CZECH HYDROMETEOROLOGICAL INSTITUTE

Air Quality Control Division

NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC, NIR

(REPORTED INVENTORY 2008)

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 2010

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CONTENT

Executive Summary

ES 1. Background Information

As a Party to the *United Nations Framework Convention on Climate Change* (UNFCCC), the Czech Republic is required to prepare and regularly update national greenhouse gas (GHG) inventories. In addition, as a result of membership in the European Union, the Czech Republic must also fulfil its reporting requirements concerning GHG emissions and removals following from Decision of the European Parliament and Council No. 280/2004/EC. This edition of the *National Inventory Report* (NIR) deals with national greenhouse gas inventories for the 1990 to 2008 period with accent on the latest year 2008.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: *Revised 1996 IPCC Guidelines* (IPCC, 1997); *Good Practice Guidance* (IPCC, 2000); *Good Practice Guidance for LULUCF* (IPCC, 2003); application of this general methodology on country specific circumstances will be described in category-specific chapters. When a method used to estimate emissions is improved or when some gaps are identified, a need to recalculate the whole time series may arise in order to maintain consistency. This means that data presented this year can be changed in the next submission.

The *National Inventory Report* is elaborated in accordance with the UNFCC reporting guidelines (UNFCCC, 2006). However, Annex I Parties that are also Parties to the *Kyoto Protocol* are also required to report supplementary information required under Article 7.1 of the *Kyoto Protocol* that is specified by Decision 15/CPM.1. Thus the second part contains the Kyoto elements of the report. The both parts of the *National Inventory Report,* together with the data output - *Common Reporting Format* (CRF) Tables, are submitted annually by 15. April.

The structure of this NIR attempts to follow new methodical handbook published by the Secretariat published "*Annotated outline of the National Inventory Report including elements under the Kyoto Protocol*" (UNFCCC, 2009).

ES 2. Summary of National Emission and Removal Related Trends and Emission and Removals from KP-LULUCF Activities

ES 2.1. GHG inventory

In 2008, the most important GHG in the Czech Republic was CO_2 contributing 84.8 % to total national GHG emissions and removals expressed in $CO_{2\ eq.}$, followed by CH_4 - 8.6 % and N_2O - 5.7 %. PFCs, HFCs and SF_6 contributed for 0.98 % to the overall GHG emissions in the country. The energy category accounted for 83.9 % of the total GHG emissions and removals followed by Industrial Processes and Solvent Use 10.9 %, Agriculture 6.1 % and Waste 2.6 %. Total GHG emissions and removals (with *5 Land Use, Land-Use Change and Forestry*) amounted to 136 633.609 Gg $CO_{2\ eq.}$ and decreased by 28.7 % from 1990 to 2008.

Table ES 1 provides data on emissions by categories and Table ES 2 by gas from 1990 to 2008.

Tab. ES 1 Summary of GHG emissions by category 1990 - 2008 *[Gg $CO_{2\ eq.}$]*

	1 Energy	2 Industrial Processes	3 Solvent Use	4 Agriculture	5 LULUCF	6 Waste
1990	156 237	19 596	765	15 937	-3 630	2 650
1991	149 171	14 612	728	14 161	-9 043	3 052
1992	132 980	16 062	691	12 344	-10 794	3 057
1993	131 540	12 916	651	10 811	-9 439	3 062
1994	121 270	13 848	616	9 976	-7 143	3 152
1995	125 523	14 310	596	9 897	-7 211	3 193
1996	132 973	14 037	587	9 487	-7 621	3 167
1997	125 381	14 873	585	9 315	-6 661	3 150
1998	118 449	14 166	580	8 889	-6 998	3 180
1999	116 191	12 146	578	8 897	-7 155	3 194
2000	121 420	13 610	569	8 659	-7 545	3 250
2001	124 076	12 863	550	8 883	-7 890	3 275
2002	120 282	12 558	540	8 625	-7 645	3 344
2003	118 885	13 753	525	8 020	-5 746	3 333
2004	118 813	14 954	519	8 362	-6 190	3 341
2005	119 757	13 598	514	8 066	-6 687	3 423
2006	120 007	14 996	513	7 937	-3 472	3 484
2007	119 751	15 527	512	8 117	-730	3 555
2008	114 623	14 345	515	8 324	-4 778	3 605

Over the period 1990 - 2008 CO_2 emissions and removals decreased by 27.9 %, mainly by emissions reduction in *1 Energy*; although CO_2 emissions from *1A3 Transport* category rapidly increased during the period. CH_4 emissions decreased by 37.0 % during the same period mainly due to lower emissions from *1 Energy*, *4 Agriculture* and *6 Waste*; N_2O emissions decreased by 36.7 % over the same period due to emission reduction in *4 Agriculture* and despite increase from the *1A3 Transport* category. Emissions of HFCs and PFCs increased more than 1 700 times and 200-times, respectively, whereas SF_6 emissions decreased by 37.4 % from the base year (1995) to 2008.

ES 2.2. KP-LULUCF activities

Emission and removals estimates of GHGs for the year 2008 are presented in Table ES 2.

Tab. ES 2 Summary of GHG emissions and removals for KP LULUCF activities *[Gg $CO_{2\ eq.}$]*

	Article 3.3 activities		Article 3.4 activities			
	Afforestration and Reforestration	Deforestation	Forest Management	Cropland Management	Grazing Land Management	Revegetation
2008	-272.0	160.2	-4413.7	NA	NA	NA

ES 3. Overview of Source and Sink Category Emission Estimates and Trends, including KP-LULUCF Activities

ES 3.1. GHG inventory

In 2008, 114 623 Gg $CO_{2\ eq.}$, that are 83.9 % of national total emissions (including *5 Land Use, Land-Use Change and Forestry*) arose from *1 Energy*; 95.6 % of these emissions arise from fuel combustion activities. The most important sub-category of *1 Energy* with 54.4 % of total sectoral emissions in 2008 is *1A1 Energy Industries*, *1A2* M*anufacturing Industries and Construction* responses for 14.0 % and *1A3 Transport* for 16.3 % of total sectoral emissions. From 1990 to 2008 emissions from *1 Energy* decreased by *26.6* %.

2 Industrial Processes is the second largest category with 10.5 % of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2008 (14 345 Gg $CO_{2\ eq.}$); the largest sub-category is 2C *Metal Production*. From 1990 to 2008 emissions from *2 Industrial Processes* decreased by 26.8 %.

In 2008, 0.4 % of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in the Czech Republic (515 Gg $CO_{2\ eq.}$) arose from the category *3 Solvent and Other Product Use*. From 1990 - 2008 emissions from *3 Solvent and Other Product Use* decreased by 32.6 %.

4 Agriculture is the third largest category in the Czech Republic with 6.1 % of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2008 (8 324 Gg $CO_{2\ eq.}$); 61.3 % of emissions is coming from *4D Agricultural Soils*. From 1990 to 2008 emissions from *4 Agriculture* decreased by 48.8 %.

5 Land Use, Land-Use Change and Forestry is the only category where removals exceed emissions. Removals from this category increased from 1990 to 2008 by 61.6 % to 4 778 Gg $CO_{2\ eq.}$

2.6 % of the national total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2008 arose from *6 Waste.* Emissions from *6 Waste* increased from 1990 to 2008 by 36.0 % to 3 605 Gg $CO_{2\ eq.}$

Tab. ES 3 Summary of GHG emissions by gas 1990 - 2008 *[Gg $CO_{2\ eq.}$]*

	$CO_{2\ total}$ [1]	CO_2 [2]	CH_4 [1]	N_2O [1]	HFCs	PFCs	SF_6
1990	145 236	154 381	16 880	10 488	NO	NO	77
1991	129 016	139 916	15 877	9 371	NO	NO	77
1992	129 016	139 916	15 877	9 371	NO	NO	77
1993	126 297	135 855	14 884	8 282	NO	NO	77
1994	119 491	126 754	13 981	8 171	NO	NO	76
1995	124 073	131 396	13 733	8 426	1	0	75
1996	130 889	138 650	13 552	8 005	101	4	78
1997	125 025	131 834	13 123	8 154	245	1	95
1998	117 144	124 273	12 651	8 090	317	1	64
1999	113 453	120 730	12 146	7 905	268	3	77
2000	119 482	127 138	12 178	7 889	263	9	142
2001	120 714	128 719	12 337	8 132	393	12	169
2002	117 207	124 974	12 155	7 869	391	14	68
2003	118 712	124 607	11 881	7 463	590	25	101
2004	119 383	125 711	11 656	8 091	600	17	52
2005	118 397	125 216	11 786	7 797	594	10	86
2006	122 631	126 264	12 208	7 649	872	23	83
2007	125 451	126 388	11 873	7 708	1 606	20	76
2008	115 799	120 742	11 687	7 811	1 262	27	47

ES 3.2. KP-LULUCF activities

Emission and removals estimates of GHGs for the year 2008 are presented in Table ES 4.

Tab. ES 4 Summary

	CO_2 emissions	CO_2 removals	CH_4	N_2O
2008	159.8	4 299.9	6.8	0.05

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 to 2008 are presented in Table ES 5.

[1] emissions including LULUCF category

[2] emissions excluding LULUCF category

Tab. ES 5 Indirect GHGs and SO_2 for 1990 - 2008 *[Gg]*

	NO_X	CO	NMVOC	SO_2
1990	742	1 071	311	1 876
1991	732	1 157	273	1 772
1992	708	1 162	257	1 559
1993	691	1 194	233	1 469
1994	451	1 075	255	1 290
1995	430	932	215	1 095
1996	447	965	265	934
1997	471	981	272	981
1998	414	812	267	442
1999	391	726	247	269
2000	397	680	244	264
2001	333	687	220	251
2002	319	587	203	237
2003	326	630	203	232
2004	334	622	198	227
2005	279	556	182	219
2006	284	540	179	211
2007	286	584	174	217
2008	262	498	166	174
NEC[3]	286	-	220	283

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2008: for NO_X by 64.6 %, for CO by 53.5 %, for NMVOC by 46.7 % and for SO_2 by 90.7 %. The most important emission source for indirect greenhouse gases and SO_2 are fuel combustion activities.

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

Part 1: Annual inventory Submission

1. Introduction and general issues

1.1 Background information

1.1.1 *Climate change*

Greenhouse gases (i.e. gases that contribute to the greenhouse effect) have always been present in the atmosphere, but now the concentrations of a number of them are increasing as a result of human activity. Over the past century, the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halogenated hydrocarbons, i.e. greenhouse gases, have increased as a consequence of human activity. Greenhouse gases prevent the radiation of heat back into space and cause warming of the climate. According to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2007), the atmospheric concentrations of CO_2 have increased by 35%, CH_4 concentrations have more than doubled and N_2O concentrations have risen by 18%, compared with the pre-industrial era. Ground-level ozone also contributes to the greenhouse effect. The amount of ozone formed in the lower atmosphere has increased as a result of emissions of nitrogen oxides, hydrocarbons and carbon monoxide.

Relatively new, man-made greenhouse gases that are entering the atmosphere cause further intensification of the greenhouse effect. These include, in particular, a number of substances containing fluorine (F-gases), among them HFCs (hydrofluorocarbons). HFCs are used instead of ozone-layer-depleting CFCs (freons) in refrigerators and other applications, and their use is on the increase. Compared with carbon dioxide, all the other greenhouse gases occur at low (CH_4, N_2O) or very low concentrations (F-gases). On the other hand, these substances are more effective (per molecule) as greenhouse gases than carbon dioxide, which is the main greenhouse gas.

The threat of climate change is considered to be one of the most serious environmental problems faced by humankind. The average surface temperature of the earth has risen by about 0.6–0.9°C in the past 100 years and, according to the fourth IPCC assessment report, will rise by another 1.8–4.0°C in the next 100 years, depending on the emission scenario. The increase of the average surface temperature of the Earth, together with the increase in the surface temperature of the oceans and the continents, will lead to changes in the hydrologic cycle and to significant changes in the atmospheric circulation, which drives rainfall, wind and temperature on a regional scale. This will increase the risk of extreme weather events, such as hurricanes, typhoons, tornadoes, severe storms, droughts and floods.

In consequence of scientific indications that human activities influence the climate and an increasing public awareness about local and global environmental issues during the middle of the 1980s, climate change became part of the political agenda. The *Intergovernmental Panel on Climate Change* (IPCC) was established in 1988 and, two years later, they concluded that anthropogenic climate change was a global threat and asked for an international agreement to deal with the problem. The *United Nations* started negotiations to create a *Framework Convention on Climate Change* (UNFCCC), which came into force in 1994. The long-term goal consisted in stabilizing the amount of greenhouse gases in the atmosphere at a level where harmful anthropogenic climate changes are prevented. Since UNFCCC came into force, the Framework Convention has evolved and a Conference of the Parties (COP) is held every year. The most important addition to the Convention was negotiated in 1997 in Kyoto, Japan. The *Kyoto Protocol* involves binding obligations for the Annex I countries (including all EU member states and other industrialized countries). Altogether, the emissions of greenhouse gases by these countries should be at least 5 % lower during 2008-2012 compared to the base year of 1990 (for fluorinated greenhouse gases, 1995 can be used as a base year). In 2001 the Czech Republic ratified the *Kyoto Protocol* and it came into force on February 16, 2005, even though it has not been ratified by the United States.

Under the *Kyoto Protocol*, the Czech Republic is committed to decrease its emissions of greenhouse gases in the first commitment period, i.e. from 2008 to 2012, by 8% compared to the base year of 1990 (the base year for F-gases is 1995).

1.1.2 *Greenhouse gas inventories*

Annual monitoring of greenhouse gas emissions and removals is one of the obligations following from the *UN Framework Convention on Climate Change* and its *Kyoto Protocol*. 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 the institution responsible for compiling GHG inventories. Thereafter, CHMI has been the official provider of Czech greenhouse gas emission data. The role of CHMI was improved following implementation of NIS in 2005, when CHMI was designated by ME as the coordinating institution of the official national GHG inventory.

The inventory covers anthropogenic emissions of direct greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, SF_6 and indirect greenhouse gases NO_x, CO, NMVOC and SO_2. Indirect means that they do not contribute directly to the greenhouse effect, but that their presence in the atmosphere may influence the climate in various ways. As mentioned above, ozone (O_3) is also a greenhouse gas that is formed by the chemical reactions of its precursors: nitrogen oxides, hydrocarbons and/or carbon monoxide.

The obligations of the *Kyoto Protocol* have led to an increased need for international supervision of the emissions reported by the parties. The Kyoto Protocol therefore contains rules for how emissions should be estimated, reported and reviewed. Emissions of the direct greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 are calculated as CO_2 equivalents and added together to produce a total. Together with the direct greenhouse gases, also the emissions of NO_x, CO, NMVOC and SO_2 are reported to UNFCCC. These gases are not included in the obligations of the Kyoto Protocol. The emission estimates and removals are reported by gas and by source category and refer to 2008. Full time series of emissions and removals from 1990 to 2008 are included in the submission.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: *Revised 1996 IPCC Guidelines* (IPCC, 1997); *Good Practice Guidance* (IPCC, 2000); *Good Practice Guidance for LULUCF* (IPCC, 2003); application of this general methodology under country-specific circumstances will be described in the sector-specific chapters. When a method used to estimate emissions is improved or when some gaps are identified, a need to recalculate the whole time series may arise in order to maintain consistency. This means that data presented this year can change in the next submission.

At the beginning of 2009, the Secretariat published a methodical handbook entitled "*Annotated outline of the National Inventory Report including elements under the Kyoto Protocol*" (UNFCCC, 2009), providing instructions on how to combine the existing requirements on reporting pursuant to decision 18/CP.8 and 14/CP.11, see (UNFCCC, 2006) with the requirements on reporting pursuant to Article 7.1 of the Kyoto Protocol given in Decision 15/CMP.1. This report attempts to follow this methodical handbook.

The current data submission (2010) for UNFCCC and for the European Community contains all the data sets for 1990 - 2008 in the form of the official UNFCCC software called *CRF Reporter* (version 3.4).

1.2 National Inventory System and Institutional Arrangement

The National Inventory System (NIS), as required by the *Kyoto Protocol* (Article 5.1) and by Decision No. 280/2004/EC, has been in place since 2005. As approved by the *Ministry of Environment* (ME), which is the single national entity with overall responsibility for the national greenhouse gas

inventory, the founder of CHMI and its superior institution, the established institutional arrangement is as follows:

The *Czech Hydrometeorological Institute* (CHMI), under the supervision of the *Ministry of the Environment*, is designated as the coordinating and managing organization responsible for the compilation of the national GHG inventory and reporting its results. 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. Mr. Pavel Fott is the representative of CHMI for NIS performance.

Sectoral inventories are prepared by sector experts from sector-solving institutions, which are coordinated and controlled by CHMI. The responsibilities for GHG inventory compilation from the 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 Ltd. (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 ME secures contacts with other relevant governmental bodies, such as the *Czech Statistical Office*, the *Ministry of Industry and Trade* and the *Ministry of Agriculture*. In addition, the ME provides financial resources for the NIS performance to the CHMI, which annually concludes contacts with sector-solving institutions.

More detailed information about NIS is given in the *Initial Report* (ME, 2006) and in the 5th *National Communication* (ME, 2009).

1.3 Inventory Preparation

1.3.1 *Brief Description of the inventory process*

UNFCCC, the *Kyoto Protocol* and the EU greenhouse gas monitoring mechanism require the Czech Republic to annually submit a *National Inventory Report* (NIR) and *Common Reporting Format* (CRF) tables. The annual submission contains emission estimates for the second but last year, so that the 2010 submission contains estimates for the calendar year of 2008. The organisation of the preparation and reporting of the Czech greenhouse gas inventory and the duties of its institutions are detailed in the previous section (1.2).

The preparation of the inventory includes the following three stages:

1) inventory planning,

2) inventory preparation and

3) inventory management.

During the first stage, specific responsibilities are defined and allocated: as mentioned before, CHMI coordinates the national GHG inventory, including the planning period. Within the inventory system, specific responsibilities, "sector-solving institutions", are defined for the different source categories, as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

During the second stage, the inventory preparation process, experts from sector-solving institutions collect activity data, emission factors and all the relevant information needed for final estimation of emissions. They also have specific responsibilities regarding the choice of methods, data processing

and archiving. As part of the inventory plan, the NIS coordinator approves the methodological choice. Sector-solving institutions are also responsible for performing Quality Control (QC) activities that are incorporated in the QA/QC plan, (see Chapter 1.5). All data collected, together with emission estimates, are archived (see below) and documented for future reconstruction of the inventory.

In addition to the actual emission data, the background tables of the CRF are filled in by the sector experts, and finally QA/QC procedures, as defined in the QA/QC plan, are performed before the data are submitted to the UNFCCC.

For the inventory management, reliable data management to fulfil the data collecting and reporting requirements is necessary. As mentioned above, data are collected by the experts from the sector solving institutions and the reporting requirements increase rapidly and may change over time. The data and calculation spreadsheets are stored in a central network server at CHMI, which is regularly backed up to ensure data security. The inventory management includes a control system for all documents and data, for records and their archives, as well as documentation on QA/QC activities (see Chapter 1.5).

1.3.2 *Activity Data Collection*

Collection of activity data is based mainly on the official documents of the *Czech Statistical Office* (CSO), which are published annually, where the *Czech Statistical Yearbook* is the most representative example. However for industrial processes, because of the *Czech Act on Statistics*, production data are not generally available when there are fewer 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 the relevant inquiries. In a few cases, the Czech register of individual sources and emissions, called REZZO, is utilized as source of activity data.

Emission estimates from Sector 1A *Fuel Combustion Activities* 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. data on transportation statistics).

So far, data from the emission trading system has been used to only a limited degree in the Czech national greenhouse gas inventory (e.g. in the sector of Industrial processes - mineral products). It was recommended to the Czech inventory team during the recent “in-country review” that the data from EU ETS be used to a greater degree. For this purpose, the team began to prepare an “improvement plan” to provide for gradual inclusion of the relevant EU ETS data in the national inventory. The next part of this “improvement plan” will consist in gradual introduction of higher tiers into the national inventory. At the present time, CHMI, in cooperation with ME, is preparing a database of activities and emission data from the EU ETS system, which could be used in preparation of the national inventory. Consequently, it can be expected that these data will be employed more extensively only in future inventories.

1.3.3 *Data Processing and Storage*

Data Sector *1A Fuel Combustion Activities* 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. This system was recently a bit modified to be more transparent.

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.

Following the calculations, all the relevant data are put into the *Common Reporting Format* (CRF) to be reported and to be stored together with detailed calculation spreadsheets and with additional pieces of information (documents about inventory planning and management, QA/QC protocols, etc).

Originally, the calculation spreadsheets related to the individual sectors were stored only in the relevant sector-solving institutions. However, on the basis of recommendations from the “in-country review” in 2007, a quite simple system was evolved for central archiving, based on storage of documents from institutions participating in the national system in a central address-structured FTP data box located at CHMI. During the next “in-country review” in 2009, this system was evaluated as only partly satisfactory and consequently it was decided to further improve the archiving system using more sophisticated software.

1.4 Brief General Description of Methodology

The methods used in the Czech greenhouse gas (GHG) inventory are consistent with the IPCC methodology, which has been prepared for the purpose of compilation of national inventories of anthropogenic GHG emissions and removals. The existing and valid version of the IPCC methodology consists of the *Revised 1996 IPCC Guidelines* (IPCC 1997), *IPCC Good Practice Guidance* (IPCC 2000) and *IPCC Good Practice Guidance for LULUCF* (IPCC 2003).

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 consist of three tiers. Tier 1 is typically characterized by simpler calculations, based on the basic statistical data and on the use of generally recommended emission factors (*default*) of global or continental applicability, tabulated directly in above mentioned methodical manuals.

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 Tier 3 are usually considered to consist in procedures based on the results of direct measurements carried out under local conditions.

Methods of higher tiers should be applied mainly for key categories. Key categories (key source categories) are defined as categories that cumulatively contribute 90% or more to the overall uncertainty either in level or in trend. Apparently, procedures in higher tiers should be more accurate and should better reflect reality. However, they are more demanding in all respects, and especially they are more expensive. An overview of the methods and emission factors used by the Czech Republic for estimation of emissions of greenhouse gases is given in the CRF Table “Summary 3”.

Because of the above-described problems encountered in the application of the methods of higher tiers, these procedures have so far been introduced only for some key categories. For example, for combustion of fuels, country-specific factors are employed only for brown and hard coal, while the default emission factors are employed for the other fuels. Similarly, for Industrial Processes, only the Tier 1 method is used for the production of iron and steel. In contrast, the methods of higher tiers and/or country-specific factors are employed far more frequently for other key categories. Chapter 10 describes the “Improvement Plan”, which will also encompass gradual introduction of more sophisticated methods of higher tiers.

All direct GHG emissions can also be expressed in terms of total (or aggregated) values, which are calculated as a sum of the emissions of the individual gases multiplied by the 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). The 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. Consequently, 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.

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 the *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 to CRF. A detailed description of the methodology used to estimate emissions of *precursors* is provided in the *Czech Informative Inventory Report (IIR) 2008, Submission under the UNECE / CLRTAP Convention*, published in March 2010.

