81.93	75.98	75.98	73.48	80.63	83.41
B. Waste-water Handling	39.31	34.96	32.48	31.16	29.02	29.64	30.77	27.43	27.52	24.84	26.64	24.57
C. Waste Incineration												
D. Other												
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Memo Items:												
International Bunkers	**0.18**	**0.14**	**0.08**	**0.11**	**0.16**	**0.12**	**0.07**	**0.16**	**0.10**	**0.13**	**0.15**	**0.18**
Aviation	0.18	0.14	0.08	0.11	0.16	0.12	0.07	0.16	0.10	0.13	0.15	0.18
Marine												
Multilateral Operations												
CO_2 Emissions from Biomass												

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)											
Total Emissions	**36.34**	**29.76**	**26.69**	**28.24**	**29.71**	**28.42**	**27.07**	**26.17**	**26.37**	**26.75**	**26.37**	**26.31**
1. Energy	**4.57**	**4.14**	**3.93**	**4.30**	**4.16**	**4.31**	**4.47**	**4.46**	**4.78**	**4.98**	**4.98**	**5.10**
A. Fuel Combustion (Sectoral Approach)	4.57	4.14	3.93	4.30	4.16	4.31	4.47	4.46	4.78	4.98	4.98	5.10
1. Energy Industries	2.08	1.92	2.00	2.16	1.34	1.29	2.06	1.95	2.16	2.21	2.14	2.14
2. Manufacturing Industries and Construction	1.27	1.13	0.90	0.88	0.44	0.43	0.63	0.60	0.65	0.77	0.67	0.71
3. Transport	0.26	0.39	0.56	0.83	1.77	1.94	1.41	1.58	1.66	1.75	1.92	2.01
4. Other Sectors	0.96	0.68	0.47	0.43	0.61	0.65	0.38	0.33	0.31	0.25	0.26	0.24
5. Other												
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels												
2. Oil and Natural Gas												
2. Industrial Processes	**3.90**	**3.25**	**3.21**	**3.64**	**3.33**	**3.60**	**3.86**	**3.22**	**3.63**	**3.59**	**3.22**	**3.13**
A. Mineral Products												
B. Chemical Industry	3.90	3.25	3.21	3.64	3.33	3.60	3.86	3.22	3.63	3.59	3.22	3.13
C. Metal Production												
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use	**0.66**	**0.69**	**0.69**	**0.69**	**1.00**	**0.60**	**0.71**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**
4. Agriculture	**26.56**	**21.04**	**18.21**	**18.95**	**20.57**	**19.26**	**17.39**	**17.14**	**16.62**	**16.84**	**16.83**	**16.73**
A. Enteric Fermentation												
B. Manure Management	2.14	1.84	1.53	1.55	1.55	1.52	1.44	1.44	1.36	1.35	1.25	1.26
C. Rice Cultivation												
D. Agricultural Soils	24.41	19.20	16.68	17.40	19.02	17.73	15.95	15.70	15.26	15.49	15.58	15.47
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Changes in Forest and Other Woody Biomass Stocks												
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.64**	**0.64**	**0.66**
A. Solid Waste Disposal on Land												
B. Waste-water Handling	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.64	0.64	0.64
C. Waste Incineration												0.02
D. Other												
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Memo Items:												
International Bunkers	**0.02**	**0.02**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.02**
Aviation	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
Marine												
Multilateral Operations												
CO_2 Emissions from Biomass												

TABLE 10 EMISSION TRENDS (HFCs. PFCs and SF_6)
(Sheet 4 of 5)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(Gg)												
Emissions of HFCs(5) - CO_2 equivalent (Gg)	**2.21**	**134.51**	**295.62**	**381.78**	**411.87**	**674.32**	**1 045.17**	**1 092.37**	**1 343.94**				
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01				
HFC-41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-43-10mee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-125	0.00	0.00	0.00	0.00	0.03	0.05	0.06	0.07	0.09				
HFC-134	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-134a	0.00	0.10	0.23	0.29	0.14	0.26	0.44	0.49	0.58				
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-143a	0.00	0.00	0.00	0.00	0.03	0.05	0.07	0.06	0.08				
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-236fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
HFC-245ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Emissions of PFCs(5) - $_2$ equivalent (Gg)	**0.35**	**4.21**	**7.00**	**9.10**	**2.70**	**9.42**	**14.49**	**17.91**	**28.62**				
CF_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
C_4F_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
$c-C_4F_8$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
C_5F_{12}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
C_6F_{14}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Emissions of SF_6(5) - quivalent (Gg)	**166.82**	**183.07**	**323.13**	**131.69**	**110.85**	**205.90**	**223.20**	**211.85**	**339.26**				
SF_6	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01				

