CZECH HYDROMETEOROLOGICAL INSTITUTE

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

NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC, NIR

(REPORTED INVENTORY 2004)

NIR was compiled by the Czech GHG inventory team from institutions involved in National Inventory System, NIS:

KONEKO, CDV, CHMI, IFER, CUEC
coordinated by CHMI

The report was prepared in accordance with the UN Framework Convention on Climate Change related to national inventory submission 2006

Prague
April 2006

AUTHORS OF INDIVIDUAL CHAPTERS

Executive Summary

Dusan Vacha (CHMI)
Jan Pretel (CHMI)

Chapter 1 - Introduction and General Issues

Pavel Fott (CHMI)

Chapter 2 - Trend in Total Emissions

Dusan Vacha (CHMI)
Jan Pretel (CHMI)

Chapter 3 - Energy - (CRF sector 1)

Jan Blaha (KONEKO)
Vladimir Neuzil (KONEKO)
Jiri Dufek (CDV)

Chapter 4 - Industrial Processes (CRF sector 2)

Dusan Vacha (CHMI)
Pavel Fott (CHMI)
Vladimir Neuzil (KONEKO)

Chapter 5 - Solvent and Other Product Use (CRF sector 3)

Vladimir Neuzil (KONEKO)

Chapter 6 - Agriculture (CRF sector 4)

Zuzana Exnerova (IFER)
Pavel Fott (CHMI)

Chapter 7 - Land Use, Land-Use Change and Forestry (CRF sector 5)

Emil Cienciala (IFER)
Jan Apeltauer (IFER)

Chapter 8 - Waste (CFR sector 6)

Miroslav Havranek (CUEC)

Chapter 9 - Recalculations

Pavel Fott (CHMI)

CONTENT

EXECUTIVE SUMMARY 9

ES 1. Background Information 9

ES 2. Summary of National Emission and Removal Related Trends 9

ES 3. Overview of Source and Sink Category Emission Estimates and Trends 11

ES 4. Overview of Emission Estimates and Trends of Indirect GHGs and SO_2 11

1 INTRODUCTION AND GENERAL ISSUES 13

1.1 Background 13

1.2 Institutional Arrangement for this Inventory Submission 14

1.3 Institutional Arrangement Established by NIS 14

1.4 Process of Inventory Preparation (data collection, data processing, data storage) 15

1.4.1 Activity Data Collection 15

1.4.2 Data Processing and Storage 15

1.5 Methodologies and Data Sources 15

1.5.1 Overview 15

1.5.2 Good Practice Guidance and its Implementation in the Czech Inventory 17

1.6 QA/QC Plan 18

1.6.1 Quality control procedures (QC) 18

1.6.2 Quality assurance procedures (QA) 19

1.7 Key Source Categories 19

1.8 Uncertainty Analysis 22

2 TREND IN TOTAL EMISSIONS 25

2.1 Emission Trends of Aggregated GHG Emissions 25

2.2 Emission Trends by Gas 26

2.3 Emission Trends by Sources 28

2.4 Emission Trends of Indirect GHGs and SO_2 31

3 ENERGY - (CRF SECTOR 1) 35

3.1 Energy - Combustion processes (CRF Sector 1.A.) 35

3.1.1 Sector Characterization 35

3.1.2 Carbon Dioxide Emissions 35

3.1.2.1 Reference Approach 36

3.1.2.2 Sectoral Approach 36

3.1.3 Methane Emissions 40

3.1.4 Nitrous Oxide Emissions 41

3.1.5 Activity Data 42

3.1.6 Direct GHG Emissions - Overview 44

3.1.7 Precursor Emissions 44

3.1.8 QA/QC Procedures 45

3.1.9 Survey of Present State and Expected Improvements 45

3.2 Energy - Fugitive Emissions (Sector CRF 1.B.) 45
3.2.1 Sector Characterization 45
3.2.2 Methane Emissions from Mining and Post-mining Coal Treatment 46
3.2.3 Methane Emissions from Gas Extraction, Storage, Transit, Transport and Distribution 47
3.2.4 Methane Emissions from Petroleum Extraction, Refining and Storage 48
3.2.5 Activity Data and Emission Factors 49
3.2.6 Emission Trends 51
3.2.7 Precursor Emissions 51
3.2.8 QA/QC Procedures and Recalculations 52
3.2.8.1 Internal Quality Control 52

4 INDUSTRIAL PROCESSES (CRF SECTOR 2) 55
4.1 Sector Characterization 55
4.2 Carbon Dioxide Emissions 56
4.2.1 Mineral Products 56
4.2.2 Iron and Steel Production 59
4.2.3 Ammonia production 60
4.3 Methane and Nitrous Oxide Emissions 60
4.4 Recalculations, QA/QC and Plans for Improvement 62
4.5 Production of Halocarbons and SF_6 (CRF Sector 2.E) 64
4.6 Consumption of Halocarbons and SF_6 (CRF Sector 2.F) 64
4.6.1 Source Category Description 64
4.6.2 General Methodological Aspects 65
4.6.3 Sector-Specific Methodological Aspects 66
4.6.3.1 Refrigeration and Air Conditioning Equipment 66
4.6.3.2 Foam Blowing and Production of Sound-Proof Windows 66
4.6.3.3 Fire Extinguishers 66
4.6.3.4 Aerosols / Metered Dose Inhalers and Solvents 66
4.6.3.5 Semiconductor Manufacture 67
4.6.3.6 Electrical Equipment 67
4.6.3.7 Others 67
4.6.4 Uncertainty, Consistency, QA/QC, Recalculations and Planned Improvement 67

5 SOLVENT AND OTHER PRODUCT USE (CRF SECTOR 3) 69
5.1 Activity data and transfer of data to the CRF Reporter 70
5.2 Trends 70
5.3 QA/QC procedures and recalculations 71

6 AGRICULTURE (CRF SECTOR 4) 73
6.1 Sector Characterization 73
6.2 Methane Emissions 73
6.2.1 Enteric fermentation of cattle 74
6.2.2 Enteric fermentation of other livestock 76
6.2.3 Emissions of methane from manure management 77
6.3 Nitrous Oxide Emissions 77
6.4 Emission Trends 77
6.5 OA/QC, Recalculations and Plans for Improvement 78

7 LAND USE, LAND-USE CHANGE AND FORESTRY (CRF SECTOR 5) ... 81
7.1 Overview ... 81
7.1.1 Estimated emissions ... 81
7.1.2 Methodology for representing land-use areas ... 82
7.1.3 Methodology to estimate emissions ... 84
7.2 Forest Land (5.A.) ... 85
7.2.1 Source category description ... 85
7.2.2 Methodological aspects ... 86
7.2.3 Uncertainty and time consistency ... 89
7.2.4 QA/QC and verification ... 89
7.2.5 Recalculations ... 89
7.2.6 Source-specific planned improvements ... 90
7.3 Cropland (5.B.) ... 91
7.3.1 Source category description ... 91
7.3.2 Methodological aspects ... 91
7.3.3 Uncertainties and time series consistency ... 92
7.3.4 QA/QC and verification ... 92
7.3.5 Recalculations ... 92
7.3.6 Source-specific planned improvements ... 92
7.4 Grassland (5.C.) ... 93
7.4.1 Source category description ... 93
7.4.2 Methodological aspects ... 93
7.4.3 Uncertainties and time series consistency ... 93
7.4.4 QA/QC and verification ... 94
7.4.5 Recalculations ... 94
7.4.6 Source-specific planned improvements ... 94
7.5 Wetlands (5.D.) ... 94
7.5.1 Source category description ... 94
7.5.2 Methodological aspects ... 94
7.5.3 Uncertainties and time series consistency ... 95
7.5.4 QA/QC and verification ... 95
7.5.5 Recalculations ... 95
7.5.6 Source-specific planned improvements ... 95
7.6 Settlements (5.E.) ... 95
7.6.1 Source category description ... 95
7.6.2 Methodological aspects ... 95
7.6.3 Uncertainties and time series consistency ... 95
7.6.4 QA/QC and verification ... 95
7.6.5 Recalculations ... 95
7.6.6 Source-specific planned improvements ... 96
7.7 Other Land (5.F.) ... 96
7.7.1 Source category description ... 96
7.7.2 Methodological aspects ... 96
7.7.3 Uncertainties and time series consistency ... 96
7.7.4 QA/QC and verification ... 96
7.7.5 Recalculations ... 97

7.7.6 Source-specific planned improvements 97
7.8 Acknowledgement 97
8 WASTE (CFR SECTOR 6) 99
8.1 Sector Characterization 99
8.2 Emissions from Solid Waste Landfills 99
8.3 Emissions from Wastewater Handling 102
8.3.1 Emissions from Municipal Wastewater 102
8.3.2 Emissions from Treatment of Industrial Wastewater 104
8.3.3 Emissions of CO_2 from waste incineration 106
8.3.4 Emissions of N_2O from Municipal Wastewater 107
8.3.5 Emissions of N_2O from Municipal Waste Incineration 108
8.4 Changes in Inventory and Recalculations 108
8.5 QA/QC and Plans for Improvement of Inventory Quality 108
9 RECALCULATIONS 111
9.1 History of Czech Inventories 111
9.2 Overview of Recalculations 112
9.2.1 Previous recalculations 112
9.2.2 Recent recalculations 112
10 REFERENCES 115
ABBREVIATIONS 119

APPENDIX I – EMISSION INVENTORY 2004 121
APPENDIX II – EMISSION INVENTORY OVERVIEW FOR 1990 - 2004 137
APPENDIX III – NOTATION KEYS 149

EXECUTIVE SUMMARY

ES 1. Background Information

Czech Republic as the Party to the United Nations Framework Convention on Climate Change (UNFCCC), is required to produce and regularly update National Greenhouse Gas Inventories. To date, National Greenhouse Gas Inventories have been produced for 1990 to 2004.

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 fifth version of the National Inventory Report (NIR) submitted by the Czech Republic; it is an update of the NIR submitted in 2005. This report is based on the figures submitted to the UNFCCC in CRF 2006 submission, which contains data for 2004 and revised data for 1990 to 2003. 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.

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 2004 as included in the CRF tables Submission 2006. 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 2006 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 2006 is under the responsibility of Mr. Pavel Fott of the Czech Hydrometeorological Institute, Department of Emission and Sources, as a National GHG Inventory Expert.

ES 2. Summary of National Emission and Removal Related Trends

In 2004, 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, 7.7 % and N_2O, 5.8 %. PFCs, HFCs and SF6 contributed for 0.4 % to the overall GHG emissions in the country. The energy sector accounted for 86.3 % of the total GHG emissions followed by Industrial Processes 9.1 %, Agriculture 5.7 % and Waste 2.0 %. Total GHG emissions (without CO_2 from land-use change and forestry) amounted to 147 177 Gg $CO_{2\ eq.}$ and decreased by 25.0 % from 1990 to 2004.

Tab. 1 provides data on emissions by sectors and Tab. 2 by gas from 1990 to 2004.

Tab. 1 Summary of GHG emissions by sector 1990 - 2004 *[Gg $CO_{2\ eq}$]*

	Energy	Industrial Processes	Solvent Use	Agriculture	LUCF	Waste
1990	157 971	19 050	765	15 474	-1 730	2 944
1991	151 112	14 240	728	13 721	-9 966	3 285
1992	134 011	15 687	691	11 959	-9 658	3 268
1993	133 279	12 560	651	10 452	-8 886	3 115
1994	126 631	13 491	616	9 648	-8 294	3 146
1995	127 087	14 028	596	9 586	-7 769	3 166
1996	129 086	13 748	587	9 180	-10 800	2 766
1997	132 862	14 560	585	9 010	-5 304	2 492
1998	124 170	13 872	580	8 601	-3 466	2 858
1999	118 290	11 869	578	8 608	-4 814	2 664
2000	124 204	13 305	569	8 394	-6 828	2 694
2001	125 170	12 563	550	8 594	-7 015	2 620
2002	120 126	12 258	540	8 359	-6 106	2 808
2003	122 973	13 467	525	7 778	-5 689	2 839
2004	122 762	12 946	519	8 044	-4 804	2 839

Tab. 2 Summary of GHG emissions by gas 1990 - 2004 *[Gg $CO_{2\ eq}$]* [1]

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
1990	165 060	18 590	12 604	n.a.	n.a.	n.a.
1991	155 261	17 012	10 853			
1992	140 160	15 881	9 611			
1993	136 704	14 809	8 580			
1994	131 242	13 914	8 417			
1995	132 125	13 580	8 724	1	0	75
1996	133 506	13 470	8 260	101	4	78
1997	138 032	12 716	8 469	245	1	95
1998	129 188	12 258	8 416	317	1	64
1999	122 099	11 553	8 069	268	3	77
2000	129 017	11 531	8 258	263	9	141
2001	129 033	11 458	8 491	393	12	168
2002	124 040	11 434	8 204	391	14	67
2003	128 075	11 109	7 744	590	25	100
2004	127 297	10 895	8 318	600	17	50

Over the period 1990 - 2004 CO_2 emissions and removals decreased by 26.8 %, mainly by emissions reduction in *Energy*; although CO_2 emissions from *Transport* sector rapidly increased. CH_4 emissions decreased by 41.4 % during the same period mainly due to lower emissions from *Energy*, *Agriculture* and *Waste*; N_2O emissions decreased by 34.0 % over the same period due to emission reduction in *Agriculture* and despite increase from the *Transport* sector. Emissions of HFCs and PFCs increased more than 817-times and 140-times, respectively, whereas SF_6 emissions decreased by 34 % from the base year (1995) to 2004.

[1] CO_2 emissions incl. LUCF sector

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

In 2004, 122 762 Gg $CO_{2\ eq.}$, that are 86.3 % of national total emissions (including land-use change and forestry) arose from *Energy*; 95.7 % of these emissions arise from fuel combustion activities. The most important sub sector of *Fuel Combustion* with 47.7 % of total sectoral emissions in 2004 is *Energy Industries*, M*anufacturing Industries and Construction* responses for 22.2 % and *Transport* for 13.0 % of total sectoral emissions. From 1990 to 2004 emissions from *Energy* decreased by 22.3 %.

Industrial Processes is the third largest sector with 9.1 % of total GHG emissions (including land-use change and forestry) in 2004 (12 946 Gg $CO_{2\ eq.}$); the largest sub sector is *Metal Production*. From 1990 to 2004 emissions from *Industrial Processes* decreased by 32.0 %.

Agriculture is the third largest sector in the Czech Republic with 5.7 % of total GHG emissions (including land-use change and forestry) in 2004 (8 044 Gg $CO_{2\ eq.}$); approximately 60 % of emissions is coming from *Agricultural Soils*. From 1990 to 2004 emissions from *Agriculture* decreased by 48.0 %.

In 2004, 0.4 % of total GHG emissions (including land-use change and forestry) in the Czech Republic (519 Gg $CO_{2\ eq.}$) arose from the sector *Solvent and Other Product Use*. From 1990 - 2004 emissions from *Solvent and Other Product Use* decreased by 32.1 %.

2.0 % of the national total GHG emissions (including land-use change and forestry) in 2004 arose from *Waste.* Emissions from *Waste* decreased from 1990 to 2004 by 3.6 % to 2 839 Gg $CO_{2\ eq.}$

Land Use, Land-Use Change and Forestry is the only sectors where removals exceed emissions. Removals from this sector decrease total emissions by 3.4 % in 2004.

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 2004 are presented in Tab. 3.

Tab. 3 Indirect GHGs and SO_2 for 1990 - 2004 *[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
2004	333	600	198	227
NEC[2]	286	-	220	283

[2] NEC - National Emission Ceilings according to Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2004: for NO_X by 39 %, for CO by 52 %, for NMVOC by 55 % 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. This Decision also requires establishing a National Inventory System (NIS) pursuant to the Kyoto Protocol (Art. 5.1) from December 2005.

The *Czech Hydrometeorological Institute* (CHMI) was appointed in 1995 by the *Ministry of Environment* (ME), which is the founder and supervisor of CHMI, to be an institution responsible for compilation of GHG inventories. Thereafter CHMI is the official provider of Czech greenhouse gas emission data. The role of CHMI was improved following implementation of NIS, as CHMI was designated by ME as the single entity responsible for preparation of the official national GHG inventory.

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; *Fourth National Communication*, 2006) for the 1990 – 1995, 1990 - 1999 and 1990-2003 periods, respectively.

This report includes GHG emission inventory in the Czech Republic for 2004 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 reported. 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; *Good Practice Guidance for LULUCF*, 2003); application of this general methodology on country specific circumstances will be described in following paragraphs.

This version of NIR represents the fifth volume 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 years 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 is expected to be completed next year.

Since 1998, inventory data have been reported in *Common Reporting Format*. Moreover, data for some previous years (1990 - 1995) have also been revised and converted to this format over the last few years.

The current data submission (2006) for UNFCCC and for the European Community contains all the data sets presented previously in the form of the new official UNFCCC software called *CRF – Reporter*. Moreover, the results of some necessary recalculations mentioned in previous NIRs are presented in the 2006 submission for the first time. The team compiling the Czech GHG inventory is of the opinion that, following these recalculations, the Czech Republic is capable of submitting its *initial assigned amount* determination for the first commitment period (2008 – 2012) of the Kyoto Protocol.

1.2 Institutional Arrangement for this Inventory Submission

The *Czech Hydrometeorological Institute* (CHMI), under the supervision of the *Ministry of Environment* (ME), is responsible for preparation of the national inventory. The national inventory system (NIS), as required by the *Kyoto Protocol* (Article 5.1) and by Decision No. 280/2004/EC, which demands allocation of sectoral responsibilities to more specialized and competent co-operating institutions possessing a higher level of sectoral skill and expertise, should now be in place. However, NIS was only gradually implemented during the past year when the GHG inventory was complied. Therefore, the existing practice in compilation of the GHG inventory for the 2006 submission of results 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. CHMI also provides for collection of activity data and emission factors where necessary, especially for Industrial processes.

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 including Solvent use. The Charles University Environment Centre (CUEC) is responsible for compilation of inventories from the Waste sector.

As a result of implementing NIS, the following institutions - sectoral compilers have been co-opted for co-operation: Institute for Forest Ecosystem Research (IFER) for the LUCF and Agriculture sectors and Transport Research Centre (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 Institutional Arrangement Established by NIS

As approved by the Ministry of Environment, the established institutional arrangement for the next three years (2006-2008) is as follows:

The Czech Hydrometeorological Institute, under the supervision of the Ministry of Environment, which is the founder of CHMI and is its superior institution, is designated as the single national entity with overall responsibility for the national greenhouse gas inventory. The main tasks of CHMI consist in inventory management, general and cross-cutting issues, QA/QC, communication with the relevant UN FCCC and EU bodies, etc. Sectoral inventories are prepared by sectoral compilers (sectoral experts) from sector-specialist institutions, which are coordinated and controlled by CHMI. The responsibilities for GHG inventory compilation from individual sectors are allocated in the following way:

- KONEKO MARKETING Ltd. (KONEKO), Prague, is responsible for compilation of the inventory in sector 1, Energy, for stationary sources including fugitive emissions
- Transport Research Centre (CDV), Brno, is responsible for compilation of the inventory in sector 1, Energy, for mobile sources
- Czech Hydrometeorological Institute (CHMI), Prague, is responsible for compilation of the inventory in sectors 2 and 3, Industrial Processes and Product (Solvent) Use
- Institute of Forest Ecosystem Research (IFER), Jilové u Prahy, is responsible for compilation of the inventory in sectors 4 and 5, Agriculture and Land Use, Land Use Change and Forestry
- Charles University Environment Centre (CUEC), Prague, is responsible for compilation of the inventory in sector 6, Waste.

Official submission of the national GHG Inventory is prepared by CHMI and approved by the Ministry of Environment. Moreover, the Ministry of Environment secures contacts with other relevant governmental bodies, such as the Czech Statistical Office, the Ministry of Industry and Trade and the Ministry of Agriculture.

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

1.4.1 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 *1.A.* - 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).

1.4.2 Data Processing and Storage

Data Sector 1.A. - 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 LULUCF, a specific spreadsheet system is used, respecting the national methodology. 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.

1.5 Methodologies and Data Sources

1.5.1 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 sulphur 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 are preferred. However, sufficiently reliable energy statistics are required for good quality inventories.

Another source, or rather sink of CO_2, is related to Land Use, 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 catalysts (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.

1.5.2 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) and *Good Practice Guidance for* LULUCF, 2003. 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*.

In GHG emission inventories for 2000 - 2004 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 should also be pointed out that *Good Practice Guidance for LULUCF* has only recently been prepared and was approved by COP in December 2003; consequently this methodology was not employed in former submissions, which were based on the former methodical instructions given in the *Revised 1996 IPCC Guidelines*, 1997. The relevant estimates of emissions and removals from the LULUCF sector based on the newer methodology are presented for the first time in the 2006 submission.

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. Originally, these emissions were treated under sub-category 1.A.2. (to be compatible with the *Reference Approach*). Starting with 2001, these emissions were classified under 2.C.1. (Metal production, Production of iron and steel). Emissions from ammonia production have only recently been re-classified (from 1.A.2. to 2.B.1.) in a similar way. Corresponding recalculations and re-categorizations of the whole time series since the reference year of 1990 are presented for the first time in this submission. In accordance with *Good Practice Guidance,* the relevant recalculations for Agriculture, indicated in previous NIRs, have recently been completed and finally are given in this submission.

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.

1.6 QA/QC Plan

Preparation of a QA/QC plan is one of the important obligations following from NIS. The plan is now being prepared but has not yet been completed. Elaboration of the QA/QC plan reflects the institutional arrangements: each institution should elaborate its own system of QA/QC procedures, including designation of a responsible QA/QC expert for each sector. Sectoral QA/QC plans are integral parts of the overall NIS QA/QC plan, which is developed by the NIS manager.

1.6.1 Quality control procedures (QC)

QC is designed to provide routine technical checks to measure and control the quality of the inventory, to ensure consistency, integrity, correctness, and completeness of the data and to identify and address errors and omissions. Its scope covers a wide range of inventory processes, from data acquisition and handling and application of the approved procedures and methods to calculation of estimates and documentation. These procedures are performed according to the *IPCC Good Practice Guidance*, 2000 (GPG)

Parts of these procedures are carried out by sectoral compilers (SC) and parts by the NIS manager. SC concentrate more on activity data and the sector-specific methods employed; the NIS manager mostly checks appropriate use of methodology, carries out a trend analysis and compares data from other possible sources. Both sectoral and overall inventory compilers employ the new CRF Reporter's automatic control. When a sectoral inventory is forwarded to CHMI, this step is accompanied by a detailed check by the NIS manager. These all procedures correspond mainly to the Tier 1 QC approach in accordance with GPG.

The Tier 2 approach has so far been used only in some special cases. It is e.g. partly used in the transport sub-sector, where activity data based on energy statistics (provided by experts from the KONECO) are combined with activity data based on transport statistics (provided by experts from CDV). Appropriate use of EFs is discussed in a similar way.

1.6.2 Quality assurance procedures (QA)

QA generally consists of independent third-party review activities to ensure that the inventory represents the best possible estimates of emissions and removals and to support the effectiveness of the QC program (GPG).

A thorough review of the draft GHG estimates is regularly performed in December by experts from the Slovak Hydrometeorological Institute, responsible for the Slovak GHG inventory preparation. In this way, methods used in the Czech Republic are compared with those employed in Slovakia. The draft inventory may also be checked or reviewed by the Ministry of Environment as part of the approval process. These procedures are also recorded and archived.

The results of this review, together with findings of the review process performed by an international review team organized by UN FCCC, are utilized in the process of inventory planning for the coming years. Relevant findings are analysed by the NIS manager in co-operation with sectoral compilers to eliminate possible omissions and imperfections.

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

1.7 Key Source Categories

The *Good Practice Guidance* provides two tiers of determining these *key sources (key categories)*. *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 2004, where trend analysis (Tab. 1.2) led to inclusion of N_2O from road transport and using of F-gases. These values increased, in contrast to the overall trend. Analogous key source analyses for years 1999, 2000, 2001 and 2003 are presented in former NIRs. 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 2004 (*Tier 1 - Level assessment*)

Sources / categories of sources	Gas	Emissions *[Gg $CO_{2\ eq.}$]*	Share *[%]*	Cumulative *[%]*
Energy: Stationary Combustion - Solid (CO2)	**CO2**	73 464	49.8	49.8
Energy: Stationary Combustion - Gas (CO2)	**CO2**	18 550	12.6	62.4
Energy: Mobile Combustion - Road	**CO2**	14 539	9.9	72.2
Energy: Stationary Combustion - Liquid (CO2)	**CO2**	7 460	5.1	77.3
Industrial: Iron and steel (CO2)	**CO2**	6 726	4.6	81.8
Energy: Fugitive Emissions - Coal Mining (CH4)	**CH4**	4 662	3.2	85.0
Industrial: Mineral Products - decarbonizing (CO2)	**CO2**	3 625	2.5	87.4
Agriculture: Direct Emissions N2O from Soils	**N2O**	2 957	2.0	89.4
Agriculture: Enteric Fermentation (CH4)	**CH4**	2 390	1.6	91.1
Agriculture: Indirect Emissions N2O from Agriculture	**N2O**	1 810	1.2	92.3
Waste: Landfiles (CH4)	**CH4**	1 796	1.2	93.5
Energy: Mobile Combustion - Off Road incl. Waters	**CO2**	1 522	1.0	94.5
Industrial: Nitric Acid + other Chem. Ind. (N2O)	**N2O**	1 155	0.8	95.3
Energy: Stationary Combustion	N2O	941	0.6	96.0
Energy: Mobile Combustion - Aircraft, incl. Bunkers	CO2	889	0.6	96.6
Industrial: Ammonia (CO2)	CO2	699	0.5	97.0
Energy: Mobile Combustion - Road	N2O	640	0.4	97.5
Waste + Solvent Use: Waste Incineration + SU	CO2	631	0.4	97.9
Industial: Usage of New Gases	F-gases	600	0.4	98.3
Energy: Fugitive Emissions - Oil and Gas (CH4)	CH4	565	0.4	98.7
Agriculture: Manure Management (CH4)	CH4	516	0.3	99.0
Waste: Wastewater Handling	CH4	513	0.3	99.4
Agriculture: Manure Management (N2O)	N2O	371	0.3	99.6
Energy: Stationary Combustion	CH4	278	0.2	99.8
Waste: Wastewater Handling	N2O	202	0.1	100.0
Energy: Mobile Combustion - Road	CH4	34	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	N2O	19	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	CH4	6	0.0	100.0
Energy: Mobile Combustion - Aircraft, incl. Bunkers	N2O	5	0.0	100.0
Energy: Mobile Combustion - Aircraft, incl. Bunkers	CH4	3	0.0	100.0

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

Sources / categories of sources	Gas	Emiss. 90 [Gg $CO_{2\,eq.}$]	Emiss. 04 [Gg $CO_{2\,eq.}$]	Level [%]	Trend [%]	Part [%]	Cum. [%]
Energy: Stationary Combustion - Solid (CO2)	**CO2**	111 909	73 464	49.8	9.5	24.4	24.4
Energy: Mobile Combustion - Road	**CO2**	5 995	14 539	9.9	9.1	23.2	47.6
Energy: Stationary Combustion - Gas (CO2)	**CO2**	12 933	18 550	12.6	8.0	20.4	68.0
Energy: Stationary Combustion - Liquid (CO2)	**CO2**	13 518	7 460	5.1	2.4	6.2	74.2
Industrial: Iron and steel (CO2)	**CO2**	12 533	6 726	4.6	2.4	6.2	80.4
Agriculture: Enteric Fermentation (CH4)	**CH4**	4 869	2 390	1.6	1.1	2.9	83.3
Energy: Fugitive Emissions - Coal Mining (CH4)	**CH4**	7 600	4 662	3.2	0.9	2.4	85.7
Agriculture: Direct Emissions N2O from Soils	**N2O**	5 285	2 957	2.0	0.9	2.3	88.0
Agriculture: Indirect Emiss. N2O from Agriculture	**N2O**	3 620	1 810	1.2	0.8	2.1	90.1
Energy: Stationary Combustion	**CH4**	1 216	278	0.2	0.6	1.5	91.6
Energy: Mobile Combustion - Road	**N2O**	71	640	0.4	0.5	1.4	93.0
Industial: Usage of New Gases	**F-gases**	76	600	0.4	0.5	1.3	94.2
Industrial: Mineral Products - decarbonizing (CO2)	**CO2**	4 362	3 625	2.5	0.3	0.8	95.0
Waste: Landfiles (CH4)	CH4	1 957	1 796	1.2	0.3	0.8	95.8
Energy: Mobile Combustion - Aircraft, incl. Bunkers	CO2	766	889	0.6	0.3	0.7	96.5
Industrial: Nitric Acid + oth. Chem. Ind. (N2O)	N2O	1 210	1 155	0.8	0.2	0.6	97.1
Agriculture: Manure Management (CH4)	CH4	1 009	516	0.3	0.2	0.6	97.6
Waste + Solvent Use: Waste Incineration + SU	CO2	550	631	0.4	0.2	0.5	98.1
Energy: Mobile Combustion - Off Road incl. Waters	CO2	2 304	1 522	1.0	0.2	0.5	98.6
Agriculture: Manure Management (N2O)	N2O	690	371	0.3	0.1	0.3	99.0
Energy: Fugitive Emissions - Oil and Gas (CH4)	CH4	896	565	0.4	0.1	0.2	99.2
Waste: Wastewater Handling	CH4	825	513	0.3	0.1	0.2	99.4
Industrial: Ammonia (CO2)	CO2	807	699	0.5	0.1	0.2	99.7
Waste: Wastewater Handling	N2O	162	202	0.1	0.1	0.2	99.8
Energy: Stationary Combustion	N2O	1 319	941	0.6	0.0	0.1	100.0
Energy: Mobile Combustion - Road	CH4	25	34	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	N2O	29	19	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Aircraft, incl. Bunkers	CH4	4	3	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Off Road incl. Waters	CH4	8	6	0.0	0.0	0.0	100.0
Energy: Mobile Combustion - Aircraft, incl. Bunkers	N2O	7	5	0.0	0.0	0.0	100.0

1.8 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 3 % 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. Uncertainty analysis results for 2004 are very similar to results for 2003 and 2001, see (Fott *at al*, 2004)

Tab. 1.3 Tier 1 Uncertainty analysis in levels and trends for 2004

Input DATA						Uncertainty in Level		Un. in trend
IPCC Source Category	Gas	Base year emissions (1990)	Year emissions (2004)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year	Uncertainty introduced into the trend in total national emissions
		[Gg $CO_{2\,eq}$]		*[%]*	*[%]*	*[%]*	*[%]*	*[%]*
1.A. Energy: Stac. Comb. - Solid, KEY(L,T)	CO2	111 909	73 464	4.0	4.0	5.66	2.83	2.13
1.A. Energy: Stac. Comb. - Liquid, KEY(L,T)	CO2	13 518	7 460	4.0	3.0	5.00	0.25	0.22
1.A. Energy: Stac. Comb. - Gas, KEY(L,T)	CO2	12 933	18 550	4.0	3.0	5.00	0.63	0.55
1.A. Energy: Mob. Comb. - Road, KEY(L,T)	CO2	5 995	14 539	4.0	3.0	5.00	0.50	0.45
1.A. Energy: Mob. Comb. - Off Road	CO2	2 304	1 522	4.0	3.0	5.00	0.05	0.04
2 Industrial: Mineral Products, KEY(L,T)	CO2	4 362	3 625	5.0	20.0	20.62	0.51	0.14
2 Industrial: Iron and Steel, KEY(L,T)	CO2	12 533	6 726	7.0	4.0	8.06	0.37	0.34
2 Industrial: Ammonia	CO2	807	699	4.0	3.0	5.00	0.02	0.02
3,6 Solvent Use + Waste incineration	CO2	550	631	20.0	5.0	20.62	0.09	0.09
1.A. Energy: Stacionary Combustion	CH4	1 216	278	4.0	50.0	50.16	0.10	0.16
1.A. Energy: Mob. Comb. - Road	CH4	25	34	4.0	50.0	50.16	0.01	0.00
1.B. Energy: Fugitive - Coal Mining, KEY (L,T)	CH4	7 600	4 662	4.0	40.0	40.20	1.28	0.25
1.B. Energy: Fugitive - Oil and Gas	CH4	896	565	4.0	30.0	30.27	0.12	0.02
4 Agriculture: Enteric Ferm., KEY(L,T)	CH4	4 869	2 390	7.0	30.0	30.81	0.50	0.23
4 Agriculture: Manure Man.	CH4	1 009	516	7.0	60.0	60.41	0.21	0.08
6 Waste: Landfiles, KEY(L)	CH4	1 957	1 796	25.0	40.0	47.17	0.58	0.33
6 Waste: Wastewater Handling	CH4	825	513	50.0	50.0	70.71	0.25	0.19
1.A. Energy: Stacionary Combustion	N2O	1 319	941	4.0	80.0	80.10	0.51	0.03
1.A. Energy: Mob. Comb. - Road, KEY(T)	N2O	71	640	4.0	80.0	80.10	0.35	0.24
2 Industrial: Nitric Acid, etc., KEY(L)	N2O	1 210	1 155	10.0	25.0	26.93	0.21	0.09
4 Agriculture: Direct N2O from Soils, KEY(L,T)	N2O	5 285	2 957	15.0	250.0	250.45	5.05	1.32
4 Agriculture: Indirect N2O from Agriculture, KEY (L, T)	N2O	3 620	1 810	15.0	250.0	250.45	3.09	1.17
4 Agriculture: Manure Man.	N2O	690	371	7.0	250.0	250.10	0.63	0.19
6 Waste: Wastewater Handling	N2O	162	202	20.0	50.0	53.85	0.07	0.04
2 Usage of New Gases, KEY (T)	F-gases	76	600	20.0	20.0	28.28	0.12	0.10
	Total	**195 742**	**146 646**				**6.89**	**2.96**
							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 2004. 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 - 2004 excl. bunkers *[Gg $CO_{2\ eq}$]*