In October of 2009, the Czech national greenhouse gas inventory was subjected to the "*in-country review*". The Czech national inventory team learned of the contents of the draft of the relevant review report (ARR) relatively late (in January 2010) and was thus not able to fully take into account the comments and recommendations of the international review team (ERT) in this submission. Nonetheless, in some feasible cases, the comments were taken into account in this year's submission; in more complicated cases, the comments and recommendations will be taken into account in the 2011 submission.

Methodical aspects will be described in greater detail in sector-oriented Chapters 3 to 8 and in Chapter 10 "Recalculations and Improvements". Chapter 10 will also be concerned with the reactions of the Czech team to the comments and recommendations of the recent international review organised by UNFCCC.

1.5 Information on the QA/QC Plan

In the "in-country review" in October of 2009, the original QA/QC was considered inadequate and thus it is necessary to immediately establish a new conception of the QA/QC plan, an outline of which is presented in this chapter. For reasons of time, it has so far been possible to implement it only partly. Nonetheless, the Czech NIS team anticipates that, following experience with this implementation, it will be possible to correct and up-date this plan so that it can be employed to the full extent in the 2011 submission.

The QA/QC system is an integral part of the national system. It ensures that the greenhouse gas inventories and reporting are of high quality and meet the criteria of transparency, consistency, comparability, completeness, accuracy and timeliness set for the annual inventories of greenhouse gases.

The objective of the National Inventory System (NIS) is to produce high-quality GHG inventories. In the context of GHG inventories, high quality provides that both the structures of the national system (i.e. all institutional, legal and procedural arrangements) for estimating GHG emissions and removals and the inventory submissions (i.e. outputs, products) comply with the requirements, principles and elements arising from UNFCCC, the *Kyoto Protocol*, the IPCC guidelines and the EU GHG monitoring mechanism (Decision of the European Parliament and of the Council No 280/2004/EC).

1.5.1 *CHMI as a coordinating institution of QA/QC activities*

The NIS coordinator (NIS manager) from the *Czech Hydrometeorological Institute* (CHMI) controls and facilitates the quality assurance and quality control (QA/QC) process and nominates QA/QC guarantors from all sector-solving institutions. The NIS coordinator cooperates with the archive administrator on implementation and documentation of all the QA/QC procedures.

The Czech NIS team, which consists of involved experts from CHMI and experts from sector-solving institutions, cooperates in addressing QA/QC issues and in development and improvement of the QA/QC plan. QA/QC issues are discussed regularly (about four times a year) by the CHMI experts and the sectoral expert at bilateral meetings. At least once a year, a joint meeting of all the involved experts is organised by CHMI (by the NIS coordinator). The work of the Czech inventory team is regularly checked (at least three times a year) by the *Ministry of the Environment* (ME) during supervisory days. At these times, the NIS coordinator provides ME with information about all QA/QC

activities and discusses the potential for any further improvements. ME also annually approves the QA/QC plan prepared by CHMI in cooperation with the sector-solving institutions.

An electronic quality manual including e.g. guidelines, plans, templates and checklists has been developed by CHMI and is available to all participants in the national inventory system via the Internet (FTP box for NIS). All the relevant documentation concerning QA/QC activities is archived centrally at CHMI.

In addition to consideration of the special requirements of the guidelines concerning greenhouse gas inventories, the development of the inventory quality management system follows the principles and requirements of the ISO 9001 standard. ISO 9001 certification was awarded to CHMI in March 2007.

The CHMI ISO 9001 working manual encompasses the NIS segment, which is obligatory for the relevant experts at CHMI and is also recommended for experts from the sector-solving institutions. The NIS segment is developed in the form of flow-charts (diagrams) and consists of three sub-segments: (i) Planning and management of GHG inventories (ii) Preparation of sectoral inventories (iii) Compilation of data and text outputs.

In this way, the NIS segment defines the rules for cooperation between CHMI as coordinating institution and the experts from the sector-solving institutions. This involves the phase of inventory planning (including QA/QC procedures) and provides instructions for the inventory compilation and for preparation of data and text outputs (CRF Tables, NIR). All the main principles mentioned above are also incorporated into the regular contracts between the CHMI and the sector-solving institutions, which are renewed annually.

1.5.2 *QA/QC process*

The starting point for preparing a high-quality GHG inventory consists in consideration of the expectations and requirements directed at the inventory. The inventory principles defined in the UNFCCC and IPCC guidelines, that is, transparency, consistency, comparability, completeness, accuracy and timeliness, are dimensions of quality for the inventory and form the set of criteria for assessing the output produced by the national inventory system. In addition, the principle of continuous improvement is included.

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on the inventory principles. Quality objectives are concrete expressions about the standard that is aimed at in the inventory preparation with regard to the inventory principles. The aim of the objectives is to be appropriate and realistic while taking account of the available resources and other conditions in the operating environment. Where possible, quality objectives should be measurable.

The quality objectives regarding all calculation sectors for the 2010 inventory submissions are the following:

1. Continuous improvement

- Treatment of review feedback is systematic
- Improvements promised in the National Inventory Report (NIR) are introduced
- Improvement of the inventory should be systematic. An improvement plan for a longer time horizon focused on gradual implementation of higher tiers for almost all key categories is being developed.

2. Transparency

- Archiving of the inventory is systematic and complete
- Internal documentation of calculations supports emission and removal estimates
- CRF tables and the National Inventory Report (NIR) include transparent and appropriate descriptions of emission and removal estimates and of their preparation.

3. Consistency

- The time series are consistent
- Data have been used in a consistent manner in the inventory.

4. Comparability
- The methodologies and formats used in the inventory meet comparability requirements.

5. Completeness
- The inventory covers all the emission sources, sinks and gases

6. Accuracy
- The estimates are systematically neither greater nor less than the actual emissions or removals
- The calculation is correct
- Inventory uncertainties are estimated.

7. Timeliness
- High-quality inventory reports reach their recipient (EU / UNFCCC) within the set time.

The quality objectives and the planned general QC and QA procedures regarding all the calculation sectors are recorded as the QA/QC plan. The QA/QC plan specifies the actions, the schedules for the actions and the responsibilities to attain the quality objectives and to provide confidence in the Czech national system's capability and implementation to perform and deliver high-quality inventories. The QA/QC plan is updated annually.

1.5.3 *Quality control procedures*

The QC procedures, which aim at attainment of the quality objectives, are performed by the experts during inventory calculation and compilation according to the QA/QC plan.

The QC procedures used in the Czech GHG inventory comply with the *IPCC Good Practice Guidance*. General inventory QC checks (IPCC, 2000), Table 8.1 and (IPCC 2003), Table 5.5.1 include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control checks. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are employed on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

Once the experts have implemented the QC procedures, they complete the QA/QC form for each source/sink category, which provides a record of the procedures performed. The results of the completed QC checks are recorded in the internal documents for the calculation and archived in the expert organisations and at CHMI. Key findings are summarised in the sector-specific chapters of NIR.

Specifically, QC procedures in the sectors are organised as described below:

Each sector-solving institution – KONEKO, CDV, CHMI (Industrial processes), IFER and CUEC – will suggest, to the NIS coordinator (CHMI, Mr. Pavel Fott), their QA/QC guarantors, responsible for the compliance of all the QA/QC procedures in the given sector with the IPCC *Good Practice Guidance* (IPCC, 2000) and (IPCC, 2003) and also with the QA/QC plan.

At the basic level of control (Tier 1), individual steps should be controlled according to the Table 8.1 (IPCC, 2000) and Table 5.5.1 (IPCC, 2003). The first step is carried out by the person responsible for the respective sub-sector (auto-control). This is followed by the 2nd step carried out by an expert familiar with the topic. The reporting on the implemented controls is documented in a special form prepared by CHMI. The completed form with all the records of the performed checks is, for QC, Tier 1, submitted to the NIS coordinating institution – CHMI, together with data outputs: (i) XML file generated by the CRF Reporter, (ii) detailed calculation spreadsheet in MS Excel format, containing, in addition to all the calculation steps, also all the activity data, emission factors and other parameters, as well as further supplementary data necessary for emission determination in the given category. All these files are then submitted to the central archive at CHMI. The records of the performed QC checks, Tier 2, are submitted later.

The sectoral QA/QC guarantor, in cooperation with the NIS coordinator, will assess the conditions for Tier 2 in the given sector (e.g. comparison with EU ETS data or with other independent sources). If everything is in order, the sectoral QA/QC guarantor organizes the QC check according to Tier 2.

CHMI, as the NIS coordinating institution, carries out mainly formal control of data outputs in the CRF Reporter, similar to the "Synthesis and Assessment" control performed by the UNFCCC Secretariat. Thus, CHMI controls the consistency of time series, and possible IEF exceedance of the expected intervals (outliers), as well as the completeness and suitability of the use of notation keys and commentaries in the CRF Reporter (mainly for NE and IE), etc.

1.5.4 *Quality assurance procedures*

Quality assurance comprises a planned system of review procedures. The QA reviews are performed after application of the QC procedures to the finalised inventory. The inventory QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures employed and to identify areas where improvements could be made. While QC procedures are carried out annually and for all the sectors, it is anticipated that QA activities will be performed by the individual sectors at longer intervals. Each sector should be reviewed by a QA audit approx. once in three years, as far as possible. In addition, QA activities should be focused mainly on key categories.

Peer reviews (QA procedures) are sector- or category-specific projects that are performed by external experts or groups of experts. The reviewers should preferably be external experts who are independent of the inventory preparation. The objective of the peer review is to ensure that the inventory results, assumptions and methods are reasonable, as judged by those knowledgeable in the specific field. More detailed information about peer reviews will be given in the sector specific part of this QA/QC plan.

Peer reviews may also be based on bilateral collaboration. For example, the Czech and Slovak GHG inventory teams have annual meetings about once a year to exchange information, experience and views relating to the preparation of the national GHG inventories. This collaboration also provides opportunities for bilateral peer reviews (QA audits). An example of this collaboration is the QA audit focused on General and crosscutting issues and on Transport, which was performed by Slovak GHG inventory experts in November 2009. The objectives of this QA review were (i) to judge the suitability of the General and crosscutting issues (including uncertainty) and to check whether the national approach used for road transport is in line with the IPCC methodology, and (ii) to recommend improvements in both cases. Similar bilateral QA reviews concentrated more on individual sectors are planned for the future with an anticipated frequency of one QA audit for about a third of the sectors per year.

The annual UNFCCC inventory reviews have similar and even more important impact on improving the quality of the national inventory. Therefore, the Czech team very carefully analyzes the comments and recommendations of the international Expert Review Team and strives to implement them as far as possible.

1.6 Key Source Categories

The *Good Practice Guidance* (IPCC, 2000) and (IPCC, 2003) provides two tiers of determining these *key categories (key sources)*. *Key categories* 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 used 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 on the basis of trends, i.e., trend assessment). The sources or their

categories are for level assessment ordered on the basis of decreasing contribution to total emissions. The *key categories* were considered to be those 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.

In previous submissions, only *key sources* identification not considering the LULUFC sector based on *Good Practice Guidance* (IPCC, 2000), were performed. Starting with the 2008 submission, the *key categories* are identified according to *Good Practice Guidance for LULUCF* (IPCC, 2003), which also considers categories from LULUCF. However, for the right identification of *key categories*, also assessment without consideration of the LULUCF categories was employed. It is obvious from Tab. 1.1 that no additional *key category* was identified when the LULUCF categories were not considered.

On the whole, 26 *key categories* were identified either by *level assessment* or by *trend assessment*. Of this quantity, 5 *key categories* belong to the LULUCF sector. 14 categories were identified as key in both ways. A summary of the assessed numbers concerning *key categories* is given in Tab. 1.2.

Tab. 1.1 Identification of key categories by level assessment (LA) and trend assessment (TA) for 2008 evaluated with and without LULUCF (Tier 1)

Sec.	Level Assessment (LA) with LULUCF IPCC Source Categories	GHG	LA, %	Cum, %	KC	Sec.	Trend Assessment (TA) with LULUCF IPCC Source Categories	GHG	Rel TA,%	NT	with LULUCF	without* LULUCF
1A	1.A Stationary Combustion - Solid Fuels	CO2	45.51	45.51	1	1A	1.A Stationary Combustion - Solid Fuels	CO2	25.17	1	LA,TA	LA,TA
1A	1.A.3.b Transport - Road Transportation	CO2	11.90	57.42	2	1A	1.A.3.b Transport - Road Transportation	CO2	24.23	2	LA,TA	LA,TA
1A	1.A Stationary Combustion - Gaseous Fuels	CO2	10.88	68.30	3	1A	1.A Stationary Combustion - Gaseous Fuels	CO2	12.81	3	LA,TA	LA,TA
2	2.C.1 Iron and Steel Production	CO2	5.05	73.35	4	2	2.C.1 Iron and Steel Production	CO2	3.14	5	LA,TA	LA,TA
1A	1.A Stationary Combustion - Liquid Fuels	CO2	3.63	76.97	5	1A	1.A Stationary Combustion - Liquid Fuels	CO2	8.31	4	LA,TA	LA,TA
5	5.A.1 Forest Land remaining Forest Land	CO2	3.10	80.07	6	5	5.A.1 Forest Land remaining Forest Land	CO2	1.99	9	LA,TA	
1B	1.B.1.a Coal Mining and Handling	CH4	3.03	83.10	7	1B	1.B.1.a Coal Mining and Handling	CH4	1.98	10	LA,TA	LA,TA
4	4.D.1 Agricultural Soils, Direct Emissions	N2O	1.97	85.07	8	4	4.D.1 Agricultural Soils, Direct Emissions	N2O	1.13	15	LA,TA	LA,TA
6	6.A Solid Waste Disposal on Land	CH4	1.65	86.72	9	6	6.A Solid Waste Disposal on Land	CH4	2.25	7	LA,TA	LA,TA
4	4.A Enteric Fermentation	CH4	1.64	88.36	10	4	4.A Enteric Fermentation	CH4	2.09	8	LA,TA	LA,TA
2	2.A.1 Cement Production	CO2	1.36	89.72	11						LA	LA
4	4.D.3 Agricultural Soils, Indirect Emissions	N2O	1.25	90.97	12	4	4.D.3 Agricultural Soils, Indirect Emissions	N2O	1.47	12	LA,TA	LA,TA
2	2.F.1-6 F-gases Use - ODS substitutes	F-gas	0.86	91.84	13	2	2.F.1-6 F-gases Use - ODS substitutes	F-gas	2.34	6	LA,TA	LA,TA
1A	1.A.5.b Mobile sources in Agric. and Forestry	CO2	0.78	92.61	14						LA	LA
2	2.A.3 Limestone and Dolomite Use	CO2	0.69	93.31	15	2	2.A.3 Limestone and Dolomite Use	CO2	0.97	16	LA,TA	LA,TA
2	2.A.2 Lime Production	CO2	0.50	93.81	16						LA	LA
1A	1.A.3.b Transport - Road Transportation	N2O	0.47	94.28	17	1A	1.A.3.b Transport - Road Transportation	N2O	1.17	14	LA,TA	LA,TA
2	2.B.2 Nitric Acid Production	N2O	0.45	94.73	18						LA	LA
1B	1.B.1.b Fugitive Emission from Oil, Nat. Gas	CH4	0.43	95.16	19						LA	
					20	1A	1.A Stationary Combustion - Solid Fuels	CH4	1.51	11	TA	TA
					21	5	5.B.1 Cropland remaining Cropland	CO2	1.34	13	TA	
					22	6	6.C Waste Incineration	CO2	0.82	17	TA	TA
					23	1A	1.A Stationary Combustion - Other fuels	CO2	0.76	18	TA	TA
					24	4	4.D.2 Pasture, Range and Padock Manure	N2O	0.56	19	TA	TA
					25	1A	1.A Stationary Combustion - Biomass	CH4	0.50	20	TA	TA
					26	4	4.B Manure Management	CH4	0.49	21	TA	

* evaluated without LULUCF

Tab. 1.2 Figures for key categories assessed in different ways

Key categories (KC) with LULUCF	26	KC assessed without LULUCF	22
KC assessed by LA	**19**	**KC assessed by LA**	**17**
KC assessed by TA	**21**	**KC assessed by TA**	**18**
KC assessed by LA + TA concurrently	**14**	**KC assessed by LA + TA concurrently**	**13**
KC assessed by only LA	**4**	**KC assessed by only LA**	**4**
KC assessed by only TA	**7**	**KC assessed by only TA**	**5**

Of the overall number of 26 key categories, some of them are right on the 95 % borderline and thus appear only occasionally. This is particularly true of subcategories 1B1b (LA) and 4B (TA). Inclusion of "*6C Waste Incineration*" (TA) could be caused by the fact that these emissions were not determined in the reference year of 1990.

1.7 Uncertainty Analysis

Results of the uncertainty analysis for 2006 are given in Tab. 1.3

Uncertainty analysis of Tier 1, which is presented in this volume of NIR, employs the same source categorization as used in *key categories* assessment. In previous submissions, only sectors without LULUCF have so far been considered. Starting with the 2008 submission, the LULUCF sector is also considered.

The reported results are based on "default" uncertainty data presented in the Good Practice Guidance, combined with uncertainties based on "expert judgment". Uncertainty data from the LULUCF sector are explained in Chapter 7. To achieve more reliable results, it is necessary to gather more relevant uncertainty data concerning both the activity data and the emission factors. As soon as more precise uncertainty estimates appear, they will be immediately inserted in the calculation spreadsheet.

Relatively high uncertainty in level (9.8 %) could be connected with a particularly high uncertainty that was estimated for 5A1 category "Forest land remaining forest land – CO_2". The value of 2.9 % 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.

Tab. 1.3 Uncertainty analysis in level and trend assessments for 2008 (Tier 1)

Input DATA						**Uncertainty in Level**		**Uncert. in trend**
IPCC Source Category	Gas	Base year emissions (1990)	Year emissions (2006)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007	Uncertainty introduced into the trend in total national emissions
		[Gg $CO_{2\ eq.}$]		[%]	[%]	[%]	[%]	[%]
1.A Stationary Combustion - Solid Fuels	CO2	110 713	66 948	4.0	4.0	5.66	7.68	3.97
1.A Stationary Combustion - Gaseous Fuels	CO2	12 438	16 005	4.0	3.0	5.00	0.34	0.24
1.A Stationary Combustion - Liquid Fuels	CO2	13 518	5 336	4.0	3.0	5.00	0.04	0.03
1.A Stationary Combustion - Other fuels	CO2	0	413	8.0	10.0	12.81	0.00	0.00
1.A.3.a Transport - Civil Aviation	CO2	149	45	4.0	3.0	5.00	0.00	0.00
1.A.3.b Transport - Road Transportation	CO2	5 995	17 510	4.0	3.0	5.00	0.41	0.31
1.A.3.c Transport - Railways	CO2	647	289	4.0	3.0	5.00	0.00	0.00
1.A.3.d Transport - Navigation	CO2	56	16	4.0	3.0	5.00	0.00	0.00
1.A.3.e Transport - Other Transportation	CO2	494	148	4.0	3.0	5.00	0.00	0.00
1.A.5.b Mobile sources in Agriculture and Forestry	CO2	1 601	1 146	4.0	3.0	5.00	0.00	0.00
2.A.1 Cement Production	CO2	2 489	1 996	5.0	10.0	11.18	0.03	0.01
2.A.2 Lime Production	CO2	1 337	742	5.0	10.0	11.18	0.00	0.00
2.A.3 Limestone and Dolomite Use	CO2	678	1 017	5.0	10.0	11.18	0.01	0.00
2.A.7 Glass, Bricks and Ceramics	CO2	326	362	5.0	10.0	11.18	0.00	0.00
2.B.1 Ammonia Production	CO2	807	616	5.0	7.0	8.60	0.00	0.00
2.C.1 Iron and Steel Production	CO2	12 533	7 423	7.0	5.0	8.60	0.22	0.15
3 Solvents and Other Product Use	CO2	550	283	5.0	5.0	7.07	0.00	0.00
6.C Waste Incineration	CO2	0	446	20.0	5.0	20.62	0.00	0.00
1.A Stationary Combustion - Solid Fuels	CH4	1 335	154	4.0	50.0	50.16	0.00	0.04
1.A Stationary Combustion - Gaseous Fuels	CH4	21	26	4.0	50.0	50.16	0.00	0.00
1.A Stationary Combustion - Liquid Fuels	CH4	13	4	4.0	50.0	50.16	0.00	0.00
1.A Stationary Combustion - Biomass	CH4	56	310	4.0	50.0	50.16	0.01	0.01
1.A Stationary Combustion - Other fuels	CH4	0	1	8.0	50.0	50.64	0.00	0.00
1.A.3.a Transport - Civil Aviation	CH4	0	0	20.0	50.0	53.85	0.00	0.00
1.A.3.b Transport - Road Transportation	CH4	25	30	7.0	50.0	50.49	0.00	0.00

Tab. 1.3 Uncertainty analysis in levels and trend assessments for 2008 (Tier 1), continuation

Input DATA						**Uncertainty in Level**		**Uncert. in trend**
IPCC Source Category	Gas	Base year emissions (1990)	Year emissions (2006)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007	Uncertainty introduced into the trend in total national emissions
		[Gg CO2 eq.]		[%]	[%]	[%]	[%]	[%]
1.A.3.c Transport - Railways	CH4	1	0	10.0	50.0	50.99	0.00	0.00
1.A.3.d Transport - Navigation	CH4	0	0	10.0	50.0	50.99	0.00	0.00
1.A.3.e Transport - Other Transportation	CH4	1	0	10.0	50.0	50.99	0.00	0.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH4	7	2	20.0	50.0	53.85	0.00	0.00
1.B.1.a Coal Mining and Handling	CH4	7 600	4 459	5.0	40.0	40.31	1.73	0.07
1.B.1.b Fugitive Emission from Oil, Nat. Gas and Other	CH4	897	634	5.0	30.0	30.41	0.02	0.00
2.A.7 Glass, Bricks and Ceramics	CH4	3	4	5.0	50.0	50.25	0.00	0.00
2.B.5 Other	CH4	8	24	5.0	50.0	50.25	0.00	0.00
2.C.1 Iron and Steel Production	CH4	127	67	7.0	50.0	50.49	0.00	0.00
4.A Enteric Fermentation	CH4	4 869	2 412	5.0	20.0	20.62	0.13	0.02
4.B Manure Management	CH4	1 009	472	5.0	30.0	30.41	0.01	0.00
6.A Solid Waste Disposal on Land	CH4	1 663	2 430	25.0	40.0	47.17	0.70	0.27
6.B Wastewater Handling	CH4	825	514	30.0	40.0	50.00	0.04	0.01
1.A Stationary Combustion - Solid Fuels	N2O	495	309	4.0	80.0	80.10	0.03	0.00
1.A Stationary Combustion - Gaseous Fuels	N2O	7	9	4.0	80.0	80.10	0.00	0.00
1.A Stationary Combustion - Liquid Fuels	N2O	34	14	4.0	80.0	80.10	0.00	0.00
1.A Stationary Combustion - Biomass	N2O	27	96	4.0	80.0	80.10	0.00	0.00
1.A Stationary Combustion - Other fuels	N2O	0	2	8.0	80.0	80.40	0.00	0.00
1.A.3.a Transport - Civil Aviation	N2O	4	2	20.0	70.0	72.80	0.00	0.00
1.A.3.b Transport - Road Transportation	N2O	71	685	7.0	70.0	70.35	0.12	0.06
1.A.3.c Transport - Railways	N2O	8	5	10.0	70.0	70.71	0.00	0.00
1.A.3.d Transport - Navigation	N2O	1	0	10.0	70.0	70.71	0.00	0.00
1.A.3.e Transport - Other Transportation	N2O	0	0	10.0	70.0	70.71	0.00	0.00
1.A.5.b Mobile sources in Agriculture and Forestry	N2O	20	24	20.0	70.0	72.80	0.00	0.00
2.B.2 Nitric Acid Production	N2O	1 127	662	5.0	20.0	20.62	0.01	0.00