Chemical	GWP
HFCs	
HFC-23	11700
HFC-32	650
HFC-41	150
HFC-43-10mee	1300
HFC-125	2800
HFC-134	1000
HFC-134a	1300
HFC-152a	140
HFC-143	300
HFC-143a	3800
HFC-227ea	2900
HFC-236fa	6300
HFC-245ca	560
PFCs	
CF_4	6500
C_2F_6	9200
C_3F_8	7000
C_4F_{10}	7000
$c-C_4F_8$	8700
C_5F_{12}	7500
C_6F_{14}	7400
SF_6	23900

(5) Enter information on the actual emissions. Where estimates are only available for the potential emissions. specify this in a comment to the corresponding cell. Only in this row the emissions are expressed as CO_2 equivalent emissions in order to facilitate data flow among spreadsheets.

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

Czech Republic
2003
Submission 2005

GREENHOUSE GAS EMISSIONS	1990	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)											
Net CO_2 emissions/removals	161 862	133 252	125 945	127 148	128 294	132 718	124 511	117 692	123 886	123 633	118 566	123 276
CO_2 emissions (without LUCF) (6)	163 990	139 789	130 626	131 398	132 780	137 357	128 268	121 093	127 902	127 996	123 058	127 124
CH_4	16 763	14 390	13 008	12 855	12 594	12 085	11 421	10 691	10 714	10 485	10 373	10 210
N_2O	11 266	9 227	8 275	8 754	9 211	8 811	8 390	8 111	8 175	8 291	8 151	8 157
HFCs	0	0	0	2	135	296	382	412	674	1 045	1 092	1 344
PFCs	0	0	0	0	4	7	9	3	9	14	18	29
SF_6	0	0	0	167	183	323	132	111	206	223	212	339
Total (with net CO_2 emissions/removals)	**189 891**	**156 869**	**147 229**	**148 926**	**150 421**	**154 240**	**144 844**	**137 020**	**143 665**	**143 692**	**138 436**	**143 354**
Total (without CO_2 from LUCF) (6)	**192 019**	**163 406**	**151 910**	**153 176**	**154 907**	**158 879**	**148 602**	**140 421**	**147 681**	**148 056**	**142 928**	**147 203**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)											
1. Energy	171 018	145 150	135 779	136 686	137 909	142 428	132 666	125 274	132 472	130 265	125 303	123 398
2. Industrial Processes	4 708	4 316	3 849	3 989	3 936	4 323	4 465	3 968	4 336	6 991	6 798	13 017
3. Solvent and Other Product Use	734	671	596	577	662	522	566	551	549	531	521	480
4. Agriculture	12 521	9 934	8 459	8 685	9 188	8 681	7 933	7 844	7 542	7 592	7 431	7 409
5. Land-Use Change and Forestry (7)	-2 073	-6 511	-4 640	-4 216	-4 437	-4 591	-3 710	-3 346	-3 966	-4 308	-4 435	-3 790
6. Waste	2 983	3 307	3 186	3 205	3 163	2 878	2 924	2 729	2 731	2 621	2 808	2 839
7. Other	0	0	0	0	0	0	0	0	0	0	0	0

(6) The information in these rows is requested to facilitate comparison of data. since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

(7) Net emissions.

Appendix III - Notation Keys

The Sectoral and Summary Report Tables summarize final inventory results. The notation shown in the key (see Table) should be used to show where countries believe the identified source is zero (0). Where countries have opted not to estimate (NE) a particular source of each greenhouse gas. this should be shown. Data problems may limit the possibility of separating out each source individually; in this case it is included elsewhere (IE) and this should also be included in the table with a footnote indicating where the emission source/sink has been reported. Finally. countries may report a particular category as not occurring (NO) in their country.

Table - Notification Keys

PART	Partly estimated
ALL	Full estimate of all possible sources
NE	Not estimated
IE	Estimated but included elsewhere
NO	Not occurring
NA	Not applicable
0	Source is estimated to be zero