	$CO_{2\ total}$ [3]	$CO_{2\ LUCF}$ [4]	CH_4	N_2O	HFCs	PFCs	SF_6	Total emissions	
								incl. LUCF	excl. LUCF
1990	165 060	163 281	18 590	12 604	n.a.	n.a.	n.a.	194 474	196 253
1991	155 261	145 254	17 012	10 853				173 119	183 126
1992	140 160	130 466	15 881	9 611				155 958	165 653
1993	136 704	127 781	14 809	8 580				151 170	160 093
1994	131 242	122 908	13 914	8 417				145 239	153 573
1995	132 125	124 314	13 580	8 724	1	0	75	146 694	154 505
1996	133 506	123 012	13 470	8 260	101	4	78	144 924	155 418
1997	138 032	133 035	12 716	8 469	245	1	95	154 562	159 559
1998	129 188	125 560	12 258	8 416	317	1	64	146 615	150 243
1999	122 099	117 227	11 553	8 069	268	3	77	137 195	142 068
2000	129 017	122 136	11 531	8 258	263	9	141	142 338	149 218
2001	129 033	121 960	11 458	8 491	393	12	168	142 483	149 556
2002	124 040	117 875	11 434	8 204	391	14	67	137 984	144 149
2003	128 075	122 326	11 109	7 744	590	25	100	141 894	147 644
2004	127 297	122 427	10 895	8 318	600	17	50	142 306	147 177
% [5]	-22.9 %	-25,0 %	-41.4 %	-34.0 %	817 - times	141 - timesx	-34.1 %	-26,8 %	-25.0 %

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

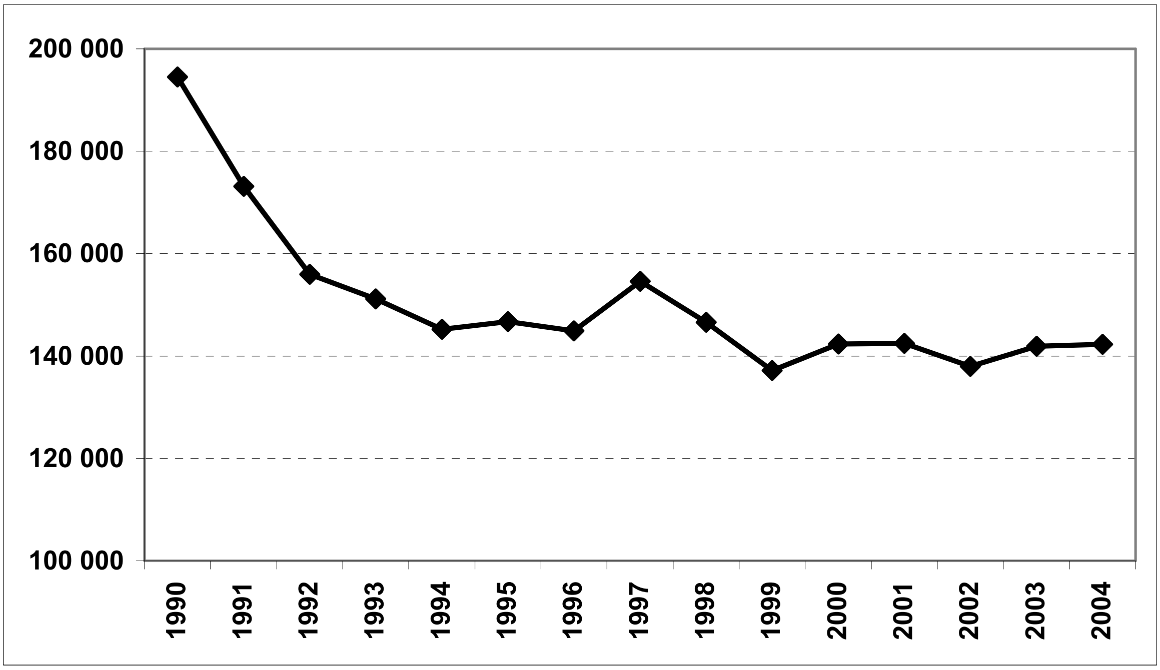
GHG emissions in have been fluctuating since 1993; nevertheless the overall trend in the period of 1990 to 2002 has been decreasing (see Fig. 2.1) by 29.0 %. From 2002 to 2004 the total GHG emissions (incl. LUCF) increased by 3.1 %.

[3] CO_2 emissions excl. LUCF sector

[4] CO_2 emissions from LUCF sector

[5] relative to base year.

Fig. 2.1 Total GHG emissions (incl. LUCF) for the period from 1990 - 2004 *[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 (25.3 %), followed by some fluctuations in the following years, but the overall trends has been slightly decreasing (2.0 %) between 1994 and 2004. In the period from 1994 to 2004 emissions fluctuated with maximum in 1997, 2000 – 2001, 2004 and minimum in 1995, 1999 (the lowest emissions since 1990) and 2002. As mentioned above, from 2003 to 2004 emissions increased by 0.3 %, resulting in total emissions of 142 306 Gg $CO_{2\ eq.}$ in 2004 (incl. LUCF). The increas was caused mainly by N_2O emission increase by 7.4 % and HFCs increase 1.7 % and CH_4 and PFCs and SF_6 reduction by 1.9 % and 29 % and 50 %, resp. The total GHG emissions in 2004 were 26.9 % below the base year level.

2.2 Emission Trends by Gas

Tab. 2.2 presents the GHG emissions of the base year and 2004 and their share in total.

Tab. 2.2 GHG emissions by gas in the base year and in 2004

	Base year	2004	Base year	2004
	[Gg $CO_{2\ eq}$]		[%]	
$CO_{2\ emissions}$	165 060	127 297	84.8	89.5
$CO_{2\ removals}$	-1 779	-4 871	-0.9	-3.4
$CO_{2\ Total}$	163 281	122 427	83.9	86.0
CH_4	18 590	10 895	9.6	7.7
N_2O	12 604	8 318	6.5	5.8
F-gases	76	667	0.04	0.5
Total (incl. LUCF)	194 550	142 306	100.0	100.0

The major greenhouse gas in the Czech Republic is CO_2, which represents 89.5 % of total GHG emissions in 2004, compared to 84.8 % in the base year. It is followed by CH_4 (7.7 % in 2004, 9.6 % in the base year), N_2O (5.8 % in 2004, 6.5 % in the base year) and F-gases (0.5 % in 2004, 0.04 % 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 - 2004 in index form (base year = 100 %)

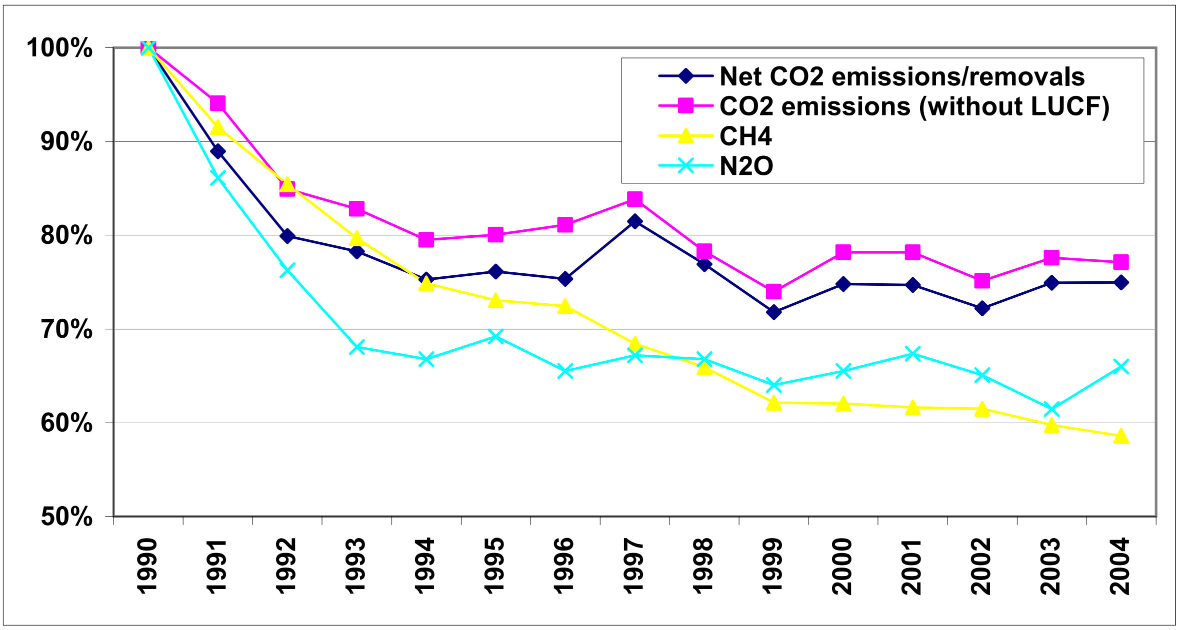
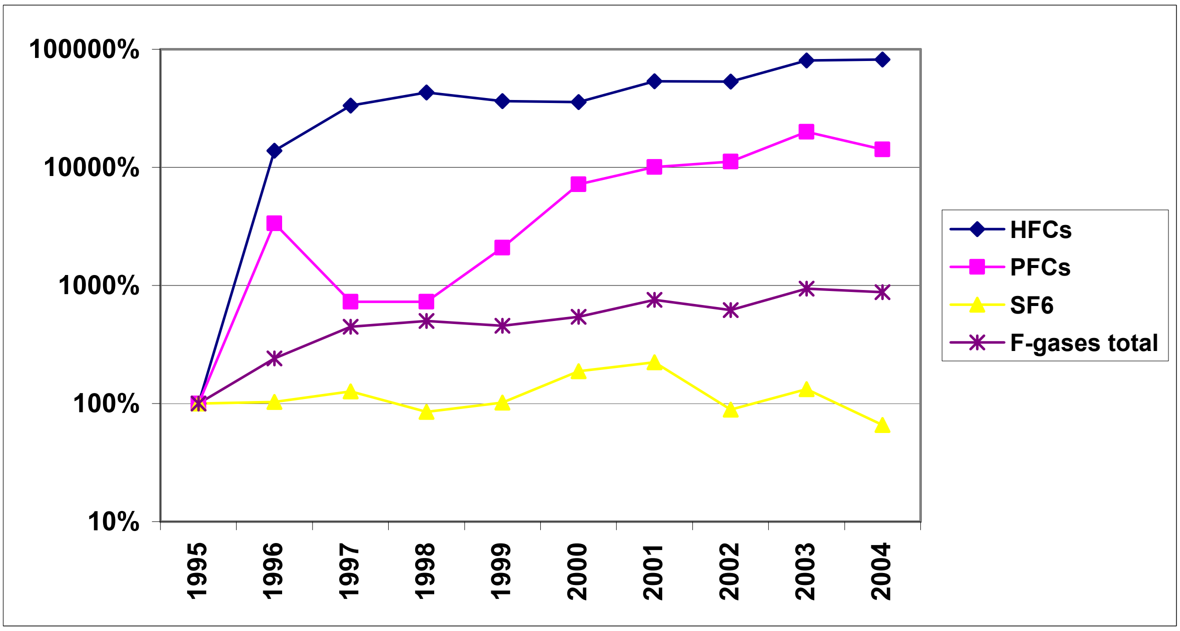


Fig. 2.3 Trend in HFCs, PFCs and SF_6 emissions 1995 - 2004 in index form (base year = 100 %)



CO_2

CO_2 emissions have been strongly decreasing in the beginning of 90's, followed by small inter-annual fluctuations. Decrease in CO_2 emissions (excl. LUCF) from 2003 to 2004 by 0.6 % contributed to a total decrease of 22.9 % from 1990 to 2004 (25.0 % decrease incl. LUCF). Quoting in absolute figures, CO_2 emissions decreased from 163 281 to 122 427 Gg $CO_{2\ eq.}$ (see Tab. 2.2) in the period from

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

1990 to 2004, 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. CO_2 emissions increased remarkably between 1990 and 2004 from the *Transport* sector from 7 342 to 15 229 Gg $CO_{2\ eq.}$.

CH_4

CH_4 emissions decreased steadily during the period from 1990 to 2004, from 18 590 to 10 895 Gg $CO_{2\ eq.}$ (see Tab. 2.2). In 2004 CH_4 emissions were 41.4 % 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 33.2 % over this period and than fluctuated with maximum value in 1997. N_2O emissions decreased between 1990 and 2004 from 12 604 to 8 318 Gg $CO_{2\ eq.}$ In 2004 N_2O emissions were 34.0 % 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 actual emissions increased remarkably between 1995 and 2004 from 0.7 to 600 Gg $CO_{2\ eq.}$ In 2004, HFCs emissions are 817 times higher than in the base year 1995.

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

PFCs

PFCs actual emissions show very similar trend as HFCs emissions. They increased remarkably between 1995 and 2004 from 0.12 to 17 Gg $CO_{2\ eq.}$ In 2004, PFCs emissions are more than 140 times higher than in the base year 1995.

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

SF_6

SF_6 actual emissions in 1995 amounted for 75 Gg $CO_{2\ eq.}$ Between 1995 and 2004 they inter annually fluctuated with maximum of 168 Gg $CO_{2\ eq.}$ in 2001 and minimum of 50 Gg $CO_{2\ eq.}$ in 2004. They were by 34.1 % below 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. 2.3 presents a summary of GHG emissions by sectors for the period from 1990 to 2004:

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

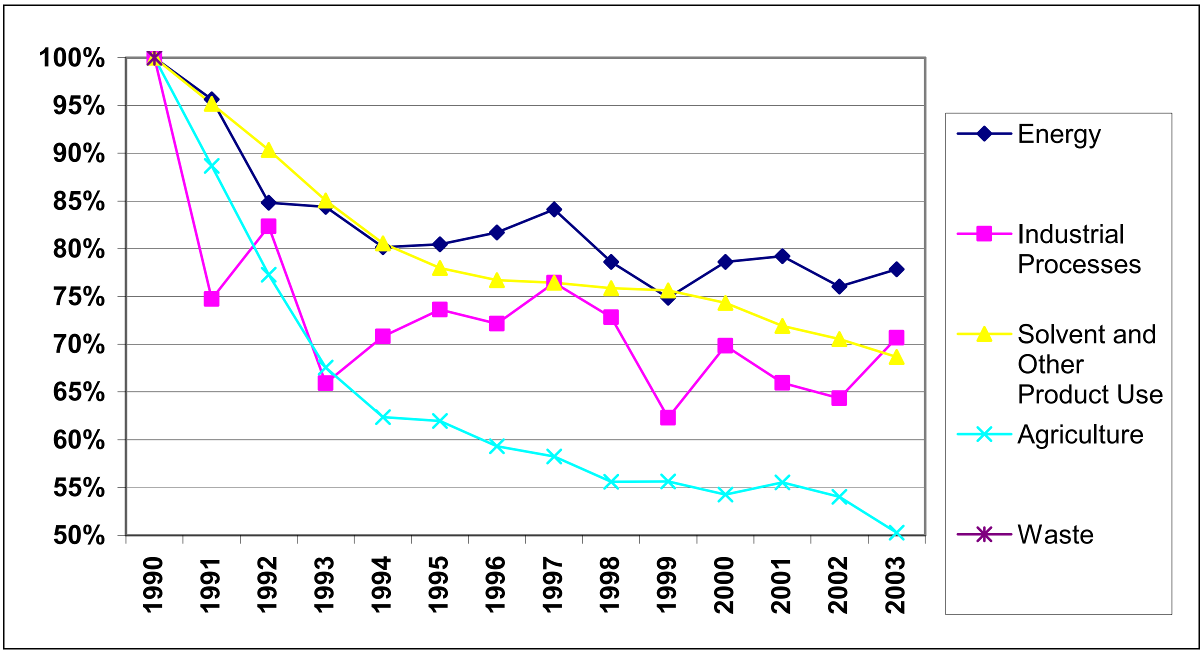
Tab. 2.3 Summary of GHG emissions by sector 1990-2003 *[Gg $CO_{2\ eq}$]*

	Energy	Industrial Processes	Solvent Use	Agriculture	LUCF	Waste
1990	157 971	19 050	765	15 474	-1 730	2 944
1991	151 112	14 240	728	13 721	-9 966	3 285
1992	134 011	15 687	691	11 959	-9 658	3 268
1993	133 279	12 560	651	10 452	-8 886	3 115
1994	126 631	13 491	616	9 648	-8 294	3 146
1995	127 087	14 028	596	9 586	-7 769	3 166
1996	129 086	13 748	587	9 180	-10 800	2 766
1997	132 862	14 560	585	9 010	-5 304	2 492
1998	124 170	13 872	580	8 601	-3 466	2 858
1999	118 290	11 869	578	8 608	-4 814	2 664
2000	124 204	13 305	569	8 394	-6 828	2 694
2001	125 170	12 563	550	8 594	-7 015	2 620
2002	120 126	12 258	540	8 359	-6 106	2 808
2003	122 973	13 467	525	7 778	-5 689	2 839
2004	122 762	12 946	519	8 044	-4 804	2 839

The dominant sector is the *Energy* sector, which caused for 86.3 % of total GHG emissions in 2004 (81.2 % in 1990), followed by the sectors *Industrial Processes* and *Agriculture*, which caused for 9.1 % and 5.7 % of total GHG emissions in 2004, resp. (9.8 % and 8.0 % in 1990, resp.) *Waste* sector covered 2.0 %, *Solvent and Other Product Use* 0.4 and *LUCF* - 3.4 % in 2004.

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 - 2004 by sectors in index form (base year = 100)



Tab. 2.4 GHG emissions by sectors in the base year and in 2004

	Base year	2004	Base year	2004
	[Gg $CO_{2\ eq}$]		*[%]*	
Energy	157 971	122 762	81.2	86.3
Industry	19 126	12 946	9.8	9.1
Solvent	765	519	0.4	0.4
Agriculture	15 474	8 044	8.0	5.7
LUCF	-1 730	-4 804	-0.9	-3.4
Waste	2 944	2 839	1.5	2.0
Total	194 550	142 306	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 2004. In the period 1994 – 2004 emissions varied from around 125 000 Gg $CO_{2\ eq.}$; nevertheless the overall slightly declining trend could be observed between 1994 and 2004 (total decrease between 1990 and 2004 is 22.3 %).

95.7 % 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 48.0 % of all CH_4 emissions in 2004. 50.9 % of all CH_4 emissions in 2004 originated from *Energy* sector.

CO_2 emission from fossil fuel combustion is the main source of emissions. The most important source in 2004 was the *Energy* sector with a share of 78.6 % in national total emissions (excl. LUCF) or 81.2 % 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 2004.

Industrial Processes (IPCC Category 2)

GHG emissions from the *Industrial Processes* sector fluctuated during the period 1990 to 2004. Between 1990 and 2004 emissnons from this sector decreased by 32.0 %. In 2004 emissions amounted for 12 946 Gg $CO_{2\ eq.}$.

The main sources in the *Industrial Processes* sector are *Metal Production* (52.4 %), *Mineral Products* (28.0 %), *Chemical Industry* (nitric acid and ammonia production) 14.4 %) and *Consumption of Halocarbons and SF_6* (5.2 %) of the sectoral emissions in 2004.

The most important GHG of the *Industrial Processes* sector was CO_2 with 85.3 % of total emissions, followed by N_2O (8.9 %), HFCs (4.6 %), CH_4 (0.6 %), SF_6 (0.4 %) and PFCs (0.2 %).

Solvent and Other Product Use (IPCC Category 3)

In 2004, 0.4 % of total GHG emissions (519.3 Gg $CO_{2\ eq.}$) arose from the *Solvent and Other Product Use* sector. Emissions generally decreased in the period from 1990 to 2004 (in 1990 to 1994 emissions decreased by 19.5 %). In 2004 GHG emissions from *Solvent and Other Product Use* were 32.1 % below the base year level. 58.7 % of these emissions were CO_2, N_2O emissions contributed by 41.3 %.

Agriculture (IPCC Category 4)

GHG emissions from the sector *Agriculture* decreased near over the all period from 1990 to 2004; in 2004 emissions were by 48.0 % below the base year level.

They amounted for 8 044 Gg $CO_{2\ eq.}$ in 2004, which corresponds to the 5.7 % of national total. The most important sub sector agricultural soils (N_2O emissions) contributed by 59.3 % to sectoral total in 2004, followed by the enteric fermentation (CH_4 emissions, 29.7 %) and manure management (CH_4 and N_2O emissions, 6.4 % and 4.6 % resp.).

Agriculture is the largest source for N_2O and second largest source for CH_4 emissions: 61.8 % of all N_2O emissions and 26.7 % of all CH_4 emissions in 2004 originated from this sector. N_2O emissions amounted for 5 138.3 Gg $CO_{2\ eq.}$, which corresponds to 63.9 % of sectoral emissions, CH_4 contributed by 36.1 % (2 905.8 Gg $CO_{2\ eq.}$) in 2004.

Land-Use Change and Forestry (IPCC Category 5)

GHG removals from the *Land-Use Change and Forestry* sector vary through the whole time series with minimum of 1 730 Gg $CO_{2\ eq.}$ in 1990 and maximum 10 800 $CO_{2\ eq.}$ in 1996. In 2004 removals were almost 3 times higher than in the base year.

Removals amounted to 4 804 Gg $CO_{2\ eq.}$ in 2004, which corresponds to - 3.4 % to national total emissions and removals. Emissions and removals are calculated from the all categories and according to GPG for LULUCF; IPCC 2003.

LUCF category is the largest sink for CO_2. CO_2 removals from this sector amounted to 4 870.7 Gg, CH_4 emissions amounted for 60.2 Gg $CO_{2\ eq.}$, N_2O to 6.1 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 1991 followed by steady decrease by 2001. In 2004 emissions amounted for 2 839 Gg $CO_{2\ eq.}$, which is 3.6 % 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 2004.

The main source is solid waste disposal on land, which caused for 63.3 % of sectoral emissions in 2004, followed by wastewater handling (25.1 %) and waste incineration (11.7 %).

81.3 % of all emissions from *Waste* sector are CH_4 emissions; CO_2 contributes by 11.5 % and N_2O by 7.2 %.

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. 2.5 presents a summary of emission estimates for indirect GHGs and SO_2 for the period from 1990 to 2004. 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. 2.5 Emissions of indirect GHGs and SO_2 1990 - 2004 *[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
2004	333	600	198	227
NEC[2]	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 2004 (NMVOCs by 55.1 %, CO by 52.3 % and NO_X by 38.8 %). SO_2 emissions decreased by 87.9 % compared to 1990 level.

NO_X

NO_X emissions decreased from 544 to 333 Gg during the period from 1990 to 2004. In 2004 NO_X emissions were 38.8 % 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 600 Gg during the period from 1990 to 2004. In 2004 CO emissions were 52.3 % below the 1990 level. In 2004, more than 90 % 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* (approximately 5 %).

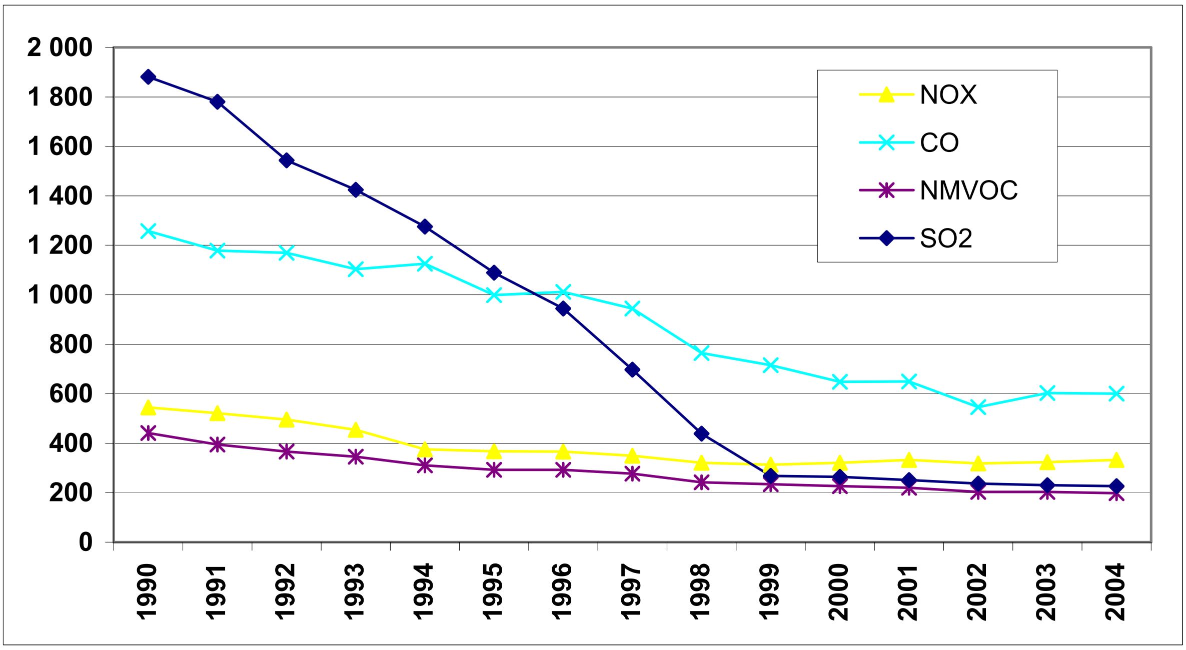
NMVOC

NMVOC emissions decreased from 441 to 198 during the period from 1990 to 2004. In 2004 VOC emissions were 55.1 % 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 227 Gg during the period from 1990 to 2004. In 2004 SO_2 emissions were 87.9 % below the 1990 level. In 2004, 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 - 2004



3 Energy - (CRF Sector 1)

3.1 Energy - Combustion processes (CRF Sector 1.A.)

3.1.1 Sector Characterization

Combustion processes included in category 1.A. 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* (level assesment) considered correspond to the combustion of fossil fuels in category 1.A. and, of these, the first four most important contribute approx. 78 % 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 manufacturing industry (1.A.2.) for period 1990 – 2002 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.

All inventory data for 1990-2004 were converted to the form of the new official UNFCCC software called *CRF – Reporter.* The only exceptions consist in the activity data for 1998 and 1997, for which activity data from sector 1.A. are not yet available in the CRF structure; however, these data are available in the form of primary calculation sheets. The activity data for these years will be converted to the CRF Reporter during 2006 and will be submitted as part of the 2007 submission.

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 crude oil, natural gas (of crude oil 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, crude oil, petroleum products, 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 products (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, 2005)

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:

1.A.1 - Energy & Transformation Activities

a. - Public electricity and heat production

b. - Petroleum refining

c. - Manufacture of solid fuels and other energy industries

1.A.2 - Manufacturing industries and construction (including industrial electricity and heat production)

a. - Iron and steel

b. - Non-ferrous metals

c. - Chemicals

d. - Pulp, paper and print

e. - Food processing, beverages and tobacco

f. - Other (Non metallic minerals, Transport equipment, Machinery, Mining and quarrying, Wood and wood products, Construction, Textile and leather, Non-specified)

1.A.3 - Transport

a. - Civil aviation

b. - Road transportation

c. - Railway

d. - Navigation

e. - Gas and petroleum pipelines transportation

1.A.4 - Other sectors

a. - Commercial / Institutional

b. - Residential

c. – Agriculture/Forestry/Fisheries

1.A.5 - Other

a. Stationary

Other non-specified

b. Mobile

Agriculture / Forestry / Fishing

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.

The CO_2 emissions from masout (residual fuel oil) used for ammonia production are reported under 2.B.1. and emissions from the iron and steel industry are reported under 2.C.1. (Industrial processes) in accordance with the *Good Practice Guidance*.

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, CO_2 from masout used for ammonia production was reported in 1.A.2. for the whole time series. Since 2003, a rearrangement has been performed and this source has been included in Sector 2 - Industry (2.B.1.). Now this rearrangement, which respects the IPCC Good Practice (*Good Practice Guidance*, 2000) was finally completed for the whole data series since 1990.

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 1.A.2., 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 2.C.1. (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 2.C.1.. At the same time, CO_2 emissions from non-energy use of fuels (masout) used for ammonia production, have been transferred to 2.B.1.. Recalculation for the whole time series was performed this year.

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 masout used for ammonia production are covered under 2.B.1. and emissions from consumption of coke in blast furnace are covered under 2.C.1., it is necessary to add the CO_2 contribution from 2.B.1. and 2.C.1. to the emissions from 1.A. 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 – 2004

	Reference approach *[Gg CO_2]*	Sectoral approach 1.A. *[Gg CO_2]*	Ammonia 2.B.1. and pig iron 2.C.1. production *[Gg CO_2]*	Total 1.A. + 2.B.1. + 2.C.1. *[Gg CO_2]*	Deviation *[%]*
1990	162 922	146 808	13 339	160 147	1,70
1991	151 493	141 087	9 563	150 651	0,56
1992	138 836	124 730	11 036	135 766	2.21
1993	133 080	124 226	8 444	132 670	0.31
1994	126 258	118 083	9 072	127 155	0.71
1995	130 292	118 668	9 402	128 070	1.71
1996	.	120 704	8 812	129 516	.
1997	.	124 639	9 286	133 925	.
1998	122 733	116 246	8 311	124 557	1.49
1999	115 207	110 932	6 639	117 571	2.05
2000	122 116	116 607	7 823	124 429	1.89
2001	124 730	117 538	7 232	124 770	0.03
2002	120 956	112 617	7 423	120 040	0.76
2003	125 718	115 698	8 280	123 978	1.38
2004	125 671	115 617	7 424	123 041	2.09

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. 3.2 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 2004. There was a substantial increase in consumption of natural gas. The consumption of biomass also increased in 2004, especially as a consequence of an increase in the prices of natural gas and electricity.

Tab. 3.2 Total primary energy supply in 1990 - 2004

	Total Primary Energy Supply	Of which Coal	
	[PJ]	*[PJ]*	*[%]*
1990	2 069.6	1 326.8	64.1
1991	1 929.6	1 229.1	63.7
1992	1 788.2	1 099.0	61.5
1993	1 748.5	1 035.6	59.2
1994	1 683.1	963.7	57.3
1995	1 748.3	983.9	56.3
1996	1 823.1	993.1	54.5
1997	1 744.1	951.7	54.6
1998	1 658.3	856.7	51.7
1999	1 617.6	797.0	49.3
2000	1 657.0	877.9	53.0
2001	1 706.2	887.3	52.0
2002	1 694.9	854.6	50.4
2003	1 815.2	868.7	47,9
2004	1 839.6	856.8	46.6
Decrease in consumption 1990 - 2004	230.0	470.0	17.5

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 - 2004, as can be seen in Tab. 3.3.