Tab. 1.3 Uncertainty analysis in levels and trend assessments for 2008 (Tier 1), continuation

Input DATA						**Uncertainty in Level**		**Uncert. in trend**
IPCC Source Category	Gas	Base year emissions (1990)	Year emissions (2006)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2007	Uncertainty introduced into the trend in total national emissions
		[Gg $CO_{2\ eq.}$]		[%]	[%]	[%]	[%]	[%]
2.B.5 Other	N2O	84	94	30.0	40.0	50.00	0.00	0.00
3 Solvents and Other Product Use	N2O	215	233	5.0	70.0	70.18	0.01	0.00
4.B Manure Management	N2O	700	338	5.0	100.0	100.12	0.06	0.01
4.D.1 Agricultural Soils, Direct Emissions	N2O	4 815	2 895	20.0	50.0	53.85	1.30	0.20
4.D.2 Pasture, Range and Padock Manure	N2O	916	366	10.0	100.0	100.50	0.07	0.02
4.D.3 Agricultural Soils, Indirect Emissions	N2O	3 627	1 841	20.0	50.0	53.85	0.53	0.11
6.B Wastewater Handling	N2O	162	204	20.0	50.0	53.85	0.01	0.00
6.C Waste Incineration	N2O	0	10	15.0	70.0	71.59	0.00	0.00
2.F.1-6 F-gases Use - ODS substitutes	F-gas	0	1 269	20.0	20.0	28.28	0.07	0.05
2.F.7 F-gases Use - Semiconductore Manufacture	F-gas	0	38	20.0	20.0	28.28	0.00	0.00
2.F.8 F-gases Use - Electrical Equipment	SF6	78	24	20.0	20.0	28.28	0.00	0.00
2.F.9 F-gases Use - Other SF6	SF6	0	6	20.0	20.0	28.28	0.00	0.00
5.A.1 Forest Land remaining Forest Land	CO2	-4 777	-4 558		273.0	273.00	82.93	2.69
5.A.1 Forest Land remaining Forest Land	CH4	100	144		50.0	50.00	0.00	0.00
5.A.1 Forest Land remaining Forest Land	N2O	10	15		50.0	50.00	0.00	0.00
5.B.1 Cropland remaining Cropland	CO2	1 089	69		12.3	12.31	0.00	0.00
5.C.1 Grassland remaining Grassland	CO2	59	5		11.7	11.65	0.00	0.00
5.A.2 Land converted to Forest Land	CO2	-280	-283		58.3	58.34	0.01	0.00
5.B.2 Land converted to Cropland	CO2	226	96		51.6	51.55	0.00	0.00
5.C.2 Land converted to Grassland	CO2	-187	-389		13.8	13.75	0.00	0.00
5.D.2. Land converted to Wetlands	CO2	23	22		77.6	77.63	0.00	0.00
5.E.2 Land converted to Settlements	CO2	86	95		126.5	126.53	0.01	0.00
5.B.2. Land converted to Cropland	N2O	21	7		2.8	2.83	0.00	0.00
	Total	**191 554**	**136 634**				**9.83**	**2.88**
							Level uncertainty	**Trend uncertainty**

1.8 General Assessment of Completeness

CRF Table 9 (Completeness) has been used to give information on the aspect of completeness. This part of the text includes additional information. All the categories of sources and sinks included in the IPCC Guidelines are covered. No additional sources and sinks specific to the Czech Republic have been identified. Both direct GHGs as well as precursor gases are covered by the Czech inventory. The geographic coverage is complete.

1.8.1 *Notation keys*

The sources and sinks not considered in the inventory but included in the IPCC Guidelines are clearly indicated and the reasons for this exclusion are explained. In addition, the notation keys presented below are used to fill in the blanks in all the CRF tables. Notation keys are used according to the UNFCCC guidelines on reporting and review (FCCC/CP/2002/8).

Allocations to categories may differ from Party to Party. The main reasons for different category allocations are different allocations in the national statistics, insufficient information on the national statistics, national methods, and the impossibility of disaggregating the reported emission values.

IE (included elsewhere):

"IE" is used for emissions by sources and removals by sinks of greenhouse gases that have been estimated but included elsewhere in the inventory instead of in the expected source/sink category. Where "IE" is used in the inventory, the CRF completeness table (Table 9) indicates where (in the inventory) these emissions or removals have been included. This deviation from the expected category is explained.

NE (not estimated):

"NE" is used for existing emissions by sources and removals by sinks of greenhouse gases that have not been estimated. Where "NE" is used in an inventory for emissions or removals, both the NIR and the CRF completeness table indicate why the emissions or removals have not been estimated. For emissions by sources and removals by sinks of greenhouse gases marked by "NE", check-ups are in progress to establish if they actually are "NO" (not occurring). As part of the improvement programme of the inventory, it is planned that these source or sink categories will be either estimated or allocated to "NO".

Overview of not estimated (NE) categories of sources and sinks and categories included elsewhere (IE) and the relevant explanations are given in CRF Table 9(a).

2. Trend in Greenhouse Gas 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 Description and Interpretation of Emission Trends for Aggregated Greenhouse Gas Emissions

Tab. 2.1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2008. 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 - 2008 excl. bunkers *[Gg $CO_{2\ eq.}$]*

	$CO_{2\ total}$ [4]	CO_2 [5]	CH_4	N_2O	HFCs	PFCs	SF_6	Total emissions	
								incl. LULUCF	excl. LULUCF
1990	160 571	164 333	18 563	12 342	NO	NO	78	191 554	195 184
1991	145 236	154 381	16 880	10 488	NO	NO	77	172 681	181 724
1992	129 016	139 916	15 877	9 371	NO	NO	77	154 341	165 135
1993	126 297	135 855	14 884	8 282	NO	NO	77	149 540	158 979
1994	119 491	126 754	13 981	8 171	NO	NO	76	141 719	148 862
1995	124 073	131 396	13 733	8 426	1	0	75	146 308	153 519
1996	130 889	138 650	13 552	8 005	101	4	78	152 630	160 251
1997	125 025	131 834	13 123	8 154	245	1	95	146 643	153 304
1998	117 144	124 273	12 651	8 090	317	1	64	138 266	145 265
1999	113 453	120 730	12 146	7 905	268	3	77	133 850	141 006
2000	119 482	127 138	12 178	7 889	263	9	142	139 962	147 507
2001	120 714	128 719	12 337	8 132	393	12	169	141 757	149 647
2002	117 207	124 974	12 155	7 869	391	14	68	137 703	145 349
2003	118 712	124 607	11 881	7 463	590	25	101	138 771	144 516
2004	119 383	125 711	11 656	8 091	600	17	52	139 799	145 989
2005	118 397	125 216	11 786	7 797	594	10	86	138 671	145 357
2006	122 631	126 264	12 208	7 649	872	23	83	143 465	146 937
2007	125 451	126 388	11 873	7 708	1 606	20	76	146 733	147 463
2008	115 799	120 742	11 687	7 811	1 262	27	47	136 634	141 412
% [6]	-27,9%	-26,5%	-37,0%	-36,7%	1718 - times	224 - times	-39,4%	-21.6	-22.5

Note: Global warming potentials (GWPs) used (100 years time horizon): CO_2 = 1; CH_4 = 21; N_2O = 310; SF_6 = 23 900; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

GHG emissions and removals have been decreasing since 1990; nevertheless the decrease was not uniform. The fastest decrease was on the beginning of the period prior to the year 1994. Then the

[4] CO_2 emissions including LULUCF category

[5] CO_2 emissions excluding LULUCF category

[6] relative to base year.

emission development continues in short 4 or 5 years-long waves. From 2007 to 2008 the total GHG emissions (incl. *LULUCF*) decreased very rapidly by 6.9 % or 10 099 Gg CO_2 eq. resulting in total emissions of 136 634 Gg CO_2 eq.. The decrease was caused mainly by CO_2, CH_4 and HFC emission decrease by 7.7 %; 1.6 % and 21.4 % respectively and N_2O emission increase by 1.3 % compared to previous year. The total GHG emissions and removals in 2008 were 28.7 % below the base year level including *LULUCF* and 27.5 %, when excluding *LULUCF*.

In 1989 the Czech(oslovak) economy was one of the centrally planed economies with high level of monopolization. All economics processes were controlled through central plan. For all practical purposes, there was no real market and this situation resulted in an ever depending economic and technological lag which results in high energy and material inefficiency. Since 1989 to the present the economy transformed successfully to a relatively developed market economy. The transformation led to a decline in production, investment in environmental protection, energy efficiency, fuel switch and increased use of renewable energy.

Greenhouse gases trend passed between 2007 and 2008 a significant change because economic crisis significantly influenced emissions (decreased). Sinks has been positively affected by the absence of calamitous situations requiring logging, which in 2007 significantly reduced sinks in LULUCF sector.

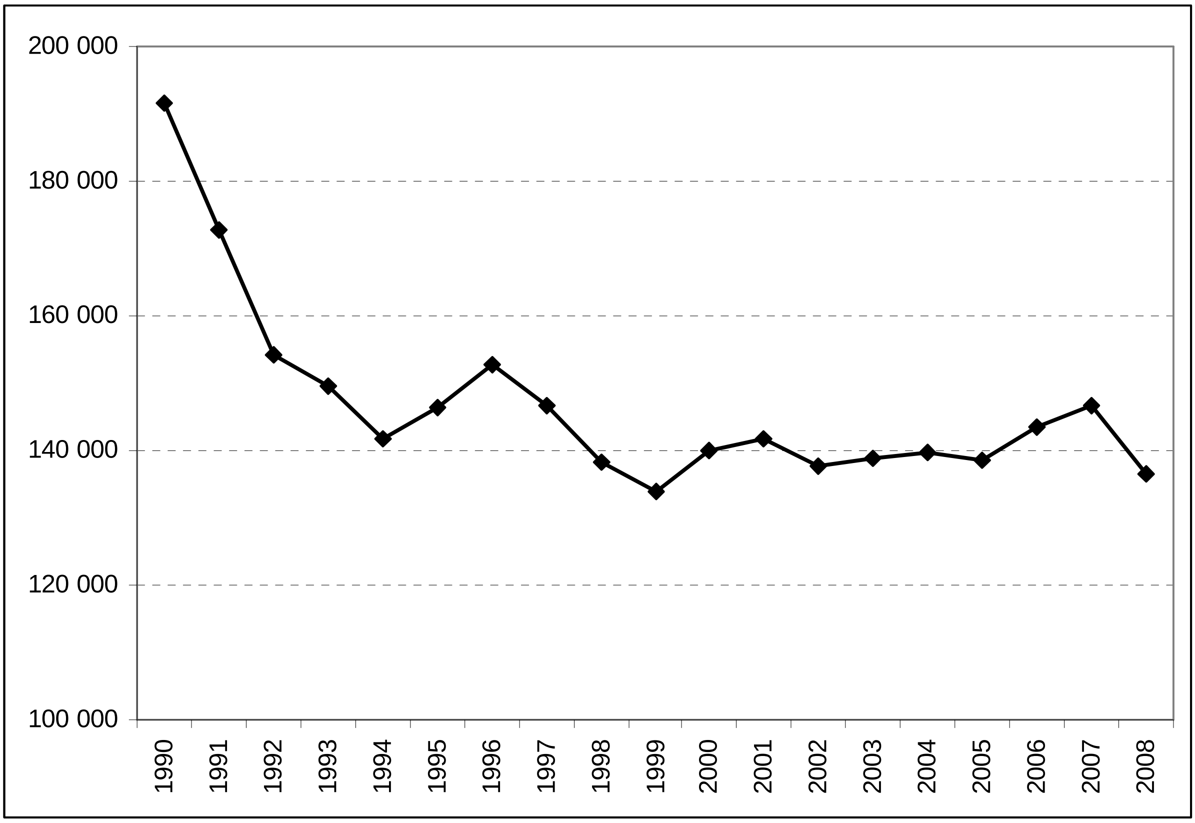


Fig. 2.1 Total GHG emissions (incl. LULUCF) for the period from 1990 - 2008 ***[Gg $CO_{2\ eq.}$]***

2.2 Description and Interpretation of Emission Trends by Gas

Tab. 2.2 presents the GHG emissions of the base year and 2008 and their share in total.

Tab. 2.2 GHG emissions by gas in the base year and in 2008

	Base year	2008	Base year	2008
	[Gg $CO_{2\ eq.}$]		*[%]*	
$CO_{2\ emissions}$	164 333	120 742	85.8%	86.3%
$CO_{2\ removals}$	-3 761	-4 943	-2.0%	-3.5%
$CO_{2\ Total}$	160 571	115 799	83.8%	82.7%
CH_4	18 563	11 687	9.7%	8.3%
N_2O	12 342	7 811	6.4%	5.6%
F-gases	76	1 337	0.0%	1.0%
Total (incl. LULUCF)	191 554	139 962	100.0%	100.0%

The major greenhouse gas in the Czech Republic is CO_2, which represents 82.7 % of total GHG emissions and removals in 2008, compared to 83.8 % in the base year. It is followed by CH_4 (8.3 % in 2008, 9.7 % in the base year), N_2O (5.6 % in 2008, 6.4 % in the base year) and F-gases (1.0 % in 2008, 0.04 % in the base year).

The trend of individual gas emissions is presented in Fig. 2.2 and Fig. 2.3 relative to emissions in the respective base years [7].

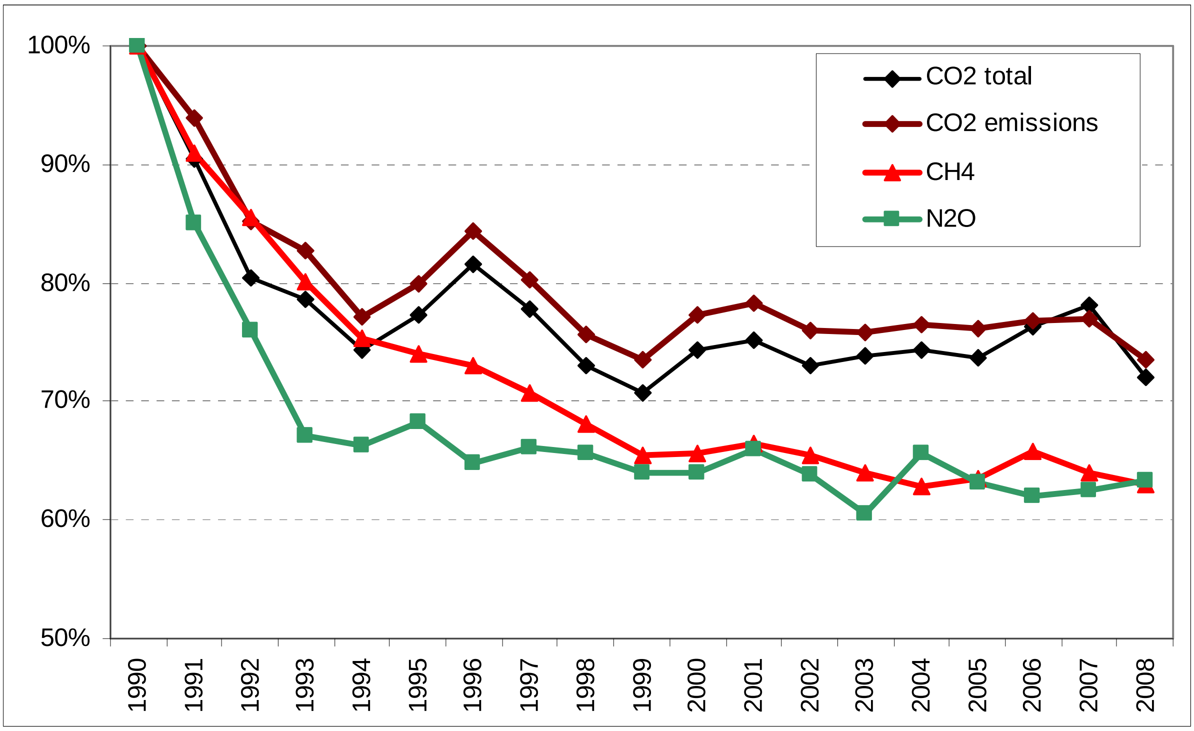


Fig. 2.2 Trend in CO_2, CH_4 and N_2O emissions 1990 - 2008 in index form (base year = 100 %)

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

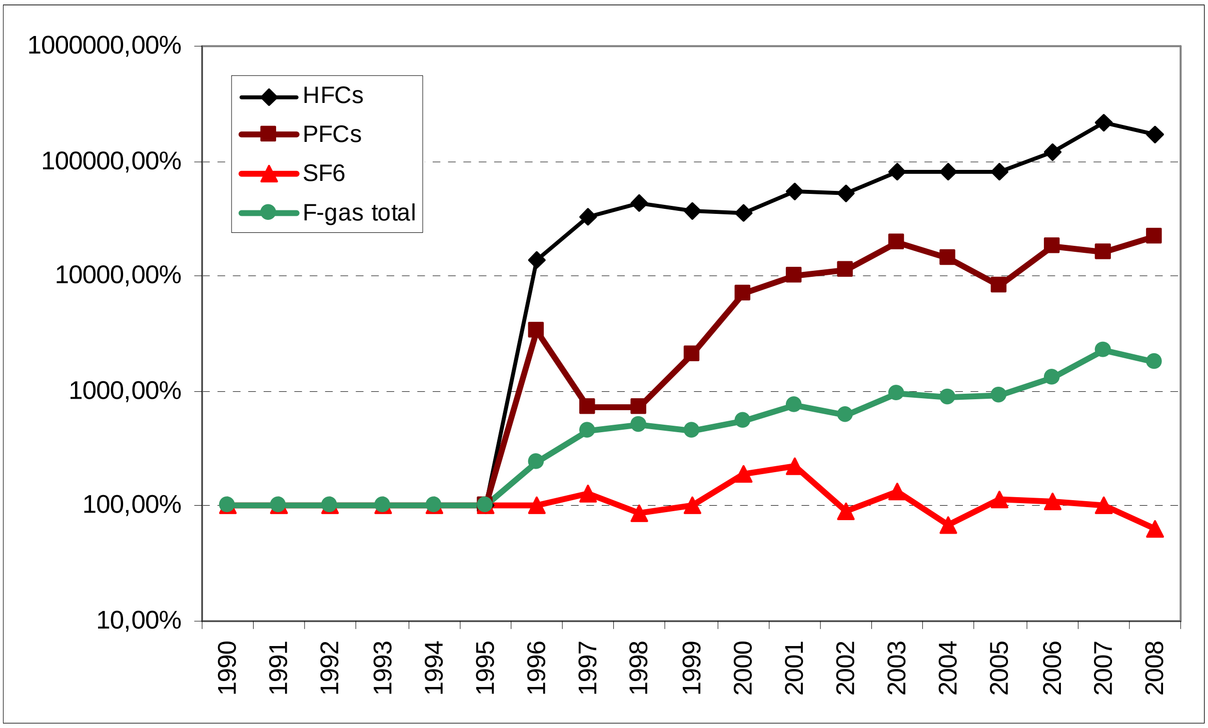


Fig. 2.3 Trend in HFCs, PFCs and SF_6 actual emissions 1995 - 2008 in index form (base year = 100 %)

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. *LULUCF*) from 2007 to 2008 by 4.5 % increase the total decrease to 26.5 % from 1990 to 2008 (27.9 % decrease incl. *LULUCF*). Quoting in absolute figures, CO_2 emissions and removals decreased from 160 571 to 115 799 Gg $CO_{2\,eq.}$ in the period from 1990 to 2008, mainly due to lower emissions from the *1 Energy* category (mainly *1A2 Manufacturing Industries & Construction*, *1A4A Commercial / Institutional and 1A4B Residential*).

The main source of CO_2 emissions is fossil fuel combustion; within the *1A Fuel Combustion* category, *1A1 Energy Industry* and *1A2 Manufacturing Industries & Construction* sub-categoies are the most important. CO_2 emissions increased remarkably between 1990 and 2007 from the *1A3 Transport* category from 7 342 to 18 506 Gg CO_2. Between 2007 to 2008 emissions from *1A3 Transport* decreased by 2.7 % and this is the first observed decrease since 1990.

CH_4

CH_4 emissions decreased almost steadily during the period from 1990 to 2004, slightly increase from 2004 to 2006 and decrease by 4.3 % between 2006 and 2008 (see Tab. 2.2). In 2008 CH_4 emissions were 37.0 % below the base year level, mainly due to lower contribution of *1B Fugitive Emissions from Fuels* and emissions from *4 Agriculture* and despite increase from the *6 Waste* category.

The main sources of CH_4 emissions are *1B Fugitive Emissions from Fuels* (solid fuel), *4 Agriculture* (*4A Enteric Fermentation* and *4B Manure Management*) and *6 Waste* (*6A Solid Waste Disposal on Land* and *6B Waste-water Handling*).

N_2O

N_2O emissions strongly decreased from 1990 to 1994 by 33.8 % over this period and than shows slow decreasing trend with inter-annual fluctuation. N_2O emissions decreased between 1990 and 2008 from 12 342 to 7 811 Gg $CO_{2\,eq.}$ In 2008 N_2O emissions were 36.7 % below the base year level, mainly due to lower emissions from *4 Agriculture* and despite increase from the *1A3 Transport* category.

The main source of N_2O emission is category *4D Agricultural Soils* (others less important sources are *2 Industrial Processes* - *2B Chemical Industry* and *1A Fossil Fuel Combustion*).

HFCs

HFCs actual emissions increased remarkably between 1995 and 2008 from 0.7 to 1 262 Gg $CO_{2\ eq.}$. Emissions of HFCs have been increasing since the base year 1995, when they were started to use. In 2008, HFCs emissions were more than 1 700 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 to the year 2008 as they increased remarkably between 1995 and 2008 from 0.12 to 27 Gg $CO_{2\ eq.}$ In 2008, PFCs emissions are 224 times higher than in the base year 1995. These gases have been imported and used before 1995.

The main sources of PFCs emissions are *Semiconductor Manufacture*, *Refrigeration* and *Air Conditioning Equipment*.

SF_6

SF_6 actual emissions in 1995 amounted for 75 Gg $CO_{2\ eq.}$ Between 1995 and 2008 they inter annually fluctuated with maximum of 169 Gg $CO_{2\ eq.}$ in 2001 and minimum of 47 Gg $CO_{2\ eq.}$ in 2008. In 2008, they were by 37.4 % below the base year level.

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

2.3 Description and Interpretation of Emission Trends by Category

Tab. 2.3 presents a summary of GHG emissions by categories for the period from 1990 to 2008:

Category 1. Energy
Category 2. Industrial Processes
Category 3. Solvent and Other Product Use
Category 4. Agriculture
Category 5. Land Use, Land-Use Change and Forestry
Category 6. Waste

The dominant category is the *1 Energy* category, which caused for 81.1 % of total GHG emissions in 2008 (80.0 % in 1990) excluding LULUCF, followed by the categoies *2 Industrial Processes* and *4 Agriculture*, which caused for 10.1 % and 5.9 % of total GHG emissions in 2008, resp. (10.0 % and 8.2 % in 1990, resp.) *6 Waste* category covered 2.5 %, *3 Solvent and Other Product Use* 0.4 % and *5 LULUCF* category removed in 2008 - 4 778 Gg $CO_{2eq.}$.

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

Tab. 2.3 Summary of GHG emissions by category 1990-2008 *[Gg $CO_{2\ eq.}$]*

	1 Energy	2 Industrial Processes	3 Solvent Use	4 Agriculture	5 LULUCF	6 Waste
1990	156 237	19 596	765	15 937	-3 630	2 650
1991	149 171	14 612	728	14 161	-9 043	3 052
1992	132 980	16 062	691	12 344	-10 794	3 057
1993	131 540	12 916	651	10 811	-9 439	3 062
1994	121 270	13 848	616	9 976	-7 143	3 152
1995	125 523	14 310	596	9 897	-7 211	3 193
1996	132 973	14 037	587	9 487	-7 621	3 167
1997	125 381	14 873	585	9 315	-6 661	3 150
1998	118 449	14 166	580	8 889	-6 998	3 180
1999	116 191	12 146	578	8 897	-7 155	3 194
2000	121 420	13 610	569	8 659	-7 545	3 250
2001	124 076	12 863	550	8 883	-7 890	3 275
2002	120 282	12 558	540	8 625	-7 645	3 344
2003	118 885	13 753	525	8 020	-5 746	3 333
2004	118 813	14 954	519	8 362	-6 190	3 341
2005	119 757	13 598	514	8 066	-6 687	3 423
2006	120 007	14 996	513	7 937	-3 472	3 484
2007	119 751	15 527	512	8 117	-730	3 555
2008	114 623	14 345	515	8 324	-4 778	3 605

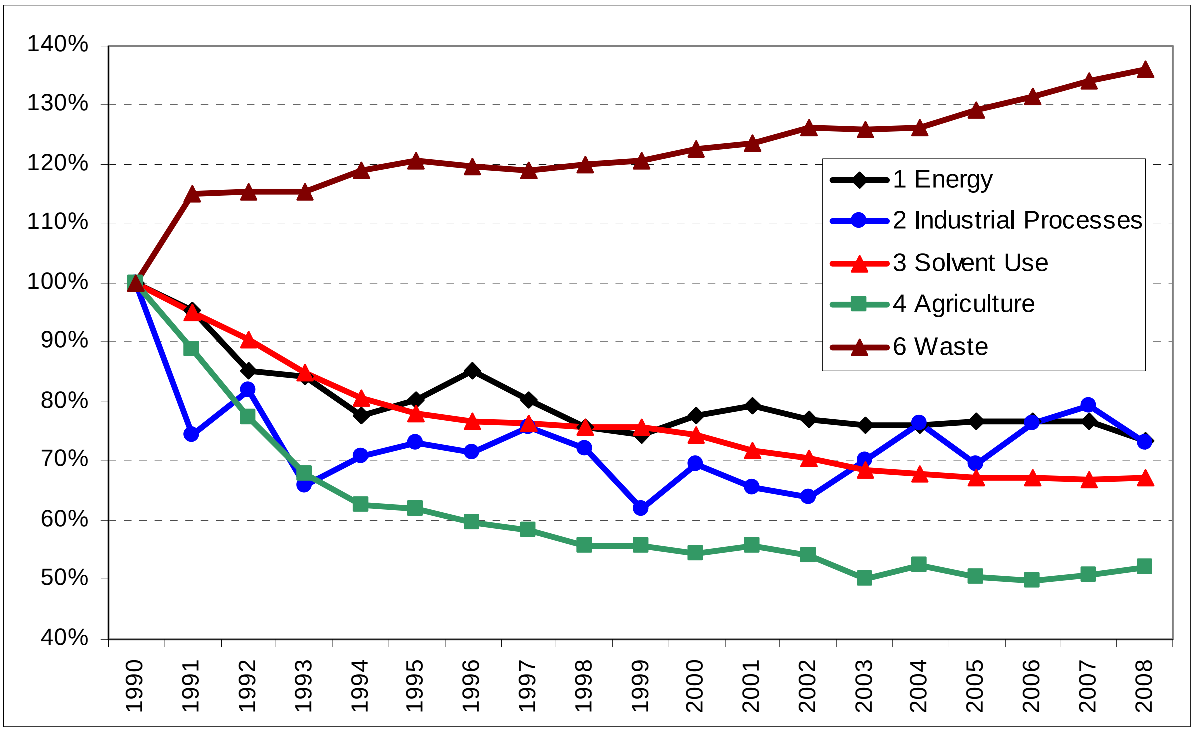


Fig. 2.4 Emission trends in 1990 - 2008 by categories in index form (base year = 100)

Tab. 2.4 GHG emissions by categories in the base year and in 2008

	Base year	2008	Base year	2008
	[Gg $CO_{2\ eq.}$]		[%]	
1 Energy	156 237	114 623	81.6%	83.9%
2 Industry	19 596	14 345	10.2%	10.5%
3 Solvent	765	515	0.4%	0.4%
4 Agriculture	15 937	8 324	8.3%	6.1%
5 LULUCF	-3 630	-4 778	-1.9%	-3.5%
6 Waste	2 650	3 605	1.4%	2.6%
Total	191 554	136 634	100.0 %	100.0 %

Energy (IPCC Category 1)

The trend for GHG emissions from *1 Energy* category shows decreasing trend of emissions. They strongly decreased from 1990 to 1995 and than fluctuated by 2002, then they stayed relatively stable by 2007. In the period 2002 – 2007 emissions stayed from around 120 000 Gg $CO_{2\ eq.}$ Total decrease between 1990 and 2008 is 26.6 %.. Between 2007 to 2008 emissions from *1 Energy* category decreased by 4.3 %

From the total 114 623 Gg $CO_{2\ eq.}$ in 2008 - 95.6 % comes from *1A Fuel Combustion*, the rest are *1B Fugitive Emissions from Fuels* (mainly solid fuels). *1B Fugitive Emissions from Fuels* is the largest source for CH_4, which represented 43.6 % of all CH_4 emissions in 2008. 48.1 % of all CH_4 emissions in 2008 originated from *Energy* category.

CO_2 emission from fossil fuel combustion (category *1 Energy*) is the main source of emissions in CR inventory with a share of 78.9 % in national total emissions (incl. *LULUCF*) or 76.3 % excl. *LULUCF* in 2008. CO_2 contributes for 94.1 % to total GHG emissions from *1 Energy* category, CH_4 for 4.9 % and N_2O for 1.0 % in 2008.

Industrial Processes (IPCC Category 2)

GHG emissions from the *2 Industrial Processes* category fluctuated during the period 1990 to 2008. In early 90's emissions decreased very rapidly, then fluctuated with minimum in 1999 and subsequently increased. Between 1990 and 2008 emissions from this category decreased by 26.8 %. In 2008 emissions amounted for 14 345 Gg $CO_{2\ eq.}$.

The main categories in the *2 Industrial Processes* category are *2C Metal Production* (52.2 %), *2A Mineral Products* (28.7 %), *2F Consumption of Halocarbons and* SF_6 (9.3 %) and *2B Chemical Industry* (9.7 %) of the sectoral emissions in 2008.

The most important GHG of the *2 Industrial Processes* category was CO_2 with 84.7 % of sectoral emissions, followed by HFCs (8.8 %), N_2O (5.3 %), CH_4 (0.7 %), SF_6 (0.3 %) and PFCs (0.2 %).

Solvent and Other Product Use (IPCC Category 3)

In 2008, 0.4 % of total GHG emissions (515.3 Gg $CO_{2\ eq.}$) arose from the *3 Solvent and Other Product Use* category. Emissions generally decreased steadily in the period from 1990 to 2008 (in recent years the decrease was slowed). In 2008 GHG emissions from *3 Solvent and Other Product Use* were 32.6 % below the base year level. 54.9 % of these emissions were CO_2, N_2O emissions contributed by 45.1 %.

Agriculture (IPCC Category 4)

GHG emissions from the category *4 Agriculture* decreased relatively steadily near over the all period from 1990 to 2006 and then began to increase slightly. Despite the fact, in 2008 emissions were by 47.8 % below the base year level.

They amounted for 8 824 Gg $CO_{2\ eq.}$ in 2008, which corresponds to the 5.9 % of national total emissions (excluding LULUCF). The most important sub-category agricultural soils (N_2O emissions) contributed by 61.3 % to sectoral total in 2008, followed by the enteric fermentation (CH_4 emissions, 29.0 %) and manure management (CH_4 and N_2O emissions, 5.7 % and 4.1 % resp.).

4 Agriculture is the largest source for N_2O and second largest source for CH_4 emissions: 69.6 % of all N_2O emissions and 24.7 % of all CH_4 emissions in 2008 originated from this category. N_2O emissions amounted for 5 440.5 Gg $CO_{2\ eq.}$, which corresponds to 65.4 % of sectoral emissions, CH_4 contributed by 34.6 % (2 883.4 Gg $CO_{2\ eq.}$) in 2008.

Land Use, Land-Use Change and Forestry (IPCC Category 5)

GHG removals from the *5 Land Use, Land-Use Change and Forestry* category vary through the whole time series with minimum of 730 Gg $CO_{2\ eq.}$ in 2007 and maximum 10 749 $CO_{2\ eq.}$ in 1992. In 2008 removals were by 31.6 % above the base year level.

Removals amounted to 4 778 Gg $CO_{2\ eq.}$ in 2008, which corresponds to - 3.5 % to national total emissions and removals. Emissions and removals are calculated from the all categories and according to GPG for LULUCF; IPCC 2003.

LULUCF category is the largest sink for CO_2. CO_2 removals from this category amounted to 4 943.1 Gg in 2008, CH_4 emissions amounted for 143.6 Gg $CO_{2\ eq.}$, N_2O to 21.2 Gg $CO_{2\ eq.}$

Waste (IPCC Category 6)

GHG emissions from *6 Waste* category slowly increased during the whole period. In 2008 emissions amounted for 3 605 Gg $CO_{2\ eq.}$, which is 36.0 % above the base year level. The increase of emissions is mainly due to higher emissions of CH_4 from *6A Solid Waste Disposal on Land* (and partly due to increase N_2O emissions from *6B Waste-water Handling*), which is the most important category. As a result of CH_4 recovery systems installed in *6B Waste-water Handling* emissions decreased in this category by 37.7% compared to the base year. The share of this category in total emissions was 2.5 % in 2008 (excluding LULUCF).

The main source is solid *6A Solid Waste Disposal on Land*, which caused for 67.4 % of sectoral emissions in 2008, followed by *6B Waste-water Handling* (CH_4 - 14.3 % and N_2O - 5.7 %) and 6C Waste Incineration (CO_2 – 12.4 %; CH_4 - negligible and N_2O - 0.3 %) .

81.7 % of all emissions from *Waste* category are CH_4 emissions; CO_2 contributes by 12.4 % and N_2O by 5.9 %.

2.4 Description and Interpretation of Emission Trends of Indirect Grennhouse Gases 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) 2008, Submission under the UNECE / CLRTAP Convention*, which was published in March 2010.

Tab. 2.5 presents a summary of emission estimates for indirect GHGs and SO_2 for the period from 1990 to 2008. 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.

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2008 (NMVOCs by 46.7 %, CO by 53.5 % and NO_X by 64.6 %). SO_2 emissions decreased by 90.7 % compared to 1990 level.

Tab. 2.5 Emissions of indirect GHGs and SO_2 1990 - 2008 *[Gg]*

	NO_X	CO	NMVOC	SO_2
1990	742	1 071	311	1 876
1991	732	1 157	273	1 772
1992	708	1 162	257	1 559
1993	691	1 194	233	1 469
1994	451	1 075	255	1 290
1995	430	932	215	1 095
1996	447	965	265	934
1997	471	981	272	981
1998	414	812	267	442
1999	391	726	247	269
2000	397	680	244	264
2001	333	687	220	251
2002	319	587	203	237
2003	326	630	203	232
2004	334	622	198	227
2005	279	556	182	219
2006	284	540	179	211
2007	286	584	174	217
2008	262	498	166	174
NEC[8]	286	-	220	283

NO_X

NO_X emissions decreased from 742 to 262 Gg during the period from 1990 to 2008. In 2008 NO_X emissions were 64.6 % below the 1990 level. Nearly 99 % of NO_X emissions originate from *1 Energy*, mainly subsectors *1A1 Energy Industries, 1A3 Transport* (road), *1A2 Manufacturing Industries and Construction* and *1A5 Other*.

CO

CO emissions decreased from 1 071 to 498 Gg during the period from 1990 to 2008. In 2008 CO emissions were 53.5 % below the 1990 level. In 2008, approximately 85 % of total CO emissions originated from *1 Energy* (subsectors *1A3 Transport, 1A2 Manufacturing Industries and Construction* and *1A4 Other Sectors (Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries)*), followed by *5A Forest land* (12.0 %) and *Industrial Processes* (3.1 %).

NMVOC

NMVOC emissions decreased from 311 to 166 during the period from 1990 to 2008. In 2008 NMVOC emissions were 46.7 % below the 1990 level. There are two main emission source categories, first is *3 Solvent and Other Product Use* (54.3 % of the national total) and second is *1 Energy* (45.0 % - mainly subsectors *1A3 Transport (20.8 %),* and *1A4 Other Sectors* (*Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries*) 16.5 %).

[8] NEC - National Emission Ceilings according to Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001. Emissions targets for NO_X, NMVOC and SO_2 should be met by 2010

SO_2

SO_2 emissions decreased from 1 876 to 174 Gg during the period from 1990 to 2008. In 2008 SO_2 emissions were 90.7 % below the 1990 level. In 2008, 99.6 % of total SO_2 emissions originated from *1 Energy* mainly subsectors *1A1 Energy Industies, 1A2 Manufacturing Industries and Construction* and *1A4 Other Sectors (Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries)*).

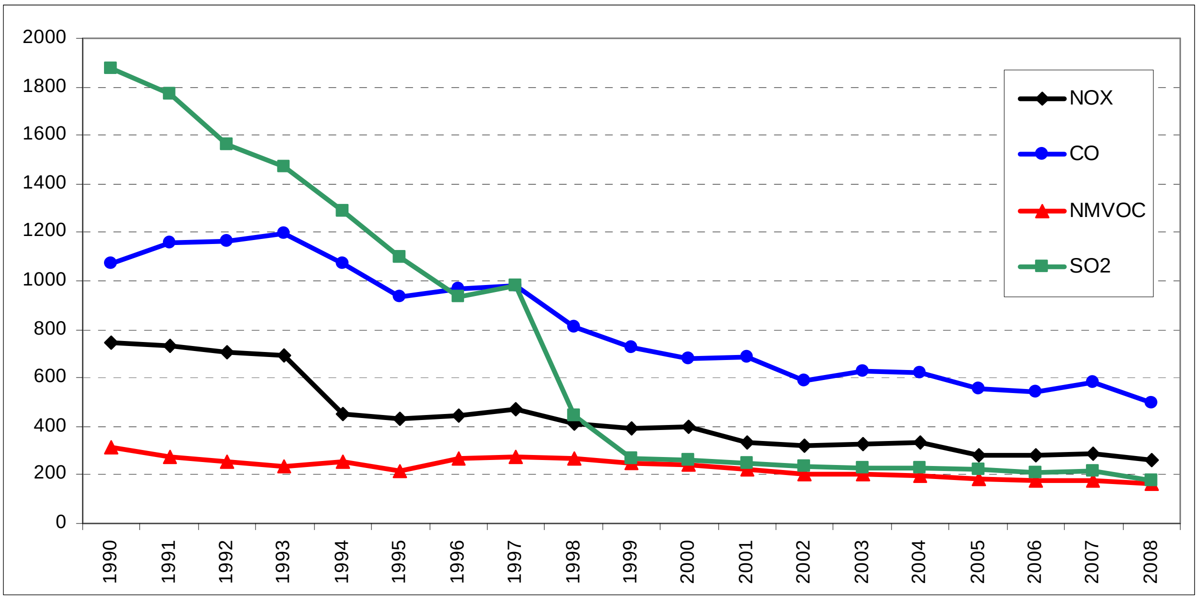


Fig. 2.5 Emissions of indirect GHGs and SO_2 1990 – 2008

2.5 Description and Interpretation of Emission Trends for KP-LULUCF inventory

There is only one year estimate, so it is impossible to describe and interpret emission trends for KP-LULUCF inventory in 2010 submission.

3. Energy (CRF Sector 1)

Activity data for treating the whole sector are based on the energy balance of the Czech Republic prepared by the *Czech Statistical Office*. Data from the energy balance form the basic framework for processing greenhouse gas emissions from combustion in stationary and mobile sources. Greenhouse gas emissions from stationary sources are calculated from the activity data and the emission factors. CO_2 emissions from mobile sources are calculated from the emission factors, while data on CH_4 and N_2O emissions are calculated using the special CTR model.

Processing of the activity data is based on the total energy balance of the Czech Republic. The energy balance is prepared by CSO, and is divided into chapters for solid fuels, liquid fuels, Natural Gas, renewable energy sources and production of heat and electrical energy. Information on the energy balance forms the basis for preparing a database of activity data in the Reference and Sector approaches. The Reference approach is based on data from the source part of the energy balance; the Sector approach involves processing of data on fuel consumption in a structure corresponding to the requirements of the IPCC categorization.

Inventories of CO_2, CH_4 and N_2O emissions are performed using a different procedure in subsector 1A3 Transport and in the other subsectors: combustion of fuel in stationary sources (1A1, 1A2, 1A4) and other mobile sources (1A5). The CTR model is used for mobile sources in subsector 1A3 Transport. A calculation procedure based on the activity data and on the country-specific or default emission factors is used for the other subsectors.

Fugitive emissions in sector 1B are determined by calculation from activity data and country-specific or default emission factors. The activity data are obtained from the sector statistics and annual targeted surveys.

3.1 Overview of sector

Combustion processes included in category 1A make a decisive contribution to total emissions of greenhouse gases. Almost all emissions of carbon dioxide, with the exception of decomposition of carbonate materials, occurring, e.g., in cement production, are derived from the combustion of fossil fuels in stationary and mobile sources. Consequently, the greatest attention is paid in the IPCC Guidelines (IPCC, 1997) to inventories of emissions from these categories.

On the whole, 9 key sources have been identified in sector 1A, the most important of which are the first 3 in Table 3.1. This group of sources contributes 77.0 % to total greenhouse gas emissions (without LULUCF).

Table 3.1 Overview of key categories in Sector 1A (2008)

Category		Character of category	Gas	% of total GHG*
1A	Stationary Combustion - Solid Fuels	KC (LA, TA, LA*, TA*)	CO_2	47.3
1A3b	Transport - Road Transportation	KC (LA, TA, LA*, TA*)	CO_2	12.4
1A	Stationary Combustion - Gaseous Fuels	KC (LA, TA, LA*, TA*)	CO_2	11.3
1A	Stationary Combustion - Liquid Fuels	KC (LA, TA, LA*, TA*)	CO_2	3.8
1A5b	Mobile sources in Agriculture and Forestry and Other	KC (LA, LA*)	CO_2	0.8
1A3b	Transport - Road Transportation	KC (LA, TA, TA*)	N_2O	0.5
1A	Stationary Combustion - Other Fuels	KC (TA, TA*)	CO_2	0.3
1A	Stationary Combustion - Biomass	KC (TA, TA*)	CH_4	0.2
1A	Stationary Combustion – Other Fuels	KC (TA, TA*)	CH_4	0.1

* assessed without considering LULUCF

KC: key category, LA, LA*: identified by level assessment with and without considering LULUCF, respectively
TA, TA*: identified by trend assessment with and without considering LULUCF, respectively

It is apparent from the table that the first three categories are of fundamental importance for the level of greenhouse gas emissions in the Czech Republic and, of these, the combustion of solid fuels constitutes a decisive source. This consists primarily in the combustion of solid fuels for the production of electricity and supply of heat. Another important category consists in the combustion of liquid fuels in the transport sector and the combustion of Natural Gas has approximately the same importance. This corresponds mostly to the direct production of heat for buildings in the private and public sector and for households. Consequently, increased attention is paid to it.

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. All the CRF tables in sector 1A were appropriately completed for the entire required time interval of 1990 to 2008; only aggregate values were filled in for sector 1A2 for the 1990 and 2002 periods, i.e. without division into subsectors 1A2a - 1A2f. The currently available energy production statistics do not provide the necessary activity data in this period for division of this category into the individual branches of industry.

On the basis of the requirements of the Expert Review Team (ERT) following from the meetings on October 12 to 17 2009, the activity data were adjusted according to the questionnaires in the official CSO reports for IEA - EUROSTAT – UNECE in 2003 – 2007 and data from these questionnaires was newly used for 2008 (CSO, 2009). This step represents substantial progress in refinement of activity data. Closer cooperation with CSO was established in 2008 and will continue in the coming years.

Information for the years prior to 2003 was left in the original form from the previous submissions. Consideration will be given to adjustment of the data prior to 2003 in a later stage of the work.

The activity data in this year's submission were extended to include the consumption of Other Fuels and greenhouse gas emissions from these fuels were determined. As this consists exclusively of consumption in cement-plant furnaces, this consumption and emissions were included in category 1A2f.

The CSO reports represent the official reports of the Czech Republic, for international purposes, on the consumption of the individual kinds of fuel. They consist in a set of data on liquid, solid and gaseous fuels in independent datasets. They contain source and consumption parts of the energy balance in a structure that permits processing of activity data in the CRF structure. The use of these reports is advantageous especially because they provide a very similar data structure to CRF. The transition from the final CSO balance to the use of these reports does not affect the consistency of the time series, as the same data are involved.

The overall energy balance for 2008 is given in Annex 8.

The fact that only CSO data were employed constitutes a substantial improvement in the methodology of processing activity data. The data of other institutions and organizations were used for control. These consisted in documents of the Ministry of Industry and Trade (MIT), the Czech Association of the Petroleum Industry – CAPPO, Czech Gas Association and other organizations.

Emissions Trends

Emissions trends – emissions from the 1A sector decreased by 25 % from 146 Tg CO_2 equivalents in 1990 to 107 Tg CO_2 equivalents in 2008.