Tab. 3.3 Share of individual categories on the CO_2 emissions in 1990 - 2004 *[%]*

	Energy Industry	Manufacturing Industry	Transport	Commercial, services	Residential	Agriculture
1990	39.6	32.1	5.0	6.5	14.2	2.6
1991	41.1	35.1	4.7	6.0	10.9	2.1
1992	41.6	38.8	6.0	5.5	12.0	2.1
1993	43.6	34.0	6.0	4.2	10.3	2.0
1994	46.5	30.5	6.4	5.0	9.9	1.7
1995	48.3	27.8	8.0	4.8	9.7	1.4
1996	47.3	29.6	8.2	4.3	9.1	1.4
1997	46.6	28.2	9.1	5.2	9.4	1.5
1998	49.6	24.2	9.3	5.1	10.4	1.4
1999	47.8	25.6	10.8	5.1	9.2	1.5
2000	50.9	25.0	9.5	4.7	8.4	1.4
2001	50.7	25.7	10.3	3.7	8.5	1.3
2002	51.3	23.2	11.0	4.1	8.9	1.5
2003	50.9	23.8	11.6	3.8	8.3	1.5
2004	50.1	23.4	13.2	3.8	8.2	1.3

The fraction of emissions from the manufacturing 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 2004 are practically at the same level as in 1990.

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*, CSO 2005). 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.

In the 1990 – 2001 period, CH_4 emissions from stationary sources were calculated as a fraction of C_xH_y emissions, determined in the framework of REZZO (national emission register for traditional pollutants). These emissions represent CH_4 + NMVOC. The fraction of CH_4 was assumed to equal 35 – 50 %. However, this distribution could not be verified for the individual fuels. These calculated emissions of CH_4 are low, especially for gaseous fuels and biomass. Consequently, since 2003, all CH_4 emissions have been determined on the basis of default emission factors from the IPCC Guidelines.

CH_4 emissions from mobile sources 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.

The Czech Republic has been very successful in stabilizing and decreasing methane emissions derived from traffic-related greenhouse gases emissions. The annual trends in these emissions are being constantly decreased and are very similar to other hydrocarbons emissions, which are limited in accordance with UN ECE regulations. New vehicles must fulfil substantially higher EURO standards for hydrocarbons than older vehicles (EURO IV standard at the present). The greatest problems are associated with the slow renewal of the freight transport fleet. There has been almost no decrease in the number of older trucks in this country and these older vehicles are frequently used in the construction and food industries (Adamec et al, 2005a).

Methane emissions from mobile sources were calculated using methane emission factors taken from the internal database, containing both data from Czech emission measurements (mostly obtained from the Motor Vehicle Research Institute - TÜV UVMV) and internationally accepted values from the IPCC methodology, European Environmental Agency - Emission Inventory Guidebook, CORINAIR, etc. The resultant emission factors were calculated using the weighted averages of all data classified according to transport vehicle categories. The following categories were included: conventional petrol-fuelled passenger cars, petrol-fuelled passenger cars fulfilling EURO limits, diesel-fuelled passenger cars, light-duty vehicles, heavy-duty vehicles, diesel locomotives, diesel-fuelled watercraft, aircraft fuelled by aviation petrol and kerosene-fuelled aircraft (Adamec et al, 2005b).

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 catalysts. The emissions factors for N_2O for vehicles with diesel motors and for vehicles with gasoline motors without catalysts 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 catalysts. The IPCC methodology (*Revised 1996 IPCC Guidelines*, 1997) gives three pairs of emission factors for passenger cars with catalysts (for new and deactivated catalysts). The value for a deactivated catalysts is approximately three times that for a new catalysts. 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 catalysts was taken as the final emission factor for passenger cars with catalysts.

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 catalysts 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 catalysts (Adamec *et al*, 2002). According this study, the fraction of petrol-propelled vehicles equipped with three-way catalysts 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 catalysts.

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 catalysts, or the expected increase in the number of fluid-bed combustion units.

This approach was recently revised and modified by CDV Brno (Transport Research Centre), which has become a member of the Czech national GHG inventory team. CDV Brno has been providing the transport data for the official Czech inventory since 2004. The CDV approach is based on combination of measurements performed for some cars typically used in the Czech Republic with widely used EFs values taken from literature (see Dufek, 2005).

The situation in relation to reporting N_2O emissions is rather complicated, as some of the measurements performed in the past in the Czech Republic were substantially different from the internationally recognized emission factors. Consequently, control measurements were performed on

N_2O emissions from the commonest cars in the Czech passenger vehicle fleet (Skoda Felicia, Fabia and Octavia) in 2004 and 2005. These corrections brought the results closer to those obtained using IPPC emission factors than the older data, leading to better harmonization of the results of the nitrous oxide emission inventory per energy unit with those obtained in other countries. The locally measured data for measurements of N_2O emissions in exhaust gases were verified by assigning weighting criteria for each measurement; the most important of these criteria were the number of measurements, the analysis method, the type of vehicle and the fraction of these vehicles in the Czech vehicle fleet. (Dufek, 2005 and Jedlicka et al, 2005)

Nitrous oxide emission factors were obtained using a similar method to that employed for methane, by statistical evaluation of the weighted averages of the emission factors for each category of vehicle (see Chapter 3.1.3), employing the interactive database. This database now encompasses the results of the Czech measurements performed in 2004 and 2005 (Adamec et al, 2005b).

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 2004. 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 2004 are issued in 2005). The preliminary energy balance for 2004 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.

Tab. 3.4 Primary energy supply of fossil fuels in 2002 and 2003

		Coal	Crude Oil and Petroleum Products	Gas	TOTAL Fossil Fuels
2002					
Final balance CSO	*[TJ]*	862 795	317 152	328 095	1 508 042
Preliminary balance KONEKO	*[TJ]*	854 583	316 190	324 987	1 495 760
Deviation	*[TJ]*	-8 212	-962	-3 108	-12 282
	[%]	-0.95	-0.30	-0.95	**-0.81**
IEA balance	*[TJ]*	858 294	357 134	324 896	1 540 324
Deviation	*[TJ]*	-4 501	39 962	-3 199	32 282
	[%]	-0.52	12.61	-0.98	2.14
2003					
Final balance CSO	*[TJ]*	868 656	346 300	328 255	1 543 211
Preliminary balance KONEKO	*[TJ]*	875 486	350 979	328 072	1 554 537
Deviation	*[TJ]*	6 830	4 679	-783	11 326
	[%]	0.79	1.35	-0.06	**0.73**
IEA balance	*[TJ]*	873 785	367 182	328 245	1 569 212
Deviation	*[TJ]*	5 129	20 882	-10	26 001
	[%]	0.59	6.03	0.00	1.68

The values of the primary energy supply of fossil fuels in the individual balances illustrate the justifiability of the use of preliminary data. This consumption basically determines total CO_2 emissions. Tab. 3.4 gives the deviations in the preliminary and final balance over the past two years.

Because of the small deviations of the values for the primary energy supply of fossil fuels, it is apparent that the deviation in CO_2 emissions, calculated on the basis of the preliminary and definitive CSO balance, is less than 1 %.

Determination of the activity data for revision of 1990 - 1995 was based on the total CSO balances for these years. 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. Since 2003, new basic information has permitted separation of fuel consumption in the individual branches of the manufacturing industry. In previous years, the entire consumption in the manufacturing industry was reported in 1.A.2.f. other.

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*, 2005).

The share of transport in total energy consumption has exhibited an increasing trend in the Czech Republic since 2004. Individual road and freight transport make the greatest contribution to energy consumption in transport, corresponding to 88.7 %. Energy consumption in air transport has increased slightly (1.6 %), corresponding to an increase in performance. The amount of fuel sold is monitored annually and constitutes the main input data for calculation of energy consumption. The sales of diesel fuel continue to increase substantially. Simultaneously, there has been increased consumption of alternative fuels, particularly liquid petroleum gas (LPG). The termination of subsidies and uncompetitive prices have led to a reduction in sales of bio-diesel fuel. The consumption of compressed natural gas (CNG) also decreased in 2004 (Adamec et al, 2005a).

The consumption of petrol, diesel fuel, LPG, CNG and bio-diesel fuel are determined from the distribution of total fuels sold, after subtracting the amounts used for purposes other than as automotive fuel and the amounts placed in reserves. These energy consumption values were recalculated to mass fuel consumption and classified in more detailed vehicle categories as mentioned above. The percentage share of consumption by the individual transport modes was calculated. The model is based on the principle of distribution of fuel consumption according to transport performance and numbers of vehicles (Adamec et al, 2005a).

For similar reasons, another specialized model, again of the MAED type, was used to determine energy consumption in the household category. Calculations took into account the results of the statistical studies "Energy consumption in households", carried out in 1997 and 2004 by CSO on the basis of the PHARE / EUROSTAT method. All of categories 1.A.1. to 1.A.6. were filled with data on consumption of the individual solid, liquid and gaseous fuels, including non-energy consumption (petrochemical materials, lubricating oils). The consumption by mobile sources outside of the area of transportation is also determined in the subsectors of construction and agriculture/forestry/fishing

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, all energy balances (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 (1.A.2.) is reported as a whole. The current energy statistics provide sufficient data for classification into the individual branches of industry up to 2003.

Comparison of the results of the inventory for 2004 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 2005. 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. The new CRF Reporter employed for the first time this year substantially assists in application of control procedures, where attempts were made to utilize graphic depiction of time series for identification of gaps in the individual subcategories of sources.

3.1.9 Survey of Present State and Expected Improvements

- Emission inventories for 1996 - 2004 were compiled in a consistent manner using the *Revised IPCC Guidelines*
- The former, not entirely consistent data for 1990 - 1995, were recently revised including incorporating data into CRF. The revised data are now consistent with the 1996 - 2004 period. All the 1990 – 2004 inventory data was converted to the CRF Reporter, with the exception of activity data for 1996 and 1997. This will be supplemented in the 2007 submission.
- Emissions from masout used for amonia production are covered under 2.B.1. and emissions from iron and steel (specifically coming from coke input to blast furnaces) are covered under 2.C.1..
- The inventory data for the manufacturing industry for 2003 and 2004 are reported according to the individual branches.
- To eliminate duplications, starting with the 2003 inventory, emissions from combustion of petrochemical products and lubricants are reported only in sector 6.
- 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 1.B.)

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 1.B. 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. 3.5).

Tab. 3.5 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	3.2
Fugitive Emissions from Oil & Gas operations		CH_4	0.4

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. 3.6, 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, i.e. 18.3 m^3 CH_4 / t. It should be pointed out that an old emission factor of 23.9 m^3 CH_4 / t, recommended by the former IPCC Methodology (*IPCC Guidelines,* 1995) for the Czech republic, was used originally for data 1990 - 1995; relevant recalculation of these period using actual national emission factor 18.3 m^3 CH_4 / t was performed in 1997. The activity data for all years since 1990 are taken from (*Mining Yearbook*, 1994 - 2004)

The use of the constant emission factor 18.3 m^3 CH_4 / t for the whole time series 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. 3.7.

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.

Tab. 3.6 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. 3.7 Trends of mined natural gas of coal origin (NG) and its ratio to hard coal (HC) mining

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
NG *[mil. m^3]*	127.1	124.4	151.3	139.8	139.6	154	146.9	128
Ratio NG / HC	6.3	7.2	8.8	8.5	8.8	9.8	9.7	8.6
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	
NG *[mil. m^3]*	126.5	118.1	98.7	115.6	112.8	117.9	116.3	
Ratio NG / HC	8.7	8.8	7.1	8.1	7.9	8.7	8.7	

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.

Complete time series of activity data and methane emissions were transferred to the new CRF Reporter.

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/storage.

Tab. 3.9 lists CH_4 emissions reported separately for refining and storage. The activity data are identical for the two subcategories; the emission factor for refining equals 900 kg/PJ, the emission factor for storage equals 250 kg/PJ and the summary emission factor equals 1159 kg/PJ. In the CRF Reporter program, CH_4 emissions are reported jointly in category 1.B.2.A.4 - refining/storage. No CH_4 emissions are formed in the distribution of liquid fuels (category 1.B.2.A.5 – Distribution of oil products). The data for 1994 to 2004 were treated in this manner. Total emissions in the individual years did not change.

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 - 2004, *Statisical Yearbook*, 2005) and, since 1998, in the periodical publication Energy Management in the Czech Republic in Numbers (*Energy Economy*, 1999 - 2004). 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.

Tab. 3.8 and 3.9 illustrate the calculation of fugitive emissions of methane from solid, liquid and gaseous fuels.

Tab. 3.8 Calculation of CH_4 emissions from coal mining in 2004

	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)	13.302	18.3	243	0.67	163
*OKR** (Tier 3)	13.302	18.3	243	0.67	163
Post-Mining (Tier 1)	13.302	2.45	33	0.67	22
*OKR** (Tier 1)	13.302	2.45	33	0.67	22
Mining (Tier 1)	44.498	1.15	51	0.67	34
Post-Mining (Tier 1)	44.498	0.1	4	0.67	3
				Total	**222**

** Ostrava-Karviná coal-mining area*

Tab. 3.9 Calculation of CH_4 emissions from oil and natural gas in 2004

	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	12.83	5 287	67 821	0.068
Refining		*PJ oil refined*	*kg CH_4 / PJ*		
	1 - 2	281.9	1 150	253 676	0.254
Storage		*PJ oil refined*	*kg CH_4 / PJ*		
	1	281.9	250	70 465	0.070
				CH_4 from oil	**0.392**
Production / Processing	***GAS***	*PJ gas produced*	*kg CH_4 / PJ*		
(domestic production NG)	2	8.31	39 365	326 960	0.327
Transmission & Distribution		*PJ gas consumed*	*kg CH_4 / PJ*		
(transit transport, high and low pressure pipeline)	2	1 667	14 834	24 721 748	24.722
Other Leakage		*PJ gas consumed*	*kg CH_4 / PJ*		
Underground storage	3	98.64	14 762	1 456 094	1.456
				CH_4 from gas	**26.505**

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.

Data in Tab. 3.10 for the Gas subcategory were calculated using the emission factors listed in Table 3.11.

Tab. 3.10 Emission factors for the Gas subcategory

CRF category	Description	Emission factors			Units
		low	**medium**	**high**	
1.B.2.B.2	production	0.05	0.2	0.7	% of production
1.B.2.B.3	pipelines	200	2 000	20 000	m^3/km p.a.
	compressor stations	6 000	20 000	100 000	m^3/MW p.a.
1.B.2.B.5.1	underground storage	0.05	0.1	0.7	% of annual turnover
1.B.2.B.4	regulation stations and measurement	1 000	5 000	50 000	m^3/station p.a.
	distribution pipelines	100	1 000	10 000	m^3/km p.a.
	consumption	2	5	20	m^3/comsumption site p.a.

These emission factors were determined by the International Gas Union in 1998 in Study Group 8.1 Methane Emissions (*Gas and the Environment*, 2000). Emission factors can be divided into low, medium and high. This method of calculation of methane emissions was selected because quite accurate activity data are available for the individual parts of the gas supply system in the above table. On the basis of consultations with gas supply professionals, emission factors were chosen for the individual years, corresponding to the technical condition of the individual parts of the gas supply system. Up to 2003, emissions from compressor stations of the transit gas pipeline, transporting natural gas from the east through the CR to the countries of Western Europe, were calculated using these emission factors. Methane emissions from compressor stations are formed during controlled discharge of natural gas into the air when starting up the compressors. Information on discharged gas is monitored for economic reasons. In 2005, data was obtained on the volume of gas discharged

retroactively to 1990 (Perlík, 2005). Consequently, recalculation was performed for the entire monitored period in the Gas subcategory.
The time series following recalculation is given in the following table.

Tab. 3.11 Trend of CH_4 emissions from natural gas activities *[Gg CH_4]*

Year	1990	1991	1992	1993	1994	1995	1996	1997
natural gas activities	41.80	35.63	32.73	31.74	30.97	31.06	33.63	33.33
Year	1998	1999	2000	2001	2002	2003	2004	
natural gas activities	35.08	34.32	32.62	30.58	31.48	28.57	26.50	

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 original data for period 1990-1995 in 1997 is now consistent and corresponds to the trends in coal mining in this country.

Tab. 3.12 Trend of CH_4 emissions from coal mining and post-mining activities *[Gg CH_4]*

	1990	1991	1992	1993	1994	1995	1996	
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	
	1997	1998	1999	2000	2001	2002	2003	2004
Present value	263.5	253.1	229.0	239.0	244.7	237.5	228.2	222.0

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

	1990	1991	1992	1993	1994	1995	1996	1997
Oil and natural gas	42.67	36.36	33.45	32.49	31.77	31.76	34.40	33.78
	1998	1999	2000	2001	2002	2003	2004	
Oil and natural gas	35.52	34.72	32.99	30.95	31.83	28.96	26.90	

Methane emissions were recalculated for 1991 and 1993 for the Energy - Fugitive Emissions category. Complete time series of activity data and methane emissions were transferred to the new CRF Reporter.

Tab. 3.14 Trend of CH_4 emissions from Energy - Fugitive Emissions *[Gg CH_4]*

	1990	1991	1992	1993	1994	1995	1996	1997
Emissions CH_4	404.57	357.35	339.41	330.48	313.76	308.37	302.88	297.25
	1998	1999	2000	2001	2002	2003	2004	
Emissions CH_4	288.57	263.68	271.98	275.69	269.31	257.17	248.90	

3.2.7 Precursor Emissions

Ozone precursors (NO_X, CO, NMVOC) 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 and Recalculations

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 1.B. 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.

Data are stored in files containing calculation for each year separately so that the calculation can be repeated. The files contain the activity data and the emission factors employed. The results of emission calculations are then transferred to trend tables and graphic outputs are created from them, permitting rapid control of important inter-annual deviations. In case of occurrence of important deviations, the calculation is controlled again and, if no error is found, the deviation is considered to correspond to fact. This procedure permits control of the individual activity data, from which the overall activity data used in the CRF Reporter for the individual subcategories is then composed.

The use of the new CRF Reporter then permits rapid control of the overall activity data and emission data and facilitates discovery of any errors. This method was fully utilized in the preparation of the latest emission inventory.

3.2.8.2 Recalculations

Recalculation was carried out in subcategory 1.B.2.B – Gas. This was performed because new data was obtained on the technical discharge of natural gas at compressor stations in the transit system for the transport of natural gas across the territory of the CR. This discharge is subject to the technical requirements in managing the system and is significantly affected by the number of start-ups of compressors in the given year.

Emissions in subcategory 1.B.2.B.3 Transmission were determined in our methodology both on the actual linear parts of the gas pipelines and separately at the compressor stations using different procedures, and were then added together, see Tab. 3.10. Originally, emissions were calculated in the two individual subcategories using EFs. During recalculation, only emissions on the linear part were calculated using EFs and emissions from compressor stations were calculated according to the actual values on discharge of gas into the air (Perlík, 2005). The reference data consists in the total transport of natural gas across CR, so that the aggregated EFs in CRF can change substantially from one year to the next.

Recalculation was performed in the described manner for the entire 1990 – 2004 period. In addition, minor adjustments were made in category 1.B.2.A Oil for 1998 – 2000. In this case, recalculation was not involved, but rather adjustment of the proportions between the individual subcategories was made. The values remained unchanged for the other years. Similarly, no recalculations were made for category 1.B.1 Solid fuels.

4 Industrial Processes (CRF Sector 2)

4.1 Sector Characterization

In principle, 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 1.A.2.). It should also be borne in mind that emissions occurring during petroleum refining belong in categories 1.A.1.b. or 1.B.2. (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, lime, glass and ceramic). 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 (2.F.) 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	2.5
Iron and steel	Key source	CO_2	4.6
HNO_3 production	Key source	N_2O	0.8
NH_3 production	-	CO_2	0.5

Other sources of direct greenhouse gases are minor, except of CO_2 emissions from iron and steel production, which were originally reported in the energy category 1.A.2. In the 2001 inventory, these emissions were re-classified according to Good Practice (*Good Practice Guidance*, 2000) as emissions from Industrial processes, 2.C.1. Naturally, this constitutes a quite important key source under Industrial processes. In this way, the relevant rearrangements have been applied to 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. These emissions were also originally reported under 1.A.2., as formerly there were two reasons for inclusion of these emissions under Energy (1.A.2.) - to respect previous continuity and due to difficulties associated with identification of the amount of gasified fuel (residual oil).

These difficulties were overcome for the data for 2003 and hereafter and the technologically specific emission factor of 2.41 Gg CO_2 / Gg NH_3 was determined from the relevant technical literature (*Ullman's Encyclopedia*, 2005), so that the CO_2 emissions from ammonia production are correctly reported in sector 2.B.1. In this way, the relevant rearrangements are 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 (2.A.1.) 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 1.A.2.

In principle, carbon dioxide emissions can be calculated according to the IPCC methodology from the production of cement (Tier 1) or clinker (Tier 2). Starting this year, the latter approach has been employed so far in this inventory and all the previous reported data were recalculated. Data on cement clinker production is available in the Czech Republic from two independent sources, 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 limestone and dolomite used in 1990, 1996, 1998 - 2001 (the EF value was extrapolated for the other years). These data collected for implementation of the EU Emission Trading Scheme and it is also planned that data from this scheme will be used in preparation of the emissions inventory in this sector. EF varies from 0.5267 to 0.5534 t CO_2 / t clinker. This value is in accordance with GPG default EF value.

In 2004, 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). CO_2 emissions from this sector decreased regularly since 1990 to 2002 and then slightly increase. Process-related emissions from cement production for the whole 1990 - 2004 period are presented in Tab. 4.2.

Tab. 4.2 Activity data and CO_2 emissions from cement production in 1990 - 2004

	Cement clinker produced *[t / year]*	Process-specific CO_2 emissions *[Gg]*
1990	4 726	2 489
1991	4 368	2 309
1992	4 653	2 468
1993	4 122	2 195
1994	4 134	2 208
1995	3 740	2 005
1996	3 934	2 116
1997	3 829	2 083
1998	3 758	2 068
1999	3 547	1 963
2000	3 537	1 937
2001	2 954	1 629
2002	2 549	1 403
2003	2 725	1 500
2004	3 017	1 661

CO_2 is emitted from Lime production (2.A.2.) during the calcination step. 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.

Emissions from this sector were calculated as the sum of CO_2 emissions from lime production and CO_2 removals from the atmosphere during lime use. In 2004, a study (Vacha, 2004) was performed and proposed a new relationship between emissions and removals. The previous assumption that emissions and removals are identical was out-of-date and unjustified and was also criticized by review teams. Close cooperation with the Czech Lime Association yielded data on lime production from limestone and dolomite and competent emissions and also data about lime distribution (use). Eight categories of lime use were defined in the study (iron and steel production, chemical industry, another industry, production of construction material, construction industry, environmental protection, agriculture and export). It can be assumed that the CO_2 emissions from lime production in the sectors denoted in bold are partly or fully removed. Based on this information, it is assumed that 35 % of emissions are removed. County-specific EFs are based on the lime composition and production in the individual installations.

Activity data are based on statistics from the Czech Lime Association, which publishes data on pure lime production, so that these data were considered to be more accurate in comparison with data from the Czech Statistical Office, which do not differentiate between lime and hydrated lime.

Only CO_2 emissions generated in the process of the calcination step of lime treatment are considered under Category 2.A.2. CO_2 emissions from combustion processes (heating of kilns and furnaces) are reported under Category 1.A.2. Tab. 4.3 lists data for pure lime production (taken from the Czech Lime Association).

As can be seen in Tab. 4.3 the overall trend for lime production decreased slightly in the 1990 - 2004 period; in 2004 lime production was 16 % lower than in 1990.

Tab. 4.3 Activity data and CO_2 emissions from lime production and use in 1990 - 2004

	Lime produced *[t / year]*	Process-specific CO_2 emissions *[Gg]*
1990	1 823	869
1991	1 152	549
1992	1 134	540
1993	1 062	506
1994	1 100	524
1995	1 115	531
1996	1 133	540
1997	1 163	554
1998	1 087	518
1999	1 074	512
2000	1 130	539
2001	1 128	538
2002	1 112	530
2003	1 102	525
2004	1 103	526

The category Limestone and Dolomite Use (2.A.3.) includes emissions from sulphur removal with limestone and emissions from limestone and dolomite use in sintering plants.

From the chemical standpoint, sulphur 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 sulphur-removal technology employed and the stoichiometric excess. These amounts have increased since 1996, when the first sulphur-removal unit came into operation; recently, emissions have varied slightly above 0.5 Mt CO_2. However, this figure is not expected to increase further.

The results of this methodology were validated with data from the EU Emission Trading Scheme, which includes all installations with sulphur-removal units in the Czech Republic. The differences between these two data sources and methodologies were relatively very small.

Emissions from limestone and dolomite use in sintering plants are new sources which were identified in the process of preparation of the EU Emission Trading Scheme. Only 2 sintering plants have existed in the CR in recent times. CO_2 emissions from this category are calculated on the basis of data from statistics (production of agglomerate / sinter) and the EF value, which was derived from EU ETS CO_2 emission data based on the limestone and dolomite compositions and consumptions (t CO_2 / t sinter). Tab. 4.4 lists data for this category.

Tab. 4.4 CO_2 emissions from Limestone and Dolomite Use in desulfurization unit and sinter plant in 1990 – 2004 [Gg]

	CO_2 emissions from desulfurization	CO_2 emissions from sinter plant
1990	NO	678
1991	NO	605
1992	NO	283
1993	NO	251
1994	NO	291
1995	NO	519
1996	76	587
1997	241	510
1998	417	492
1999	537	438
2000	540	468
2001	551	482
2002	551	492
2003	560	473
2004	551	494

The Other (2.A.7) category summarizes emissions from *Glass Production* (2.A.7.1) and from *Brick and Ceramics Production* (2.A.7.2). These two sources are relatively unimportant sources. CO_2 emissions from Glass production equalled 233 Gg in 2004. Emissions 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). Tab. 4.5 lists data for Glass Production and from Brick and Ceramics Production.

Emissions from *Brick and Ceramics Production* are derived particularly from the decomposition of alkaline carbonates and fossil organic compounds included in the raw materials. The EF value was derived from individual installation data collected for EU ETS (emissions) and from CSO (production). The calculation is based on the total production of ceramic products and the EF value.

Tab. 4.5 CO_2 emissions from Glass Production and Brick and Ceramics Production in 1990 – 2004 *[Gg]*

	CO_2 emissions from Glass Production	CO_2 emissions from Brick and Ceramics Production
1990	173	153
1991	148	128
1992	146	123
1993	142	147
1994	154	151
1995	116	144
1996	123	176
1997	136	213
1998	142	271
1999	146	211
2000	168	226
2001	168	202
2002	189	152
2003	198	162
2004	233	161

4.2.2 Iron and Steel Production

In accordance to the IPCC *Good Practice* (*Good Practice Guidance*, 2000) starting with GHG emission inventory 2001, re-categorization of the CO_2 emissions formed in the metallurgy industry in the process of production of iron and steel was carried out. As mentioned above, these emissions, which are connected with the actual metallurgical process, were previously included in category 1.A.2. Obviously, they now constitute a significant key source in category 2. To achieve time consistency, the above-mentioned rearrangement has recently been applied to the whole time series since 1990 and is presented in this submission for the first time.

CO_2 emissions were determined for subcategory 2.C.1. using a procedure corresponding to Tier 1 of the *Good Practice Guidance* for 2.C.1.. This calculation was based on the amount of coke consumed in blast furnaces. 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, in reality, emitted in the form of the products of combustion of blast-furnace gas occurring mainly in metallurgical plants, while a smaller part is emitted from heat treatment of pig iron during its transformation to steel.

The relevant activity data and corresponding emissions are given in Tab. 4.6

Tab. 4.6 Activity data and CO_2 emissions from iron and steel in 1990 - 2004

Year	1990	1991	1992	1993	1994	1995	1996	1997
Coke consumed								
in Blast Furnaces, *[kt]*	4 222	2 959	3 447	2 582	2 724	2 866	2 643	2 811
CO_2 from 2.C.1., *[Gg]*	12 533	8 781	10 230	7 690	8 231	8 659	8 012	8 553
Year	1998	1999	2000	2001	2002	2003	2004	
Coke consumed								
in Blast Furnaces, *[kt]*	2 483	1 964	2 321	2 174	2 270	2 499	2 203	
CO_2 from 2.C.1., *[Gg]*	7 555	5 996	7 086	6 612	6 882	7 576	6 726	

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 technologically specific emission factor 2.41 Gg CO_2 / Gg NH_3 (Markvart and Bernauer, 2005). 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 this submission, the entire time series from 1990 will be rearranged in this way to ensure time consistency. The relevant activity data and corresponding emissions are given in Tab. 4.7

Tab. 4.7 Activity data and CO_2 emissions from ammonia production in 1990 – 2004

Year	1990	1991	1992	1993	1994	1995	1996	1997
Residual Fuel Oil used for NH_3 product., *[TJ]*	11 113	10 770	11 104	10 383	11 593	10 235	11 015	10 095
Ammonia produced, *[kt]*	335.9	325.5	335.6	313.8	350.4	309.3	332.9	305.1
CO_2 from 2.B.1., *[Gg]*	806.8	781.9	806.1	753.8	841.6	743.0	799.7	732.9
Year	1998	1999	2000	2001	2002	2003	2004	
Residual Fuel Oil used for NH_3 product., *[TJ]*	10 407	8 864	10 144	8 538	7 449	9 696	9721	
Ammonia produced, *[kt]*	314.5	267.9	306.6	258.0	225.1	293.0	290.8	
CO_2 from 2.B.1., *[Gg]*	755.5	643.6	736.5	619.9	540.8	703.9	698.7	

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), describing conditions prior to 2004, that the resulting emission factor depends on the technology employed: higher emission factor values are usually given for processes carried out at normal pressure, while lower values are usually given for medium-pressure processes. Two types of processes were carried out in this country before 2004, 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 Non-Selective Catalytic Reduction (NSCR), which also removes N_2O to a considerable degree.

Studies (Markvart and Bernauer, 2000, 2003) recommend the following emission factors for various types of production technology and removal processes that are given in Tab. 4.8. The emission factors for the basic process (without DENOX 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).

Tab. 4.8 Emission factors for N_2O recommended by (Markvart and Bernauer, 2000) for 1990 - 2003

Pressure in HNO_3 production	0,1 MPa			0,4 MPa		
Technology DENOX	--	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

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)

Studies (Markvart and Bernauer, 1999, 2000, 2003, 2004) also gives the value of N_2O emissions from the production of caprolactam starting this year: 0.27 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.

During 2003, conditions changed substantially as a result of the installation of new technologies operating under a pressure of 0.7 MPa. At the same time, some older units operating under atmospheric pressure of 0.1 MPa were phased out. These changes in technology were monitored in the latest study of Markvart and Bernauer (Markvart and Bernauer, 2005). This study presents a slightly modified table of N_2O emission factors, while those for new technologies were obtained from a set of continuous emission measurements lasting several months. Other values are based on several discrete measurements. A table of these technology-specific emissions factors is given below.

Tab. 4.9 Emission factors for N_2O recommended by (Markvart and Bernauer, 2005) for 2004

Pressure	0.1 MPa	0.4 MPa	0.4 MPa	0.7 MPa
DENOX process	SCR	SCR	NSCR	SCR
EF, kg N_2O / t HNO_3 (100 %)	9.05	4,9	2.72	7.8

Tab. 4.10 gives the emissions of N_2O from production of nitric acid including production values. 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 6.3 - 6.9 kg/t (weighed average), was also employed for revised data for 1990-1995.

Estimation of CH_4 from Industry is based on the CORINAIR methodology. Industrial processes emit only 6.6 – 3.3 Gg of methane. This contribution (3.55 Gg in 2005) is not very important; however, during rigorous application of the QA/QC procedures, small gaps have recently been identified in the inventory and thus the entire CH_4 series from Industry was completely revised. 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. 4.10 Emission trends for HNO_3 production and N_2O emissions

	Production of HNO_3, *[Gg HNO_3 (100 %)]*	Emissions of N_2O *[Gg N_2O]* from HNO_3 production
1990	530.0	3.63
1991	349.6	2.37
1992	439.4	2.98
1993	335.9	2.27
1994	439.8	2.94
1995	498.3	3.37
1996	484.8	3.06
1997	483.1	3.33
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
2004	533.7	3.46

4.4 Recalculations, QA/QC and Plans for Improvement

In 2004, a study (Vacha, 2004) was performed and proposed a new methodology for cement production, based on clinker production. This study was prepared in close cooperation with the Czech Cement Association. The previous method was based on cement production and default EF values, while the new methodology is based on clinker production and country-specific EF values. A comparison of the results of the Tier 1 (cement, default EF) and Tier 2 (clinker, country-specific EF) methods is given in Tab. 4.11. The results obtained by the new methodology are somewhat lower for recent years with a greater difference for the 1990's. These changes are a result of changes in the types of cement produced and also in the use of blast furnace slag.