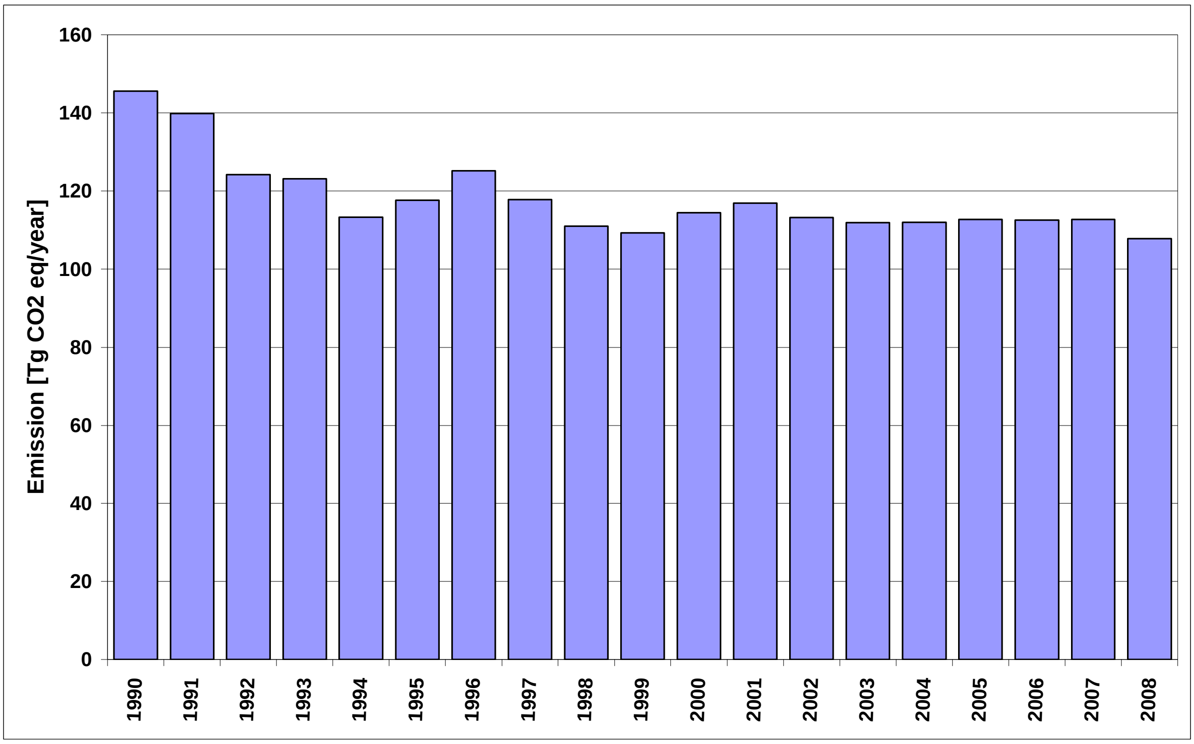


Fig. 3.1 Trend total CO_2 eq in period 1990 – 2008

Table 3.2 Emissions of greenhouse gases and their trend from 1990 – 2008 from IPCC Category 1 Energy

	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]
1990	145 613	474.2	2.148
1991	139 912	409.4	2.135
1992	124 194	389.0	1.992
1993	123 104	370.9	2.085
1994	113 312	349.2	2.012
1995	117 653	341.2	2.272
1996	125 200	333.6	2.474
1997	117 785	324.5	2.521
1998	111 053	311.3	2.770
1999	109 287	285.1	2.956
2000	114 438	292.7	2.691
2001	116 935	298.0	2.846
2002	113 266	289.8	3.000
2003	111 948	281.0	3.346
2004	111 982	273.1	3.535
2005	112 774	278.2	3.675
2006	112 597	297.9	3.725
2007	112 735	276.9	3.875
2008	107 856	267.7	3.699
Trend 1990/2008	**-25.9%**	**-43.6%**	**72.2%**

Emission trends by subcategories

The individual subsectors make different contributions to trends in emissions. Fig. 3.2 illustrates the trends in emissions on the example of CO_2 emissions. The greatest increase in emissions occurred in subsector 1A3 Transport, by 145 %, from 7.3 Tg CO_2 in 1990 to 18.0 Tg CO_2 in 2008. Emissions from subsector 1A1 Energy Industry were practically constant with slight fluctuations over the entire

period; the greatest reduction occurred in subsectors 1A2 and 1A4 from 47.6 and 32.3 Tg CO_2 in 1990 to 16.0 and 10.6 Tg CO_2 in 2008, respectively.

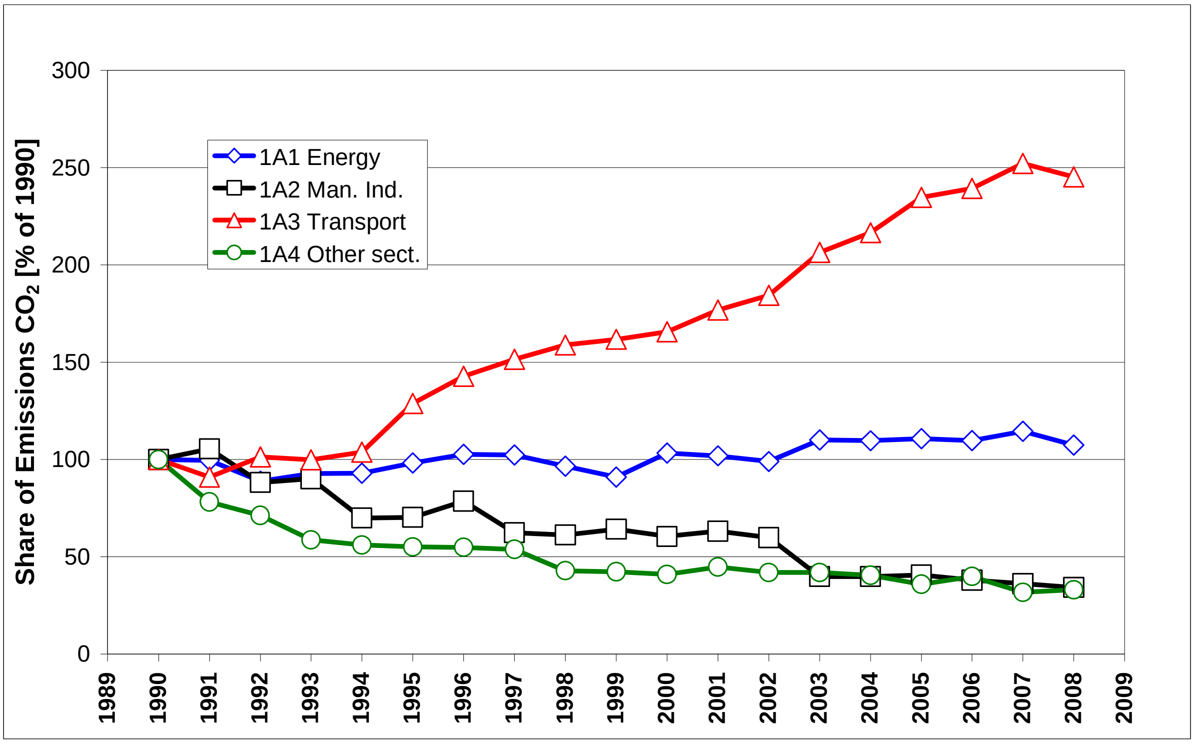


Fig. 3.2 Share of CO_2 emissions from 1990 - 2008 in individual sub-sectors

Table 3.2 gives the trends in GHG emissions in the individual subcategories of the Energy sector. It is apparent from the table that there was a considerable increase in the area of transport and a substantial reduction in the processing industry and in households, as well as the areas of Commercial and Institutional and Agriculture, Forestry and Fishing. The increase in emissions from fugitive emissions from fuels is caused mostly by the increase in CH_4 emissions from mining of solid fuels, mainly reflecting the increase in underground mining of Hard Coal.

Table 3.3 Total GHG emissions in [Gg CO_2 equivalent] from 1990 – 2008 by sub categories of energy.

	1	1A	1A1	1A2	1A3	1A4	1A5	1B	1B1	1B2
1990	156 237	147 740	57 970	46 885	7 454	33 803	1 628	8 497	7 600	897
1991	149 171	141 666	57 664	49 442	6 794	26 333	1 432	7 505	6 741	765
1992	132 980	125 852	51 507	41 349	7 590	24 063	1 342	7 129	6 425	703
1993	131 540	124 599	53 748	42 254	7 522	19 778	1 297	6 941	6 258	683
1994	121 270	114 680	53 902	32 814	7 822	18 835	1 306	6 590	5 922	668
1995	125 523	119 046	56 882	32 964	9 746	18 425	1 029	6 477	5 809	668
1996	132 973	126 611	59 527	36 847	10 808	18 320	1 109	6 362	5 638	724
1997	125 381	119 138	59 307	29 258	11 488	17 926	1 160	6 243	5 533	710
1998	118 449	112 388	55 955	28 761	12 126	14 262	1 284	6 061	5 314	747
1999	116 191	110 653	52 748	30 135	12 411	14 094	1 264	5 538	4 808	730
2000	121 420	115 707	59 890	28 364	12 593	13 599	1 261	5 713	5 019	694
2001	124 076	118 286	59 081	29 619	13 459	14 888	1 238	5 790	5 139	651
2002	120 282	114 625	57 383	28 103	14 068	13 902	1 170	5 656	4 987	669
2003	118 885	113 484	63 801	18 726	15 789	14 045	1 123	5 402	4 792	609
2004	118 813	113 585	63 591	18 681	16 576	13 596	1 140	5 228	4 662	566
2005	119 757	114 429	64 159	19 093	17 955	12 095	1 128	5 327	4 650	677
2006	120 007	114 355	63 636	17 820	18 301	13 493	1 106	5 652	4 960	692
2007	119 751	114 491	66 353	16 952	19 268	10 799	1 119	5 260	4 567	693
2008	114 623	109 530	62 317	16 097	18 731	11 214	1 172	5 093	4 459	634
Total Trend 1990 - 2008	***-26.6%***	***-25.9%***	***7.5%***	***-65.7%***	***151.3%***	***-66.8%***	***-28.0%***	***-40.1%***	***-41.3%***	***-29.3%***

3.2 Fuel combustion (CRF 1A)

Combustion of fuels is in CRF divided into the individual subsectors prescribed by the IPCC methodology. The fuel consumption in the individual subsectors yields the activity data for subsequent calculation of greenhouse gas emissions. The fuel consumption is taken from the energy balance of the Czech Republic and is transformed to the IPCC structure. Transformation of data is described in Chapter 3.2.6 under the descriptions of the individual subsectors. Consumption of the other kinds of fuels (Other fuels) was taken from the national ETS system (ETS, 2009).

3.2.1 *Comparison of the sectoral approach with the reference approach*

The IPCC Reference Approach (IPCC, 1997) is based on determining carbon dioxide emissions from domestic consumption of individual fuels (called also as apparent consumption). Domestic fuel consumption is calculated in the usual manner as:

extraction + imports – exports – international bunkers - change in stocks

“International Bunkers” enters the calculation for the Czech Republic only for “jet kerosene” fuel.

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 LULUCF 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.

Total national consumption is corrected by subtracting non-energy consumption. A substantial portion of fuels for non-energy use consist stored carbon in petroleum products (lubricating and special oils, asphalt and particularly naphtha used in the production of plastics, etc.). Stored carbon is encompassed also in non-energy products (tars) produced from Hard Coal in Coke plants and from gasification process of Brown Coal in the production of energy gas (fuel for combined steam-gas systems) are also

important. On the other hand, some of the intermediate products from the pyrolysis of petrochemical materials are 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 (CSO, 2009 - the last reported year was 2008).

The amount of carbon corresponding to the individual fuels is calculated from the domestic consumption of the individual fuels using the carbon emission factors. This amount is multiplied by a stoichiometric coefficient of 44/12 and the relevant oxidation factors. The sum of the results for all the fuels corresponds to the total amount of CO_2 derived from fossil fuels.

Processing of the activity data for the Sectoral Approach is described in detail in Chapter 3, Energy. The comparison of data on fuel consumption from the Sectoral and Reference approaches, respectively, is presented in Table 3.4.

Table 3.4 Comparison of the Sectoral and Reference approaches – fuel consumption

	Reference Approach	Sectoral Approach	Fixed Fuels **	Coke in Iron Industry	Res. Oil in NH_3 Product.	Total *	Approach Difference
	[TJ/year]	[TJ/year]	[TJ/year]	[TJ/year]	[TJ/year]	[TJ/year]	[%]
1990	1 899 006	1 691 398	41 814	118 229	11 227	1 862 668	1.9
1991	1 770 924	1 655 782	37 247	82 841	10 880	1 786 750	-0.9
1992	1 631 753	1 485 220	38 002	96 506	11 217	1 630 945	0.0
1993	1 586 646	1 479 230	39 928	72 545	10 489	1 602 192	-1.0
1994	1 512 563	1 359 556	35 097	77 645	11 711	1 484 009	1.9
1995	1 579 022	1 442 264	46 597	81 683	10 339	1 580 883	-0.1
1996	1 649 612	1 554 379	27 174	75 586	11 128	1 668 267	-1.1
1997	1 576 222	1 467 835	23 823	80 683	10 198	1 582 538	-0.4
1998	1 491 248	1 403 523	23 743	71 273	10 513	1 509 052	-1.2
1999	1 453 437	1 392 461	23 189	56 561	8 955	1 481 166	-1.9
2000	1 486 658	1 439 020	23 281	66 851	10 248	1 539 399	-3.5
2001	1 535 915	1 474 588	35 962	62 380	8 625	1 581 555	-3.0
2002	1 496 467	1 439 158	33 231	64 927	7 525	1 544 840	-3.2
2003	1 548 138	1 444 063	49 895	71 468	9 795	1 575 220	-1.7
2004	1 565 828	1 455 322	61 394	80 100	9 721	1 606 537	-2.6
2005	1 546 471	1 466 564	64 352	69 039	8 478	1 608 433	-4.0
2006	1 573 597	1 466 712	71 263	79 482	8 086	1 625 544	-3.3
2007	1 573 125	1 470 518	64 584	75 750	7 575	1 618 428	-2.9
2008	1 503 580	1 422 647	69 491	70 028	7 423	1 569 589	-4.4

* “Total“ is a sum of preceding columns excluding Reference Approach

** “Fixed Fuels” means non-combusted fuels containing stored carbon

It is apparent from the table that consumption of fuels taken into account in the Reference Approach and the “Total” consumption do not differ too much. The comparison of CO_2 emissions is presented in Table 3.5.

Table 3.5 Comparison of the Sector and Reference approaches – CO_2 emissions

	Reference Approach	Sectoral Approach	Coke in Iron Industry	Res. Oil in NH_3 Product.	Total *	Approach Difference
	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	[%]
1990	161 238	145 613	12 533	807	158 953	1.4
1991	149 741	139 912	8 781	782	149 475	0.2
1992	137 075	124 194	10 230	806	135 230	1.3
1993	131 760	123 104	7 690	754	131 548	0.2
1994	125 025	113 312	8 231	842	122 385	2.1
1995	128 814	117 653	8 659	743	127 055	1.4
1996	135 020	125 200	8 012	800	134 012	0.7
1997	129 140	117 785	8 553	733	127 071	1.6
1998	120 749	111 052	7 555	756	119 363	1.1
1999	116 996	109 287	5 996	644	115 927	0.9
2000	121 307	114 438	7 086	736	122 260	-0.8
2001	123 767	116 935	6 612	620	124 167	-0.3
2002	120 867	113 266	6 882	541	120 689	0.1
2003	123 569	111 948	7 576	704	120 228	2.7
2004	123 871	111 981	8 491	699	121 171	2.2
2005	121 643	112 774	7 318	609	120 701	0.8
2006	123 886	112 597	8 425	581	121 603	1.8
2007	125 007	112 735	8 030	550	121 315	3.0
2008	117 811	107 856	7 423	539	115 818	1.7

* “Total” is a sum of preceding columns excluding Reference Approach

The table can be further extended to include CO_2 emissions formed by oxidation of solvents in the Solvent Use sector and the effect of carbon permanently fixed in plastics (Naphtha), in Lubricants, Bitumen and Coal tars is also calculated.

Table 3.6 Comparison of the Reference Approach and the total of emitted CO_2

	Reference Approach	Sectoral Approach	Coke in Iron Ind.	Res. Oil in NH_3 Prod.	Solvent Use	Non emited CO_2	Total *	Approach Difference
	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	CO_2 [Gg]	[%]
1990	161 238	145 613	12 533	807	550	3 189	162 692	-0.9
1991	149 741	139 912	8 781	782	514	2 880	152 869	-2.1
1992	137 075	124 194	10 230	806	476	2 925	138 631	-1.1
1993	131 760	123 104	7 690	754	436	3 078	135 062	-2.5
1994	125 025	113 312	8 231	842	402	2 663	125 450	-0.3
1995	128 814	117 653	8 659	743	382	3 555	130 992	-1.7
1996	135 020	125 200	8 012	800	372	2 058	136 442	-1.1
1997	129 140	117 785	8 553	733	370	1 803	129 244	-0.1
1998	120 749	111 052	7 555	756	366	1 797	121 526	-0.6
1999	116 996	109 287	5 996	644	364	1 754	118 045	-0.9
2000	121 307	114 438	7 086	736	354	1 766	124 380	-2.5
2001	123 767	116 935	6 612	620	335	2 763	127 265	-2.8
2002	120 867	113 266	6 882	541	325	2 564	123 578	-2.2
2003	124 541	113 659	7 576	704	311	3 853	126 103	-1.3
2004	124 701	113 304	8 491	699	305	4 723	127 522	-2.3
2005	123 577	113 934	7 318	609	299	4 927	127 087	-2.8
2006	124 035	114 948	8 425	581	298	5 469	129 721	-4.6
2007	126 204	116 297	8 030	550	300	4 953	130 130	-3.1
2008	117 811	107 856	7 423	539	283	5 317	121 418	-3.1

* “Total” corresponds to the sum of the preceding columns excluding Reference Approach

For comparison of the Reference and Sectoral approaches, the tables published in last year’s submission were extended to include 2008 data and assessment was performed of the difference between the Reference Approach and the Sectoral Approach. For this purpose, the comparison also included carbon from fossil fuels that are a source of CO_2 emissions in the other sectors. This refers mainly to the carbon that is reported under metallurgical Coke in Sector 2 Industrial Processes. It also encompasses residual oil, which is used for the production of ammonia, also in Sector 2 Industrial Processes.

A certain percentage of fossil carbon is converted in transformation processes to the form of solvents, which are used in coatings and other operations for surface treatment. This amount of carbon is reported in Sector Solvent and Other Product Use. The carbon can have two fates. Most large painting plants are equipped with facilities for disposal of NMVOC emissions. This equipment converts NMVOC either directly or indirectly to CO_2 (thermal and catalytic oxidation, biofilters). When solvents are used in small painting plants or outside of plants, the carbon evaporates into the air in the form of NMVOC. After a certain period of time, this is again oxidized to CO_2.

The comparison must also include the carbon dioxide that would be formed from permanently fixed carbon.

3.2.2 *International bunkers fuels*

In the Czech Republic, this corresponds only to the storage of Kerosene Jet Fuel for international air transport, as the Czech Republic does not have an ocean fleet.

Basic activity data are available in the CSO energy balance (CSO, 2009). Table 3.7 gives the amount of stored Kerosene Jet Fuel**.**

Table 3.7 Kerosene Jet Fuel in international bunkers

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
[TJ/year]	**8 714**	**7 836**	**6 938**	**6 841**	**6 340**	**6 400**	**6 858**	**6 857**	**7 361**	**6 885**
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	
[TJ/year]	**7 578**	**8 140**	**8 800**	**10 219**	**13 163**	**13 683**	**14 073**	**14 462**	**14 895**	

3.2.3 *Feedstocks and non-energy use of fuels*

The energy balance of the Czech Republic encompasses a number of items that contain information on the consumption of fuel used as a raw material for production of other kinds of fuels. This corresponds mainly to petroleum, which is given in the source part of the energy balance; however, its entire volume undergoes transformation to other kinds of fuel, so that petroleum itself does not enter the fuel balance as activity data in CRF for the calculation of greenhouse gases.

In the energy balance structure, improvement of fuels is included in the Transformation Sector chapter. This chapter contains information on the amounts of fuel used for the production of electrical energy and heat and simultaneously also for conversion (improvement) of the original fuels to other kinds (e.g. Coke, Briquettes, Coal Gases, etc.). Fuels from the Transformation Sector chapter employed for the production of electrical energy and heat are transferred directly to the CRF structure as activity data to sector 1A1 – Energy Industry. Fuels and other items in the Transformation Sector chapter need to be seen as raw materials for production of the derived fuels and this amount from the energy balance does not enter the CRF structure as activity data, as no greenhouse gases are formed from them in this stage.

The classification in the energy balance in the Transformation sector is dependent on the kind of fuel. The following survey gives those items of the Transformation sector that correspond to raw material inputs into the improvement processes.

Solid fuels	Liquid fuels
Transformation Sector	**Transformation Sector**
Patent Fuel Plants (Transformation)	Gas Works (Transformation)
Coke Ovens (Transformation)	For Blended Natural Gas
BKB Plants (Transformation)	Coke Ovens (Transformation)
Gas Works (Transformation)	Blast Furnaces (Transformation)
Blast Furnaces (Transformation)	Patent Fuel Plants (Transformation)
Coal Liquefaction Plants (Transformation)	Non-specified (Transformation)

Natural Gas is not currently used as a raw material in the Czech Republic. Things were different at the beginning of the 1990’s, when Natural Gas was used as a raw material in the production of Coal Gas. Biofuels are not used in transformation processes.

The decomposition of Petroleum also leads to a number of products that are not intended for energy use. This corresponds to the production of plastics, Lubrication Oils and other Lubricants, solvents for production of coatings and other uses in the Solvent Use sector, production of Bitumen, etc.

Part of these material fluxes become waste, while part is used up irreversibly and this carbon must be considered to be carbon stored permanently.

Naphta - another part of fossil carbon is used as raw material for the manufacture of plastics. Plastics end up in waste incineration plants or in landfills. In incineration plants, the carbon in the plastics is converted to CO_2. This CO_2 is reported in Sector 6C Waste Incineration. In managed landfills, plastics very slowly decompose through biochemical processes.

However, part of plastics stores carbon from petrochemical raw materials for a long time. At the beginning of the monitored period, the fraction of carbon stored for naphtha was estimated at 50%. The remaining 50% of carbon was considered to oxidise to CO_2. Recently, plastics have been increasingly recycled. The recycled material obtained is used to manufacture products with long lifetimes. Consequently, since 2004, the fraction of stored carbon has been gradually increased from a value of 50% to a value of 80%. The following survey gives the gradual increase.

1990 - 2003	2004	2005	2006	2007	2008
0.5	0.6	0.7	0.8	0.8	0,8

Starting in 2007, a constant value of 80 % will be used in subsequent years, unless further refining arguments arise.

Lubricating oils and other lubricants are not produced primarily as energy production materials. However, part of the oils is returned to the energy system after the end of their lifetimes as lubricants. They are then converted to alternative fuels and burned. The CRF structure specifies 50 % recovery as fuels over the entire time series from 1990.

Asphalt (Bitumen) is a product of petroleum processing. As it is used primarily for treating the surfaces of roadways, its entire volume must be considered to be permanently stored carbon that is 100% fixed over the entire time series.

Coal Tars are utilized primarily as a raw material for the production of soot as a filler for rubber for production of tires. Part of the Tars is used as additive fuel in energy-production installations for production of electricity and heat. This part has been reported separately in the energy balance since 2003. This permits estimation of the ratio between tar for energy-production and other uses. Up until 2002, the fraction of tars for non-energy use was estimated at 75%; since 2003, the fraction has been determined on the basis of information from the CSO – EUROSTAT – IEA questionnaires (CSO, 2009) in the following way:

2003	2004	2005	2006	2007
74.1	69.2	85.7	87.9	82.3

These values were used to complete CRF in the *1AD Feedstocks and non-energy use of fuels* chapter.

3.2.4 *CO_2 capture from flue gases and subsequent CO_2 storage*

Not performed in the Czech Republic.

3.2.5 *Country-specific issues*

The country-specific conditions in the Czech Republic are determined primarily by the specific properties of the solid fuels mined in this country. Specific CO_2 emission factors are determined for these kinds of solid fuels. A survey of these emission factors, incl. NCV and oxidation factors is given in Table 3.8.

Table 3.8 Average Net caloricic values (NCV), CO_2 emission factors and oxidation factors used in the Czech GHG inventory - 2008

Fuel (IPCC 1996 Guidelines definitions)	NCV [TJ/Gg]	CO_2 EF [a] [t CO_2/TJ]	Oxidation factor	CO_2 EF [b] [t CO_2/TJ]
Coking Coal	28.5	93.24	0.98	91.38
Other Bituminous Coal	23.4	93.24	0.98	91.38
Lignite (Brown Coal)	12.6	99.99	0.98	97.99

a) Emission factor without oxidation factor
b) Resulting emission factor with oxidation factor

Other country-specific conditions are employed in sector 1B, where the country-specific emission factors are used in the calculation of methane emissions from underground mining. In addition, methane emissions in the Natural Gas sector are calculated according to the country-specific approach. More details are given in chapter 3.4 Fugitive emissions.

3.2.6 *Source category*

Combustion sources are divided into 5 basic categories in the Sectoral approach:

1A1 Energy industries

1A2 Manufacturing Industries and Construction

1A3 Other transportation (combustion of part of Natural Gas during its transport in compressors)

1A4 Other sectors – incl. mobile sources in the Agriculture/Forestry/Fishing sector

1.5 Other – other mobile sources not included elsewhere

In the Sectoral approach, CO_2 emissions are derived from the consumption of the individual kinds of fuel in the individual subcategories using emission and oxidation factors.

The following text gives a description of the individual subcategories and evaluates their specific features in the Czech Republic.

3.2.6.1 Source category description

1A1 Energy industries

1A1a Public electricity and heat production

Under source category 1A1a, "Public electricity and heat production", the energy balance includes district heating stations and electricity and heat production of public power stations.

This category encompasses all facilities that produce electrical energy and heat supplies, where this production is their main activity and they supply their products to the public mains. Examples include the power plants of the ČEZ, a.s. company, DALKIA, a.s. power plants and heating plants, ENERGY UNITED, a.s. and a number of others in the individual regions and larger cities in the Czech Republic.

The share of CO_2 emissions in sector 1 A was 50.7 % for 2008.

The Total Installed Capacity equaled 15 GW in 2008, of which 9.7 GW was produced at installations burning fossil fuels. A total of 88 TWh of electricity was produced in the Czech Republic, of which 59 at sources burning fossil fuels. Solid fuels (especially Brown Coal) have a dominant position, they corresponded to 96% of total fuel in 2008 and this fraction has not changed in the long-term trends.

In the final energy balance of CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in section **Transformation Sector** under the items:

- Main Activity Producer Electricity Plants
- Main Activity Producer CHP Plants
- Main Activity Producer Heat Plants
- Autoproducer Electricity Plants
- Autoproducer CHP Plants
- Autoproducer Heat Plants

The category includes consumption of all kinds of fuels in enterprises covered by the NACE Rev. 2:

35.11 Production of electricity

35.30 Steam and air conditioning supply (production, collection and distribution of steam and hot water for heating, power and other purposes)

Since 2007, the country-specific emission factor, equal to 27.27 t C/TJ, has been used to calculate CO_2 emissions, with a factor of 25.43 t C/TJ for combustion of Other Bituminous Coal. Thus, CO_2 emissions are determined for approx. 95% of fuels using country-specific factors, i.e. at the level of Tier III.

1A1b Petroleum refining

This category encompasses all facilities that process raw petroleum imported into this country as their primary raw material. Domestic petroleum constitutes approx. 3.5 % of the total amount. All fuels used in the internal refinery processes, internal consumption (reported by companies as "own use") for production of electricity and heat and heat supplied to the public mains are included in emission calculations in this subcategory. This corresponds primarily to the Česká rafinérská, a.s. company in the Czech Republic. Fugitive CH_4 emissions are included in category *1B2Fugitive Emissions from Fuels - Oil*.

The share of CO_2 emissions in sector 1 A was only 0.8 % for 2008.

In the final energy balance of CSO (CSO,2009), the consumption of the individual kinds of fuels in this sector was reported under the item:

Operational (internal) consumption – refinery.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported under the item:

Refinery Fuel

Relevant NACE Rev. 2 code:

19.20 Manufacture of refined petroleum products

Greenhouse gas emissions in this subcategory are calculated using the national default emission factors at the Tier II level – see *Table 3.3 Net caloric values (NCV), CO_2 emission factors and oxidation factors used in the Czech GHG inventory.*

1A1c Manufacture of solid fuels and other energy industries

This category includes all facilities that process solid fuels from mining through coking processes to the production of secondary fuels, such as Brown-coal Briquettes, Coke Oven Gas or generator gas. It also includes fuels for the production of electrical energy and heat for internal consumption (reported by companies as “own use”).

There are a number of companies in the Czech Republic that belong in this category. These are mainly companies performing underground and surface mining of coal and its subsequent processing, located in the vicinity of coal deposits. The category also includes Coke plants and the production of generator gas. Other energy industries, such as facilities for extraction of Natural Gas and Petroleum are of minor interest in the Czech Republic.

In the final energy balance of CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector was reported under the items:

- Operational (internal) consumption – mining
- Operational (internal) consumption – Coke plants
- Operational (internal) consumption – briquette plants
- Operational (internal) consumption – pressure gasworks

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Energy Sector under the item:

- Coal Mines
- Oil and Gas Extraction
- Coke Ovens (Energy)
- Gas Works (Energy)
- Patent Fuel Plants (Energy)
- BKB Plants (Energy)
- Non-specified (Energy)

There are embodied the fuels of economic part according to NACE Rev. 2

05.10 Mining of Hard Coal

05.20 Mining of Lignite

06.10 Extraction of Crude Oil

06.20 Extraction of Natural Gas

19.10 Manufacture of Coke oven products (operation of Coke ovens, production of Coke and Semi-Coke, production of Coke Oven Gas)

19.20 Manufacture of refined petroleum products (this class also includes: manufacture of Peat Briquettes, manufacture of Hard-coal and Lignite fuel Briquettes)

1A2 Manufacturing industries and construction

This source category consists of several sub-source categories defined in close harmony with the IPCC categorisations (CRF) and includes all stationary combustion emission sources that are not included in categories 1A1 and 1A4. It is described in detail via the relevant sub-chapters.

Data for the 1990 – 2002 period are reported as a sum for the entire sub-category group. Since 2003, the inventory has been performed in the detailed CRF structure. The originally used data from the national energy balance did not permit division of the fuel consumption into subsectors 1A2a to 1A2f and thus the data were reported for the entire category *1A2 Manufacturing industries and construction*, in the CRF Reporter under subcategory 1A2f. Transition to the new format of source data (CSO, 2009) permitted utilization of the data for more detailed classification in this subcategory.

1A2a Iron and steel

1A2b Non-ferrous metals

1A2c Chemicals

1A2d Pulp, paper and print

1A2e Food processing, beverages and tobacco

1A2f Other

Category 1A2 includes all companies and enterprises whose main economic activity is denoted in the 12000 – 36000 range in the NACE system.

1A2a Iron and steel

This category includes manufacturing in the area of pig iron (blast furnaces), rolling steel, casting iron, steel and alloys and is related only to ferrous metals.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Iron and Steel

There are embodied the fuels of economic part according to NACE Rev. 2

Iron and steel (NACE Group 271 and Class 2731)

1A2b Non-ferrous metals

This category encompasses combustion processes in various areas of production of nonferrous metals. In the Czech Republic, this corresponds mainly to foundry processes; primary production of nonferrous metals is not performed on an industrial scale in this country.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Non-Ferrous Metals

There are embodied the fuels of economic part according to NACE Rev. 2

Non-ferrous metals (NACE Group 272 and Class 2732)

1A2c Chemicals

This subcategory includes all the processes in the organic and inorganic chemical industry and all related processes, incl. petrochemistry.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Chemical (including Petrochemical)

There are embodied the fuels of economic part according to NACE Rev. 2

Chemicals (NACE Division 24)

1A2d Pulp, paper and print

This subcategory includes all manufacturing processes related to the production of paper, cardboard and in printing plants. There are two primary paper production factories in the Czech Republic with a

high consumption of waste wood from production processes. The other plants select the kind of fuel on the basis of the same criteria as the rest of the processing industry.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Paper, Pulp and Printing

There are embodied the fuels of economic part according to NACE Rev. 2

Pulp, paper and print (NACE Divisions 22 and 22)

1A2e Food processing, beverages and tobacco

This subcategory includes all manufacturing processes related to the production of foodstuffs, beverages and foodstuff preparations. The subcategory also includes fuel consumption in the tobacco industry. The nature of the production processes permits the use of a relatively high fraction of biofuel.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Food, Beverages and Tobacco

There are embodied the fuels of economic part according to NACE Rev. 2

Food processing, beverages and tobacco (NACE Divisions 15 and 16)

1A2f Other

This subcategory includes the remaining enterprises in the processing industry not included in subcategories 1A2a to 1A2e. This is an energy-demanding branch with high fuel consumption, such as the cement industry, lime production, the glass industry, production of ceramic materials, the textile and leather industry, wood processing and subsequent production processes, the entire machine industry, incl. production of means of transport and the construction industry. Consequently, the fraction of consumption of fuel and emissions in this subcategory substantially exceeds the fuel consumption in the other subsectors of 1A2 and corresponds to about 40 % of the total for sector 1A2.

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Non-Metallic Minerals
- Transport Equipment
- Machinery
- Mining (excluding fuels) and Quarrying
- Wood and Wood Products
- Construction
- Textiles and Leather
- Non-specified (Industry)

In this year's submission, this subcategory also includes the combustion of other kinds of fuel (Other Fuels). Activity data and data on CO_2 production were taken from the national ETS system (ETS, 2009), while CH_4 and N_2O emissions were calculated using the default emission factors for solid and liquid fuels.

1A3e Other transportation

The TRC model describes only emissions from highway, shipping and air transport. In order for the balance in sector 1A2 to be complete, the pipeline transport of Natural Gas is treated separately and is included under *1A3e Other transportation.* The consumption of Natural Gas for powering compressors for the transit gas pipeline is included in a separate subcategory under stationary combustion sources. This consumption is reported in the Questionnaire IEA – CSO (CSO, 2009) in capture Transport Sector under the item:

Pipeline Transport

According to the ERT recommendation of 2009, default emission factors are used in the entire time series for CH_4 and N_2O.

1A4 Other sectors

This category includes all the combustion processes in the sub categories described below. They can be generally defined as heat production processes for internal consumption.

1A4a Commercial/Institutional

This subcategory includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

In the final energy balance of CSO (CSO, 2008), the consumption of the individual kinds of fuels in this sector is reported under the item:

Other branches

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Commercial and Public Services

Where fuel consumption is reported here under the item:

- Non-specified (Other)

it is included under 1A4a Commercial/Institutional on the basis of an agreement with CSO.

1A4b Residential

Fuel consumption in households is determined on the basis of the results of the statistical study “Energy consumption in households”, published in 1997 and 2004 by the Czech Statistical Office according to the PHARE/EUROSTAT method.

In the final energy balance of CSO (CSO, 2008), the consumption of the individual kinds of fuels in this sector was reported under the item:

Households

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

Residential

1A4c Agriculture/Forestry/Fisheries

This subcategory contains combustion sources at stationary facilities for heating buildings, breeding and other operational facilities. The subcategory does not include fuel consumption for powering off-road means of transport and machinery. They are reported in category A5b Mobile - Agriculture, Forestry and Fishing.

In the final energy balance of CSO (CSO, 2008), the consumption of the individual kinds of fuels in this sector was reported under the item:

Agriculture

In the Questionnaire IEA – CSO (CSO, 2009), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Agriculture/Forestry
- Fishing

1A5 Other

1A5b Other – mobil sources

For reporting consumption of motor fuels, that was not report in sector 1A3 Transport and could not reported in the other sectors as consumption of fuels in stationary sources is in CRF used this sub-category.

3.2.6.2 Methodological issues

According to IPCC methodology (IPCC, 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 (Crude Oil) 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 should not be very significant.

The resultant emissions are determined by the Sectoral approach (SA), while the Reference approach (RA) is used for control.

The original data on the final national energy balance from CSO (series of data in the 1990 – 2002 time series) were taken for the CRF structure directly in TJ. The time series from 2003 was constructed on the basis of data from the IEA – CSO Questionnaire (CSO, 2009), where the data on fuel consumption are given in various ways. Data are available for solid and liquid fuels in mass units (kt p.a.), where the net caloric values of these fuels are also tabulated. The consumption of gaseous fuels derived from fossil fuels is given in TJ p.a. Natural Gas is given in thousand m^3 and the consumption in TJ is also tabulated; however, in this case it is calculated using the gross caloric value.

Consequently, the original calculation model was extended to include use of the net caloric value for processing data in the 2003 – 2008 time series.

Table 3.9 Net caloricic values (NCV) used in the Czech GHG inventory – 2008

NCV [TJ/Gg]	1A1a	1A1b	1A1c	1A2	1A4a	1A4b	1A4c	1A5	Weighted Average
Refinery Gas		49.50							49.50
LPG				43.83	43.83	43.83	43.83		43.83
Naphtha				43.95					43.95
Gasoline						43.40		43.40	43.40
Kerosene Jet Fuel					43.30			43.30	43.30
Other kerosene				42.80	42.80				42.80
Diesel Oil			42.76	42.76				42.76	42.76
Heating and Other Gasoil	42.60		42.60	42.60	42.60		42.60		42.60
Fuel Oil - Low Sulphur	39.61	39.61		39.61	39.61		39.61		39.61
Fuel Oil - High Sulphur				39.65					39.65
Lubricants				40.20					40.20
Other Oil		40.30		40.30					40.30
Anthracite				30.00					30.00
Other Bitumenous Coal	23.46			23.31	23.35	23.35	23.35		23.42
Brown Coal + Lignite	12.59		12.32	12.32	13.50	13.50	13.50		12.61
Coke				27.30	27.30	27.30	27.30		27.30
Coal Tars			37.00	37.00					37.00
Brown Coal Briquets	23.65					22.00			22.06

Natural Gas is given in the statistic reporting in the IEA – CSO Questionnaire (CSO, 2009) in thousand m^3 and in TJ; however, the data in TJ was calculated using the gross caloric value. Information on the average values of the gross caloric value and the net caloric value of Natural Gas are given in Table 3.13**.**

Recalculation of volume units to mass units for Natural Gas was performed using the density 0.69 kg/m^3 (t = 15 °C, p = 101.3 kPa).

Table 3.10 Average values of the gross caloric value and the net caloric value of Natural Gas – Questionnaire IEA – CSO (CSO,2009) , 2008

[kJ/kg]	GCV	NCV	GCV/NCV
Indigenous Production	37 479.0	33 731.1	1.11
Associated Gas	38 900.0	35 010.0	1.11
Non-Associated Gas	35 225.0	31 702.5	1.11
Total Imports (Balance)	37 978.0	34 180.2	1.11
Total Exports (Balance)	37 978.0	34 180.2	1.11
Stock Changes (National Territory)	38 769.0	34 892.1	1.11
Inland Consumption (Calculated)	37 960.0	34 164.0	1.11
Inland Consumption (Observed)	37 960.0	34 164.0	1.11
Opening Stock Level (National Territory)	37 901.0	34 110.9	1.11
Closing Stock Level (National Territory)	37 977.0	34 179.3	1.11

The values of consumption of Natural Gas were taken from this statistical report in TJ and the values were then divided by a coefficient of 1.11 for recalculation from the gross caloric value to the net caloric value – see Table 3.10.

The greenhouse gas emissions were calculated as the product of the activity data and the relevant emission factor. A survey of the emission factors employed for CO_2 is given in Table 3.11 The experimentally determined country-specific values of the emission factors were used for Coal and Lignite (Fott, 1999); for the other fuels, the default emission factors from the IPCC methodology (IPCC, 1997) were used. Oxidation factors used in the national inventory are the default values taken from the IPCC methodology (IPCC, 1997).

Table 3.11 Carbon content emissions factors used in the Czech GHG inventory – 2008

Fuel (IPCC 1996 Guidelines definitions)	NCV [TJ/Gg]	CO_2 EF [a]		Oxidation factor	CO_2 EF [b] [t CO_2/TJ]
		[t C/TJ]	[t CO_2/TJ]		
Crude Oil	42.35	20.00	73.33	0.99	72.60
Refinery Gas	49.50	15.71	57.60	0.995	57.32
LPG	43.83	17.21	63.10	0.995	62.79
Naphtha	43.95	19.99	73.30	0.99	72.56
Gasoline	43.40	20.02	73.41	0.99	72.68
Kerosene Jet Fuel	43.30	19.50	71.50	0.99	70.79
Other kerosene	42.80	19.61	71.90	0.99	71.18
Diesel Oil	42.76	20.21	74.10	0.99	73.36
Heating and Other Gasoil	42.60	20.21	74.10	0.99	73.36
Fuel Oil - Low Sulphur	39.61	21.11	77.40	0.99	76.63
Fuel Oil - High Sulphur	39.65	21.11	77.40	0.99	76.63
Lubricants	40.20	19.99	73.30	0.99	72.56
Other Oil	40.30	19.99	73.30	0.99	72.56
Petroleum Coke	37.50	27.50	100.83	0.98	98.81
Anthracite	30.00	26.81	98.30	0.98	96.34
Coking Coal [d]	28.75	25.43	93.24	0.98	91.38
Other Bitumenous Coal [d]	23.42	25.43	93.24	0.98	91.38
Brown Coal + Lignite [d]	12.61	27.27	99.99	0.98	97.99
Coke Owen Coke	27.30	29.18	106.99	0.98	104.85
Coal Tars	37.00	22.01	80.70	0.98	79.09
Brown Coal Briquets	22.06	26.59	97.50	0.98	95.55
Coke Owen Gas (TJ/mill. m^3)	15.62 [c]	13.00	47.67	0.995	47.43
Natural Gas (TJ/Gg)	49.51	15.30	56.10	0.995	55.82
Natural Gas (TJ/mill. m^3)	34.16 [c]	15.30	56.10	0.995	55.82

a) Emission factor without oxidation factor
b) Resulting emission factor with oxidation factor
c) TJ/mill. m^3, t=15 ^oC, p=101.3 kPa
d) Country specific values of CO_2 EFs

Methane emissions from fuel combustion from stationary 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) (IPCC, 1997) includes only summary fuel categories:

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

Only the first four categories were filled with activity 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.

Table 3.12 CH_4 emission factors in the individual sectors used in the Czech GHG inventory (1990 – 2008)

[kg CH_4/TJ]	1A1	1A2*)	1A3e	1A4a	1A4b	1A4c
Liquid fuels	3	2		10	10	10
Solid fuels	1	10		10	300	300
Gaseous fuels	1	5	5	5	5	5
Biomass	30	30		300	300	300

*) The emission factors are also valid for the other kinds of fuels (Other Fuels).

N_2O emissions from stationary sources do not belong amongst *key sources* in the CR.

In 2008 N_2O emissions from combustion of all kinds of fuel were recalculated using the default emission factors over the entire time series.

This submission employed the emission factors for N_2O in all the sectors as tabulated below (uniformly for the entire sector of stationary combustion sources):

Liquid fuels	0.6 kg N_2O/TJ
Solid fuels	1.4 kg N_2O/TJ
Gaseous fuels	0.1 kg N_2O/TJ
Biomass	4.0 kg N_2O/TJ

A considerable part of the non-energy consumption consists in non-energy consumption of petroleum (lubricating and special oils, asphalt and particular petrochemical raw materials used for the production of plastic materials, etc.). Non-energy products formed from Bituminous Coal in Coke plants and from Brown Coal in the production of coal gas (historical) and energy gas (fuel for the combined steam-gas cycle) are also important.

In this context, emphasis is placed on the correct determination of the fraction of stored (fixed) carbon in the non-energy use of fossil fuels. Calculation of its amount is based on the assumption that a certain amount of the carbon contained non-energy raw materials remains fixed in the long term and is not released as CO_2. In the CR balance (CSO, 2009), this consists in:

- petrochemical raw materials (Naphtha) mainly used for the production of plastic materials
- lubricating oils (Lubricants)
- Coal Tars from coking of Bituminous Coal and from gasification of Brown Coal
- asphalt (Bitumen)

Part of the intermediate products from pyrolysis of petrochemical raw materials is used directly as heating gases and oils, part of the final products (plastic materials) are also burned after use in municipal waste incinerators, but part ends up in land-fills. Thus, a considerable part of the input carbon remains bonded for a longer time in plastic materials. As plastic materials are being

increasingly recycled, the fraction of carbon stored in plastics has been gradually increased from 50% to 80% between 2003 and 2006 (in period 1990 - 2002 this fraction was considered constant, 50%).

In addition, most lubricating and special oils are finally used as heating oils or are burned during their use (lubricating oils for combustion motors). Part of the oils is used for production of alternative fuels and part is burned in incinerators, but at least half remains permanently anchored in lubricants. Consequently, a fraction of stored carbon of 50% is used in the balance.

Coal tars have a similar fate and are also used for impregnation of roofing materials and for soot (additive in the production of rubber). Consequently, a value of stored carbon fraction of 75 % is used.

Practically one hundred percent fixation is assumed for asphalt.

Data on the consumption of other fuels are newly used in the greenhouse gas inventories. Information on the consumption of Other Fuels was taken from the national ETS database (ETS, 2009) and is related only to the use of these fuels in cement production.