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. 4.12 compares the results of previous and recent methodologies

Tab. 4.11 Cement production Tier 1 and Tier 2 methodology - activity data, EF and emissions results comparison for 1990 - 2004

	Tier 1			Tier 2		
	Cement produced *[t / year]*	EF used *[t CO_2/ t cement]*	CO_2 emissions *[Gg]*	Clinker produced *[t / year]*	EF used *[t CO_2/ t clinker]*	CO_2 emissions *[Gg]*
1990	6 434	0,4985	3 207	4 726	0.5267	2 489
1991	5 610		2 797	4 368	0.5286	2 309
1992	6 145		3 063	4 653	0.5305	2 468
1993	5 393		2 688	4 122	0.5324	2 195
1994	5 252		2 618	4 134	0.5342	2 208
1995	4 831		2 408	3 740	0.5361	2 005
1996	4 973		2 479	3 934	0.5380	2 116
1997	5 011		2 498	3 829	0.5441	2 083
1998	4 874		2 430	3 758	0.5502	2 068
1999	4 241		2 114	3 547	0.5534	1 963
2000	4 093		2 040	3 537	0.5476	1 937
2001	3 591		1 790	2 954	0.5514	1 629
2002	3 249		1 604	2 549	0.5506	1 403
2003	3 502		1 746	2 725	0.5506	1 500
2004	3 709		1 849	3 017	0.5506	1 661

Tab. 4.12 Lime production previous and recent methodology - activity data, EF and emissions results comparison for 1990 - 2004

	Previous			Recent		
	Lime produced *[t / year]*	EF used *[t CO_2/ t lime]*	CO_2 emissions *[Gg]*	Lime produced *[t / year]*	EF used *[t CO_2/ t lime]*	CO_2 emissions *[Gg]*
1990	1 490	0	0	1 823	0,7884 *t CO_2/ t lime* 93 % purity of lime 35 % removals	869
1991	1 391		0	1 152		549
1992	1 337		0	1 134		540
1993	1 147		0	1 062		506
1994	1 212		0	1 100		524
1995	1 186		0	1 115		531
1996	1 176		0	1 133		540
1997	1 217		0	1 163		554
1998	1 151		0	1 087		518
1999	1 142		0	1 074		512
2000	1 202		0	1 130		539
2001	1 312		0	1 128		538
2002	1 258		0	1 112		530
2003	1 262		0	1 102		525
2004	1 366		0	1 103		526

Other time series were also checked in the framework of recalculation in the Industrial Processes sector. A problem associated with activity data was identified in the Glass Production sector, where the time-series is not fully consistent, because of a change in the data source since the 1995 data on glass production were obtained from CSO and then from Association of the Glass and Ceramic Industry of the Czech Republic. Table 4.8 lists the old and new CO_2 emissions from Glass Production. Changes were made only in the activity data, not in the methodology.

Tab. 4.13 Glass production previous and recent emissions results comparison for 1990 – 2004 [kt CO_2]

	CO_2 emissions from Glass Production	
	Old data	New data
1990	173	173
1991	148	148
1992	146	146
1993	142	142
1994	154	154
1995	201	116
1996	123	123
1997	136	136
1998	232	142
1999	248	146
2000	210	168
2001	210	168
2002	189	189
2003	198	198
2004	233	233

Two new sources of CO_2 emissions from sintering plants and from ceramic production were newly added to the inventory. Emissions from sintering plants are reported in category 2.A.3 together with emissions from sulphur removal with limestone. CO_2 emissions from ceramic production are reported in category 2.A.7.2. Emissions from these categories were quantified and reported for whole time series for the first time in this NIR.

The above-described changes in reallocation of CO_2 emissions from iron and steel from 1.A.2. to 2.C.1. since 2001 have been followed by the relevant changes in the whole time series since 1990. The CO_2 series from ammonia synthesis have been rearranged in a similar way (from 1.A.2. to 2.B.1.).

Technology-specific methods for N_2O emission estimates have been improved by incorporating direct emission measurements, especially for new technologies (0.7 MPa), which are now predominant in the Czech Republic.

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. The greatest attention was focused on identifying gaps and imperfections using the new reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs. Attention was also focused on checking sources from inter-sector boundaries (Energy, Industry) that they are neither omitted nor counted twice.

Activity data available in the official CSO materials in relation to QA/QC were independently determined by experts from CHMI and KONEKO Marketing Ltd. and were mutually compared. Experts at CHMI additionally checked most of the calculations carried out by experts at KONEKO Marketing Ltd. and vice versa. A similar approach was employed in cooperation of CHMI with the external consultants (M. Markvart and B. Bernauer).

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

HFCs, PFCs and SF_6 (denoted as F-gases) emissions were recalculated in this year. The main change was made in the methodology, where a potential approach was replaced by an actual approach.

Emissions of F-gases in the Czech Republic are at a relatively low level due to the absence of large industrial sources of F-gases emissions. As mentioned above, F-gases are not produced in the 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-gases emissions and there is no aluminium 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 easy disaggregated reporting and / or use of the highest tiers, are currently available in the Czech Republic.

For source consumption of F-gases, potential emissions increased from 169.4 Gg $CO_{2\ eq.}$ in 1995 to 1 444.0 Gg $CO_{2\ eq.}$ in 2004. This significant increase could be explained mainly due to a substantial increase in HFCs usage. For the source consumption of F-gases, actual emissions increased from 76.1 Gg $CO_{2\ eq.}$ in 1995 to 667.2 Gg $CO_{2\ eq.}$ in 2004. This significant increase could be explained mainly due to a substantial increase in HFCs usage in refrigeration. Detailed information about actual and potential emissions is listed in the CRF tables.

Tab. 4.14 HFCs, PFCs and SF_6 potential emissions in 1995 - 2004 *[Gg $CO_{2\ eq}$]*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HFCs	2.2	134.5	479.4	577.9	411.9	674.3	1 045.1	1 092.4	1 343.9	1 215.0
PFCs	0.4	4.2	1.2	1.2	2.7	9.5	14.5	17.9	28.6	21.0
SF_6	166.8	183.1	180.5	126.0	110.9	206.0	223.2	211.8	339.3	208.0
Total	169.4	321.8	661.1	705.1	525.5	889.8	1 282.8	1 322.2	1 711.8	1 444.0

Tab. 4.15 HFCs, PFCs and SF_6 actual emissions in 1995 - 2004 *[Gg $CO_{2\ eq}$]*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HFCs	0.7	101.3	244.8	316.6	267.6	262.5	393.4	391.3	590.1	600.3
PFCs	0.1	4.1	0.9	0.9	2.6	8.8	12.3	13.7	24.5	17.3
SF_6	75.2	77.5	95.3	63.9	76.5	141.4	167.8	66.8	99.8	49.6
Total	76.1	182.9	341.0	381.3	346.7	412.7	573.5	471.8	714.5	667.2

4.6.2 General Methodological Aspects

Currently, the national F-gases inventory is based on the method of actual emissions. The method of potential emissions is used only as supporting information.

According to the *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 the relatively short time of F-gases usage, it has been assumed that the disposed amount is insignificant. The potential methodology is the same for all categories of use of F-gases. The actual emissions methodology is specified for each category. The method employed 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, 2005) which also contents all relevant information for potential and actual emissions calculations. Emissions of F-gases are based on data on import and export of individual chemicals or their mixtures (as bulk), but not on products.

4.6.3 Sector-Specific Methodological Aspects

This chapter specifies the actual emissions methodology used for a given sector. In the following chapters, individuals sectors with similar methodology are connected, e.g. a similar approach is used in the foam blowing and sound-proof windows sectors for estimation of actual emissions, and thus the approach is described in one joint chapter. More detailed information on the data and methodology used are included in a special study prepared by the external partners Řeháček and Michálek in 2005.

The most important category in view of actual emissions is Refrigeration, which is responsible for 85 % of actual F-gases emissions.

4.6.3.1 Refrigeration and Air Conditioning Equipment

In the CRF tables, emissions from this category are divided into only two sub-categories: *2.IIA.F.1.1 Domestic Refrigeration* and *2.IIA.F.1.6 Mobile Air-Conditioning*; emissions from other subcategories are also included in these two categories, because of lack of detailed information.

Emissions from *Mobile Air-Conditioning* include mainly emissions from the “First-Fill” in the Skoda Auto Company and from the relatively small amount used for servicing old equipment. The calculation was performed using Equation 3.44 from 2000 GPG; recently has been assumed that emissions from disposal and destruction are negligible because of the relatively short time of use of F-gases in this sector. The contribution of this sector to the total actual F-gases emissions was 4.8 % in 2004. It can be anticipated that emissions from this category will increase in the future.

Emissions from *Domestic Refrigeration* include mainly emissions from servicing old equipment. The calculation is performed using the Tier 2 top-down approach methodology (Equation 3.40 from 2000 GPG); recently it has been assumed that emissions from removal from use and destruction are negligible because of the relatively short time of use of F-gases in this sector. This sector has the highest share on the total actual emissions of F-gases, which equalled 80.9 % in 2004.

4.6.3.2 Foam Blowing and Production of Sound-Proof Windows

F-gases are used in the Czech Republic only for producing hard foam. Only HFC-143a is used regularly for foam blowing. HFC-227ea was used once for testing purposes. SF_6 is used for production of sound-proof windows. Emissions from these different categories are calculated in a similar way. The default methodology and EF described in 2000 GPG are used for sound-proof windows, specifically Equations 3.24 and 3.35. Similar equations are used for foam blowing. The share of these sectors in the total emissions of F-gases equalled 0.5 and 4.0 %, respectively, in 2004.

4.6.3.3 Fire Extinguishers

Emission from this category is calculated on the basis of GPG 2000. Calculations are based on data about production of new equipment and data about service of old equipment. The share of this sector in the total actual F-gases emissions was 2.0 % in 2004.

4.6.3.4 Aerosols / Metered Dose Inhalers and Solvents

Emissions from these categories (*2.F.4 Aerosols / Metered Dose Inhalers* and *2.F.5 Solvents*) are based on 2000 GPG and Equation 3.35; EF equals 50 %. The contribution of these sectors to the total actual F-gases emissions equalled 3.7 and 0.2 %, respectively, in 2004.

4.6.3.5 Semiconductor Manufacture

Actual emissions from this category are calculated on the basis of Tier 1 methodology. Emissions from this category correspond to only 0.5 % of the total actual 2004 emissions of F-gases. The percentage shares in previous years were higher, but decreased mainly because of a decrease in use of F-gases in this category. No data are available for more precise emission calculations and this category is not very important.

4.6.3.6 Electrical Equipment

Emissions from this category are calculated according to 2000 GPG, specifically Equation 3.13., which is called the Tier 3a method. Basic data about new equipment and services can be obtained from above mentioned questionnaires. This equipment is produced by only one company and is serviced by several companies. Emissions from this category correspond to only 2.8 % of the total actual emissions of F-gases in 2004. The share of this category in the total actual emissions has decreased rapidly since 1995 due to a decrease in the use of SF_6 in this sector and increase in the use of HFCs in refrigeration.

4.6.3.7 Others

This category includes the *2.F.9 Other / Laboratories* category. This category was included in the 2006 submission for the first time and encompasses emissions of SF_6 from laboratory use. The share of this sector in the total actual emissions of F-gases is negligible. Potential and actual emissions are calculated in the same way in this sector.

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

No uncertainty analysis has been made for the time being.

Time series consistency is ensured as the relevant inventory approaches are employed identically across the whole reporting period from the base year of 1995 up to 2004.

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

This year, recalculations were performed to replace the potential methodology approach to actual methodology. Details of the applied actual emissions approach are included in Chapter 3.6.3 and its sub-chapters.

In the future, it is planned that data will be obtained about lifetime of refrigeration and air-conditioning equipment and information about disposal and destruction of equipment containing F-gases.

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 2004, CO_2 emissions were calculated at the level of 0.3 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 Ltd. 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.
- regular monitoring of economic activities and economic developments in the CR, knowledge and monitoring of important operations in the sphere of surface treatments, especially in the area of application of coatings, degreasing and cleaning
- regular monitoring of investment activities is performed in the CR for technical branches affecting the consumption of solvents and for overall developmental technical trends of all branches of industry
- monitoring of implementation of BAT in the individual technical branches
- technical analysis of consumption of solvents in households; NMVOC emissions from households are entirely fugitive and, according to qualified estimates, contribute 16.5 % to total NMVOC emissions.

5.1 Activity data and transfer of data to the CRF Reporter

The activity data used in the individual categories and subcategories vary considerably. Basic processing of data is performed in a more detailed classification than that used in the CRF Reporter. A survey of the individual groups of products and the formats of the activity data for basic processing of emission data are apparent from the following survey.

Tab. 5.2 Structure for basic processing of emission data and the dimensions of activity data

A Paint Application	**EF - units**
PAINT APPLICATION - MANUFACTURE OF AUTOMOBILES	10^3 m^2
PAINT APPLICATION - CAR REPAIRING	t of paint
PAINT APPLICATION - CONSTRUCTION AND BUILDINGS	t of paint
PAINT APPLICATION - DOMESTIC USE	t of paint
PAINT APPLICATION - COIL COATING	10^3 m^2
PAINT APPLICATION - WOOD	t of paint
OTHER INDUSTRIAL PAINT APPLICATION	t of paint
OTHER NON INDUSTRIAL PAINT APPLICATION	t of paint
B Degreasing and Dry Cleaning	
METAL DEGREASING	t
DRY CLEANING	t
ELECTRONIC COMPONENTS MANUFACTURING	t
OTHER INDUSTRIAL CLEANING	t
C Chemical Products Manufacture / Processing	
POLYESTER PROCESSING	t
POLYVINYLCHLORIDE PROCESSING	t
POLYSTYRENE FOAM PROCESSING	t
RUBBER PROCESSING	t
PHARMACEUTICAL PRODUCTS MANUFACTURING	t
PAINTS MANUFACTURING	t
INKS MANUFACTURING	t
GLUES MANUFACTURING	t
ADHESIVE MANUFACTURING	t
ASPHALT BLOWING	t
TEXTILE FINISHING	10^3 m^2
LEATHER TANNING	10^3 m^2
D Other	-

It is apparent from the table that uniform expression of the activity data cannot be employed, as this corresponds in the individual cases to consumption of coatings, degreasing agents, solvents and, in some cases, the weight of the final production, e.g. Dry Cleaning. Consequently, total NMVOC emissions are employed as activity data in the CRF Reporter.

NMVOC emissions oxidize relatively rapidly in the atmosphere, so that CO_2 emissions generated as a consequence of this atmospheric oxidation are also reported in CRF. The CO_2 emissions are calculated using a conversion factor that contains the ratio C/NMVOC = 0.855 and a recalculation ratio of C to CO_2 equal to 44/12. The overall conversion factor has a value of 3.14.

5.2 Trends

NMVOC emissions exhibit a long-term decreasing trend. This is caused by a great many factors, the chief of which are primarily gradual replacement of synthetic coatings and other agents with a high content of volatile substances by water-based coatings and other preparations with low solvent contents in industry and amongst the population. In addition, BAT have been introduced in large industrial enterprises, especially those covered by the regime of Act No. 76/2002 Coll., on integrated prevention (IPPC). This favourable trend has been slowed down recently by increasing domestic production, especially in the automobile industry.

Tab. 5.3 Trend of NMVOC emissions from Solvent and Other Product Use *[Gg NMVOC]*

	1990	1991	1992	1993	1994	1995	1996	1997
Emissions NMVOC	175.1	163.4	151.6	138.7	127.8	121.5	118.4	117.8
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	
Emissions NMVOC	116.4	115.8	112.6	106.7	103.5	98.8	97.0	

5.3 QA/QC procedures and recalculations

The emission data in this section were taken from the UNECE / CLRTAP inventories in NFR. Annual reports are available on the method of calculation of the individual years from 1998. Following transfer of the emission data to the new CRF Reporter, it was apparent that trends in the emissions for all of Sector 3 – Solvent and Other Product Use – did not exhibit any significant deviations.

A control was performed of the company processing the data (SVÚOM Ltd. Prague) and the coordinator of processing of UNECE / CLRTAP inventories in NFR. It was found that more exact data was available to 2000, permitting placing of consumption of the individual types of solvents and other preparations containing NMVOC in individual subcategories, from which the emissions are calculated in 4 main subcategories of *Sector 3 – Solvent and Other Product Use*. As the total consumption of substances containing NMVOC in all of CR is relatively well known, from 2000 the emissions which could not be identified in individual subcategory *3.B. – Decreasing and Dry Cleaning* were transferred to *Category 3.D. – Other Solvent Use*, because they were lacking in the overall balance.

At the present time, no recalculation has been performed, but the results of the QA/QC procedures lead to the conclusion that it will be advantageous in the near future to perform slight correction of the data from 2000.

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 by denitrification processes in soils. 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	1.2
Enteric fermentation	Key source	CH_4	1.6
Manure management	-	CH_4	0.3
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. As enteric fermentation is considered according to Tab. 6.1 to constitute a *key source*, preference should be given to determination in Tier 2.

For quite a long time, calculations were based on historical studies (Dolejš, 1994) and (Jelínek *et al*, 1996). In principle, emissions from animal excrements could be calculated according to Tier 1 (this is not a *key source*); however, because of tradition and for consistency of the time series, the final values were also calculated according to Tier 2 using the emission factors from above-mentioned studies (Dolejš, 1994; Jelínek et al, 1996). An approach based on historical studies was indicated to be obsolete in many reviews organized by UNFCCC. Moreover, IEFs (implied emission factors) were mostly found as outliers: especially EFs for enteric fermentation in cattle seemed to be substantially underestimated. Details of the historical approach are given in former NIRs.

The Czech team accepted critical remarks put forth by the International Review Teams (ERT) and prepared a new concept for calculation of CH_4 emissions. This new concept, in accordance with the plan for implementing Good Practice, is based on the following options:

1) Emissions of methane from enteric fermentation of livestock (a *key source*) come predominantly from cattle. Therefore Tier 2, as described in Good Practice (*Good Practice Guidance*, 2000) is applied only to cattle.
2) CH_4 emissions from enteric fermentations of other farm animals are estimated by the Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighbouring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed.
3) CH_4 emissions from manure management for all farm animals are estimated by the Tier 1 approach. For similar reasons as in the previous paragraphs, default EFs for Western Europe were employed.

Increased attention was first paid to enteric fermentation. It was stated that cooperation with specialized agricultural experts is crucial to obtain new consistent and comparable data of suitable quality. The relevant nationally specific data, milk production, weight, weight gain for growing animals, type of stabling, etc. were collected by our external experts (Hons and Mudrik, 2003). Moreover, statistical data for sufficiently detailed classification of cattle, which are available in the Czech Republic, were also collected at the same time. Calculation of enteric fermentation of cattle using the Tier 2 approach was described in a study (Kolar, Havlikova and Fott, 2004) for the whole time series since 1990 using the above-mentioned country-specific data. The necessary QA/QC procedures were performed in cooperation with experts from IFER, which is now taking over responsibility for sector 4 “Agriculture” in accordance with the National Inventory System.

6.2.1 Enteric fermentation of cattle

As the most important output of the national study (Kolar, Havlikova and Fott, 2004), a system of calculation spreadsheets have been developed and used for all the relevant calculations of CH_4 emissions: new results for 2004 and recalculations of the whole time series in the 1990 – 2003 period.

The emission factor for methane from fermentation (EF) in kg / head p.a. according to the (*Revised 1996 IPCC Guidelines*, 1997) and (*Good Practice Guidance*, 2000) is proportional to the daily food intake and the conversion factor. It thus holds that

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

where the “daily food intake” (MJ / day) is taken as the mean feed ration for the given type of cattle (there are several subcategories of cattle) and Y is the conversion factor, which is considered to be Y = 0.06 for cattle. Coefficient 55.65 has dimensions of MJ / kg CH_4.

In principle, this equation should be solved for each cattle subcategory, denoted by index i. The Czech Statistical Office, see (*Statistical Yearbooks*, 1990 – 2005), provides following categorization of cattle:

- Calves younger than 6 months of age
- Young cattle 6 – 12 months of age (young bulls, young heifers)
- Bulls over 1 year of age, including bullocks (1 – 2 years, over 2 years)
- Heifers 1 – 2 years of age
- Heifers over 2 years of age
- Cows

More disaggregated sub-categories given above in parenthesis are given in the study by external agricultural consultants of CHMI (Hons and Mudrik, 2003). In the calculation, it is also very important to distinguish between dairy and sucker cows (nursing cows), where the fraction of sucker cows (sucker cows / all cows) gradually increased in the 1990 – 2004 time period from 2.43 % assessed for 1990 to 17 % for 2004, see (Hons and Mudrik, 2003).

According to the IPCC methodology, Tier 2 (*Revised 1996 IPCC Guidelines*, 1997 and *Good Practice Guidance*, 2000), the “daily food intake” for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight (including the final weight of mature animals), weight gain (for growing animals), daily milk production including the percentage of fat (for cows) and the feeding situation (stall, pasture). Examples of input data used (Hons and Mudrik, 2003) are given below, Tab. 6.2 – Tab. 6.4.

Tab. 6.2 Weights of individual categories of cattle, 1990 – 2004, in kg

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004
Mature cows (dairy and sucker)	520	540	580
Heifers > 2 years	485	490	505
Bulls and bullocks > 2 years.	750	780	820
Heifers 1-2 years	380	385	395
Bulls 1-2 years	490	510	530
Heifers 6-12 months	275	280	285
Bulls 6-12 months	325	330	335
Calves to 6 months	128	132	133

Tab. 6.3 Weight gains of individual categories of cattle, 1990 – 2004, in kg / day

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004
Heifers 1-2 years	0.69	0.74	0.73
Bulls 1-2 years	0.74	0.76	0.84
Heifers 6-12 months	0.55	0.63	0.70
Bulls 6-12 months	0.82	0.94	1.12
Calves to 6 months	0.58	0.62	0.68

Tab. 6.4 Feeding situation, 1990 – 2004, in % of pasture, otherwise stall is considered

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004
Mature cows (dairy and sucker)	10	20	20
Heifers > 2 years	30	30	30
Bulls and bullocks > 2 years	30	40	40
Heifers 1-2 years	30	40	40
Bulls 1-2 years	30	40	40
Heifers 6-12 months	30	40	40
Bulls 6-12 months	30	40	40

Percentages of pasture are related only to the summer part of the year (180 days), while only the stall type is used in the rest of year. Milk production statistics are displayed in Tab. 6.4., in which only milk from dairy cows is considered. Milk from sucker cows is not included in this table; the relevant daily milk production of 3.5 l /day head was used for the calculation.

As the official statistics (specifically from the Czech Statistical Office) provide population values for cows and other cattle, the resulting EFs in the CRF tables are defined for the categories of “all cows” and “cattle other than cows”, even though the relevant cells in the CRF are denoted as “dairy cows” and “other cattle”.

Details of the calculation are given in the above-mentioned study (Kolar, Havlikova and Fott, 2004) and the results are illustrated in Tab. 6.6. It is obvious that EFs have increased slightly since 1990 because of the increasing weight and milk production for cows and because of the increasing weight and weight gain for other cattle. It is remarkable that default values for Western Europe were attained in the mid nineties (100 and 48 kg CH_4 / head p.a.). On the other hand, CH_4 emission form enteric fermentation of cattle dropped during the 1990 – 2004 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

Tab. 6.5 Milk production of dairy cows, 1990 – 2004

	Dairy cows [thousands]	Milk production [thousands liters per year]	Daily production [liters / day head]	Fat content [%]
1990	1206.0	4 695 770	10.67	4.03
1991	1165.0	4 096 310	9.63	4.09
1992	1006.1	3 720 648	10.13	4.07
1993	902.0	3 349 971	10.18	4.10
1994	796.1	3 133 907	10.79	4.04
1995	732.1	3 031 091	11.34	4.02
1996	712.6	3 039 290	11.69	4.08
1997	656.3	2 703 493	11.29	4.02
1998	598.4	2 716 317	12.44	4.05
1999	583.3	2 736 226	12.85	4.03
2000	547.7	2 708 119	13.55	4.00
2001	528.7	2 701 761	14.00	4.03
2002	495.7	2 727 578	15.08	3.98
2003	489.7	2 646 000	14.80	3.98
2004	475.6	2 569 759	14.80	3.98

Tab. 6.6 Methane emissions from enteric fermentation, cattle (Tier 2), 1990 – 2004

	Cows [thousands]	Other [thousands]	EF, cows [kg CH_4 / hd]	EF, other [kg CH_4 / hd]	Em, cows [Gg CH_4]	Em, other [Gg CH_4]	Emissions [Gg CH_4]
1990	1236	2296	96.01	44.38	118.7	101.9	220.6
1991	1195	2165	92.16	44.98	110.1	97.4	207.5
1992	1036	1914	93.95	46.08	97.3	88.2	185.5
1993	932	1580	94.20	45.61	87.8	72.1	159.9
1994	830	1331	96.04	45.36	79.7	60.4	140.1
1995	768	1262	99.84	47.58	76.7	60.1	136.7
1996	751	1238	101.38	47.86	76.1	59.2	135.4
1997	702	1164	99.04	48.35	69.5	56.3	125.8
1998	647	1054	103.27	48.36	66.8	51.0	117.8
1999	642	1015	107.09	50.99	68.8	51.8	120.5
2000	615	960	108.76	51.13	66.9	49.1	116.0
2001	611	971	109.52	51.47	66.9	50.0	116.9
2002	596	924	111.42	51.87	66.4	47.9	114.3
2003	590	884	110.42	52.14	65.2	46.1	111.2
2004	573	855	110.43	52.03	63.3	44.5	107.8

6.2.2 Enteric fermentation of other livestock

Compared to cattle, the contribution of other farm animals to the whole CH_4 emissions from enteric fermentation is much smaller, only about 5 %. Therefore, CH_4 emissions from enteric fermentation of other farm animals (other than cattle) are estimated by the Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighbouring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed. The obsolete national approach used in the past, which was found not to be comparable with other European countries (Dolejš, 1994 and Jelínek *et al*, 1996), was definitively abandoned. In this (2006) submission, newly recalculated values are presented for the whole period since 1990.

6.2.3 Emissions of methane from manure management

Methane emissions from manure management were not identified as a key source and hence CH_4 emissions from manure management for all farm animals are estimated by the Tier 1 approach. Default EFs for Western Europe were employed for similar reasons as in the previous paragraph. Similarly as for enteric fermentation, the obsolete national approach used in the past was abandoned because of lack of comparability with other countries. In this (2006) submission, newly recalculated values are presented for the whole period since 1990.

6.3 Nitrous Oxide Emissions

Nitrous oxide emissions from agriculture are calculated by the Tier 1 approach of the IPCC methodology, which includes:

- direct emissions from agricultural soils
- emissions from animal stables and manure management
- indirect emissions coming from atmospheric deposition
- indirect emissions from nitrogenous substances flushed into water courses and reservoirs

For the relevant calculations, a set of interconnected spreadsheets in EXCEL elaborated according to the IPCC methodology (*Revised 1996 IPCC Guideline*s, 1997) has been used for several years. The standard calculation of Tier 1 required the following input information:

- the number of head of farm animals (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 Yearbooks of the Czech Republic (*Statistical Yearbooks*, 1990 – 2005).

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 has not yet been classified according to this system, we performed the calculation for AWMS parameters presented in the IPCC methodology (*Revised 1996 IPCC Guideline*s, 1997) for the case of Western Europe. Nevertheless, collection of the relevant country specific AWMS parameters is under way and perhaps it will be possible to employ such an approach sometime in the future.

6.4 Emission Trends

The trend series should now be consistent both for methane and for nitrous oxide. For methane, 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 partly stabilized somewhat in agriculture since 1994.

Tab. 6.7 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	4868.85	1009.39	5975.25	3619.47
1991	4587.79	969.03	5122.13	3041.61
1992	4111.38	888.58	4378.75	2580.13
1993	3556.47	810.73	3865.70	2219.11
1994	3114.53	710.53	3699.23	2123.80
1995	3032.24	673.44	3716.28	2164.35
1996	3003.74	676.64	3499.59	2000.39
1997	2801.94	656.46	3526.56	2022.13
1998	2627.34	624.48	3403.80	1944.97
1999	2683.38	619.30	3384.89	1920.59
2000	2577.06	585.53	3316.07	1915.18
2001	2595.87	582.08	3450.61	1965.19
2002	2534.90	558.52	3338.70	1927.58
2003	2468.19	541.76	3018.52	1749.89
2004	2389.81	516.03	3328.21	1810.05

6.5 OA/QC, Recalculations and Plans for Improvement

In the process of implementation of the Good Practice (*Good Practice Guidance*, 2000) increased attention was first paid to enteric fermentation, which has led to a decision to revise the existing method of determination methane emissions. It was stated that cooperation with specialized agricultural experts is crucial to achieve new consistent and comparable data of the proper quality. As explained in the beginning of this chapter, the traditional but obsolete approach was found to be unacceptable. Furthermore, recalculations of CH_4 emissions from Agriculture were also recommended by several recent Review Reports under the UNFCCC review process for National GHG inventories.

Consequently, it was decided to revise the entire procedure for calculation of methane emissions from livestock in accordance with the *Good Practice Guidance*. Recently, such an approach (Tier 2) 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 - 2003 period using nationally specific data collected by our external experts (Hons and Mudrik, 2003). As stated in the relevant part of Chapter 6.2, other methane emissions from Agriculture were also recalculated by Tier 1 methods and reported this year as a part of the 2006 submission using new software (CRF Reporter).

Definitive recalculation of the entire methane emission series from Agriculture since 1990 was checked (QA/QC procedures) by experts from IFER. This institute (Institute of Forest Ecosystem Research, IFER) has become a new sector compiler for Agriculture and also for LULUCF (see the next Chapter) as an integral part of the consortium of institutions forming the National Inventory System, NIS.

In relation to the consistency of the emission series for N_2O, it should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology (*Revised 1996 IPCC Guidelines*, 1997). Emission estimates for 1990, 1992, 1994 and 1995 were obtained and reported in several recent years; the data for 1991 and 1993 are reported (together with the current year, 2004) this year as part of the 2006 submission.

Relevant QA/QC procedures for agriculture will be implemented in accordance with the general QA/QC plan given in Chapter 1. Close cooperation of experts from IFER and CHMI is expected to achieve this goal. To achieve improvements in the future, the NIS team plans to implement the Revised 2006 IPCC Guidelines as soon as they are approved and launched. The NIS team believes that the new methodology helps to better identify and address existing gaps, specifically in the area of emissions and removals of GHG from different kinds of soils.

7 Land Use, Land-Use Change and Forestry (CRF Sector 5)

7.1 Overview

The emission inventory of the Land Use, Land Use Change and Forestry (LULUCF) sector includes emissions and removals of greenhouse gases resulting from land use, land-use change and forestry. The inventory is based on the application of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG for LULUCF; IPCC 2003) and the new reporting format adopted by the 9th Conference of Parties to UNFCCC. Hence, this submission represents a new revision (recalculation) of the greenhouse-gas inventory concerning forests (previously reported under category 5.A. of the earlier reporting format) and a new estimation for other land-use categories (previously not reported).

In the Czech Republic, approximately 54 % of the land is under agriculture (cropland and grassland), 34 % is covered by forests, 10 % represents settlements and other land including infrastructure, while open water and wetlands account for less than 2 %.

The implementation of GPG for LULUCF in the national emission inventory means manifold new requirements on the inventory of the sector. It should be noted that these requirements can be implemented only gradually and stepwise in this country. Hence, the current inventory of the LULUCF sector represents the initial phase of this revision and will undergo further development, consolidation and refinement in the coming years. In this context, it is necessary to consider the current submission as transitory, leading to further improvement of the estimates of this sector.

The current inventory includes CO_2 emissions and removals and emissions of non-CO_2 gases (CH_4, N_2O, NO_x and CO) for *in-situ* burning in forestry. The assessment discerns six major LULUCF land-use categories: 5.A.: Forest Land, 5.B.: Cropland, 5.C.: Grassland, 5.D.: Wetlands 5.F.: Settlements and 5.F.: Other Land, which were linked to the categories of the Czech cadastral classification of lands. Additionally, emissions from liming on Cropland and Grassland are presented in the corresponding CRF tables

The current submission covers the whole reporting period from the base year of 1990 to 2004.