Table 3.13 Consumption, NCV and EF – Other fuels in the cement industry in 2003 - 2008

Fuel - [kt/year]	kind	2003	2004	2005	2006	2007	2008
Plastics	Solid			33.5	27.5	33.0	
Household RDF	Solid			25.9	38.9	60.3	71.0
Rubber/ Used Tyres	Solid	19.2	25.6	42.9	41.0	40.7	47.0
Industrial Sludges	Solid	11.8	17.1	10.1	10.4		20.0
Municipal Sewage Sludges	Solid			6.2			1.0
Animal meal, Bone meal, Fats	Solid	6.1	16.7	40.7	25.6	20.0	29.0
Coal /Carbon Waste incl shales	Solid	12.4	7.8	5.3	7.6		22.0
Agricultural Wastes	Bio	0.3	0.1				
Solid Alternative Fuels (Impregnated Saw Dust)	Solid	60.2	79.3				27.0
Solvents and Related Waste	Liquid	23.6	19.3	7.4	9.5	4.5	13.0
Oil and Oily Waste	Liquid	21.2	21.0	10.0	24.2	1.7	2.0
Others	Solid					6.3	14.0

NCV - [MJ/kg]	kind	2003	2004	2005	2006	2007	2008
Plastics	Solid			25.0	26.0	25.0	
Household RDF	Solid			20.0	20.0	21.0	24.3
Rubber/ Used Tyres	Solid	26.0	26.0	25.0	25.0	25.0	23.6
Industrial Sludges	Solid	20.0	20.0	20.0	22.5		14.6
Municipal Sewage Sludges	Solid	7.0	7.0	7.0			7.0
Animal meal, Bone meal, Fats	Solid	17.0	17.0	18.0	17.5	19.0	17.2
Coal /Carbon Waste incl shales	Solid	21.0	21.0	21.0	26.0		27.3
Agricultural Wastes	Bio	16.0	16.0				
Solid Alternative Fuels (Impregnated Saw Dust)	Solid	22.0	22.0				20.2
Solvents and Related Waste	Liquid	24.0	24.0	39.0	38.0	40.0	37.8
Oil and Oily Waste	Liquid	33.0	33.0	30.0	27.0	35.0	32.5
Others	Solid					38.0	18.9

CS EF - [CO_2/TJ]	kind	2003	2004	2005	2006	2007	2008
Plastics	Solid			97.0	97.0	97.0	
Household RDF	Solid			45.0	45.0	45.0	45.0
Rubber/ Used Tyres	Solid	99.0	99.0	99.0	99.0	99.0	99.0
Industrial Sludges	Solid	90.0	90.0	90.0	90.0		90.0
Municipal Sewage Sludges	Solid	89.0	89.0	89.0			89.0
Animal meal, Bone meal, Fats	Solid	93.0	93.0	93.0	93.0	93.0	93.0
Coal /Carbon Waste incl shales	Solid	94.5	94.5	94.5	94.5		94.5
Agricultural Wastes	Bio	104.0	104.0				
Solid Alternative Fuels (Impregnated Saw Dust)	Solid	81.0	81.0				81.0
Solvents and Related Waste	Liquid	71.0	71.0	71.0	71.0	71.0	71.0
Oil and Oily Waste	Liquid	79.0	79.0	79.0	79.0	79.0	79.0
Others	Solid					77.9	75.3

Table 3.14 CO_2 Emissions from use of Other fuels in the cement industry in 2003 - 2008

Emission CO_2 [kt/year]	**kind**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Plastics	Solid			81.3	69.4	80.0	
Household RDF	Solid			23.3	35.0	56.9	77.5
Rubber/ Used Tyres	Solid	49.4	65.9	106.1	101.6	100.6	109.6
Industrial Sludges	Solid	21.2	30.8	18.1	21.0		26.2
Municipal Sewage Sludges	Solid	0.0	0.0	3.9			0.6
Animal meal, Bone meal, Fats	Solid	9.6	26.4	68.1	41.6	35.3	46.3
Coal /Carbon Waste incl shales	Solid	24.6	15.5	10.6	18.6		56.8
Agricultural Wastes	Bio	0.5	0.2				
Solid Alternative Fuels (Impregnated Saw Dust)	Solid	107.3	141.3				44.2
Solvents and Related Waste	Liquid	40.2	32.9	20.4	25.6	12.8	34.9
Oil and Oily Waste	Liquid	55.3	54.7	23.8	51.6	4.7	5.1
Others (average of solid fuels)	Solid					18.7	20.0
Total		**308.2**	**367.7**	**355.6**	**364.4**	**309.1**	**421.3**

The default emission factors were applied for calculation of CH_4 and N_2O emissions according to character of relevant fuel.

Kind of Fuel	**[kg CH_4/TJ]**	**[kg N_2O/TJ]**
Liquid fuels	2	0.6
Solid fuels	10	1.4

3.2.6.3 Uncertainties and time-series consistency

Uncertainties

1A Fuel Combustion – Stationary sources

The emission inventory was based on 2 types of data accompanied by different levels of uncertainty:

- Activity data (consumption of individual kinds of fuels)
- Emission factors

Activity data

Information on fuel consumption is taken from CSO (CSO, 2009).

Uncertainties:

a) on the part of CSO in collecting and processing the primary data
b) on the part of the sector director in interpretation of CSO data

ad a) CSO does not explicitly state the uncertainties in the published data. However, the uncertainty differs for the individual groups of data – statistical reports from the individual enterprises (economic units with more than 20 employees); consumption by the population is calculated on the basis of models and reports by suppliers of network energy (gas, electricity), production of the individual kinds of fuels (especially automotive fuels) and customs reports (imports, exports); the remainder is calculated so that the fuel consumption is balanced. Each step is accompanied by a different level of uncertainty.

Uncertainties also arise during data processing. CSO obtains data in mass units – tons per year (1st level of uncertainty). The resultant balance is expressed in energy units – TJ p.a. Recalculation from mass units to energy units must be performed using the fuel calorific value. The determination of these values is accompanied by uncertainties following from the method employed (mostly laboratory expertise) (2nd level of uncertainty). The average fuel calorific value valid for all of the Czech Republic must be determined for each kind of fuel. Because the calorific value differs substantially in dependence on the mine location, it is necessary to determine the average calorific value on the basis of a weighted average – 3rd level of uncertainty.

ad b) The sector director introduced uncertainty into the processing that can be based on an elementary error in interpreting the data. However, because routine control procedures are employed and no fuel may be missing or calculated twice in the final balance, this uncertainty can be considered to be less than 1 % (approx. 0.5 %).

Emission factors

For calcualtions were applied

a) Default emission factors
b) Country specific emission factors

ad a) The uncertainty of the default emission factors is mostly given in the Guidelines.

ad b) The country-specific emission factors were determined on the basis of experimental data and this uncertainty can be estimated at approx. 2.5 %.

Total evaluation of uncertainties is shown in table 3.15 and 3.16

Table 3.15 Uncertainty analysis in data uncertainty for 2008 - IPCC Source Category without LULUCF

IPCC Source Category	Gas	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		[%]	[%]	[%]
1.A Stationary Combustion - Solid Fuels	CO_2	4	4	5.7
1.A Stationary Combustion - Gaseous Fuels	CO_2	4	3	5.0
1.A Stationary Combustion - Liquid Fuels	CO_2	4	3	5.0
1.A Stationary Combustion - Other fuels	CO_2	8	10	12.8
1.A.3.e Transport - Other Transportation	CO_2	4	3	5.0
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	4	3	5.0
1.A Stationary Combustion - Solid Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Gaseous Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Liquid Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Biomass	CH_4	4	50	50.2
1.A Stationary Combustion - Other fuels	CH_4	8	50	50.6
1.A.3.e Transport - Other Transportation	CH_4	10	50	51.0
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	20	50	53.9
1.B.1.a Coal Mining and Handling	CH_4	5	40	40.3
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	5	30	30.4
1.A Stationary Combustion - Solid Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Gaseous Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Liquid Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Biomass	N_2O	4	80	80.1
1.A Stationary Combustion - Other fuels	N_2O	8	80	80.4
1.A.3.e Transport - Other Transportation	N_2O	10	70	70.7
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	20	70	72.8

Table 3.16 Uncertainty analysis in data uncertainty for 2008 - IPCC Source Category with LULUCF

IPCC Source Category - without LULUCF	Gas	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		[%]	[%]	[%]
1.A Stationary Combustion - Solid Fuels	CO_2	4	4	5.7
1.A Stationary Combustion - Gaseous Fuels	CO_2	4	3	5.0
1.A Stationary Combustion - Liquid Fuels	CO_2	4	3	5.0
1.A Stationary Combustion - Other fuels	CO_2	8	10	12.8
1.A.3.e Transport - Other Transportation	CO_2	4	3	5.0
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	4	3	5.0
1.A Stationary Combustion - Solid Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Gaseous Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Liquid Fuels	CH_4	4	50	50.2
1.A Stationary Combustion - Biomass	CH_4	4	50	50.2
1.A Stationary Combustion - Other fuels	CH_4	8	50	50.6
1.A.3.e Transport - Other Transportation	CH_4	10	50	51.0
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	20	50	53.9
1.B.1.a Coal Mining and Handling	CH_4	5	40	40.3
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	5	30	30.4
1.A Stationary Combustion - Solid Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Gaseous Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Liquid Fuels	N_2O	4	80	80.1
1.A Stationary Combustion - Biomass	N_2O	4	80	80.1
1.A Stationary Combustion - Other fuels	N_2O	8	80	80.4
1.A.3.e Transport - Other Transportation	N_2O	10	70	70.7
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	20	70	72.8

Time-series consistency

The time series consistency is regularly monitored by the sector director and evaluated as an instrument for revealing potential errors. As the sector directors create the data time series from external CSO data, they cannot affect the variation in the time series of activity data during processing. However, feedback to the primary data processor does exist. If an anomaly is identified in the time series, CSO is informed of this fact and is requested to provide an explanation.

So far, no means have been found for consistent and systematic verification of the consistency of time series at CSO and for analysis of the causes of fluctuations. Rather than elementary errors, preliminary analysis indicates that the anomalies are caused solely by the methodology for ordering the statistical data in the energy balance structure. Assignment of the statistical data on fuel consumption to the individual energy balance chapters is performed by the valid methodology according to CZ-NACE (the former Czech equivalent was OKEC – Branch Classification of Economic Activities). The CZ-NACE code is assigned to economic entities on the basis of their Id.No. (Identification Numbers). This can result in substantial inter-annual changes in the individual subcategories.

Example:

The decisive CZ-NACE code for entity A is that for chemical production. He operates a large boiler with a substantial fraction of fuel in the entire 1A2c subsector. The energy production is split off to independent entity B, whose main activity is production and supply of heat. In the final analysis, the reported fuel consumption is shifted from 1A2c to 1A1a.

In the Czech Republic, the 1990's and beginning of the 20th century were a period when a route to rational utilization of means of production was sought and changes in the ownership structure of energy-production facilities were quite frequent. Consequently, consistency of the time series is interrupted in some subcategories. Justification for the exact causes of each such change lies outside the current capabilities of the sector director.

Changes in the consistency of time series of emission data must follow changes in activity data. If different anomalies occur, these anomalies are verified and any errors in the determination of the emission data are immediately eliminated.

3.2.6.4 Source-specific QA/QC and verification

The quality control system for emission inventories (Plan of QA/QC procedures) of the ENERGY sector director is based on an internal quality control system, which is based on the general part of the QA/QC plan for greenhouse gas inventories in the Czech Republic and is harmonized with the QA/QC system of the Transport sector director. As the basic background data for preparation of the activity data are based on the energy balance of the Czech Republic, the greatest emphasis is placed on cooperation with the CSO. This cooperation is based on a Memorandum of understanding between CHMI, as the NIS coordination workplace, and CSO. CSO is a state institution established for processing statistical data in the Czech Republic and, as such, employs its own control mechanisms and procedures to ensure the quality of the data.

The QA/QC system was proposed in accordance with GPG, specifically to improve the transparency of the data, consistency of the data, completeness and certainty in emission estimates in the national inventories. Responsibility is delegated for the individual phases of the QA/QC plan according to the following scheme:

Project manager of the sector director:

- prepares greenhouse gas inventories in 1A1, 1A2, 1A3e, 1A4, 1A5
- prepares or updates the QA/QC plan
- performs the QC procedures (Tier 2 level)
- proposes external experts for the QA procedure
- is responsible for the progress of all QA/QC procedures in accordance with the IPCC Good Practice Guidance (GPG) and with the QA/QC plan.

The Responsible body:

- performs the QC procedures (Tier 1 level)
- provides for storage of documents on performance of QA/QC procedures.

External evaluation (QA) is provided by an external expert (ad hoc). Choice of an external expert is the responsibility of the Project Manager on the basis of the QA/QC plan and he proposes this person for performance of the QA procedure to the coordination workplace.

QC procedures (Tier 1)

QC procedures at the Tier 1 level are related to the processing, handling, documentation, storage and transfer of information.

Basic control (auto-control) is performed by the body responsible for preparing the sector approach – the responsible body, followed by control by the project manager. At the control level (Tier 1), the individual steps are controlled according to Table 8.1 (IPCC, 2000).

The responsible body transfers the data to the CRF Reporter. After the data is transferred to the CRF Reporter, control is performed of correct conversion of data to the summary values of the activity data and emission data. If differences are found, the erroneous data are sought out and immediately corrected.

Order of steps in preparing emission inventories and performance of QC control for Tier 1:

- completion of collection of activity data (at the latest 40 days prior to the final data submission) and their conversion to the CRF structure, preparation of the "Protocol on the origin of the activity data";

- calculation of emissions – preparation of the sector and reference procedure, workbook in EXCEL format, where the calculation procedures are stored together with the input data, NCV and EF, incl. commentaries;
- submission of the set for QC – Tier 1, performance of control of preparation of the "Protocol on QC – Tier 1", which contains findings and suggestions for dealing with them;
- performance of adjustments according to the "Protocol on the QC procedure – Tier 1";
- copying the data to CRF, subsequent control of the inserted data, export of data to the XML file, submission of the XML file to the coordination workplace;
- submission of the calculation datasets and protocols on QC procedures for filing at the coordination workplace;
- submission of a proposal for external experts for preparation of QA procedures to the coordination workplace.

Table 3.17 Elements of the QC procedure at the Tier 1 level for processing of 1A ENERGY

QC activity	**Procedure**
Control of documents for selection of activity data.	Control of background material for preparing the activity data from the standpoint of their completeness and usefulness.
Control of criteria for selection of emission factors.	Control of the emission factors employed, comparison with the emission factors of similar countries, default values, country-specific EF.
Control of errors occurring in copying input data.	Verification of samples of input data in each category of sources to reveal errors occurring during copying. Control calculations of aggregations of data.
Verification of the correctness of calculations.	Repetition of the calculation in a representative sample. Selective imitation of calculation of a complicated model with an abbreviated version.
Control of whether the parameters and emission units are properly recorded and that suitable emission and oxidation factors are employed.	Control of the correctness of designation of units for the calculation sheets. Control of whether the units are properly employed in all the calculations. Control of the proper use of factors.
Control of the integrity of database sets.	Confirmation of the correctness of the relationships between the data in the database – smoothness of the time series. Control of the proper designation of the data fields and their exact adjustment. Control of suitable documentation for the individual databases.
Control of the correctness of operations with data (transfers, summation) between the individual steps in the calculation.	Control of proper aggregation of data from lower levels, especially for preparation of summary tables. Control of the correctness of data during copying from various intermediate products (various types of tables, detailed and summary).
Control of the data for calculation of uncertainties.	Control of the completeness of data from the viewpoint of background for calculation of uncertainties.
Control of internal documents.	Control of whether the internal documents are sufficiently detailed for potential repeated calculation. Control of whether all the data employed are stored for the purpose of detailed revision.
Provision for control of completeness.	Checking to ensure that emissions are reported for all the categories of sources and for every year from the base year to the present time. Control of whether the determined gaps in the data corresponding to incompleteness of the emission data in the individual categories or in the time series are documented.
Control of documentation of the performed inventory.	Confirmation of the correctness of literature references (control of references). Correctness of recording and storing.

QC procedures (Tier 2)

The procedure at the Tier 2 level is included on the basis of the requirements placed on key sources. It is concerned mainly with comparison of the data employed for drawing up the activity data with “independent data sources” (ETS, REZZO, MTI).

Order of steps in performing QC control – Tier 2:

- performance of the QC procedure – Tier 2, proposal for additional adjustments, discussion of the means and extent of corrections with the coordination workplace;
- performance of additional data corrections in CRF, commentary;
- commentary of the QA procedure with external experts;
- submission of the corrected datasets and QC protocols for filling at the coordination workplace.

QA procedures

QA procedures are performed each year (key sources); in relation to the demands on time and finances, only a certain specific part of the inventory is selected for each year; the entire inventory should be subjected to the QA procedure in this manner in 3-5 year cycles.

A "Report on the selected part of the inventory" is submitted on the performed QA procedure. An internal review process is performed for the report and the minutes are stored in the archive at the coordination workplace.

The principles of preparation of the emission inventory are further specified in detail for the individual phases of data preparation and processing and subsequent utilization of the results of calculations with subsequent storage.

Collection of activity data

In collection of activity data, all the background data are stored at the workplace of the sector director, where possible in electronic form. These consist primarily in datasets obtained from CSO as officially submitted data for drawing up the activity data. The datasets are unambiguously designated and cited under this designation.

If the data are taken from the Internet, the relevant passages (texts, tables) are stored in separate files with designation of the web site where they were obtained and the date of acquisition.

Data taken from printed documents are suitably cited, the written documents are stored in printed form at the workplace of the sector director and, where possible, the relevant passages (texts, tables) are scanned and stored in electronic form.

When the stage is completed, all the stored data are transferred to electronic media (CD, external HD, flash disks, etc.) and stored with the sector director; the most important working files that contain data sources, calculation procedures and the final results are submitted in electronic form for storage at the coordination workplace.

Conversion of activity data to the CRF format

The activity data are converted from the energy balance to the CRF structure in the EXCEL format. Each working file has a "Title page" as the first page.

The Title page shall contain particularly the following information:

- the name and description of the file
- the author of the file
- the date of creation of the file
- the dates of the latest up-dating, in order
- the source of the data employed
- description of transfer of specific data from the source files
- the means of aggregation of the data base employed in conversion
- explanations and comments.

The working files shall also contain a compulsory "Activity Data" Sheet. The Activity Data Sheet shall contain:

- complete division of the data into IPCC (SA) sectors and subsectors or individual fuels for RA, in structure compatible with CRF
- complete time series
- the units in which the activity data balance is drawn up

The conversion shall be performed in two separate sets for the Sector Approach (SA) and Reference Approach (RA). If the data conversion requires recalculation from natural units to energy units, the calorific value of the individual kinds of fuel used is included in the calculation. The calorific values employed are stored.

Calculations of emissions

These values are given in the following sheets of the working files, which also contain the "Emission Factors" sheet, the "Oxidation Factors" sheet and calculation sheets for the individual GHG gases. The necessary aggregations for transfer of the data to the CRF reporter are included.

3.2.6.5 Source-specific recalculations, changes in response to the review process

Some recalculations were performed, based primarily on changes in the activity data leading to a change in the values of the CO_2, CH_4 and N_2O emissions. The recalculations were performed particularly in order to improve the quality of the overall inventory recommended by ERT in 2009. 2003 was the decisive year for the recalculation; prior to 2002 the activity data in category 1A2 was not given in detailed classification for 1A2a – 1A2f. Detailed classification of the activity data for subcategories 1A2a – 1A2f has so far been performed on the basis of indirect data, leading to repeated criticism from the inspection bodies. The national energy balance did not contain data for the individual subsectors and their use was not suitable for these purposes. On transfer to the data from the CSO-IEA Questionnaire, it was found that it is necessary to recalculate the 2003 – 2007 time series for previous emissions and then use only this source of information. The recalculations currently do not extend back beyond 2003, as this is highly time-demanding work.

In addition, some data that were newly obtained and all the missing data were verified and supplemented or a notation key was provided so as to ensure completeness of the entire inventory. Details are given in the following text with exact allocation of the performed changes.

1. Recalculation in sectors 1A1, 1A2, 1A3e, 1A4 and 1A5 since 2003

The recalculation was performed using refined activity data in the individual subsectors. The values of the emission factors for CO_2, CH_4 and N_2O and oxidation factors for CO_2 were used in the same way as in the previous submission. The calculation method also did not change.

The recalculation involves improvement and specification of activity data by using questionnaires elaborated by the Czech Statistical Office (CSO) for IEA and Eurostat, while emissions and oxidation factors remain unchanged. This recalculation was enabled by concluding the Memorandum of understanding between CHMI and CSO on data exchange, which made questionnaires mentioned above accessible for the inventory team. So far, the activity data were taken from annually published "Energy balances of the Czech Republic" that are less suitable for conversion to UNFCCC/CRF categorisation.

The year 2003 was chosen as the starting year because data for detailed splitting for 1A2 (i.e. 1A2a, 1A2b,…,1A2f) are available since 2003.

Reasons of this recalculation were discussed during the recent "In-country review" (October 2009, Prague) with the Expert Review Team (ERT) that supported this concept. Besides, the last EU check called "Consistency Report CZ 2009" found obvious inconsistency in 1A2 category allocation.

2. Recalculation (addition of missing fuel type) in the sub-sector 1A2f since 2003

Reasons of this recalculation were discussed during the recent "In-country review" (October 2009, Prague) with the Expert Review Team (ERT) that suggested the addition of missing fuel type "Other fuels" used mainly in the cement kilns in order to improve completeness.

New data on consumption of Other fuels was used in the 2003 – 2008 time series in subsector 1A2f Other. This corresponds to the use of alternative fuels in the cement industry. These data have not yet been reported to date. Detailed background information for preparing the ETS national database provided a source of data. The results of this part of the recalculation are given in Table 3.18.

Table 3.18 Other fuels in sub-sector 1A2f – activity data, emissions of CO_2, CH_4 and N_2O

	Unit	2003	2004	2005	2006	2007	2008
Consumption of Other fuels	[TJ]	3 690	4 356	4 105	4 412	3 966	5 594
Emission CO_2	[Gg]	302.5	361.0	348.9	357.9	303.1	413.2
Emission CH_4	[Gg]	0.0268	0.0343	0.0363	0.0360	0.0377	0.0515
Emission N_2O	[Gg]	0.0042	0.0052	0.0053	0.0054	0.0054	0.0074

Detailed information on the structure of Other fuels and the emission factors used and on calculation of CO_2, CH_4 and N_2O emissions are given in Chapter *3.2.6.2 Methodological issues.*

3. Recalculation in the reference approach since 2003

Starting year 2003 for recalculation was chosen in order to keep data consistent with data mentioned above. Similarly as in the sectoral approach, all activity data were taken from questionnaires elaborated by the Czech Statistical Office (CSO, 2009) for IEA and Eurostat

In addition to previous submissions, the following data were inserted:

- Other Kerosene
- Naphtha
- Bitumen
- Lubricants
- Petroleum Coke
- Refinery feedstocks
- Anthracite
- Other fuels (In contrast to the previous years, the source of the data in this case consists in detailed background information for preparation of the ETS national database.

All the data on the newly included fuels were reported for the 2003 – 2008 time series.

4. Recalculation of CH_4 emission in the sub-sector 1A3e since 1990

Reasons of this recalculation were discussed during the recent “In-country review” (October 2009, Prague) with the Expert Review Team (United Nations, 2010) that suggested the substitution of the non-transparent CH_4 EF by the IPCC default one.

The original emission factors in the range 0.23 – 0.16 kg CH_4/TJ were replaced by the default emission factors of 5 kg CH_4/TJ.

5. Recalculations in 1B2a3 Oil Transport and supplementation of the activity data in 1B2a5 Distribution of products

Originally, this category was not filled in. A check of the completeness of the reported data led to the recalculation. The IPCC (IPCC, 2000: p 2.87) methodology gives the following emission factors for transport of petroleum (Tier 1) [Gg/10^3m^3 oil transported via pipeline]:

EF CH_4 = $5.4E^{-06}$;

EF CO_2 = $4.9E^{-07}$;

EF N_2O = 0.