7.1.1 Estimated emissions

Tab. 7.1 provides a summary of the LULUCF GHG estimates for the base year 1990 and the most recent year 2004. In 2004, the net GHG flux for the LULUCF sector estimated as the sum of CO_2 emissions and removals equalled -4.87 Mt, hereby representing the net removal of GHG gases. In relation to the sum of emissions estimated in other sectors in the country, the removals realized within the LULUCF sector decrease the GHG emissions by 3.3 %. In the base year of 1990, the corresponding total emissions and removals in the LULUCF sector equalled –1.78 Mt CO_2. In relation to the emissions estimated for all the other sectors, the inclusion of the LULUCF estimate represents a reduction in total emissions by 0.9 % for the base year 1990.

It is important to note that the emissions within the LULUCF sector exhibit a high inter-annual variability and the values shown in Tab. 7.1 should not be interpreted as trends. The entire data series can be found in the corresponding CRF tables.

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of CO_2. The major source of CO_2 in the LULUCF sector is represented by land conversion of Forest Land and Cropland to Other Land (Tab. 7.1). The major sink of CO_2 in the LULUCF sector is represented by carbon stock change in biomass in the category Forest Land remaining Forest Land.

The emissions or removals for several land-use categories are considered to be negligible and assumed to equal zero (Tab. 7.1). These assumptions are based on applying the Tier 1 estimation methodology of GPG for LULUCF, on the negligible area of the respective category of land-use or land use change and/or on the lack or negligible extent of management activities that would result in GHG emissions.

Tab. 7.1 GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2004.

Sector/category	Emissions 1990 Gg CO_2 eq.	Emissions 2004 Gg CO_2 eq.
5. Total Land-Use Categories	**-1779**	**-4871**
5.A. Forest Land	**-4139**	**-5615**
5.A.1. Forest Land remaining Forest Land	-3986	-5499
5.A.2. Land converted to Forest Land	-152	-116
5.B. Cropland	**1108**	**66**
5.B.1. Cropland remaining Cropland	(0)	(0)
5.B.2. Land converted to Cropland	(0)	(0)
5.C. Grassland	**-384**	**-115**
5.C.1. Grassland remaining Grassland	(0)	(0)
5.C.2. Land converted to Grassland	-442	-118
5.D. Wetlands	**18**	**4**
5.D.1. Wetlands remaining Wetlands	(0)	(0)
5.D.2. Land converted to Wetlands	18	4
5.E. Settlements	**(0)**	**(0)**
5.E.1. Settlements remaining Settlements	(0)	(0)
5.E.2. Land converted to Settlements	(0)	(0)
5.F. Other Land	**1618**	**789**
5.F.1. Other Land remaining Other Land	(0)	(0)
5.F.2. Land converted to Other Land	1618	789

7.1.2 Methodology for representing land-use areas

The implementation of GPG for LULUCF (IPCC 2003) represents a major revision of the emission inventory for this sector. The new reporting format requires the estimation of GHG emissions into the atmosphere by sources and sinks for six land-use categories, namely Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land. Each of these categories is divided into lands that remain in this category during the inventory year, and lands that are newly converted into the category. Accordingly, GPG for LULUCF outline the appropriate methodology to estimate emissions.

The consistent representation of land areas and identification of land-use changes are very essential steps in the inventory of the sector in line with GPG for LULUCF. Under the conditions in the Czech Republic, the identification of land-use categories was based on two key data sources. The information on the areas of individual land-use categories was based on the information of the Czech Office for Surveying, Mapping and Cadastre (COSMC), which is updated annually and published in the statistical yearbooks. The second data source utilized was the Land Cover Database of the Pan-European CORINE project (reference year 1990) and its up-dated version (reference year 2000), administered by the Czech Ministry of Environment. In this country, CORINE provides identification and mapping of 44 land use categories on a scale 1:100 000 for the years 1990 and 2000. COSMC and CORINE databases use different land use classifications that were linked so as to match the land-use categories of GPG for LULUCF (IPCC 2003). More details on linking land-use categories are given in the report to the Czech Ministry of Environment (Cienciala et al. 2005a) devoted to GHG inventory revision and implementation of GPG for LULUCF. One notable decision concerning land-use categories was to include the permanently un-stocked cadastral forest land in the IPCC category of Other Land. This also means that the Forest Land category in the current emission inventory includes only the lands used to grow forest under the accepted definition of a forest (see more in chapter 7.3).

The areas of land-use categories as of 1970, 1975, 1980, 1985, 1989 and annually until 2004 were used in this inventory. Cropland was the only category showing a decreasing trend since 1990, while the areas of other land-use categories have increased since 1990 (Fig. 7.1).

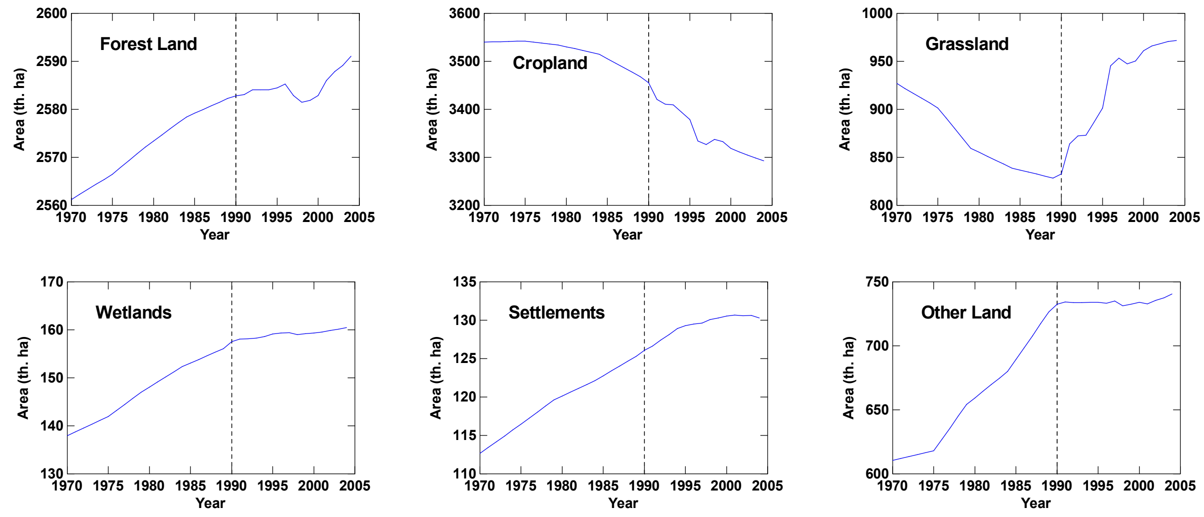


Fig. 7.1 Areas of the six major land-use categories in the Czech Republic between 1970 and 2004 (based on information from the Czech Office for Surveying, Mapping and Cadastre)

In addition to static information on land areas, it is essential to identify land use changes in terms of the type of land-use change concerned, i.e., changes from and to a particular category (Chapter 2, IPCC 2003). Since this information is not available for all land in the country since 1990, the identification of land-use changes was based on the CORINE datasets of 1990 and 2000. Overlapping the two surveys yielded a matrix representing land use transitions for the period of 10 years. Expressed in relative values (Tab. 7.2), the matrix was used to quantify the absolute transition areas of the specific land use categories in the individual years. This was performed so that each land-use change in the six major categories estimated from the cadastral data for two consecutive years was attributed by the corresponding shares of the relative matrix (Tab. 7.2).

Tab. 7.2 The identified shares of land-use change among the major land-use categories on the basis of CORINE datasets of 1990 and 2000 in the Czech Republic.

		Year 0 (1990)					
		Forest L.	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other Land**
Year 1 (2000)	**Forest Land**	-	0.033	0.473	0.014	0.010	0.470
	Cropland	0.023	-	0.890	0.001	0.005	0.081
	Grassland	0.001	0.991	-	0.000	0.001	0.007
	Wetlands	0.116	0.243	0.548	-	0.019	0.075
	Settlements	0.017	0.784	0.192	0.000	-	0.007
	Other Land	0.231	0.498	0.113	0.001	0.156	-

For example, Tab. 7.2 shows that a certain area of new Forest Land was attributed to conversion from Grassland (47.3 %), Other Land (47.0 %), etc. Thus, while the relative assignment remained constant, the absolute area changes differed annually in line with the cadastral information. This was performed for each individual year of the inventory. As no data were available on land use change representation before 1990 and beyond 2000, the same matrix of relative shares was also used for the period before the year 1990 and after the year 2000. This methodology can be classified as a combination of Approach 1 (Basic land use data) and Approach 2 (Survey of land use and land-use change) of GPG for LULUCF (IPCC 2003). Although the type of land-use conversion is identified, the annual land-use change matrix contains some inconsistencies, which are due to the modeling approach used. These inconsistencies were relatively small (within 0 to 0.5 %) relative to the respective areas of individual categories.

The land use changes that can be considered as significant were identified on the basis of the cumulative sums of the areas with the threshold of 95 % of all changes. The dominant land-use changes were the following conversions: i) Cropland to Grassland (representing 72.9 % of the total area under land-use change), ii) Cropland to Other Land (4.9 %), iii) Grassland to Cropland (4.6 %), iv) Grassland to Forest Land (2.9 %), v) Other Land to Forest Land (2.9 %), vi) Forest Land to Other Land (2.3 %), vii) Cropland to Settlements (2.1 %), viii) Settlements to Other Land (1.6 %) and ix) Grassland to Wetlands (1.3 %). Jointly, these changes represent 95.6 % of the area under land-use change. All other types of land-use change were considered to be insignificant with basically no effect on GHG emissions.

The historical data since 1970 were used to trace the lands under land use change for the period of 20 years needed for application of Tier 1 methods for soil carbon stock change. It was employed for the areas of category 5.A.2: Land converted to Forest Land, in line with GPG for LULUCF (Chapter 3; IPCC 2003). Hence, the areas of 5.A.2 represent the accumulated lands under transition for 20 years, while the conversion areas of other land-use categories were treated as annual transitions of lands between categories.

Tab. 7.3 lists the forest areas in the country and their attribution in the current inventory revision. The areas reported under category 5.A. Forest Land include the subcategory Forest Land remaining Forest Land (CRF 5.A.1.) and Land converted to Forest Land (CRF 5.A.2). The permanently unstocked area, normally included within cadastral forest land, is treated within Other Land (OL) in this emission inventory. Summarization of all the above categories yields the total cadastral forest area in the Czech Republic.

Tab. 7.3 Overview of forest land areas in the Czech Republic and their treatment in this inventory (kha)

Year	FL remaining FL (CRF 5.A.1.).	L converted to FL (CRF 5.A.2)	Unstocked area (Incl. in OL)	Cadastral forest area
1990	2562.40	20.38	46.70	2629.48
1991	2563.41	19.62	46.26	2629.30
1992	2564.47	19.58	45.02	2629.08
1993	2565.48	18.60	44.55	2628.63
1994	2566.46	17.60	45.44	2629.50
1995	2567.49	16.97	45.67	2630.13
1996	2568.87	16.40	45.73	2630.99
1997	2567.83	15.06	48.91	2631.80
1998	2567.71	13.73	52.38	2633.82
1999	2569.07	12.78	52.63	2634.47
2000	2570.31	12.53	54.46	2637.29
2001	2571.67	14.31	52.93	2638.92
2002	2572.97	14.90	55.20	2643.06
2003	2574.23	14.94	55.01	2644.17
2004	2575.52	15.53	54.69	2645.74

7.1.3 Methodology to estimate emissions

The estimation of emissions and removals of CO_2 and non-CO_2 gases for the sector was performed according to Chapter 3 of GPG for LULUCF (IPCC 2003). As it represents a major revision of the emission inventory for the LULUCF sector, it has been applied to the entire time period since the base year of 1990 up to 2004.

Currently, only the estimation of carbon stock changes in biomass (identified as the only key category of the LULUCF sector) in the category of Forest Land ranks as Tier 2 methodology. The approaches employed for the other categories rank as Tier 1 methods, or mixed Tier 1/Tier 2 once land area identification is also considered. The following text describes the inventory for the individual land-use categories, noting the vital information on the category within the conditions of this country, methodology applied, uncertainty and time consistency, QA/QC and verification, recalculations (if applicable) and source-specific planned improvements.

7.2 Forest Land (5.A.)

7.2.1 Source category description

This category includes emissions and sinks of CO_2 associated with forests and non-CO_2 gases generated by burning in forests. The category is composed of 5.A.1. Forest Land remaining Forest Land, and 5.A.2: Land converted to Forest Land.

The Czech Republic is a country with a long forestry tradition. Practically all the forests in the Czech Republic can be considered to be temperate-zone managed forests under the IPCC definition of forest management (GPG Chapter 3, IPCC 2003). With respect to the definition thresholds of the Marrakesh Accords (MA), forest land is defined as land with woody vegetation and with tree crown cover of at least 20 %, over an area exceeding 0.05 ha containing trees able to reach a minimum height of 2 m at maturity[7]. This definition excludes the areas of permanently unstocked cadastral forest land, which was (as mentioned above) treated within the category of Other Land. Hence, Forest Land in this emission inventory corresponds to the national definition of timberland (Czech Forestry Act 84/1996).

In 2004, the stocked forest area (timberland) qualifying under the category of Forest Land in this emission inventory equalled 2 591 th. ha, representing about 98 % of the cadastral forest land in the Czech Republic (the remaining area represents the permanently unstocked areas treated as Other Land in this inventory).

Forests currently occupy 33.6 % of the area of the country. The tree species composition is dominated by conifers, which represent 75.5 % of the forest area. The four most important tree species in this country are spruce, pine, beech and oak: as of 2004, they accounted for 53.3, 17.3, 6.5 and 6.5 % of the total forest area, respectively. Broadleaved tree species have been favoured in new afforestation since 1990. The proportion of broadleaved tree species increased from 21 % in 1990 to over 24 % in 2004. The total growing stock (merchantable wood volume) in forests of the country has increased constantly since 1990 (564 mil. m^3) to 658 mil. m^3 in 2004.

The primary source of activity data on forests in this country is the data in Forest Management Plans (FMP), which are administered centrally by the Forest Management Institute (FMI), Brandýs n. L. With a cycle of forest management plans of 10 years, the annual update of the FMP database is related to 1/10 of the total forest area scattered throughout the country. The information in FMP represents an ongoing national stand-wise type of forest inventory[8], on which this emission inventory is also based. FMP data were aggregated in line with the country-specific approaches at the level of four major tree species (i-beech: all broadleaved species except oaks, ii-oak: all oak species, iii-pine: pines and larch, iv-spruce: all conifers except pines and larch) and age-classes (10 year interval). For these categories, growing stock (merchantable volume, defined as tree stem and branch volume under bark with a

[7] In addition to these parameters, GPG for LULUCF also requires the minimum width to be defined, which will most likely be 20 m for the Czech Republic.

[8] The first cycle of the statistical (sample based, tree level) forest inventory was performed during 2001-2004 in this country by the Forest Management Institute (FMI). The first aggregated results were released by FMI in 2005, indicating significantly higher growing stock volumes than those reported so far for this country. However, this source with only one inventory cycle it is not readily usable for detecting carbon stock change in forests. No decision has yet been made on the 2nd national (statistical) forest inventory cycle (as of March 2006). Nonetheless, the data of the first cycle would be suitable for several other purposes, such as for constructing better and more representative country-specific biomass expansion factors for individual tree species. Unfortunately, FMI blocks releasing tree-level data for the analyses needed. Effective utilization of statistical forest inventory in the near future will also require several methodology adjustments, taking into account the specific needs of the carbon (emission) inventory. These plans are under consideration. Similarly, it remains to be decided how and when the data from the statistical forest inventory of FMI will be used for international reporting.

minimum diameter threshold of 7 cm), the corresponding areas and other auxiliary information was available for each inventory year. It can be observed that the average growing stock has increased steadily for all tree species groups since 1990 in the country (Fig. 7.2).

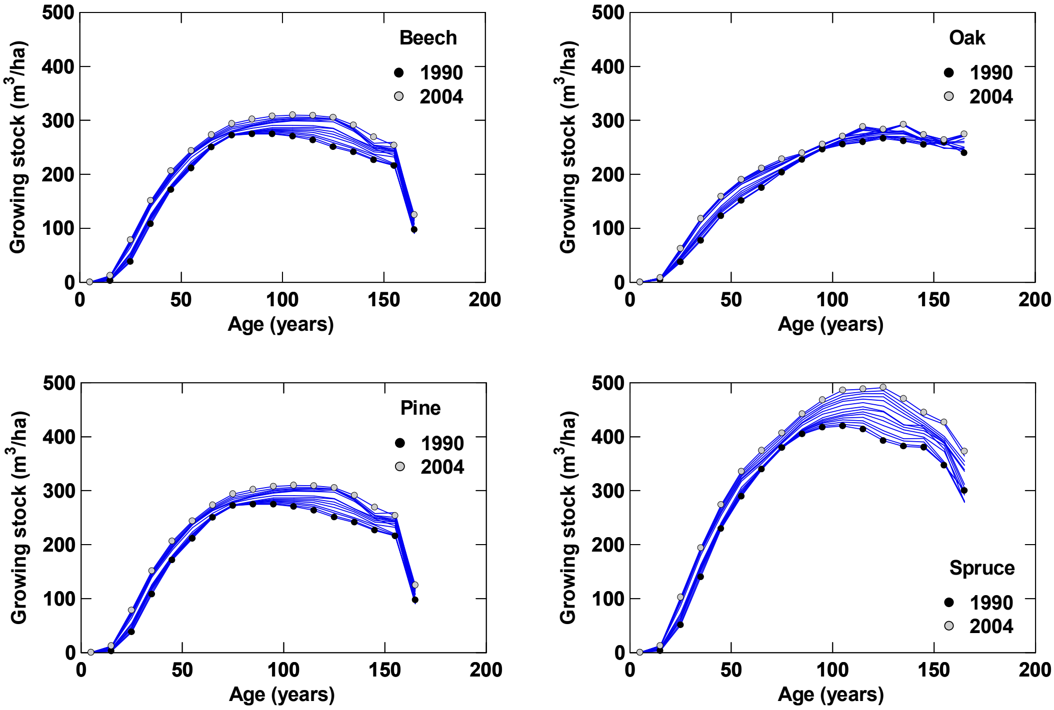


Fig. 7.2 Activity data - average growing stock volume against stand age for the four major groups of species during 1990 to 2004; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2004.

The second key activity information related to forestry is the annual harvest volume. This is available from the Czech Statistical Office. CSO collects this information on the basis of about 600 country respondents (relevant forest companies and forest owners) and encompasses commercial harvest, fuelwood, including a compensation for the forest areas not covered by the respondents. The total drain of merchantable wood from forests increased from 13.3 mil. m^3 (underbark) in 1990 to 15.6 mil. m^3 in 2004.

7.2.2 Methodological aspects

The following text describes the major methodological aspects related to emission inventory of both forest subcategories, i.e., Forest Land remaining Forest Land and Land converted to Forest Land. They were based on the identified land use categories as described in the above sections, and their actual areas can be found in the corresponding CRF Tables.

The methods of area identification employed for the category of Forest Land distinguishes the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory 5.B.1. Forest Land Remaining Forest Land. The other part represents subcategory 5.B.2: Land Converted to Forest Land, i.e., the forest areas "in transition" that were converted over the 20 years since the reporting year from the categories Grassland and/or Other Land. Other types of conversion to Forest Land were found to be insignificant. The identified forest "in transition" represented a fraction of 0.79 % of the total forest land in 1990, and 0.60 % in 2004. In line with the IPCC (2003) requirements of consistent land-use representation and meeting the applied definition of a forest, no other scattered woody vegetation was recorded included within the category of Forest

Land. The areas of forest subcategories, i.e., Forest Land Remaining Forest Land and Land converted to Forest Land, can be found in the corresponding CRF Tables.

Carbon stock change in the category of Forest Land remaining Forest Land is given by the sum of changes in living biomass, dead organic matter and soils. The carbon stock change in living biomass was estimated using the default method[9] according to Eq. 3.3.2 of GPG for LULUCF. This method is built on a separate estimation of increments and removals, and their difference.

The reported growing stock of merchantable volume from the database of FMP was the basis for assessment of the carbon increment (Eqs. 3.2.4 and 3.2.5 of GPG for LULUCF). The key input to calculate the carbon increment is the volume increment data. These values were calculated by FMI on the basis of the current growth and yield model and tables (Černý *et al*. 1996, Černý 2005) used in this country. The volume increment was available from FMI as aggregated values weighted by the proportion of the major tree species and, since 2001 also at the level of the individual major tree species (V. Henžlík – personal communication; Cienciala *et al*. 2005a). The merchantable volume increment (I_v) is converted to the biomass increment (G_{Total}) using a biomass expansion factor applicable to the increment (BEF_1 in Eq. 3.2.5; IPCC 2003) wood density (D) in a slightly adapted Eq. 3.2.5 (IPCC 2003) as

$$G_{Total} = I_V * D * BEF_1 * F_B * (1 + R) \qquad (1)$$

where F_B is a factor expanding volume under bark to volume over bark and R is a root/shoot ratio to include the below-ground component. The total biomass increment is multiplied by the carbon fraction and the applicable forest land area. Tab. 7.4 lists the factors used in the calculation of the biomass carbon stock increase.

Tab 7.4 Input data and factors used in calculation of the carbon stock increment (1990 and 2004 shown)

Variable or conversion factor	Unit	Year 1990	Year 2004
Area of forest land remaining forest land (A)	kha	2562	2576
Biomass expansion factor (BEF_1)	-	1.161	1.162
Carbon fraction in biomass (CF)	t C/t biomass	0.50	0.50
Density of wood (D)	Mg/m^3	0.428	0.433
Expansion to over-bark volume (F_B)	-	1.103	1.103
Root/shoot ratio (R)	-	0.20	0.20
Volume increment (I_v)	m^3	6.60	7.93

In Tab 7.4, A represents only the areas of Forest Land remaining Forest Land, updated annually. BEF_1 is based on IPCC (2003) defaults for broadleaves and conifers, but is weighted by the corresponding proportion of major tree species in this country. CF of 0.50 is a generally accepted default constant, which is also recommended by IPCC (2003). F_B is the average factor of the default values employed for under/over-bark wood volume calculations in this country, weighted by the actual representation of tree species; F_B is set equal to 1.10 for all tree species except oaks, for which F_B is 1.15. D is the conventional wood density defined as oven-dry biomass per volume estimated under fresh conditions, estimated as the corresponding volume-weighted IPCC (2003) default values for the major tree species (beech = 0.58, oak = 0.58, pine = 0.42 and spruce =0.40 Mg/m^3); in the case of beech, D was independently verified in a local experimental study (Cienciala et al. 2005b). R was selected as a conservative value from the range recommended for temperate-zone forests by IPCC (2003). It corresponds well to the available relevant experimental evidence (Černý 1990, Green *et al*. 2006). I_v (as described above) according to tree species is reported annually by FMI, Brandýs n. L, as aggregated values weighted by the actual proportion of tree species.

The estimation of carbon drain (L) in the category Forest Land remaining Forest Land basically follows Eqs. 3.2.6, 3.2.7 and 3.2.8 (IPCC 2003). It uses the reported annual amount of total harvest

[9] Alternative approaches of the stock-change method (Eq. 3.2.3; IPCC 2003) were also analyzed (Cienciala *et al*. 2006) for this category. However, for several reasons the default method was finally adopted, which is discussed in the cited study.

removals (*H*) reported by CSO by individual tree species. *H* covers thinning and final cut, as well as the amount of fuelwood, which is reported as an assortment under the conditions of Czech Forestry. To include a potentially unaccounted loss associated with *H,* the factor F_{HL}[10] (Eq. 2) was applied to *H.* The calculation of carbon drain (*L*; loss of carbon) otherwise follows Eq. 3.2.7 (IPCC 2003) as

$$L = H * F_{HL} * D * BEF_2 * (1 + R) * CF \tag{2}$$

where BEF_2 represents a biomass expansion factor applicable to volumes, which was taken from IPCC (2003) for temperate broadleaved and coniferous forests. Other factors (*CF, D, R*) are identical to those described under Tab. 7.4. Note that IPCC (2003) did not include *R* in the calculation of drain (Eq. 3.2.7). This is an omission that has apparently been corrected in the newly compiled methodological material for Agriculture, Forestry and Other Land Use (AFOLU) that is currently under preparation. Another note regarding adaptation of Eq. 3.2.7 (IPCC 2003) concerns the treatment of the biomass fraction left to decay in forests. This was not addressed explicitly, in line with the default assumption of IPCC (2003) that total biomass associated with the extracted roundwood volume is considered as an immediate emission. The specific values of input variables and conversion factors used to calculate *L* are listed in Tab. 7.5.

Tab. 7.5 Input data and factors used in calculation of carbon drain (1990 and 2004 shown)

Variable or conversion factor	Unit	Year 1990	Year 2004
Harvest volume (*H*) of broadleaves/conifers	Mill. m^3	1.16/12.2	1.68/13.9
Factor of unreported harvest loss (F_{HL})	-	1.02	1.02
Biomass expansion factor (BEF_2) for broadleaves/conifers	-	1.4/1.3	1.4/1.3
Carbon fraction in biomass (*CF*)	t C/t biomass	0.50	0.50
Density of wood (*D*)	Mg/m^3	0.580/0.403	0.580/0.404
Root/shoot ratio (*R*)	-	0.20	0.20

The impact of disturbance (Eq. 3.2.9, IPCC 2003) has not been explicitly estimated. To the present time, the disturbance in Czech forests since 1990 has not reached proportions above the buffering capacity of Czech forestry management practices. Consequently, any salvage felling could be flexibly allocated to the desired amount of planned wood removals, and is thereby implicitly accounted for in the reported harvest volumes.

The assessment of the net carbon stock change in organic matter (deadwood and litter) followed the Tier 1 (default) assumption of zero change in these carbon pools. This is a safe consideration, as the country did not experience significant changes in forest types, disturbance or management regimes within the reporting period. This also applies to the soil carbon pool, in which the net carbon stock change was considered to equal zero (Tier 1, IPCC 2003).

Emissions of other greenhouse gases (CH_4, CO, N_2O and NO_X) in the category of Forest Land remaining Forest Land due to burning of biomass residues were also estimated according to Eq. 3.2.19 and the emission ratios in Table 3A.1.15 (Tier 1, IPCC 2003). Under the conditions in this country, some biomass residues are burned in connection with final cut. The expert judgment employed in this inventory revision considers 30 % of the biomass residues including bark that is burned. This biomass fraction is quantified on the basis of the annually reported amount of final felling volume of broadleaved and coniferous species, BEF_2, *CF* and *D* as applied to harvest removals (above). The amount of biomass burned (dry matter) was estimated as 258 Gg in 1990 and 351 Gg in 2004. The full time series and the associated emissions of non-CO_2 gases can be found in the corresponding CRF tables.

The methods employed to estimate emissions in the Land converted to Forest Land (LCFL) sub-category are similar to those for the category of Forest Land remaining Forest Land, but they differ in some assumptions, which follow the recommendations of GPG for LULUCF. In the Czech Republic,

[10] This was set to match the limits associated with harvest operations in the Forests of the Czech Republic, s. e., the largest forest company in the country (V. Krchov – personal communication).

the LCFL category is related to conversions from two categories, namely from Grassland and from Other Land.

For estimation of the net carbon change in living biomass on LCFL by the Tier 1 method (IPCC 2003), the increment is proportional to the size of afforested areas and the growth of biomass. Under the conditions in this country, all newly afforested lands are considered as intensively managed lands under the prescribed forest management rules. The carbon increment was calculated on the basis of the default IPCC (2003) values for temperate forests (4 and 3 tons of dry matter per hectare and year for broadleaves and conifers, respectively). After weighting by the actual proportion of broadleaves and conifers, the default average biomass increment employed was 3.2 t/ha/year. The carbon loss associated with biomass in the category of LCFL was assumed negligible (zero).

The net changes of carbon stock in dead organic matter (deadwood and litter) were assumed to be negligible (zero), in line with the assumptions of the Tier 1 method (IPCC 2003).

The net changes of carbon in soils were estimated for mineral soils, while for organic soils any changes could safely be considered negligible in this country. According to the Tier 1 method of IPCC (2003), the net carbon change in mineral soils can be estimated for the areas under conversion from Grassland to Forest Land. The method employs Eqs. 3.2.31 and 3.2.32 (IPCC 2003), which quantify the net carbon change as the difference between soil carbon stock under forests (reference) and that under grassland for the corresponding conversion area, divided by the relevant duration (*T*) of the transition from the original to the reference carbon stock. *T* was set at 20 years (Tier 1, IPCC 2003), matching the period of transition for the accumulated land areas reported for the LCFL category. The IPCC (2003) reference values of soil organic carbon (95 t C/ha; soils with high activity clay, cold temperate region), employing the relative stock change factor of land use (1), management regime (0.95) and that for input of organic matter (1) are listed in Table 3.4.5 (IPCC 2003).

7.2.3 Uncertainty and time consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year 1990 to 2004.

The uncertainty estimates have not yet been reported. Their implementation is ongoing and is planned for inclusion in the next NIR. In the category of Forest Land, the preliminary assessment for the two major members of the default method for estimating carbon stock change in living biomass (key category) indicates an aggregated uncertainty of about 50 % for both increment and drain (removals).

7.2.4 QA/QC and verification

Basically all the calculations are based on the activity data taken from the official national sources, such as the Forest Management Institute (Ministry of Agriculture), the Czech Statistical Office, the Czech Office for Surveying, Mapping and Cadastre (COSMC) and the Ministry of Environment. Data sources are verifiable and updated annually. The gradual development of survey methods and implementation of information technology, checking procedures and increasing demand on quality result in increasing accuracy of the emission estimates.

All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

7.2.5 Recalculations

Since this inventory represents a new revision of the emission estimates for the LULUCF sector, all the data were recalculated. The former emission inventory of the LUCF sector reported in the respective NIRs (e.g., Fott et al. 2005) included assessment in former LUCF category 5.A.: Changes in Forest and Other Woody Biomass, based on Henžlík and Zatloukal (1994). This concerned the emissions of CO_2 and non-CO_2 gases (CH_4, N_2O) from burning biomass. Other categories that would be comparable to the current revision were not previously quantified.

In the estimation of CO_2 emissions generated in forestry, the former assessment of LUCF (5.A.) is shown to be smaller by about 34 % as compared to the new estimate for the LULUCF category 5.A. (Fig. 7.3). The reasons for the observed differences are manifold and are related to the differences in the factors employed in Eqs. 1 and 2 (revised for this inventory), inclusion of roots (not included previously; cf., e.g., Fott et al. 2005) and different organization of emission categories, notably the separation of land remaining and converted to forest land.

In the estimation of CH_4 from biomass burning in forests, the average annual difference between the old and new estimates was insignificant, although different approaches were used to assess the amount of biomass burned and differences are pronounced for some years (Fig. 7.4). In contrast, the estimation of N_2O from burning in forests differed substantially as a result of a difference of a factor of 10 in the N/C ratio employed (0.01 and 0.00112 in the new and old estimations).

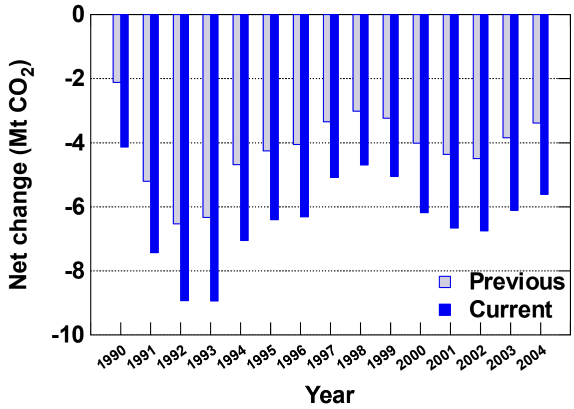


Fig. 7.3 Comparison of the current assessment of the net CO_2 change in the previous reports for the former LUCF category (5.A.) and the current LULUCF category of Forest Land (5.A)

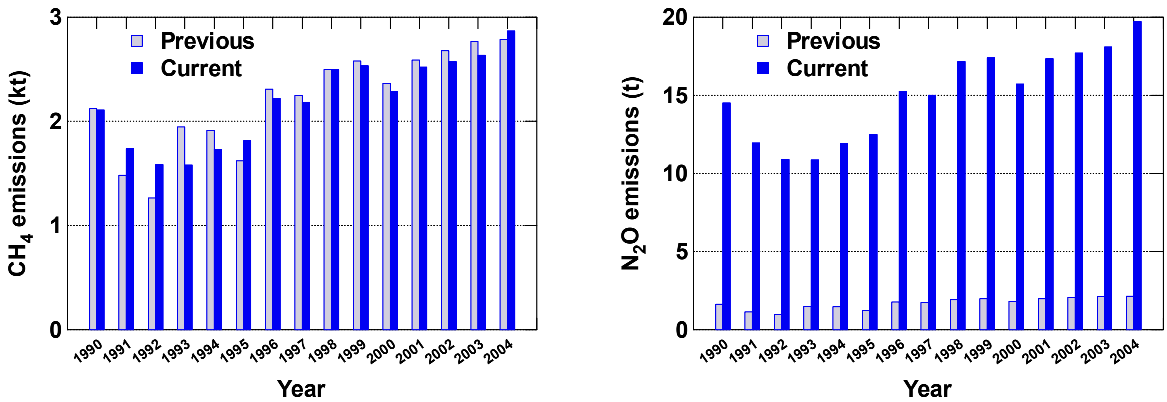


Fig. 7.4 Comparison of the previous and current assessment of CH_4 and N_2O emissions from burning of biomass residues: the net CO_2 change in the previous reports for the former LUCF category (5.A.) and the current LULUCF category of Forest Land (5.A)

7.2.6 Source-specific planned improvements

As noted above, the implementation of GPG for LULUCF will require additional effort to further consolidate the current estimates. Specific attention will be paid to verification of the factors employed in the assessment, as well as to verification of the activity data in the category, and a full assessment of uncertainty in accordance with GPG for LULUCF. Over a longer term, utilization of the stock change method as explored in Cienciala *et al.* (2006) will be considered in connection with the data from the statistical forest inventory (see [8] above).

7.3 Cropland (5.B.)

7.3.1 Source category description

In the Czech Republic, Cropland is predominantly represented by arable land (93 % of the category), while the remaining area includes hop-fields, vineyards, gardens and orchards. Cropland is spatially the largest land-use category in the country. At the same time, the area of Cropland has constantly decreased since the 1970s, with a particularly strong decreasing trend since 1990 (Fig. 7.1). While, in 1990, Cropland represented ca. 44 % of the total area of this country, this share decreased to less than 42 % in 2004. It can be expected that this trend will continue. Agricultural methods are gradually becoming more effective and the current area of arable land is becoming excessive. The conversion of arable land to grassland is also actively promoted by state subsidies. In addition, there is a generally growing demand for land for infrastructure and settlements. The current estimate of probable excess lands qualifying for a conversion to other land-use in the near future is about 600 th. ha. The conversion to grassland concerns mainly the lands of less productive regions of alpine and sub-alpine regions.

7.3.2 Methodological aspects

The emission inventory of Cropland concerns sub-categories 5.B.1. Cropland remaining Cropland and 5.B.2: Land converted to Cropland. The emission inventory of Cropland considers changes in living biomass and soil. In addition, the effect of application of agricultural lime is quantified for this category.

For category 5.B.1. Cropland remaining Cropland, the changes in biomass are estimated only for perennial woody crops. Under the conditions in this country, this might be applicable to orchards. However, since orchards represent only 1.5 % of Cropland and because of the presumably insignificant build-up of biomass there, the carbon stock change in biomass can safely be assumed to be negligible (zero).

The carbon stock changes in soil in the category Cropland remaining Cropland are given by changes in mineral and organic soils. For both of these soil categories, insignificant changes in the carbon content can be expected. This is based on the fact that there have been no major changes in cropland management in the Czech Republic during the recent decades (P. Novák, Research Institute of Ameliorations and Soil Conservation, Prague – personal communication, 2006). Management practices with potential impact on carbon in mineral soils were introduced in the 1960s, when deep ploughing practice was more frequent. In the 1970s, amelioration measures were implemented in some areas with probable impacts on the carbon stock. Changes in the carbon stock related to organic soils can be considered insignificant due to their minimal area representation and exclusion of management practices on these soils.

The application of agricultural lime was previously intensive in the country, but radically decreased during the 1990s. Hence, the amount of lime applied in 1990 equalled over 2.5 mil. t, but decreased to under 200 t annually during the most recent years (see the corresponding CRF Tables). Liming by either limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) is used to improve soil for crop growth by increasing the availability of nutrients and decreasing acidity. However, the reactions associated with lime application also lead to evolution of CO_2, which must be quantified. The quantification followed the Tier 1 method of GPG for LULUCF (Eq. 3.3.6 IPCC 2003), with an emission factor of 0.12 t C.

Category 5.B.2: Land converted to Cropland includes land conversions from other land-use categories. Cropland has generally decreased in area since 1990, but an increment in Cropland was registered once in 1998[11] according to the Czech Statistical Office. This was identified as a conversion from Grassland.

[11] According to the Czech Office for Surveying, Mapping and Cadastre, some units of land were re-classified within a revision performed in 1998. Hence, the information on land use in 1988 was to a certain (indiscernible) extent affected by an administrative intervention. The reported land areas in 1998 were considered equally valid to the other years of the reported period.

The estimation of carbon stock changes in biomass of the category Land converted to Cropland was based on quantifying the difference between the carbon stock before and after the conversion, including the estimate of one year of cropland growth (5 t C/ha; Table. 3.3.8, IPCC 2003). This follows Tier 1 assumptions of GPG for LULUCF and the recommended default values for the temperate zone. The other factors used for this estimation were 2.4 t/ha for peak above-ground biomass, 4 for the expansion factor for roots (R:S ratio), and 0 t/ha for the biomass content after the conversion to Cropland. Note that the employed inventory time period matched the annual update of land-use information obtained from the Czech Statistical Office.

The estimation of carbon stock change in soils for the category of Land converted to Cropland in the Czech Republic concerns the changes in mineral soils and the effect of liming. The soil carbon stock change following the conversion was quantified by the Tier 1 approach as the difference between the stock values attributed to the land-use considered, divided by the inventory period. The pre-conversion soil carbon stock was set at 95 t C/ha (Table 3.3.3; IPCC 2003), while the calculation of the resulting soil carbon content employs the recommended default stock change factors (Table 3.3.4; IPCC 2003) for land use, management and organic matter input equal to 1.0, 0.713 and 1.0, respectively. The stock change factor applicable to management is a weighted value of the factors applicable for a long-term cultivated level for a wet temperate regime (0.71) and temporarily fallow lands (0.82), respectively.

The category Land converted to Cropland generates emissions due to liming, which were estimated from the reported lime use and application area. The quantification approach was identical to that described above for the category of Cropland remaining Cropland.

The category Land converted to Cropland represents a source of non-CO_2 gases, namely emissions of N_2O due to mineralization processes. The estimation followed the Tier 1 approach of Eqs. 3.3.14 and 3.3.15 (IPCC 2003). Accordingly, N_2O was quantified on the basis of the detected changes in mineral soils employing a default emission factor of 0.0125 kg N_2O-N/kg N, and C:N ratio of 15.

7.3.3 Uncertainties and time series consistency

As mentioned above, the uncertainty estimates have not yet been reported. Their implementation is ongoing and is planned for inclusion in the next NIR.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2004.

7.3.4 QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of GPG for LULUCF. Data sources are verifiable and updated annually. All the input information and calculations were provided by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

7.3.5 Recalculations

No recalculations are applicable for Cropland, as this category has not been reported previously.

7.3.6 Source-specific planned improvements

Similarly as for other categories, it must be noted that the implementation of GPG for LULUCF will require additional effort to further consolidate the current estimates. Specific attention will be paid to verification of the activity data and factors related to land management. This may lead to specific stratification of the areas and corresponding refinement of the estimations concerned.

The next NIR will provide assessment of uncertainties in accordance with the requirements of GPG for LULUCF.

7.4 Grassland (5.C.)

7.4.1 Source category description

Through its spatial share of 12 %, the category of Grassland ranks third among land-use categories in the Czech Republic. Its area has been growing rapidly since 1990 (Fig. 7.1). Grassland includes pastures for cattle and meadows for feed growing.

The importance of Grassland will probably increase in this country, both for its production role and to preserve the ecological balance of the landscape. According to the national agricultural programs, the representation of Grassland should further increase to about 18 % of the area of the country. The dominant share will be converted from Cropland, the share of which is still considered excessive. After implementation of subsidies in the 1990s, the share of Grassland has increased by about 2 % since 1990.

7.4.2 Methodological aspects

The emission inventory of Grassland concerns sub-categories 5.C.1. Grassland remaining Grassland and 5.C.2. Land converted to Grassland. Similarly to Cropland, the emission inventory of Grassland considers changes in living biomass and soil. Additionally, the effect of application of agricultural lime is quantified for this category.

For the category Grassland remaining Grassland, the assumption of no change in carbon stock held in living biomass was employed, in accordance with the Tier 1 approach of IPCC (2003). This is a safe assumption for the conditions in this country and any application of higher tier approaches would not be justified with respect to data requirements and the expected insignificant stock changes.

The carbon stock change in soils encompasses changes in mineral soils, organic soils and the effect of liming. The changes in mineral soils for the category Cropland remaining Cropland was not explicitly estimated. However, it can be expected that, under the conditions in this country, the carbon stock changes can be considered insignificant as no explicit change has occurred in the management practiced on this land-use category. The application of Tier 1 approaches would require suitable stratification of soil types for major grassland types, which is not currently substantiated. Similarly, the carbon stock changes for organic soil can safely be considered negligible, due to the insignificant representation of this subcategory and no specific management imposed on these lands in this country. Hence, the only explicitly quantified effect on soil carbon is that of lime application. This was quantified as described in Section 7.3.2 for Cropland. The applicable amount of lime was set at 5 % of the reported use on agricultural land, which is based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005).

For category 5.C.2. Land converted to Grassland, the estimation included Tier 1 approaches for stock change in living biomass and soils. For living biomass, the calculation uses Eq. 3.4.13 (IPCC 2003) with the assumed carbon content before the conversion set at 5 t C/ha (Table 3.4.8; IPCC 2003), the carbon content immediately after the conversion assumed to equal zero and carbon stock from one-year growth of grassland vegetation following the conversion of 6.8 t C/ha (Table 3.4.9; IPCC 2003).

The carbon stock changes for mineral soils under the category Land converted to Grassland were determined as described under the category Land converted to Cropland, with identical default values, but reversed member subtraction. The estimation based on the employed default values gives a first approximation of the likely effect on soil carbon stock, although still subject to further refinement for the next report. The other terms in the equation quantifying the soil carbon stock change include changes in organic soils and liming. While changes in organic soils could safely be considered negligible, the liming effect on CO_2 emissions could be quantified as described above for the category Grassland remaining Grassland, employing the relevant area of the category.

7.4.3 Uncertainties and time series consistency

The uncertainty estimates have not been reported yet. Their implementation is ongoing and is planned for inclusion in the next NIR.

Time series consistency is ensured as the inventory approaches concerned are applied identically across the whole reporting period from the base year 1990 to 2004.

7.4.4 QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of GPG for LULUCF. Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

7.4.5 Recalculations

No recalculations are applicable for Grassland, as this category has not been reported previously.

7.4.6 Source-specific planned improvements

The category of Grassland will undergo a specific analysis of activity data applicable for the assessment of carbon stock changes in mineral soils. The aim is to obtain the required information for stratification of soil types, which may improve the current initial estimate of carbon stock changes in the Land converted to Grassland sub-category.

7.5 Wetlands (5.D.)

7.5.1 Source category description

The category of Wetlands as classified in the Czech Republic includes water reservoirs, lakes and rivers, covering 2.0 % of the area of the country. It should be noted that there are about 11 wetlands identified as Ramsar[12] sites in this country. However, these areas are commonly located in several IPCC land-use categories. Hence, the emission inventory of 5.D.: Wetlands concerns only the water areas listed above. In addition, the areas in this category had an increasing trend during recent decades, including the reporting period since 1990 (Fig. 7.1). It can be expected that this trend will continue and the area of Wetlands will increase further. This is mainly due to programs aimed at increasing the water retention capacity of the landscape[13].

7.5.2 Methodological aspects

The emission inventory of sub-category 5.D.1. Wetlands remaining Wetlands can address the areas in which the water table is artificially changed, which may concern peat-land draining or lands affected by regulated water bodies through human activities (flooded land). Both categories are insignificant under the conditions in this country. Hence, the emissions for Wetlands remaining Wetlands were not explicitly estimated and they can safely be considered negligible.

Sub-category 5.D.2: Land converted to Wetlands involves the conversion from Grassland. This is a minor land-use change identified in this country and represents about 1.3 % of all detected changes in land use. The emissions associated with this type of land-use change are derived form the carbon stock changes in living biomass. They were estimated using the Tier 1 approach and Eq. 3.5.6 of GPG for LULUCF, which simply relates the biomass stock before and after the conversion. The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock in Grassland (prior to the conversion) was assumed to be 6 t C/ha (IPCC 2003).

---

[12] Convention on Wetlands, Ramsar, Iran, 1971

[13] Based on the land-use history, the growth potential could be considered to be rather large. For example, as of 1990, the category included 50.7 th. ha of ponds, which represented only 28 % of their extent during the peak period in the 16th Century (Marek 2002)

7.5.3 Uncertainties and time series consistency

The uncertainty estimates are not reported here. Their implementation is ongoing and is planned for inclusion in the next NIR.

Time series consistency is ensured as the inventory approaches concerned are applied identically across the whole reporting period since the base year 1990 until 2004.

7.5.4 QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of GPG for LULUCF. Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

7.5.5 Recalculations

No recalculations are applicable for Wetlands, as this category has not been reported previously.

7.5.6 Source-specific planned improvements

For the category of Wetlands, some improvements of the estimates can be expected in connection with the revised activity data for Grasslands, which is the identified category for land conversions under 5.D.

7.6 Settlements (5.E.)

7.6.1 Source category description

The category of Settlements is defined by IPCC (2003) as all developed land for infrastructure and human settlements. However, land used for infrastructure, as well as that of industrial zones and city parks, is not included here, but within the category Other Land (5.F.). Currently, Settlements represent less than 1.7 % of the country's territory. The area of the category has increased slightly since 1990, although the trend has seemed to level off during the most recent years (see Fig. 7.1 and CRF Tables).

7.6.2 Methodological aspects

The emission inventory can include emissions associated with living biomass or other components. Under the conditions in this country, emissions of CO_2 were considered negligible, as biomass components are basically excluded from this category and potentially applicable land-use conversion has been insignificant during the reporting period.

7.6.3 Uncertainties and time series consistency

Not applicable.

7.6.4 QA/QC and verification

The activity data concerns data on areas and identification of land-use conversions as described in section 7.1.2. All the input information and relevant calculations are archived by the expert team and the coordinator of NIR. Hence, all the background information is verifiable.

7.6.5 Recalculations

Not applicable.

7.6.6 Source-specific planned improvements

No improvements related specifically to this category are planned.

7.7 Other Land (5.F.)

7.7.1 Source category description

Based on the land-use classification in the Czech Republic, the category of Other Land encompasses the infrastructure, including roads, airports, industrial areas and city parks. In addition, Other Land includes the permanently unstocked areas of cadastral forest land (Tab. 7.3), which may contain forest buildings, forest nurseries, cleared boundary lines, etc. Therefore, Other Land represents a mosaic of heterogeneous areas that cannot be classified within other major categories as elaborated above.

As of 2004, the category Other Land represented 9.4 % of the total territory of the country. The area of the category increased slightly in the past decade, mainly due to building infrastructure. The most significant land-use conversions identified for the category of Other Land were transfers from the categories Cropland and Forest Land.

7.7.2 Methodological aspects

Currently, no guidance is available for quantifying emissions for sub-category 5.F.1. Other Land remaining Other Land (IPCC 2003). However, because of the nationally-adapted definition of Other Land, the estimation of emissions associated with sub-category 5.F.2: Land converted to Other Land was performed for this inventory. The emissions result from changes in biomass and soil carbon stock.

Carbon stock change in living biomass follows the Tier 1 approach using Eq. 3.7.2 (IPCC 2003). It assumes that the entire biomass is removed in the year of conversion, while the amount of biomass prior to the conversion is set depending on the original land-use type. This was assumed to equal 5 t C/ha for Grassland (IPCC 2003), while the corresponding value for Forest Land was estimated to be about 70 to 71 t C/ha. This value was derived on the basis of the annually updated figure for the mean growing stock volume, expansion factor BEF_2 applicable to wood volumes of broadleaves (1.4) and conifers (1.3), and the root/shoot ratio (R; 0.20), in accordance with the Tier 1 approach (IPCC 2003).

Carbon stock change in mineral soils following the conversion to Other Land was estimated according to Eq. 3.7.3 (IPCC 2003), which assumes that the initial carbon stock of previous land use is lost during the conversion. The inventory period applicable for this calculation was one year, matching the annual update of land-use information. The default reference carbon stock was taken from Table 3.3.3 (95 t C/ha; IPCC 2003) with the associated factors (land use type, management regime, input of organic matter) as described in sections 7.2.2 and 7.3.2 for the conversions from Forest Land and Cropland, respectively.

7.7.3 Uncertainties and time series consistency

Similarly as for other land use categories, the uncertainty estimates are not reported. Their implementation is ongoing and planned for inclusion in the next NIR.

Time series consistency is ensured as the inventory approaches concerned are applied identically across the whole reporting period from the base year 1990 to 2004.

7.7.4 QA/QC and verification

The activity data concerns data on areas and identification of land-use conversions described in section 7.1.2. These data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

All the input information and relevant calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

7.7.5 Recalculations

No recalculations are applicable for the category Other Land, as this category has not been reported previously.

7.7.6 Source-specific planned improvements

The emission inventory for the category of Other Land may require further consolidation of activity data, specifically those on land-use sub-categories included within the nationally adapted definition. This would permit estimation using specific sub-categories within the category of Other Land. The current estimates can be considered as conservative and any further refinement may result in lower emissions compared to those currently reported.

7.8 Acknowledgement

The authors would like to thank V. Henžlík, of the Forest Management Institute in Brandýs n. Labem, for his helpful suggestions and for some of the activity data used in this chapter. Thanks are also due to P. Vopěnka, of the Institute of Forest Ecosystem Research in Jílové u Prahy, for his methodological contribution and assistance.

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 wastewater handling sub-sector was recently revised respecting the IPCC *Good Practice* (*Good Practice Guidance*, 2000). Next revision, concerning methane emissions from landfills (application of Tier 2 approach) is under development and will be included in next submission.

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 Environmental 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	0.3
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 the 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 MoE Decree No. 338/1997 Coll., on details of waste management, and the Methodical Instruction of the Waste Department of MoE 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 (*Statistical Environmental Yearbook* 2005, 2006). 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 –2004 *[thous. t MSW]*

	MSW	Landfilling		MSW	Landfilling
1990	3 764	2 371	**1998**	4 535	2 804
1991	3 853	2 388	**1999**	4 195	2 596
1992	3 944	2 484	**2000**	4 508	2 632
1993	4 037	2 543	**2001**	4 294	2 575
1994	4 132	2 561	**2002**	4 747	2 826
1995	4 229	2 621	**2003**	4 639	2 924
1996	4 329	2 683	**2004**	4 642	2 996
1997	4 431	2 739			

Tab. 8.3 Municipal waste utilization and disposal practices in the Czech Republic *[Gg]*, **2004**

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
4 642	192	128	35	152	2997	142	4	214	6	772
100 %	4.1 %	2.7 %	0.7 %	3.2 %	64.6 %	3.0 %	0.08 %	4.6 %	0.12 %	16.6 %

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 1990-2004 *[Gg CH_4]*

	Gross Annual Methane Generation	Oxidized (OX)	CH_4 recovered	Net Annual Methane Emissions
1990	112.9	16.4	3.25	93.20
1991	113.7	16.6	3.25	93.89
1992	116.4	16.9	3.45	95.98
1993	111.7	16.2	3.45	92.00
1994	112.5	16.4	3.45	92.67
1995	115.1	16.7	3.45	94.91
1996	117.8	16.8	6.03	95.04
1997	106.9	14.3	11.79	80.87
1998	109.5	14.5	13.08	81.93
1999	102.8	13.4	13.68	74.79
2000	109.4	14.5	13.36	75.98
2001	100.5	13.0	14.07	73.48
2002	110.3	14.2	15.45	80.63
2003	114.1	14.7	15.97	83.41
2004	117.0	15.1	16.38	85.53

Tab. 8.5 gives an overall survey of emissions in 1990 – 2004 and also includes recovery (R) and oxidation (OX) of methane. If we use parameters in tables above a model calculation for year 2004 can be expressed as follows:

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

$$\text{Gg } CH_4 = [(4642 \times 0.645 \times L_0) - 16.38] \times (1 - 0.15)$$

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 2004 = 85.53 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 slightly changed last year mainly due to increasing water savings in water use (aprox 10-20 %) and quite dry year. Total amount of organic pollution is constant, but density is higher than for period before 2003. From year 2003 onwards we assume 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, 2004).

Tab. 8.6 Population sewer connection and wastewater treatment, 1990-2004

	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	78.7
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
2004	10 207	77.9	94.9

Tab. 8.7 Used methane conversion factors (MCF) and share of individual technologies *[%]* in 1990-2004

	MCF	**1990**	**1993**	**1996**	**1999**	**2002**	**2004**
On-site treatment	0.15	100	100	100	100	100	100
Discharged into rivers	0.05	27	21	10	5	7	5
Aerobic treatment of water	0.05	48	54	65	70	68	72
Anaerobic treatment of water	0.50	25	25	25	25	25	23
Aerobic treatment of sludge	0.10	45	40	35	30	20	15
Anaerobic treatment of sludge	0.50	55	60	65	70	80	85

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

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

Where *tos* ispart 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 2004

Treatment on site:

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

$BOD_{(tos)}$ = 10 207 × 0.221 × 18250 = 42.518 Gg BOD/year

$Total_{(tos)}$ = 41.17 × 0.09 = 3.71 Gg CH_4

Watewater:

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

Emission factor $_{(wwt)}$ = 0.6 × ((0.719 × 0.05) + (0.230 × 0.5) + (0.051×0.05)) = 0.0921 CH_4/kg BOD

BOD $_{(wwt)}$ = 10 202 × 0.779 × (1-0.4) = 86.797 Gg BOD/year

Total $_{(wwt)}$ = 87.065 × 0.0921 = **8.02 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 × 0.779 × 0.4 = 58.043 Gg BOD/year

Total $_{(sld)}$ =58.043 × 0.264 = **15.32 Gg CH_4**

R (recovered CH_4) = 0.6 × (0.85 × 0.5) × 58.043 = 14.80 Gg CH_4

Methane emissions from municipal wastewater in 2001=

3.71 + 8.02 + 15.32 – 14.80 = **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* 2005, 2005) 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 194 mil.m^3 (actually only 189 mil.m^3 were treated) (*Statistical Environmental Yearbook* 2005, 2006), it was also possible to determine "unidentified" amount of wastewater (11 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, 2004), see Tab. 8.8.

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. 8.8 Estimation of COD generated by individual sub-categories 2004

	Production *[kt/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	42.2	11.00	24.00	0.10	1 115.1	10 036.0
Dairy Products	978.2	2.70	7.00	0.10	1 848.8	16 639.4
Malt & Beer	2 536.8	2.90	6.30	0.10	4 634.7	41 712.1
Meat & Poultry	653.1	4.10	13.00	0.25	8 702.6	26 107.9
Organic Chemicals	153.0	3.00	67.00	0.10	3 075.3	27 677.7
Pet. ref./Petrochemicals	3 560.0	1.00	0.60	0.10	213.6	1 922.4
Plastics and Resins	1 263.2	3.70	0.60	0.10	280.4	2 523.9
Pulp & Paper	704.8	9.00	162.00	0.25	256 911.8	770 735.4
Soap and Detergents	47.1	0.85	3.00	0.10	12.0	108.1
Starch production	69.3	10.00	9.00	0.10	624.0	5 615.9
Sugar Refining	526.4	3.20	9.00	0.10	1 516.1	13 644.7
Textiles(natural)	77.2	0.90	172.00	0.10	1 195.1	10 756.3
Vegetable Oils	100.0	0.85	3.10	0.10	26.4	237.2
Vegetables, Fruits & Juices	121.4	5.00	20.00	0.25	3 036.0	9 108.1
Wine & Vinegar	84.2	1.50	23.00	0.10	290.5	2 614.6
Unidentified wastewater	11 673.9	3.00	1.00	0.10	3 502.2	31 519.5
Total					286 984.7	970 959.1

Tab. 8.9 Parameters for CH_4 emissions calculation from industrial wastewater

	MCF	**1990**	**1993**	**1996**	**1999**	**2002**	**2004**
Non-treated	0.05	29 %	18 %	13 %	5 %	7 %	3 %
Aerobic treatment of water	0.06	67 %	73 %	70 %	70 %	65 %	68 %
Anaerobic treatment of water	0.70	4 %	8 %	17 %	25 %	28 %	29 %
Aerobic treatment of sludge	0.10	40 %	40 %	40 %	40 %	30 %	27 %
Anaerobic treatment of sludge	0.30	60 %	60 %	60 %	60 %	70 %	73 %

Tab. 8.10 CH_4 emissions from municipal and industrial wastewater in 1990-2004 *[Gg]*

	1990	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	27,04
Oxidized CH_4	7.47	8.18	8.88	8.89	8.99	9.70	9.69	11.06	11.41	14.76	14.80
Total CH_4 emissions	14.86	14.67	14.49	14.47	14.43	14.27	14.26	13.90	13.77	12.25	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	77.38
Oxidized CH_4	25.31	23.86	41.28	43.25	47.00	46.90	50.29	55.47	64.50	63.03	65.02
Total CH_4 emissions	24.45	17.81	14.53	15.16	16.34	13.17	13.26	10.94	12.87	12.32	12.19

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

$$\textbf{Total Gg } \mathbf{CH_4 = Gg\ CH4_{(wwt)} + Gg\ CH_{4\ (sld)} - R}$$

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 2004

Wastewater:

Emission factor $_{(wwt)}$ = methane capacity × (aerobic MCF + anaerobic MCF) + non-treated MCF))

Emission factor $_{(wwt)}$ = 0.25 × ((0.68 × 0.06)+(0.29 × 0.70)+(0.03 × 0.05)) = 0.0615 CH_4/kg BOD

COD $_{(wwt)}$ = Table 8.8 = 971 Gg COD/year

Total $_{(wwt)}$ = 0.0615 × 971 = **59.73 Gg CH_4**

Sludge:

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

Emission factor $_{(sld)}$ = 0.25 × ((0.73 × 0.3)+(0.27 × 0.1)) = 0.0615 CH_4/kg BOD

COD $_{(sld)}$ = Table 8.8 = 287 Gg COD/year

Total $_{(sld)}$ = 0.0615 × 287 = **17.65 Gg CH_4**

R (recovered CH_4) = 0.25 × ((0.73 × 0.3 × 279) + (0.28 × 0.7 × 979)) = 65.02 Gg CH_4

Methane emissions for industrial wastewater in 2003 =
59.73 + 17.65 – 65.02 = **12.19 Gg CH_4/year**

8.3.3 Emissions of CO_2 from waste incineration

Incineration of municipal solid waste does not have long tradition in the Czech Republic. First incinerator plant was built in 1989 in Brno (SAKO a.s.). From that time there were two other incinerator built - one in Liberec (TERMIZO) and newest one in 1998 in Prague (Pražské služby a.s.). Total capacity of municipal waste incinerators in the Czech Republic is shown in Tab. 8.11.

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

Tab. 8.11 Capacity of municipal waste incineration plants in the Czech Republic, 2004

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

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, 2004 (*Statistical Environmental Yearbook,* 2005*)*

	Gg of waste
Municipal Solid Waste	404.7
Clinical Waste	3.0
Hazardous Waste	60.0
Sludge Waste	NA

Calculation example for 2004

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

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 tables 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 × 404.7 + 0.836 × 3.0 + 1.643 × 60.0 = **326.54 Gg CO_2**

Emissions from waste incineration are consistently calculated only for years 2004 and 2003. We prepare to recalculate remaining data on waste incineration in the time series in following submission.

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

$$N_2O \text{ emissions} = 10\,207\,000 \times 25 \times 0.16 \times 0.01 \times 44 / 28 / 1\,000\,000 = 0.64 \text{ Gg}$$

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. Amount of proteins consumed in the Czech Republic is derived from nutrition statistics of FAO (Faostat, 2005).

8.3.5 Emissions of N_2O from Municipal Waste Incineration

Based on suggested range of emission factors (*Good Practice Guidance*, 2000, chapter waste) we estimate N_2O emission from waste incineration in the Czech Republic. Suggested emission factor range for grate furnaces incineration waste is between 5.5- 66 kg of N_2O per Gg of incinerated MSW. We used suggested average value 35 kg of N_2O per Gg of waste. Data on incinerated waste were taken from Tab. 8.12.

N_2O emissions = MSW × EF / 1000 000 = 407 × 35 / 1000000 = **0.014 Gg of N_2O**

By using GWP of 310 for N_2O **0.014 Gg** equals **4.39 Gg** of CO_2 equivalents.

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

Recently, the Czech greenhouse gas inventory underwent a few reviews by UNFCCC. Expert review teams recommended preparing a gradual transfer of calculation of methane emissions from landfills (as a key source) to Tier 2. The present Tier 1 method is not quite sufficient and it yields a bit uncertain results for the Czech Republic. It is planned to be performed this year and will be part of the next NIR, including recalculation of the entire time series and implementation of Good Practice in the calculation. We will use the LandGEM software model developed by USEPA (based on a first-order decay approach) using national specific parameters. We expect some significant changes in the landfill sector. The oxidation factor (OX), which is now set at 15 %, will also undergo revision.

We also plan to recalculate emissions from waste incineration for the entire time series, mainly because of the lack of transparency in the previous equation. However, we do not expect that the results will differ substantially. Increased transparency of all the equations is another aspect that should be addressed by filling in older years in CRF, where a substantial amount of activity data has already been filled in.

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 compositions) to decrease the uncertainties caused by inaccurate data (this will be included in Tier 2 SWDS emissions). Default IPCC factors used in the calculation are accompanied by an uncertainty that is as large as the range of suggested parameters.

The activity data are taken from official channels (Czech Statistical Office, Ministry of the Environment). Quality assurance of the activity data is guaranteed by the data provider. However, these authorities do not calculate or publish the inaccuracy or uncertainty of their data produced for the Czech Statistical Office, but the standardized comprehensive methodology harmonized with the EU is employed.

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 data series for enteric fermentation and manure management has been completed only recently.

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, based on Good Practice (*Good Practice Guidance*, 2000).

The described recalculations are summarized below (see Tab. 9.1).

9.2 Overview of Recalculations

9.2.1 Previous recalculations

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

Tab. 9.1 Survey of previous recalculations

Year of recal-culation	Recalculated years	Recalculated category	Reason of recalculation	Reporting of recalculated results
1997	1990 - 95	CH_4 from coal mining, 1.B.1.	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	HFCs, PFCs, 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- 2006 for UNFCCC Explained in NIR
2002-2005	1990 - 1995	N_2O from all sources	Application of Revised IPCC Guidelines (see topic A from the previous page)	Submissions 2002 - 2006 for UNFCCC Explained in NIR
2002-2005	1990 - 1995	CO_2 from Energy	Sectoral Approach from Revised Guidelines applied (see topic 3 from previous page)	Submissions 2002 - 2006 for UNFCCC Explained in NIR

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

9.2.2 Recent recalculations

Many gaps and imperfections were identified in the past few years and the relevant recalculations were carried out but were not yet reported in former submissions. Implementation of the new official software - CRF Reporter appeared to be a good opportunity to report these recalculations, because reporting of recalculated data is much easier in this system. Introduction of EU ETS according to Directive 87/2003/EC was another important impetus to supplement existing inventories, especially in the area of mineral processes. On the other hand, recalculations and revisions in LULUCF were motivated by the necessity to properly implement the supplemented IPCC methodology (*Good Practice in* LULUCF, 2003).

<u>Summary of recent recalculations and revisions for the 1990-2004 period reported in this submission (2006)</u>

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 has performed the relevant recalculations or rearrangements in the following subcategories:

- Rearrangement of emissions from non-energy use of fuels (production of iron and steel, production of ammonia) from category 1.A. (Combustion processes) to category 2 (Industrial processes, specifically 2.C.1. and 2.B.1.)
- Recalculation of emissions of methane from Agriculture (enteric fermentation and manure management) using the procedures described in the IPCC Good Practice (*Good Practice Guidance*, 2000)

- Rearrangement of CO_2 emissions from sulphur removal from coal combustion from category 1.B.1.c. to category 2.A.3. Limestone and Dolomite Use.
- Adding a new source (gap filling) to category 2.A.3. Limestone and Dolomite Use – emissions from limestone and dolomite use in sinter plants.
- Recalculation of CO_2 emissions from category 2.A.1. Cement Production using Tier 2 methodology based on the cement clinker production data.
- Recalculation of CO_2 emissions from category 2.A.2. Lime Production using data on lime and hydrated lime production and lime use.
- Adding a new source (gap filling) to category 2.A.7.2. Brick and Ceramics – emissions from decarbonization and fossil-organic material oxidation.
- Revision and recalculation of CO_2 series for 2.A.7.1. (Glass Production).
- Use of new Tier 2 methodology – "Actual emissions" for all relevant categories of F-gases.
- LULUCF: all previously reported categories under LUCF were recalculated. They concern i) recalculations of CO_2 emissions related to carbon stock change in the previous LUCF category 5.A. (Changes in Forest and Other Woody Biomass Stocks), currently within LULUCF category 5.A. Forest Land, Carbon Stock Change; ii) recalculations of CH_4 and N_2O emissions from controlled burning, which was previously included in LUCF category 5.E. (Other), currently under the LULUCF category 5.A. Forest Land, Biomass Burning
- Revision and recalculation of CH_4 series for 1.B.2.a. (Fugitive emissions – Natural gas)

Detailed explanations of these recalculations are given in the relevant sectoral chapters.

10 References

Adamec V., Dufek J., Jedlička J.: *Study of trends in transport in 2001 from the standpoint of the environment,* Transport Research Centre (CDV), Brno, May 2002 (in Czech)

Adamec V., Jedlička J., Dufek J. et al: *Study of trends in transport in 2004 from the standpoint of the environment,* Transport Research Centre (CDV), Brno, May 2005a (in Czech)

Adamec V., Dufek J., Jedlička J.: *Inventories of emissions of GHG form transport ,* Report of CDV for CHMI, Transport Research Centre, Brno, November 2005b (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

Cienciala E., Apltauer J., Exnerová Z., Henžlík V., Vopěnka P., Zatloukal V.: *The inventory of emissions and sinks of greenhouse-gases in the LULUCF sector according to IPCC GPG 2003 for the period of 1990-2004 (Rev. 13)*. Report for the Ministry of Envrironment, Praha. 2005a (In Czech),

Cienciala E., Apltauer J., Černý M., Exnerová Z.: *Biomass functions applicable for European beech*. Journal of Forest Science 51(4): 147-154, 2005b

Cienciala E., Henžlík V., Zatloukal V.: *Assessment of carbon stock change in forests – adopting IPCC LULUCF Good Practice Guidance in the Czech Republic*. Forestry Journal (submitted), Zvolen, 2006.

Commentary on the emission inventory of NMVOC for 2004 in the sector "Solvent use and applications - 060000", SVÚOM Ltd. Prague, October 2005 (in Czech)

Černý, M.: *Use of the growth models of main tree species of the Czech Republic in combination with the data of the Czech National Forest Inventory*. In: Neuhöferová P (ed) The growth functions in forestry. Korf´s growth function and its use in forestry and world reputation. Kostelec nad Černými lesy, Prague 2005 (in Czech).

Černý, M., Pařez, J., Malík, Z.: *Growth and yield tables for the main tree species of the Czech Republic*. App. 3, Ministry of Agriculture, Czech Forestry Act 84/1996, Praha 1996 (In Czech) ,

Černý, M.: *Biomass of Picea abies (L.) Karst. in Midwestern Bohemia*. Scand.J.For.Res. 5, 83-95, 1990.

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 Institute of Animal Production, Uhříněves, Prague 1994 (in Czech)

Dufek, J.: Verification and evaluation of weight criteria of available data sources N2O from transportation, Report CDV Brno for CHMI, Brno, November 2005

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

Energy Economy - the Czech Republic in numbers in 1994 - 2004, 1994 - 1998, 1995 - 1999 and 1996 - 2000; KONEKO marketing Ltd. Prague (Czech and English version), past edition 2005

FAOSTAT, Food Balance Sheets, Food and agriculture organization, URL: http://faostat.fao.org/faostat/, 2005

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., Pretel J., Vácha D., Bláha J., Neužil V., Havránek M.: *National GHG Inventory Report of the Czech Republic* (NIR), last year 2003, CHMI, Prague 2005

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, 21th World Gas Conference, Nice 2000

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

Good Practice Guidance for Land Use, Land Use Change and Forestry, IPCC 2003

Green C., Tobin B., O'Shea M., Farrell E., Byrne K.: *Above- and belowground biomass measurements in an unthinned stand of Sitka spruce (Picea sitchensis (Bong) Carr.)*. European Journal of Forest Research 1-10, 2006.

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

Jedlička J., Dufek J., Adamec V.: *Greenhouse gas emission balance*, (In: 20th International Air Protection Conference p. 96-99, ISBN 80-969365-2-2, High Tatras - Štrbské Pleso (Slovakia), November 23 – 25, 2005

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)

Marek V.: *Development of Land Resources in the Czech Republic.* Proceedings of the Czech National Soil Conference, Prague 2002 (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)

Markvart M., Bernauer B.: *Emissions of nitrous in from chemical industry*, Report for CHMI, Prague 2005 (in Czech)

Mining Yearbooks, 1994 - 2005 (in Czech)

Perlík, O: *Volumes of natural gas released to atmosphere from compression stations during transit transport of natural gas across the Czech Republic area in period 1990 – 2004*, RWE Transgs – private communication by e-mail, November 2005 (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)

Řeháček V., Michálek L.: Information on emissions of greenhouse gases containing fluorine in CR in 2004, Report for CHMI, Prague 2005 (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 Environmental Yearbooks of the Czech Republic. Ministery of Environment of the Czech Republic, Prague 1995-2006

Statistical Yearbook of the Czech Republic, Czech Statistical Office, Prague 1995 - 2005

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)

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

Supply of Basic Final Refinery Products in the CR, Czech Statistical Office, Prague 1995 - 2005

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)

Ullmans's encyclopedia of Industrial Chemistry, Release 2005, 7th Edition, John Willey 2005

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 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*
CGA	*Czech Gas Association*
ČPS	*Český plynárenský svaz*
CDV	*Transport Research Centre (Centrum dopravního výzkumu)*
CHMI	*Czech Hydrometeorological Institute*
ČHMÚ	*Český hydrometeorologický ústav*
CSO	*Czech Statistical Office*
ČSÚ	*Český statistický úřad*
CUEC	*Charles University Environment Center*
COŽP UK	*Centrum pro otázky životního prostředí Univerzity Karlovy*
EEA	*European Environmental Agency*
FAO	*Food and Agriculture Organization*
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)*
MŽP (ČR)	*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)*
FMI	*Forest Management Institute*
ÚHÚL	*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

2004

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(Gg)						
Total Energy	115 616,63	264,05	5,16	330,07	547,98	99,69	226,51
A. Fuel Combustion Activities (Sectoral Approach)	115 616,63	15,15	5,16	329,38	547,52	99,28	226,25
1. Energy Industries	57 876,85	0,83	2,12	99,50	9,60	8,22	137,07
a. Public Electricity and Heat Production	55 397,78	0,75	2,09	93,31	9,06	7,71	124,09
b. Petroleum Refining	1 309,68	0,05	0,00	0,77	0,21	0,01	3,25
c. Manufacture of Solid Fuels and Other Energy Industries	1 169,40	0,03	0,03	5,42	0,33	0,51	9,73
2. Manufacturing Industries and Construction	27 047,24	0,98	0,70	42,71	132,87	4,88	44,11
a. Iron and Steel	3 176,33	0,10	0,08	9,40	108,96	0,29	13,68
b. Non-Ferrous Metals	249,88	0,01	0,01	12,38	13,29	0,20	3,53
c. Chemicals	6 895,61	0,21	0,26	11,10	1,99	0,88	17,65
d. Pulp, Paper and Print	1 284,42	0,16	0,04	1,71	0,66	0,10	1,76
e. Food Processing, Beverages and Tobacco	2 716,20	0,08	0,05	2,56	2,66	0,29	3,09
f. Other *(as specified in table 1.A(a) sheet 2)*	12 724,81	0,42	0,25	5,55	5,31	3,12	4,41
Other non-specified	12 724,81	0,42	0,25	5,55	5,31	3,12	4,41
3. Transport	15 228,70	1,63	2,08	106,70	230,37	46,89	2,50
a. Civil Aviation	82,04	0,00	0,00	0,03	0,00	0,00	0,00
b. Road Transportation	14 538,60	1,61	2,07	97,76	225,45	45,73	2,33
c. Railways	249,46	0,02	0,01	7,80	4,50	1,06	0,16
d. Navigation	8,51	0,00	0,00	0,50	0,30	0,10	0,01
e. Other Transportation *(as specified in table 1.A(a) sheet 3)*	350,10	0,00	0,00	0,61	0,12	0,00	0,00
Pipeline transport	350,10	0,00	0,00	0,61	0,12	0,00	0,00

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
	(Gg)						
4. Other Sectors	14 200,32	11,45	0,22	21,00	114,34	23,53	38,97
a. Commercial/Institutional	4 416,68	0,91	0,04	4,53	4,17	1,10	4,62
b. Residential	9 496,87	10,25	0,18	16,07	109,08	22,21	33,75
c. Agriculture/Forestry/Fisheries	286,76	0,28	0,00	0,40	1,09	0,21	0,59
5. Other *(as specified in table 1.A(a) sheet 4)*	1 263,52	0,26	0,05	59,47	60,33	15,77	3,59
a. Stationary	NO	NO	NO	0,21	0,26	0,07	0,68
Other non-specified	NO	NO	NO	0,21	0,26	0,07	0,68
b. Mobile	1 263,52	0,26	0,05	59,26	60,07	15,70	2,91
Forestry and Fishing	1 263,52	0,26	0,05	59,26	60,07	15,70	2,91
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	248,90	IE,NA, NE,NO	0,69	0,46	0,41	0,26
1. Solid Fuels	IE,NA,NE	222,00	IE,NA,NO	0,64	0,42	0,13	0,25
a. Coal Mining and Handling	NE	222,00	NO	NA	NA	NE	
b. Solid Fuel Transformation	IE	IE	IE	0,64	0,42	0,13	0,25
c. Other *(as specified in table 1.B.1)*	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	IE,NE,NO	26,90	NA,NE, NO	0,05	0,04	0,28	0,01
a. Oil	IE,NE,NO	0,39	NE,NO	0,05	0,04	0,28	0,01
b. Natural Gas	NO	26,50				NE	NE
c. Venting and Flaring	NE	NE	NE	NE	NE	NE	NE
Venting	NE	NE				NE	NE
Flaring	NE	NE	NE	NE	NE	NE	NE
d. Other *(as specified in table 1.B.2)*	NO	NO	NA	NA	NA	NA	NA
Other non-specified	NO	NO	NA	NA	NA	NA	NA
Memo Items: (1)							
International Bunkers	806,88	0,15	0,01	0,99	0,26	0,05	0,06
Aviation	806,88	0,15	0,01	0,99	0,26	0,05	0,06
Marine	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO
Multilateral Operations				NE	NE	NE	NE
CO_2 Emissions from Biomass	4 818,58						

(1) Countries are asked to report emissions from international aviation and marine bunkers and multilateral operations, as well as CO_2 emissions from biomass, under Memo Items. These emissions should not be included in the national total emissions from the Energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-Use Change and Forestry sector.

Documentation Box:
Parties should provide detailed explanations on the Energy sector in Chapter 3: Energy (CRF sector 1) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.

1.AA.2 Manufacturing Industries and Construction:The whole source category 1A2 "Manufacturing Industries and Construction" for the time period 1990 - 2002 is reported under 1A2f. However, since 2003 this category has been disaggregated to relevant subcategories and so now 1A2f covers only: Non-Metallic Minerále, Transport Equipment, Machinery, Mining and Quarrying, Wood and Wood Products, Construction, Textile and Leather, Non-specified.
1.AA.4 Other Sectors:Stationary sources from Agriculture/Forestry/Fishing are reported under 1A4c, while mobile sources from Agriculture/Forestry/Fishing are reported under 1A5.
1.B Fugitive Emissions from Fuels:Emissions from underground reservoirs are reported under CRF-Reporter code 1.B.2.B.5.1 (Natural gas - other leakage), which corresponds IPCC sub-category 1.B.2.b.iii
Transmission item involves also an international transit pipelines.
1.B.1 Solid Fuels:Solid fuel transformation, IE: CH4 and precursors reported in 2.C.1 - Iron and Steel (IE) Production, CO2 reported in 1.A.2. (I

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

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	11 049,29	3,55	3,73	1 215,00	600,30	20,98	17,33	0,01	0,00	1,58	26,99	1,71	0,69
A. Mineral Products	3 625,11	0,22	NE							0,07	0,11	0,07	0,04
1. Cement Production	1 661,16												0,02
2. Lime Production	525,68												
3. Limestone and Dolomite Use	1 044,81												
4. Soda Ash Production and Use	NO												
5. Asphalt Roofing	NE										NE	NE	
6. Road Paving with Asphalt	NE									0,00	0,05	0,00	0,00
7. Other *(as specified in table 2(I)A-G)*	393,46	0,22	NE							0,07	0,06	0,07	0,02
Glass Production	232,68	NE	NE							0,07	0,06	0,07	0,02
2.A.7.2 Bricks and ceramics	160,78	0,22	NE							IE	IE	IE	IE
B. Chemical Industry	698,65	0,50	3,73		NA		NA	NA	NA	0,59	0,01	0,62	0,50
1. Ammonia Production	698,65	NE	NE							0,29	0,01	0,03	NE
2. Nitric Acid Production			3,46							0,02			
3. Adipic Acid Production	NO		NO							NO	NO	NO	
4. Carbide Production	NE,NO	NE,NO								NO	NO	NO	NO
5. Other *(as specified in table 2(I)A-G)*	IE,NE	0,50	0,27		NA		NA	NA	NA	0,29	0,00	0,59	0,50
Carbon Black		NE											
Ethylene	IE	0,50	NE										
Dichloroethylene		NE											
Styrene		NE											
Methanol		NE											
Other Chemical Industry	NE	NE	0,27		NA		NA	NA	NA	0,29	0,00	0,59	0,50
C. Metal Production	6 725,53	2,82	NA		NA,NO	NO	NA,NO	NA,NO	NA,NO	0,78	26,78	0,99	0,11
1. Iron and Steel Production	6 725,53	2,82								0,78	26,78	0,99	0,11
2. Ferroalloys Production	NE	NE								IE	IE	IE	IE
3. Aluminium Production	NO	NO					NO			NO	NO	NO	NO
4. SF_6 Used in Aluminium and Magnesium Foundries								NO	NO				
5. Other *(as specified in table 2(I)A-G)*	NA	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA
Other non-specified	NA	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA

Note: 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 applies only to source categories 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).

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

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										0,14	0,09	0,03	0,03
1. Pulp and Paper										0,14	0,09	0,03	0,03
2. Food and Drink[2]													
E. Production of Halocarbons and SF_6					NO								
1. By-product Emissions					NO								
Production of HCFC-22					NO								
Other													
2. Fugitive Emissions													
3. Other *(as specified in table 2(II))*													
Other non-specified													
F. Consumption of Halocarbons and SF_6				1 215,00	600,30	20,98	17,33	0,01	0,00				
1. Refrigeration and Air Conditioning Eq.				1 147,65	557,07	16,43	14,30	NO	NO				
2. Foam Blowing				9,36	3,40	NO	NO	NO	NO				
3. Fire Extinguishers				27,48	13,39	NO	NO	NO	NO				
4. Aerosols/ Metered Dose Inhalers				27,27	24,82	NO	NO	NO	NO				
5. Solvents				3,24	1,62	NO	NO	NO	NO				
6. Other applications using ODS[3] substi.				NO	NO	NO	NO	NO	NO				
7. Semiconductor Manufacture				NO	NO	4,55	3,03	0,00	0,00				
8. Electrical Equipment				NO	NO	NO	NO	0,01	0,00				
9. Other *(as specified in table 2(II)*				NO	NO	NO	NO	0,00	0,00				
Sound-proof windows				NO	NO	NO	NO	0,00	0,00				
laboratories				NO	NO	NO	NO	0,00	0,00				
G. Other *(as specified in tables 2(I).A-G and 2(II))*	NA	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA
Other non-specified	NA	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA

Note: 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 applies only to source categories 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).

(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.

(3) ODS: ozone-depleting substances.

Documentation box:
Parties should provide detailed explanations on the industrial processes sector in Chapter 4: Industrial processes (CRF sector 2) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.

2.B.5 Other Chemical Industry:2..B.5. Other / Other CH I = caprolactam production (emission of N2O considered constant)
2.C.1 Iron and Steel Production:Amounts of fuels consumed in 2C1 (Iron and Steel) and in 2B1 (Ammonia production) are reported in NIR.
For 2C1 the relevant value of fuel is amount of metallurgical coke supplied to blast furnace, for 2B1 the relevant value is amount of residual oil gasified for hydrogen / ammonia production.
All CO2 emissions from 2C1 (coming from metallurgical coke supplied to blast furnace) are reported under 2C1.1 "steel". Coke reported under 2C1.4 represents overall coke produced in coke ovens.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	N_2O	NMVOC
	(Gg)		
Total Solvent and Other Product Use	304,76	0,69	96,97
A. Paint Application	121,09		38,53
B. Degreasing and Dry Cleaning	57,39	NA	18,26
C. Chemical Products, Manufacture and Processing	**45,13**		14,36
D. Other	81,15	0,69	25,82
1. Use of N_2O for Anaesthesia		0,35	
2. N_2O from Fire Extinguishers		NO	
3. N_2O from Aerosol Cans		0,35	
4. Other Use of N_2O		NO	
5. Other *(as specified in table 3.A-D)*	81,15	NA	25,82
Other solvent use (SNAP 0604)	81,15	NA	25,82

Note: The quantity of carbon released in the form of NMVOCs should be accounted for in both the NMVOC and the CO_2 columns. The quantites of NMVOCs should be converted into
CO_2 equivalent emissions before being added to the CO_2 amounts in the CO_2 column.

Documentation box:
• Parties should provide detailed explanations about the Solvent and Other Product Use sector in Chapter 5: Solvent and Other Product Use (CRF sector 3) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.
• 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 in the NIR additional information (activity data and emission factors) used to derive these estimates, and provide in this documentation box a reference to the section of the NIR where this information can be found.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
	(Gg)				
Total Agriculture	**138,37**	16,58	NA,NO	NA,NO	NA,NE,NO
A. Enteric Fermentation	113,80				
1. Cattle [1]	107,76				
Option A:					
Dairy Cattle	63,28				
Non-Dairy Cattle	44,49				
Option B:					
Mature Dairy Cattle					
Mature Non-Dairy Cattle					
Young Cattle					
2. Buffalo	NO				
3. Sheep	0,93				
4. Goats	0,06				
5. Camels and Llamas	NO				
6. Horses	0,36				
7. Mules and Asses	NO				
8. Swine	4,69				
9. Poultry	NA				
10. Other *(as specified in table 4.A)*	IE				
Other non-specified	IE				
B. Manure Management	24,57	1,20			
1. Cattle [1]	13,15				
Option A:					
Dairy Cattle	8,02				
Non-Dairy Cattle	5,13				
Option B:					
Mature Dairy Cattle					
Mature Non-Dairy Cattle					
Young Cattle					
2. Buffalo	NO				
3. Sheep	0,02				
4. Goats	0,00				
5. Camels and Llamas	NO				
6. Horses	0,03				
7. Mules and Asses	NO				
8. Swine	9,38				
9. Poultry	1,99				
10. Other livestock *(as specified in table 4.B(a))*	IE				
Other non-specified	IE				

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
	(Gg)				
B. Manure Management (continued)					
11. Anaerobic Lagoons		NO			
12. Liquid Systems		0,17			
13. Solid Storage and Dry Lot		0,87			
14. Other AWMS		0,15			
C. Rice Cultivation	NO				**NO**
1. Irrigated	NO				NO
2. Rainfed	NO				NO
3. Deep Water	NO				NO
4. Other *(as specified in table 4.C)*	NO				NO
Other non-specified	NO				NO
D. Agricultural Soils [(2)]	NA,NE	15,38			NA,NE
1. Direct Soil Emissions	NE	8,68			
2. Pasture, Range and Paddock Manure [(3)]		0,86			NE
3. Indirect Emissions	NA	5,84			
4. Other *(as specified in table 4.D)*	NA	NA			NA
Other non-specified	NA	NA			NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA
1 . Cereals	NA	NA			
2. Pulses	NA	NA			
3 . Tubers and Roots	NA	NA			
4 . Sugar Cane					
5 . Other *(as specified in table 4.F)*	NA	NA	NA	NA	NA
Other non-specified	NA	NA	NA	NA	NA
G. Other *(please specify)*	**NA**	**NA**	**NA**	**NA**	**NA**
Other non-specified	NA	NA	NA	NA	NA

(1) The sum for cattle would be calculated on the basis of entries made under either option A (dairy and non-dairy cattle) or option B (mature dairy cattle, mature non-dairy cattle and young cattle).
(2) 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 of the sector Agriculture should report the amount (in Gg) of these emissions or removals in table Summary 1.A of the CRF. References to additional information (activity data, emissions factors) reported in the NIR should be provided in the documentation box to table 4.D. In line with the corresponding table in the IPCC Guidelines (i.e. IPCC Sectoral Report for Agriculture), this table does not include provisions for reporting CO_2 estimates.
(3) Direct N_2O emissions from pasture, range and paddock manure are to be reported in the "4.D Agricultural Soils" category. All other N_2O emissions from animal manure are to be reported in the "4.B Manure Management" category. See also chapter 4.4 of the IPCC good practice guidance report.
Note: The IPCC Guidelines do not provide methodologies for the calculation of CH_4 emissions and CH_4 and N_2O removals from agricultural soils, or CO_2 emissions from prescribed burning of savannas and field burning of agricultural residues. Parties that have estimated such emissions should provide, in the NIR, additional information (activity data and emission factors) used to derive these estimates and include a reference to the section of the NIR in the documentation box of the corresponding Sectoral background data tables.

Documentation box:
• Parties should provide detailed explanations on the agriculture sector in Chapter 6: Agriculture (CRF sector 4) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.
• If estimates are reported under "4.G Other", use this documentation box to provide information regarding activities covered under this category and to provide reference to the section in the NIR where background information can be found.

4 Agriculture:N2O emissions from Agriculture (manure, soils, direct, indirect) are estimated by Tier 1 approach using default parameters for Western Europe.
Emission factor for direct soil emissions (EF2) relevant to cultivated organic soils was updated to 8 kg N2O-N/ha/year. Cultivated histosoils area is considered unchanged.
4.A Enteric Fermentation:Methane EF from Enteric Fermentation for cows is calculated for both dairy and sucker cows, respectively. Resulting EF is located in "Dairy Cattle" cell.
Methane EF from Enteric Fermentation for other cattle than cows is calculated for 7 subcategories from calves to mature heifers (excluding sucker cows). Resulting EF is located in "Non-dairy Cattle" cell.
Methane EFs from Enteric Fermentation for other animals than cattle (sheep, pigs….) are estimated by Tier 1 approach, default EFs are taken for Western Europe.
Average Gross Energy (GE) was accounted by equation described in NIR (chapter 6.2.1.). Unit of GE is MJ/day.
Feeding situation is determined on based expert estimation for diary cows.
Since year 2002 number of goats does not include animals from a private sector (only agricultural sector is implied).
4.B Manure Management:Methane EFs from Manure Management for all kinds of livestock are estimated by Tier 1 approach, default EFs are taken for Western Europe
N2O emissions from Agriculture (manure, soils, direct, indirect) are estimated by Tier 1 approach using default parameters for Western Europe.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals(1), (2)	CH_4	N_2O	NO_x	CO
	(Gg)				
Total Land-Use Categories	**-4 870,69**	**2,87**	**0,02**	**0,70**	**24,59**
A. Forest Land	**-5 614,75**	**2,87**	**0,02**	**0,70**	**24,59**
1. Forest Land remaining Forest Land	-5 498,61	2,87	0,02	0,70	24,59
2. Land converted to Forest Land	-116,14	NE,NO	NE,NO		
B. Cropland	**65,90**	**NO**	**NA,NO**	**NO**	**NO**
1. Cropland remaining Cropland	NE,NO	NO	NO	NO	NO
2. Land converted to Cropland	NO	NO	NA,NO		
C. Grassland	**-114,92**	**NO**	**NO**	**NO**	**NO**
1. Grassland remaining Grassland	NE,NO	NO	NO	NO	NO
2. Land converted to Grassland	-118,38	NO	NO		
D. Wetlands	**4,24**	**NO**	**NE,NO**		
1. Wetlands remaining Wetlands (3)	NE,NO	NO	NO		
2. Land converted to Wetlands	4,24	NO	NO		
E. Settlements	**NE,NO**	**NE,NO**	**NE,NO**	**NE**	**NE**
1. Settlements remaining Settlements (3)	NE	NE	NE	NE	NE
2. Land converted to Settlements	NE,NO				
F. Other Land	**788,84**	**NE,NO**	**NE,NO**	**NE**	**NE**
1. Other Land remaining Other Land (4)		NE	NE	NE	NE
2. Land converted to Other Land	788,84				
G. Other *(please specify)* (5)					
Harvested Wood Products (6)					
Information items(7)					
Forest Land converted to other Land-Use Categories					
Grassland converted to other Land-Use Categories					

(1) According to the Revised 1996 IPCC Guidelines, for the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+). Net changes in carbon stocks are converted to CO_2 by multiplying C by 44/12 and by changing the sign for net CO_2 removals to be negative (-) and for net CO_2 emissions to be positive (+).
(2) CO_2 emissions from liming and biomass burning are included in this column.
(3) Parties do not have to prepare estimates for categories contained in appendices 3a.2, 3a.3 and 3a.4 of the IPCC good practice guidance for LULUCF, although they may do so if they wish and report in this row.
(4) Parties do not have to prepare estimates for this category contained in Chapter 3.7.1 of the IPCC good practice guidance for LULUCF, although they may do so if they wish and report in this row. This land-use category is to allow the total of identified land area to match the national area.
(5) May include other non-specified sources and sinks.
(6) Parties do not have to prepare estimates for this category contained in appendix 3a.1 of the IPCC good practice guidance for LULUCF, although they may do so if they wish and report in this row.
(7) These items are listed for information only and will not be added to the totals, because they are already included in subcategories 5.A.2 to 5.F.2.

Note: The totals for some land-use categories for N2O (5.A and 5.D), CO2 (5.B and 5.C) and CO2, CH4, N2O (5.E and 5.F) may not equal the summation of the subcategories included in this table, because these totals include data from tables 5(II), 5(IV) and 5(V), where the subcategories are not available. Emissions of CO2, CH4, N2O from 5.G Other are estimated based on the information provided in the background data tables.

Documentation box:
• Parties should provide detailed explanations on the Land Use, Land-Use Change and Forestry sector in Chapter 7: Land Use, Land-Use Change and Forestry (CRF sector 5) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.
• If estimates are reported under 5.G Other, use this documentation box to provide information regarding activities covered under this category and to provide reference to the section in the NIR where background information can be found.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2[(1)]	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	(Gg)						
Total Waste	**326,54**	**109,96**	**0,66**	**0,55**	**0,06**	**0,03**	**0,03**
A. Solid Waste Disposal on Land	**NA,NO**	**85,53**		**NA,NO**	**NA,NO**	**NA,NO**	
1. Managed Waste Disposal on Land	NA	85,53		NA	NA	NA	
2. Unmanaged Waste Disposal Sites	NO	NO		NA	NA	NA	
3. Other *(as specified in table 6.A)*	NO	NO		NO	NO	NO	
Other non-specified	NO	NO		NO	NO	NO	
B. Waste Water Handling		**24,44**	**0,64**	**NE**	**NE**	**0,03**	
1. Industrial Wastewater		12,19	NE	NE	NE	0,03	
2. Domestic and Commercial Waste Water		8,54	0,64	NE	NE	NE	
3. Other *(as specified in table 6.B)*		3,71	NA,NE	NE	NE	NE	
Treatment on site (latrines)		3,71	NA,NE	NE	NE	NE	
C. Waste Incineration	**326,54**	**NE**	**0,01**	**0,55**	**0,06**	**0,01**	**0,03**
D. Other *(please specify)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Other non-specified	NA	NA	NA	NA	NA	NA	NA

(1) CO_2 emissions from source categories Solid waste disposal on land and Waste incineration should only be included if they derive from non-biological or inorganic waste sources.

Documentation box: • Parties should provide detailed explanations on the waste sector in Chapter 8: Waste (CRF sector 6) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.
• If estimates are reported under "6.D Other", use this documentation box to provide information regarding activities covered under this category and to provide reference to the section in the NIR where background information can be found.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		Net CO_2 emissions/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		**122 426,54**	**518,80**	**26,83**	**1 215,00**	**600,30**	**20,98**	**17,33**	**0,01**	**0,00**	**332,91**	**599,61**	**198,40**	**227,22**
1. Energy		**115 616,63**	**264,05**	**5,16**							**330,07**	**547,98**	**99,69**	**226,51**
A. Fuel Combustion	Reference Approach[2]	125 671,20												
	Sectoral Approach[2]	115 616,63	15,15	5,16							329,38	547,52	99,28	226,25
1. Energy Industries		57 876,85	0,83	2,12							99,50	9,60	8,22	137,07
2. Manufacturing Industries and Construction		27 047,24	0,98	0,70							42,71	132,87	4,88	44,11
3. Transport		15 228,70	1,63	2,08							106,70	230,37	46,89	2,50
4. Other Sectors		14 200,32	11,45	0,22							21,00	114,34	23,53	38,97
5. Other		1 263,52	0,26	0,05							59,47	60,33	15,77	3,59
B. Fugitive Emissions from Fuels		IE,NA,NE,NO	248,90	IE,NA, NE,NO							0,69	0,46	0,41	0,26
1. Solid Fuels		IE,NA,NE	222,00	IE,NA,NO							0,64	0,42	0,13	0,25
2. Oil and Natural Gas		IE,NE,NO	26,90	NA,NE,N O							0,05	0,04	0,28	0,01
2. Industrial Processes		**11 049,29**	**3,55**	**3,73**	**1 215,00**	**600,30**	**20,98**	**17,33**	**0,01**	**0,00**	**1,58**	**26,99**	**1,71**	**0,69**
A. Mineral Products		3 625,11	0,22	NE							0,07	0,11	0,07	0,04
B. Chemical Industry		698,65	0,50	3,73		NA		NA	NA	NA	0,59	0,01	0,62	0,50
C. Metal Production		6 725,53	2,82	NA				NA,NO		NA,NO	0,78	26,78	0,99	0,11
D. Other Production[3]											0,14	0,09	0,03	0,03
E. Production of Halocarbons and SF_6						NO								
F. Consumption of Halocarbons and SF_6					1 215,00	600,30	20,98	17,33	0,01	0,00				
G. Other		NA	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA

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

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/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	304,76		0,69							NA	NA	96,97	NA
4. Agriculture		138,37	16,58							**NA,NO**	**NA,NO**	**NA,NE,NO**	
A. Enteric Fermentation		113,80											
B. Manure Management		24,57	1,20										
C. Rice Cultivation		NO										NO	
D. Agricultural Soils[4]		NA,NE	15,38									NA,NE	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		NA	NA							NA	NA	NA	
G. Other		NA	NA							NA	NA	NA	
5. Land Use, Land-Use Change and Forestry	(5) **-4 870,69**	**2,87**	**0,02**							**0,70**	**24,59**		
A. Forest Land	(5) -5 614,75	2,87	0,02							0,70	24,59		
B. Cropland	(5) 65,90	NO	NA,NO							NO	NO		
C. Grassland	(5) -114,92	NO	NO							NO	NO		
D. Wetlands	(5) 4,24	NO	NE,NO										
E. Settlements	(5) NE,NO	NE,NO	NE,NO							NE	NE		
F. Other Land	(5) 788,84	NE,NO	NE,NO							NE	NE		
G. Other	(5)												
6. Waste	326,54	109,96	0,66							**0,55**	**0,06**	**0,03**	**0,03**
A. Solid Waste Disposal on Land	(6) NA,NO	85,53								NA,NO	NA,NO	NA,NO	
B. Waste-water Handling		24,44	0,64							NE	NE	0,03	
C. Waste Incineration	(6) 326,54	NE	0,01							0,55	0,06	0,01	0,03
D. Other	NA	NA	NA							NA	NA	NA	NA
7. Other *(please specify)*[7]	**NA**	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	**NA**	**NA**	**NA**
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/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: [8]													
International Bunkers	**806,88**	**0,15**	**0,01**							**0,99**	**0,26**	**0,05**	**0,06**
Aviation	806,88	0,15	0,01							0,99	0,26	0,05	0,06
Marine	NA,NO	NA,NO	NA,NO							NO	NO	NO	NO
Multilateral Operations										**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**4 818,58**												

(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 the documentation box to Table 1.A.(c). For estimating national total emissions, the results from the Sectoral approach should be used, where possible.
(3) Other Production includes Pulp and Paper and Food and Drink Production.
(4) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
(5) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(6) CO_2 from source categories Solid Waste Disposal on Land and Waste Incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from Waste Incineration Without Energy Recovery are to be reported in the Waste sector, whereas emissions from Incineration With Energy Recovery are to be reported in the Energy sector.
(7) If reporting any country-specific source category under sector "7. Other", detailed explanations should be provided in Chapter 9: Other (CRF sector 7) of the NIR.
(8) Countries are asked to report emissions from international aviation and marine bunkers and multilateral operations, as well as CO_2 emissions from biomass, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-use Change and Forestry sector.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emisions/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	**122 426,54**	**518,80**	**26,83**	**1 215,00**	**600,30**	**20,98**	**17,33**	**0,01**	**0,00**	**332,91**	**599,61**	**198,40**	**227,22**
1. Energy	**115 616,63**	**264,05**	**5,16**							**330,07**	**547,98**	**99,69**	**226,51**
A. Fuel Combustion — Reference Approach[2]	125 671,20												
Sectoral Approach[2]	115 616,63	15,15	5,16							329,38	547,52	99,28	226,25
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	248,90	IE,NA, NE,NO							0,69	0,46	0,41	0,26
2. Industrial Processes	**11 049,29**	**3,55**	**3,73**	**1 215,00**	**600,30**	**20,98**	**17,33**	**0,01**	**0,00**	**1,58**	**26,99**	**1,71**	**0,69**
3. Solvent and Other Product Use	**304,76**		**0,69**							**NA**	**NA**	**96,97**	**NA**
4. Agriculture [3]		**138,37**	**16,58**							**NA,NO**	**NA,NO**	**NA,NE,NO**	
5. Land Use, Land-Use Change and Forestry	[4] **-4 870,69**	**2,87**	**0,02**							**0,70**	**24,59**		
6. Waste	**326,54**	**109,96**	**0,66**							**0,55**	**0,06**	**0,03**	**0,03**
7. Other	**NA**	**NA**	**NA**					**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Memo Items: [5]													
International Bunkers	**806,88**	**0,15**	**0,01**							**0,99**	**0,26**	**0,05**	**0,06**
Aviation	806,88	0,15	0,01							0,99	0,26	0,05	0,06
Marine	NA,NO	NA,NO	NA,NO							NO	NO	NO	NO
Multilateral Operations										**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**4 818,58**												

Note: A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.
P = Potential emissions based on Tier 1 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 the documentation box to Table 1.A.(c). For estimating national total emissions, the result from the Sectoral approach should be used, where possible.
(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
(4) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(5) Countries are asked to report emissions from international aviation and marine bunkers and multilateral operations, as well as CO_2 emissions from biomass, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-use Change and Forestry sector.

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

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**122 426,54**	**10 894,80**	**8 317,69**	**600,30**	**17,33**	**49,56**	**142 306,22**
1. Energy	**115 616,63**	**5 545,04**	**1 600,33**				**122 762,00**
A. Fuel Combustion (Sectoral Approach)	115 616,63	318,21	1 600,33				117 535,17
1. Energy Industries	57 876,85	17,43	656,44				58 550,72
2. Manufacturing Industries and Construction	27 047,24	20,55	216,15				27 283,94
3. Transport	15 228,70	34,29	644,46				15 907,45
4. Other Sectors	14 200,32	240,42	67,73				14 508,47
5. Other	1 263,52	5,51	15,56				1 284,59
B. Fugitive Emissions from Fuels	IE,NA,NE,NO	5 226,83	IE,NA,NE,NO				5 226,83
1. Solid Fuels	IE,NA,NE	4 662,00	IE,NA,NO				4 662,00
2. Oil and Natural Gas	IE,NE,NO	564,83	NA,NE,NO				564,83
2. Industrial Processes	**11 049,29**	**74,57**	**1 155,19**	**600,30**	**17,33**	**49,56**	**12 946,24**
A. Mineral Products	3 625,11	4,71	NE				3 629,82
B. Chemical Industry	698,65	10,58	1 155,19	NA	NA	NA	1 864,42
C. Metal Production	6 725,53	59,27	NA	NA,NO	NA,NO	NA,NO	6 784,80
D. Other Production							
E. Production of Halocarbons and SF_6				NO			NO
F. Consumption of Halocarbons and SF_6 [2]				600,30	17,33	49,56	667,19
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**304,76**		**214,52**				**519,28**
4. Agriculture		**2 905,84**	**5 138,26**				**8 044,10**
A. Enteric Fermentation		2 389,81					2 389,81
B. Manure Management		516,03	370,80				886,83
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NA,NE	4 767,46				4 767,46
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NA	NA				NA
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**-4 870,69**	**60,18**	**6,11**				**-4 804,40**
A. Forest Land	-5 614,75	60,18	6,11				-5 548,46
B. Cropland	65,90	NO	NA,NO				65,90
C. Grassland	-114,92	NO	NO				-114,92
D. Wetlands	4,24	NO	NE,NO				4,24
E. Settlements	NE,NO	NE,NO	NE,NO				NE,NO
F. Other Land	788,84	NE,NO	NE,NO				788,84
G. Other							
6. Waste	**326,54**	**2 309,17**	**203,28**				**2 838,99**
A. Solid Waste Disposal on Land	NA,NO	1 796,04					1 796,04
B. Waste-water Handling		513,14	198,89				712,03
C. Waste Incineration	326,54	NE	4,39				330,93
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**			**NA**	**NA**

Memo Items: [4]							
International Bunkers	806,88	3,21	4,50				814,58
Aviation	806,88	3,21	4,50				814,58
Marine	NA,NO	NA,NO	NA,NO				NA,NO
Multilateral Operations							
CO_2 Emissions from Biomass	**4 818,58**						**4 818,58**

Total CO2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [5]	147 110,62
Total CO2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	142 306,22

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.
[5] These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

Appendix II

EMISSION INVENTORY OVERVIEW FOR 1990 - 2004

TABLE 10 EMISSIONS TRENDS (CO_2) Inventory 2004
(Sheet 1 of 5) Submission 2006 v1.1
(Part 1 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)									
1. Energy	**146 808**	**141 087**	**124 730**	**124 226**	**118 083**	**118 668**	**120 704**	**124 639**	**116 246**	**110 932**
A. Fuel Combustion (Sectoral Approach)	146 808	141 087	124 730	124 226	118 083	118 668	120 704	124 639	116 246	110 932
1. Energy Industries	58 354	58 054	51 859	54 114	54 853	57 267	57 150	58 079	57 602	53 014
2. Manufacturing Industries and Construction	46 935	49 465	40 862	42 261	36 042	32 981	35 722	35 156	28 168	28 351
3. Transport	7 342	6 675	7 453	7 446	7 644	9 502	9 896	11 392	10 850	12 087
4. Other Sectors	32 577	25 484	23 234	19 130	18 259	17 905	16 709	18 796	18 480	16 211
5. Other	1 601	1 409	1 321	1 276	1 285	1 013	1 227	1 216	1 146	1 270
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO
1. Solid Fuels	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE
2. Oil and Natural Gas	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO
2. Industrial Processes	**17 701**	**13 303**	**14 597**	**11 685**	**12 400**	**12 718**	**12 430**	**13 023**	**12 219**	**10 446**
A. Mineral Products	4 362	3 740	3 561	3 241	3 328	3 316	3 618	3 738	3 908	3 807
B. Chemical Industry	807	782	806	754	842	743	800	733	756	644
C. Metal Production	12 533	8 781	10 230	7 690	8 231	8 659	8 012	8 553	7 555	5 996
D. Other Production			NE		NE	NE				
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	550	514	476	436	402	382	372	370	366	364
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-1 779**	**-10 006**	**-9 695**	**-8 923**	**-8 334**	**-7 811**	**-10 851**	**-5 354**	**-3 628**	**-4 873**
A. Forest Land	-4 139	-7 428	-8 931	-8 939	-7 053	-6 407	-6 316	-5 087	-4 693	-5 053
B. Cropland	1 108	293	96	92	96	104	107	88	1 061	82
C. Grassland	-384	-3 321	-860	-78	-1 464	-1 513	-4 644	-835	4	-299
D. Wetlands	18	6	0	2	4	6	3	1	NE,NO	3
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	1 618	443	NE,NO	NE,NO	82	NE,NO	NE,NO	480	NE,NO	395
G. Other										
6. Waste	**NA,NE,NO**	**357**	**357**	**357**	**357**	**357**	**NA,NO**	**NA,NO**	**357**	**357**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	NE	357	357	357	357	357			357	357
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 emissions including net CO2 from LULUCF (3)	**163 281**	**145 254**	**130 466**	**127 781**	**122 908**	**124 314**	**122 655**	**132 678**	**125 560**	**117 227**
Total CO2 emissions excluding net CO2 from LULUCF (3)	**165 060**	**155 261**	**140 160**	**136 704**	**131 242**	**132 125**	**133 506**	**138 032**	**129 188**	**122 099**
Memo Items:										
International Bunkers	**617**	**555**	**476**	**373**	**283**	**371**	**459**	**407**	**225**	**539**
Aviation	617	555	476	373	283	371	459	407	225	539
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations										
CO_2 Emissions from Biomass	2 304	2 350	2 309	2 267	2 220	2 352	1 572	2 727	2 645	2 776

TABLE 10 EMISSIONS TRENDS (CO_2) Inventory 2004
(Sheet 1 of 5) Submission 2006 v1.1
(Part 2 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)					
1. Energy	**116 607**	**117 538**	**112 617**	**115 698**	**115 617**	**-21,25**
A. Fuel Combustion (Sectoral Approach)	116 607	117 538	112 617	115 698	115 617	-21,25
1. Energy Industries	59 355	59 538	57 730	58 955	57 877	-0,82
2. Manufacturing Industries and Construction	29 113	30 171	26 158	27 556	27 047	-42,37
3. Transport	11 119	12 061	12 428	13 431	15 229	107,42
4. Other Sectors	15 874	14 581	15 108	14 526	14 200	-56,41
5. Other	1 146	1 188	1 193	1 230	1 264	-21,07
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	0,00
1. Solid Fuels	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	IE,NA, NE	0,00
2. Oil and Natural Gas	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	IE,NE, NO	0,00
2. Industrial Processes	**11 699**	**10 802**	**10 741**	**11 698**	**11 049**	**-37,58**
A. Mineral Products	3 876	3 570	3 317	3 418	3 625	-16,89
B. Chemical Industry	736	620	541	704	699	-13,41
C. Metal Production	7 086	6 612	6 882	7 576	6 726	-46,34
D. Other Production						0,00
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	354	335	325	311	305	-44,62
4. Agriculture						
A. Enteric Fermentation						
B. Manure Management						
C. Rice Cultivation						
D. Agricultural Soils						
E. Prescribed Burning of Savannas						
F. Field Burning of Agricultural Residues						
G. Other						
5. Land Use, Land-Use Change and Forestry[(2)]	**-6 881**	**-7 073**	**-6 165**	**-5 750**	**-4 871**	**173,81**
A. Forest Land	-6 184	-6 661	-6 757	-6 114	-5 615	35,66
B. Cropland	87	88	82	72	66	-94,05
C. Grassland	-1 146	-502	-248	-242	-115	-70,07
D. Wetlands	2	2	4	3	4	-76,18
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
F. Other Land	360	NE,NO	754	532	789	-51,26
G. Other						0,00
6. Waste	**357**	**357**	**357**	**368**	**327**	**100,00**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
B. Waste-water Handling						
C. Waste Incineration	357	357	357	368	327	100,00
D. Other	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Other non-specified	NA	NA	NA	NA	NA	0,00
Total CO2 emissions including net CO2 from LULUCF [(3)]	**122 136**	**121 960**	**117 875**	**122 326**	**122 427**	**-25,02**
Total CO2 emissions excluding net CO2 from LULUCF [(3)]	**129 017**	**129 033**	**124 040**	**128 075**	**127 297**	**-22,88**
Memo Items:						
International Bunkers	**343**	**439**	**497**	**597**	**807**	**30,81**
Aviation	343	439	497	597	807	30,81
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Multilateral Operations						0,00
CO_2 Emissions from Biomass	2 362	3 124	2 815	2 900	4 819	109,18

TABLE 10 EMISSIONS TRENDS (CH_4) Inventory 2004
(Sheet 2 of 5) Submission 2006 v1.1
(Part 1 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)									
Total CH_4 emissions	**885,23**	**810,09**	**756,24**	**705,18**	**662,59**	**646,67**	**641,41**	**605,52**	**583,73**	**550,17**
1. Energy	464,08	406,33	381,61	367,88	348,97	337,38	334,97	323,90	311,34	284,41
A. Fuel Combustion (Sectoral Approach)	59,51	48,98	42,20	37,40	35,21	29,01	32,09	26,65	22,77	20,73
1. Energy Industries	7,10	6,81	6,65	6,69	6,72	5,02	2,75	2,36	2,28	1,66
2. Manufacturing Industries and Construction	2,12	2,60	1,93	2,20	1,62	1,58	1,49	1,50	1,21	1,28
3. Transport	1,25	1,08	1,25	1,42	1,41	1,60	1,80	1,88	1,86	1,90
4. Other Sectors	48,70	38,20	32,10	26,84	25,20	20,59	25,86	20,72	17,17	15,63
5. Other	0,34	0,29	0,27	0,26	0,26	0,21	0,20	0,20	0,24	0,26
B. Fugitive Emissions from Fuels	404,57	357,35	339,41	330,48	313,76	308,37	302,88	297,25	288,57	263,68
1. Solid Fuels	361,90	320,98	305,97	298,00	281,99	276,61	268,48	263,47	253,05	228,96
2. Oil and Natural Gas	42,67	36,36	33,45	32,49	31,77	31,76	34,40	33,78	35,52	34,72
2. Industrial Processes	**6,59**	**5,65**	**4,02**	**4,11**	**4,59**	**4,94**	**4,90**	**3,73**	**3,62**	**3,73**
A. Mineral Products	0,14	0,12	0,12	0,13	0,14	0,14	0,16	0,18	0,20	0,18
B. Chemical Industry	0,39	0,29	0,33	0,33	0,39	0,37	0,39	0,40	0,45	0,47
C. Metal Production	6,06	5,24	3,57	3,65	4,06	4,42	4,34	3,15	2,97	3,09
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**279,95**	**264,61**	**238,09**	**207,96**	**182,15**	**176,46**	**175,26**	**164,68**	**154,85**	**157,27**
A. Enteric Fermentation	231,88	218,47	195,78	169,36	148,31	144,39	143,04	133,43	125,11	127,78
B. Manure Management	48,07	46,14	42,31	38,61	33,83	32,07	32,22	31,26	29,74	29,49
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**2,11**	**1,74**	**1,58**	**1,58**	**1,73**	**1,82**	**2,22**	**2,18**	**2,49**	**2,53**
A. Forest Land	2,11	1,74	1,58	1,58	1,73	1,82	2,22	2,18	2,49	2,53
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other										
6. Waste	**132,51**	**131,76**	**130,94**	**123,65**	**125,15**	**126,07**	**124,06**	**111,03**	**111,43**	**102,22**
A. Solid Waste Disposal on Land	93,20	93,89	95,98	92,00	92,67	94,91	95,04	80,87	81,93	74,79
B. Waste-water Handling	39,31	37,88	34,96	31,64	32,48	31,16	29,02	30,16	29,50	27,43
C. Waste Incineration	NE	NE	IE	IE,NE	IE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	0,18	0,17	0,14	0,11	0,08	0,11	0,16	0,12	0,07	0,16
Aviation	0,18	0,17	0,14	0,11	0,08	0,11	0,16	0,12	0,07	0,16
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations										
CO_2 Emissions from Biomass										

TABLE 10 EMISSIONS TRENDS (CH_4) Inventory 2004
(Sheet 2 of 5) Submission 2006 v1.1
(Part 2 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
			(Gg)			
Total CH_4 emissions	**549,08**	**545,63**	**544,46**	**529,02**	**518,80**	**-41,39**
1. Energy	291,18	289,90	283,93	271,12	264,05	-43,10
A. Fuel Combustion (Sectoral Approach)	19,20	14,21	14,62	13,95	15,15	-74,54
1. Energy Industries	1,27	0,68	0,66	0,73	0,83	-88,31
2. Manufacturing Industries and Construction	1,16	0,91	0,79	1,10	0,98	-53,81
3. Transport	1,92	2,04	2,21	2,32	1,63	30,54
4. Other Sectors	14,61	10,34	10,72	9,55	11,45	-76,49
5. Other	0,24	0,25	0,25	0,26	0,26	-21,79
B. Fugitive Emissions from Fuels	271,98	275,69	269,31	257,17	248,90	-38,48
1. Solid Fuels	239,00	244,74	237,48	228,21	222,00	-38,66
2. Oil and Natural Gas	32,99	30,95	31,83	28,96	26,90	-36,96
2. Industrial Processes	**3,28**	**3,58**	**3,38**	**3,96**	**3,55**	**-46,10**
A. Mineral Products	0,25	0,25	0,20	0,20	0,22	57,55
B. Chemical Industry	0,41	0,44	0,41	0,40	0,50	29,86
C. Metal Production	2,61	2,89	2,76	3,36	2,82	-53,40
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use						
4. Agriculture	**150,60**	**151,33**	**147,31**	**143,33**	**138,37**	**-50,57**
A. Enteric Fermentation	122,72	123,61	120,71	117,53	113,80	-50,92
B. Manure Management	27,88	27,72	26,60	25,80	24,57	-48,88
C. Rice Cultivation	NO	NO	NO	NO	NO	0,00
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	0,00
G. Other	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**2,28**	**2,52**	**2,57**	**2,63**	**2,87**	**35,88**
A. Forest Land	2,28	2,52	2,57	2,63	2,87	35,88
B. Cropland	NO	NO	NO	NO	NO	0,00
C. Grassland	NO	NO	NO	NO	NO	0,00
D. Wetlands	NO	NO	NO	NO	NO	0,00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
G. Other						0,00
6. Waste	**101,74**	**98,30**	**107,27**	**107,98**	**109,96**	**-17,02**
A. Solid Waste Disposal on Land	75,98	73,48	80,63	83,41	85,53	-8,23
B. Waste-water Handling	25,75	24,82	26,64	24,57	24,44	-37,84
C. Waste Incineration	IE,NE	NE	NE	NE	NE	0,00
D. Other	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
	NA	NA	NA	NA	NA	0,00
Memo Items:						
International Bunkers	0,10	0,13	0,15	0,18	0,15	-16,55
Aviation	0,10	0,13	0,15	0,18	0,15	-16,55
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Multilateral Operations						0,00
CO_2 Emissions from Biomass						

TABLE 10 EMISSIONS TRENDS (N_2O) Inventory 2004
(Sheet 3 of 5) Submission 2006 v1.1
(Part 1 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)									
Total N_2O emissions	**40,66**	**35,01**	**31,00**	**27,68**	**27,15**	**28,14**	**26,64**	**27,32**	**27,15**	**26,03**
1. Energy	**4,57**	**4,81**	**4,09**	**4,28**	**3,94**	**4,30**	**4,35**	**4,58**	**4,47**	**4,47**
A. Fuel Combustion (Sectoral Approach)	4,57	4,81	4,09	4,28	3,94	4,30	4,35	4,58	4,47	4,47
1. Energy Industries	2,08	2,12	1,92	1,94	2,00	2,16	2,04	2,04	2,06	1,95
2. Manufacturing Industries and Construction	1,27	1,47	1,09	1,27	0,90	0,88	0,67	0,67	0,63	0,60
3. Transport	0,26	0,42	0,40	0,51	0,56	0,83	1,29	1,52	1,41	1,58
4. Other Sectors	0,89	0,75	0,63	0,51	0,42	0,39	0,30	0,30	0,34	0,28
5. Other	0,06	0,06	0,05	0,05	0,05	0,04	0,05	0,05	0,05	0,05
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO
1. Solid Fuels	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO
2. Oil and Natural Gas	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO
2. Industrial Processes	**3,90**	**2,64**	**3,25**	**2,54**	**3,21**	**3,64**	**3,33**	**3,60**	**3,86**	**3,22**
A. Mineral Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Chemical Industry	3,90	2,64	3,25	2,54	3,21	3,64	3,33	3,60	3,86	3,22
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69
4. Agriculture	**30,95**	**26,34**	**22,45**	**19,63**	**18,78**	**18,97**	**17,74**	**17,91**	**17,25**	**17,11**
A. Enteric Fermentation										
B. Manure Management	2,23	2,14	1,98	1,84	1,62	1,54	1,55	1,51	1,45	1,44
C. Rice Cultivation										
D. Agricultural Soils	28,73	24,19	20,47	17,79	17,16	17,43	16,19	16,40	15,81	15,68
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,02**	**0,01**	**0,35**	**0,02**
A. Forest Land	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,01	0,02	0,02
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,34	NA,NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other										
6. Waste	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0,52	0,52	0,52	0,52	0,52	0,52	0,52	0,52	0,52	0,52
C. Waste Incineration	NE	NE	IE	IE,NE	IE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	**0,02**	**0,02**	**0,02**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**
Aviation	0,02	0,02	0,02	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations										
CO_2 Emissions from Biomass										

TABLE 10 EMISSIONS TRENDS (N_2O) Inventory 2004
(Sheet 2 of 5) Submission 2006 v1.1
(Part 2 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)					
Total N_2O emissions	**26,64**	**27,39**	**26,46**	**24,98**	**26,83**	**-34,01**
1. Energy	**4,78**	**4,98**	**4,99**	**5,10**	**5,16**	**12,87**
A. Fuel Combustion (Sectoral Approach)	4,78	4,98	4,99	5,10	5,16	12,87
1. Energy Industries	2,16	2,21	2,14	2,14	2,12	1,64
2. Manufacturing Industries and Construction	0,65	0,78	0,67	0,71	0,70	-45,26
3. Transport	1,66	1,75	1,92	2,01	2,08	697,12
4. Other Sectors	0,26	0,20	0,22	0,20	0,22	-75,52
5. Other	0,05	0,05	0,05	0,05	0,05	-20,59
B. Fugitive Emissions from Fuels	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	0,00
1. Solid Fuels	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	IE,NA, NO	0,00
2. Oil and Natural Gas	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	0,00
2. Industrial Processes	**3,63**	**3,59**	**3,14**	**3,13**	**3,73**	**-4,56**
A. Mineral Products	NE	NE	NE	NE	NE	0,00
B. Chemical Industry	3,63	3,59	3,14	3,13	3,73	-4,56
C. Metal Production	NA	NA	NA	NA	NA	0,00
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	0,69	0,69	0,69	0,69	0,69	0,00
4. Agriculture	**16,87**	**17,47**	**16,98**	**15,38**	**16,58**	**-46,45**
A. Enteric Fermentation						
B. Manure Management	1,36	1,35	1,30	1,26	1,20	-46,28
C. Rice Cultivation						
D. Agricultural Soils	15,51	16,12	15,69	14,12	15,38	-46,46
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	0,00
G. Other	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**0,02**	**0,02**	**0,02**	**0,02**	**0,02**	**35,88**
A. Forest Land	0,02	0,02	0,02	0,02	0,02	35,88
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C. Grassland	NO	NO	NO	NO	NO	0,00
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
G. Other						0,00
6. Waste	**0,65**	**0,64**	**0,64**	**0,66**	**0,66**	**25,84**
A. Solid Waste Disposal on Land						
B. Waste-water Handling	0,65	0,64	0,64	0,64	0,64	23,12
C. Waste Incineration	IE,NE	NE	NE	0,02	0,01	100,00
D. Other	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
	NA	NA	NA	NA	NA	0,00
Memo Items:						
International Bunkers	**0,01**	**0,01**	**0,02**	**0,02**	**0,01**	**-27,50**
Aviation	0,01	0,01	0,02	0,02	0,01	-27,50
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Multilateral Operations						0,00
CO_2 Emissions from Biomass						

TABLE 10 EMISSION TRENDS
(HFCs, PFCs and SF_6) Inventory 2004
(Sheet 4 of 5) Submission 2006 v1.1
(Part 1 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	Base year (1995)	1996	1997	1998	1999
	(Gg)									
Emissions of HFCs(4) (Gg CO_2 equivalent)	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**0,73**	**101,31**	**244,81**	**316,56**	**267,59**
HFC-23	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,01	0,00	0,02
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,07	0,16	0,23	0,11
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,02
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs(5) (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs(4) – (Gg CO_2 equivalent)	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**0,12**	**4,11**	**0,89**	**0,89**	**2,55**
CF_4	NA,NO	NA,NO	NA, NO	NA,NO	NA, NO	NA, NO	NA,NO	0,00	0,00	0,00
C_2F_6	NA,NO	NA,NO	NA, NO	NA,NO	NA, NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO
C_3F_8	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	0,00	0,00	NA,NO	NA,NO	0,00
C_4F_{10}	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs(5) (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF_6(4) (Gg CO_2 equivalent)	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**NA,NE, NO**	**75,20**	**77,52**	**95,31**	**63,87**	**76,53**
SF_6	NA,NO	NA,NO	NA,NE, NO	NA,NO	NA,NE, NO	0,00	0,00	0,00	0,00	0,00

TABLE 10 EMISSION TRENDS
(HFCs, PFCs and SF_6) Inventory 2004
(Sheet 4 of 5) Submission 2006 v1.1
(Part 2 of 2) CZECH REPUBLIC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)					
Emissions of HFCs(4) (Gg CO_2 equivalent)	**262,50**	**393,37**	**391,29**	**590,14**	**600,30**	**100,00**
HFC-23	0,00	0,00	0,00	0,00	0,00	100,00
HFC-32	0,00	0,00	0,00	0,00	0,00	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-125	0,01	0,02	0,02	0,04	0,05	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	0,16	0,14	0,20	0,25	0,21	100,00
HFC-152a	0,00	0,00	0,00	0,00	0,00	100,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,01	0,04	0,01	0,03	0,05	100,00
HFC-227ea	NA,NO	0,00	0,00	0,00	0,00	100,00
HFC-236fa	0,00	0,00	0,00	0,00	0,00	100,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	0,00	100,00
Unspecified mix of listed HFCs(5) (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of PFCs(4) – (Gg CO_2 equivalent)	**8,81**	**12,35**	**13,72**	**24,53**	**17,33**	**100,00**
CF_4	0,00	0,00	0,00	NA, NO	NA,NO	0,00
C_2F_6	0,00	0,00	0,00	0,00	0,00	100,00
C_3F_8	0,00	0,00	0,00	0,00	0,00	100,00
C_4F_{10}	NA,NO	NA, NO	NA, NO	NA, NO	NA,NO	0,00
$c\text{-}C_4F_8$	NA,NO	NA, NO	NA, NO	NA, NO	NA,NO	0,00
C_5F_{12}	NA,NO	NA, NO	NA, NO	NA, NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA, NO	NA, NO	0,00	NA,NO	0,00
Unspecified mix of listed PFCs(5) (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of SF_6(4) (Gg CO_2 equivalent)	**141,36**	**167,83**	**66,78**	**99,83**	**49,56**	**100,00**
SF_6	0,01	0,01	0,00	0,00	0,00	100,00

TABLE 10 EMISSION TRENDS
(SUMMARY) Inventory 2004
(Sheet 5 of 5) Submission 2006 v1.1
(Part 1 of 2) CZECH REPUBLIC

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF[3]	163 281	145 254	130 466	127 781	122 908	124 314	122 655	132 678	125 560	117 227
CO_2 emissions excluding net CO_2 from LULUCF[3]	165 060	155 261	140 160	136 704	131 242	132 125	133 506	138 032	129 188	122 099
CH_4	18 590	17 012	15 881	14 809	13 914	13 580	13 470	12 716	12 258	11 553
N_2O	12 604	10 853	9 611	8 580	8 417	8 724	8 260	8 469	8 416	8 069
HFCs	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	1	101	245	317	268
PFCs	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	0	4	1	1	3
SF_6	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	75	78	95	64	77
Total (including net CO_2 from LULUCF)[3]	**194 474**	**173 119**	**155 958**	**151 170**	**145 239**	**146 694**	**144 567**	**154 205**	**146 615**	**137 195**
Total (excluding net CO_2 from LULUCF)[3], [6]	**196 253**	**183 126**	**165 653**	**160 093**	**153 573**	**154 505**	**155 418**	**159 559**	**150 243**	**142 068**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
1. Energy	157 971	151 112	134 011	133 279	126 631	127 087	129 086	132 862	124 170	118 290
2. Industrial Processes	19 050	14 240	15 687	12 560	13 491	14 028	13 748	14 560	13 872	11 869
3. Solvent and Other Product Use	765	728	691	651	616	596	587	585	580	578
4. Agriculture	15 474	13 721	11 959	10 452	9 648	9 586	9 180	9 010	8 601	8 608
5. Land Use, Land-Use Change and Forestry[7]	-1 730	-9 966	-9 658	-8 886	-8 294	-7 769	-10 800	-5 304	-3 466	-4 814
6. Waste	2 944	3 285	3 268	3 115	3 146	3 166	2 766	2 492	2 858	2 664
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[7]	**194 474**	**173 119**	**155 958**	**151 170**	**145 239**	**146 694**	**144 567**	**154 205**	**146 615**	**137 195**

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.
(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(3) The information in these rows is requested to facilitate comparison of data, because Parties differ in the way they report CO_2 emissions and removals from LULUCF.
(4) Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.
(5) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

(6) These totals will differ from the totals reported in table Summary 2 if Parties report non-CO_2 emissions from LULUCF.

(7) Includes net CO_2, CH_4 and N_2O from LULUCF.

TABLE 10 EMISSION TRENDS (SUMMARY) (Sheet 5 of 5) (Part 2 of 2)

Inventory 2004
Submission 2006 v1.1
CZECH REPUBLIC

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	Change from base to latest reported year
	CO₂ equivalent (Gg)					
CO_2 emissions including net CO_2 from LULUCF[3]	122 136	121 960	117 875	122 326	122 427	-25,02
CO_2 emissions excluding net CO_2 from LULUCF[3]	129 017	129 033	124 040	128 075	127 297	-22,88
CH_4	11 531	11 458	11 434	11 109	10 895	-41,39
N_2O	8 258	8 491	8 204	7 744	8 318	-34,01
HFCs	263	393	391	590	600	100,00
PFCs	9	12	14	25	17	100,00
SF_6	141	168	67	100	50	100,00
Total (including net CO_2 from LULUCF)[3]	**142 338**	**142 483**	**137 984**	**141 894**	**142 306**	**-26,83**
Total (excluding net CO_2 from LULUCF)[3], [6]	**149 218**	**149 556**	**144 149**	**147 644**	**147 177**	**-25,01**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	CO_2 equivalent (Gg)					
1. Energy	124 204	125 170	120 126	122 973	122 762	-22,29
2. Industrial Processes	13 305	12 563	12 258	13 467	12 946	-32,04
3. Solvent and Other Product Use	569	550	540	525	519	-32,11
4. Agriculture	8 394	8 594	8 359	7 778	8 044	-48,02
5. Land Use, Land-Use Change and Forestry[7]	-6 828	-7 015	-6 106	-5 689	-4 804	177,70
6. Waste	2 694	2 620	2 808	2 839	2 839	-3,57
7. Other	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)[7]	**142 338**	**142 483**	**137 984**	**141 894**	**142 306**	**-26,83**

Appendix III – Notation Keys

The Sectoral and Summary Report Tables summarize final inventory results. 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

NE	Not estimated
IE	Estimated but included elsewhere
NO	Not occurring
NA	Not applicable