These emission factors were used to recalculate the CH_4 and CO_2 emissions from 1990 to 2008.

Activity data represents total amount of petroleum processed in refineries per annum.

The activity data was also supplemented in subsector 1B2a5 Distribution of products (the total volume of petroleum processed per annum in the Czech Republic, corresponding roughly to the total distribution of products in the processed petroleum). As the IPCC methodology does not mention any EFs for CO_2 or CH_4 or even for N_2O and the specific emission factors are also not known, the GHG emissions are not filled in. Notation key employed – NO: Emission factor is not occured. Emissions are expected to be very low.

6. Recalculation of emissions in 1B2c (Venting and flaring)

In the submission 2009 the emissions from venting and flaring in the oil production were firstly reported for the year 2007. Our inquiry among producers showed that this activity in the Czech Republic does not occur (NO).

7. Recalculation of emissions (addition of missing gas) in 1B2b (Fugitive emissions - Natural Gas) since 1990

Based on the above inquiry the value of CO_2/CH_4 ratio in the Natural Gas was found and so it was possible to estimate relevant emissions of CO_2 in the 1B2b sub-sector and thus to improve completeness.

The CO_2 emissions are calculated from the average CO_2 content in Natural Gas. It was found in a correspondence survey at RWE Transgas that the average CO_2 content in Natural Gas has been 0.1 to 0.3% vol. over a prolonged time. A mean value of 0.2 was selected and this was converted to wt. % using the following procedure. The average methane content in Natural Gas is 98.4 % vol. The corresponding volume fraction is then:

$$100 \times 0.2 / (98.4 + 0.2)$$

Wt. % CO_2 = Vol. % CO_2 x 44 / 22.41

The resultant value is 0.398 % wt. The CO_2 emissions corresponding to methane emissions in the individual subsectors of 1B2b were calculated using this factor.

8. Changes in 1AD Feedstock and non-energy use since 2003

In connection with changes in the activity data in the Sectoral Approach and Reference Approach, the relevant changes in the activity data were also performed in section 1AD. The changes were performed in the 2003 – 2008 time series. The fraction of carbon stored was not changed.

3.2.6.6 Source-specific planed improvements

On the basis of a requirement in the “In-country review” (October 2009, Prague), access was provided to data from the ETS national database (ETS, 2009). As this database could not be used in preparing the emission inventory for 2008 because of lack of time, the data will be used in the subsequent submission. Use of this database will lead to substantial progress in preparing the actual emission inventories and in performance of QA/QC control procedures.

When greenhouse gas emissions are calculated in subsequent years, consideration will be given to the possibility of extending the existing recalculation to before 2003. A number of calculations will be performed before a decision is made on extending the calculation and the results will be compared with the current state of the database inventory.

Further development of cooperation with CSO will be an important element in improving future working procedures. The first step in the planned improvements will consist in assessment of the suitability of extending the current recalculation to prior to 2003, or establishment of a suitable time period over which this recalculation can be performed. Subsequently, in mutual consultations, the ETS database will be compared with data in the questionnaires elaborated by the Czech Statistical Office (CSO, 2009) for IEA and Eurostat.

3.3 Mobile combustion

3.3.1 *Source category description*

The categories of means of transport for the purposes of calculations of greenhouse gas emissions did not change compared to 2008. The criteria for inclusion of a certain means of transport in a particular category consist in the kind of transport, the fuel employed and the type of emission standard that the

particular vehicle must meet (in road transport). The categories of vehicles are not as detailed for non-road transport.

The categories of mobile sources are following:

1A3a Civil Aviation

- airplanes fuelled by aviation gasoline
- airplanes fuelled by jet kerosene

1A3b Road transportation

- motorcycles,
- passenger and light duty gasoline vehicles conventional,
- passenger and light duty gasoline vehicles with EURO 1 limits,
- passenger and light duty gasoline vehicles with EURO 2 limits,
- passenger and light duty gasoline vehicles with EURO 3 limits,
- passenger and light duty gasoline vehicles with EURO 4 limits,
- passenger and light duty diesel vehicles conventional,
- passenger and light duty diesel vehicles with EURO 1 limits,
- passenger and light duty diesel vehicles with EURO 2 limits,
- passenger and light duty diesel vehicles with EURO 3 limits,
- passenger and light duty diesel vehicles with EURO 4 limits,
- passenger cars using LPG, CNG and biofuels (separately),
- heavy duty diesel vehicles and buses, conventional,
- heavy duty diesel vehicles and buses, with EURO 1 limits,
- heavy duty diesel vehicles and buses, with EURO 2 limits,
- heavy duty diesel vehicles and buses, with EURO 3 limits,
- heavy duty diesel vehicles and buses with EURO 4 limits,
- heavy duty diesel vehicles and buses using LPG, CNG and biofuels (separately).

1A3c Railways

- diesel locomotives

1A3d Navigation

- ships with diesel engines

3.3.2 *Methodological issues*

3.3.2.1 CO_2 emissions

Carbon dioxide emissions were calculated on the basis of the total consumption of the individual automotive fuels used in transport (i.e. gasoline, diesel oil, LPG, CNG, biofuels and aviation fuels) and the emission factors for the weight of CO_2 corresponding to 1 kg of fuel burned. Consumption of the individual kinds of fuel by road, railway and water transport was determined on the basis of cooperation with the CSO. Consumption in road transport was further divided up into the following categories of means of transport on the basis of statistics on transport output:

- gasoline-fuelled passenger vehicles;
- diesel vehicles for passenger and light freight transport;
- diesel vehicles for heavy freight transport and buses;
- passenger and light vehicles fuelled by LPG, CNG and biofuels (separately);
- heavy trucks and buses fuelled by LPG, CNG and biofuels (separately).

The share of transport in total CO_2 emissions has exhibited an increasing trend in the Czech Republic during the 90’s and this growth is continuing until 2007. Individual road and freight transport make the greatest contribution to energy consumption in transport. The amount of fuel sold is monitored annually and constitutes the main input data for calculation of energy consumption.

Emissions of carbon dioxide from transport decreased in 2008 for the first time in many years, to 17.73 mil. tonnes from 18.13 mil. tonnes in 2007 (Jedlička et al, 2009). From the viewpoint of greenhouse gases, this is a very favorable effect. However, it is not clear whether this decreasing trend will continue or whether it is just an anomaly. The reduction in carbon dioxide emissions is a consequence especially of the reduction in consumption of gasoline and diesel oil. The consumption of gasoline in 2008 equaled 2003 thous. t.(this figure equaled 2085 thous. t. in 2007), while the consumption of diesel fuel decreased from 3,691 to 3,658 thous tonnes. The reduction in the consumption of diesel oil is a particularly new factor, as this was recorded for the first time since 1990 – the consumption of diesel oil has consistently increased since then.

The consumption of gasoline has fluctuated around a value of 2 mil. t in the last 3-4 years. This consumption of gasoline in 2008 also includes the consumption of bioethanol, which has been mixed into gasoline in a volume of 2 % since January 1, 2008 (the fraction of bioethanol, as a renewable resource, in gasoline will continue to increase in the coming years). Thus, the actual consumption of gasoline without bioethanol will be even lower, by the mentioned 2 %. These facts (reduction in consumption) have a favorable impact on CO_2 emissions.

The reduction in consumption (and thus also in CO_2 emissions) in transport is interpreted as being a consequence of the global economic crisis, as this crisis has changed the behavior of consumers, which is reflected in transport – lower consumption of fuels, lower transport performances, especially in freight transport and, last but not least, - which is favorable – also lower emissions from transport.

The global economic crisis was characterized by several important indicators in 2008. The primary cause was the American mortgage crisis in 2007, which gradually grew into the 2008 global financial crisis; the high price of petroleum in the first half of 2008 also played an important role and led to a reduction in real GDP and increased consumer prices. The price of petroleum was driven up by speculative trading (pension and hedge funds purchased commodities to reduce the portfolio based on the stock markets), the weak dollar and increasing demand by China prior to the Olympics. When the financial crisis broke out in full force in the autumn of 2008, it swept with it not only foremost world banks and stock markets, but also the price of petroleum.

Because of the uncertainty in the developments in the economy, it is currently practically not possible to predict trends in consumption of automotive fuels in transport. The global economic crisis is reflected in transport not only positively (lower fuel consumption results in reduced emissions of almost all pollutants from transport), but also negatively (slower construction of the throughway network results in passage of heavy transport through populated areas).

Because the crisis continued into 2009, it can be assumed that fuel consumption and thus also emissions from transport will further decrease in 2009. However, at the present time, it is not possible to determine when this trend will change and when decreasing trends will again be replaced by increasing trends. The greenhouse gas emission balance reflects not only scenarios in the consumption of alternative fuels, but also especially scenarios of trends in transport infrastructures, completion of the throughway network in various variants, city by-passes, completion of railway corridors, etc.

Mobile sources used for purposes other than transport – gasoline-powered lawn mowers, chain saws, construction machinery, etc. – make a smaller contribution to the increasing consumption of gasoline and diesel oil.

In relation to CO_2 emissions from air transport, it can be stated that domestic transport makes a very small contribution to these emissions – about 1%, as it is limited mainly to flights between the three largest cities in the Czech Republic, Prague, Brno and Ostrava. Similar to road transport and consumption of aircraft fuel, this is not monitored centrally by the Czech Statistical Office. Aircraft are fuelled mainly by jet kerosene, while the consumption of and CO_2 emissions from aviation gasoline are limited to small aircraft used in agriculture and in sports and recreational activities.

The total consumption of the army and the consumption of the domestic transport (estimated on the basis of the number of flights, distances between destinations and the specific consumption of fuels per the unit of distance in the LTO regime and the cruise itself) were subtracted from the total kerosene consumption. The remaining kerosene consumption is related to the international air transport.

Carbon dioxide emissions for the 2000 – 2006 time series were recalculated in 2008. The reasons for the recalculation and more detailed information are given in the relevant chapters (Chapters 3.3.5 and 10.2).

Table 3.19 CO_2 emissions calculation from mobile sources in 1990 – 2008 *[Gg CO_2]*

	Aviation (without Bunkers) 1.A3a	Road Transportation 1.A3b	Railways 1.A3c	Navigation 1.A3d	Agriculture (Mobile) 1.A5b	Total 1.A3 + 1.A5
1990	149	5 995	647	56	1 601	8 449
1991	136	5 406	576	56	1 409	7 582
1992	119	6 228	489	54	1 321	8 211
1993	97	6 329	411	54	1 276	8 167
1994	91	6 825	331	53	1 285	8 585
1995	80	8 656	330	55	1 013	10 134
1996	72	9 678	326	45	1 092	11 213
1997	66	10 376	280	38	1 140	11 900
1998	10	10 912	350	37	1 258	12 566
1999	10	11 195	325	22	1 237	12 788
2000	8.7	11 500	326	15.5	1 233	13 084
2001	11.6	12 354	304	24.9	1 211	13 906
2002	15.1	12 952	295	12.4	1 144	14 418
2003	15.4	14 771	289	12.4	1 099	16 187
2004	15.7	15 512	286	18.6	1 115	16 948
2005	12.9	16 854	273	15.5	1 103	18 258
2006	16.1	17 154	301	18.6	1 082	18 572
2007	32.1	18 131	298	15.7	1 094	19 571
2008	45.3	17 744	289	15.0	1 146	19 239

3.3.2.2 CH_4 emissions

For road transportation, the method of methane emission calculation corresponds to the Tier 2 level, because different road vehicles produce different amounts of methane. It can be stated that methane emissions from road transportation exhibit the same differences as total hydrocarbons. Mobile emission sources were divided up into several categories according to the fuel used, the transport mode and the emission limit that a particular vehicle must meet. This division is more detailed because there are larger differences in methane production by individual vehicles. These categories are described in detail in Chapter 3.3.1 "Source category description".

The total consumption of gasoline, diesel oil, LPG, CNG and biofuels has been determined from the statistical surveys of the CSO. The next step consisted in separation of these fuel consumptions into the vehicle categories described above, according to their transport outputs acquired in the last National Traffic Census performed in the Czech Republic once every five years, last in 2005. The emission factors were the IPCC default values and, from 2004, the country-specific values as CDV became part of the emission inventory team.

The Czech Republic has been very successful in stabilizing and decreasing methane emissions derived from transport-related greenhouse gas emissions. The annual trends in these emissions are constantly decreasing and are very similar to other hydrocarbons emissions, which are limited in accordance with UN ECE regulations. New vehicles must fulfill substantially higher EURO standards for hydrocarbons than older vehicles (currently the EURO IV standard). 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 are now 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 gasoline-fuelled passenger cars, gasoline-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 gasoline and kerosene-fuelled aircraft (Adamec et al, 2005b).

Emissions of CH_4 from mobile sources are given in Table 3.20 CH_4 emissions calculation from mobile sources in 1990 – 2008 [Mg CH_4]

Table 3.20 CH_4 emissions calculation from mobile sources in 1990 – 2008 [Mg CH_4]

	Aviation (without Bunkers) 1.A3a	Road Transportation 1.A3b	Railways 1.A3c	Navigation 1.A3d	Agriculture (Mobile) 1.A5b	Total 1.A3 + 1.A5
1990	15.1	1 200.0	44.0	4.0	335.7	1 598.8
1991	13.7	1 034.0	39.0	4.0	291.9	1 382.7
1992	12.0	1 210.0	33.0	4.0	270.1	1 529.0
1993	10.2	1 270.1	28.0	4.0	262.0	1 574.3
1994	8.8	1 395.4	22.6	3.6	264.0	1 694.4
1995	6.7	1 560.0	22.5	3.7	211.1	1 804.0
1996	4.8	1 589.6	22.2	3.1	212.8	1 832.5
1997	3.6	1 492.9	19.1	2.6	184.1	1 702.2
1998	1.5	1 331.4	23.8	2.5	145.4	1 504.7
1999	1.8	1 220.1	22.2	1.5	99.4	1 344.9
2000	1.5	1 710.0	20.5	1.0	85.6	1 818.6
2001	2.1	1 740.0	19.1	1.6	84.2	1 847.0
2002	2.8	1 650.0	18.5	0.8	81.1	1 753.1
2003	2.8	1 700.0	18.1	0.8	76.2	1 797.9
2004	2.9	1 610.0	17.9	1.2	78.3	1 710.3
2005	2.3	1 620.0	17.1	1.0	77.9	1 718.3
2006	2.9	1 530.0	16.3	1.2	75.0	1 625.4
2007	5.5	1 540.0	19.0	1.0	78.3	1 643.8
2008	7.0	1 409.0	18.0	1.0	81.6	1 516.6

3.3.2.3 N_2O emissions

Nitrous oxide (N_2O) emissions decreased in 2008, similar to carbon dioxide emissions, as a consequence of the reduction in consumption of gasoline and diesel oil. Another factor is also important here – the higher emissions of newer vehicles compared to older ones, as vehicles fitted with 3-way catalytic converters reduce only NOx emissions, but not N_2O. However, this effect is suppressed in the newest vehicles as a consequence of production of vehicles with lower fuel consumption. Lower fuel consumption, both total consumption in the Czech Republic and specifically for the individual vehicles, has led to an overall reduction in nitrous oxide emissions in 2008.

Road transport was identified as a key source of N_2O emissions over the past 3 years, as the share of vehicles with high N_2O emissions has been increasing over this time. Consequently, N_2O emissions from mobile sources represent a somewhat more important contribution than CH_4 emissions. 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 gasoline-fuelled passenger cars

with catalysts. The vehicle categories for the nitrous oxide calculation are the same as for methane (see above).

Because of big differences between national N_2O measurement results and values recommended in IPCC methodology, the special verification including the statistical evaluation has been performed. The resulted values of N_2O emission factors from mobile sources are approaching to recommended IPCC values. 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 (IPCC, 1997) gives three pairs of emission factors for passenger cars with catalysts (for new and deactivated catalysts). The value for a deactivated catalyst is approximately three times that for a new catalyst. 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 *IPCC Reference Manual*, Box 3 (IPCC, 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.

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. This approach described above was recently revised and modified by CDV, which is a member of the Czech national GHG inventory team from 2005. CDV 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 (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) during 2004 - 2006 years. 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). Emissions of N_2O are given in Table 3.21 N_2O emissions calculation from mobile sources in 1990 – 2008 [Mg N_2O].

Table 3.21 N_2O emissions calculation from mobile sources in 1990 – 2008 [Mg N_2O]

	Aviation (without Bunkers) 1.A3a	Road Transportation 1.A3b	Railways 1.A3c	Navigation 1.A3d	Agriculture (Mobile) 1.A5b	Total 1.A3 + 1.A5
1990	12.6	228.0	26.5	2.3	63.2	332.6
1991	11.6	269.1	23.5	2.3	55.0	361.5
1992	10.0	369.8	20.0	2.2	51.1	453.2
1993	8.5	487.0	16.8	2.2	50.0	564.5
1994	7.5	544.1	13.6	2.2	49.7	617.0
1995	5.9	807.5	13.5	2.2	39.7	868.9
1996	4.5	939.3	13.6	1.9	42.6	1 001.9
1997	3.6	1 066.0	15.3	1.8	51.1	1 137.8
1998	1.1	1 395.9	19.6	2.1	76.0	1 494.7
1999	1.3	1 615.9	18.7	1.2	81.3	1 718.4
2000	1.2	1 260.0	18.7	0.9	82.9	1 363.7
2001	1.6	1 400.0	17.5	1.4	81.5	1 502.0
2002	2.1	1 590.0	16.9	0.7	77.8	1 687.6
2003	2.1	1 890.0	16.6	0.7	73.9	1 983.3
2004	2.2	2 060.0	16.4	1.1	75.5	2 155.2
2005	1.8	2 200.0	15.7	0.9	74.9	2 293.3
2006	2.2	2 230.0	14.9	1.1	72,7	2 320.9
2007	4.4	2 475.0	17.0	0.9	74,9	2 572.2
2008	6.0	2 398.0	17.0	0.9	78,2	2 500.1

3.3.3 *Uncertainties and time series consistency*

In spite of the fact that verification has been performed, the N_2O emission factors remain the greatest source of uncertainty for this pollutant, because the emission factors from various data sources differ. In checking the consistency of data series, attention was focused since 2006 primarily on emissions from internal air transport; particularly older data on internal flights is very difficult to obtain.

3.3.4 *Source-specific QA/QC and verification*

Consumption of all automotive fuels in the time series was determined in cooperation with CSO. The actual calculations of greenhouse gas emissions were performed by two independent institutions: The CDV and KONEKO, with regular mutual control of the results. Inaccuracies were gradually eliminated.

3.3.5 *Source-specific recalculations*

No recalculation of the time series was performed in the mobile sources sector for 2008. The last performed recalculation was reported in the last NIR (2009 submission).

3.3.6 *Source-specific planned improvement*

Control and refinement of the results will continue. In particular, studies will continue to be performed on the potential for refinement of the calculation of N_2O emissions on the basis of emission measurement results. More detailed monitoring of the statistics of air transport from the standpoint of internal flights is also expected.

The planned improvements are related particularly to provision for QA/QC procedures, including designation of responsible persons for the actual preparation of emission inventories and their control.

The possibility of separating water transport into inland and international will be considered this year and will be described in the next submission. This will be performed in relation to the quality of data on performances in shipping transport.

3.4 Fugitive emissions from solid fuels and oil and Natural Gas (CRF 1.B)

Mining, treatment and all handling of fossil fuels are sources of fugitive emissions. In the Czech Republic, CH_4 emissions from underground mining of Hard Coal are significant, while emissions from surface mining of Brown Coal, Oil and Gas production, distribution, storage and distribution are less important.

The current inventory includes CH_4 emissions for the following categories:

- *1B1 Solid fuels*
- *1B2 Oil and Natural Gas*

In *1B Fugitive Emissions from Fuels* category, especially *1B1a Coal Mining and Handling* was evaluated as a *key category* (Table 3.22). Category 1B2 also was identified as a *key category* by the latest assessment, but only in one from the four tests (LA). Moreover, identifiers placed this category just over the borderline between *key* and non-*key categories.*

Fig. 3.8 depicts methane emissions trends from selected categories from the sector *1B Fugitive Emissions from Fuels*.

Table 3.22 Overview of significant categories of sources in this sector (2008)

Category	Character of category	Gas	% of total GHG*
1B1a Fugitive Emissions from Coal Mining and Handling	KC (LA, TA, LA*, TA*)	CH_4	3.1
1B2 Fugitive Emissions from Oil & Gas operations	non-KC	CH_4	0.5

* assessed without considering LULUCF (without * means considering LULUCF)

KC: key category, LA: identified by level assessment, TA: identified by trend assessment

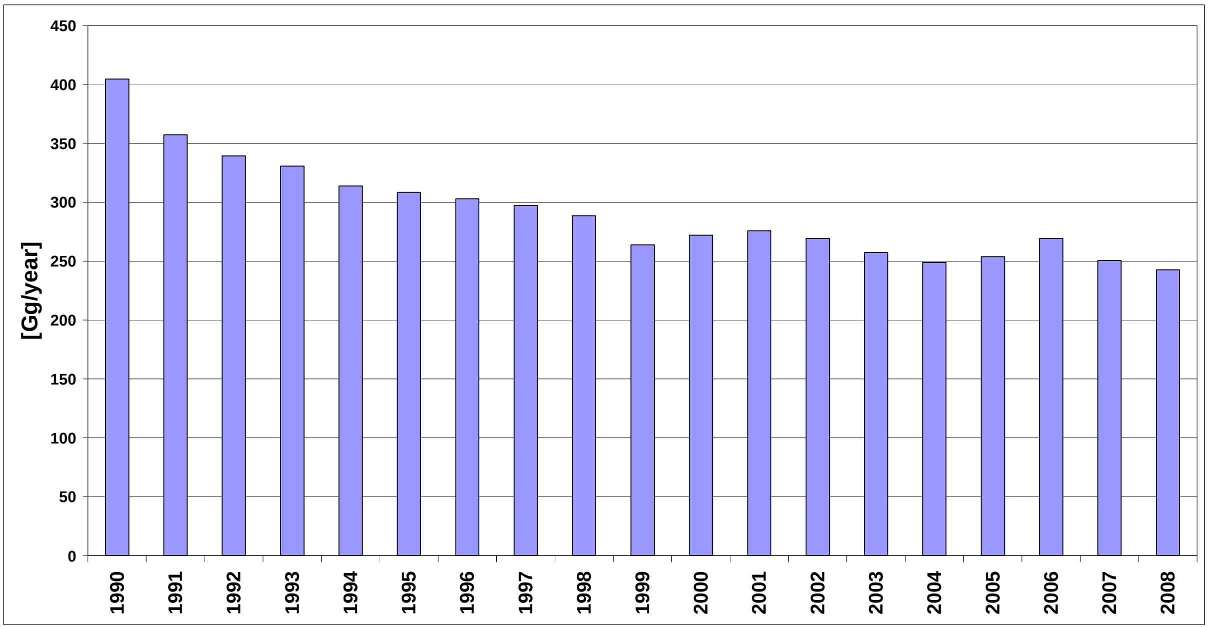


Fig. 3.3 Methane emissions trends from the sector Fugitive Emissions from Fuels [Gg CH_4]

3.4.1 *Solid Fuels (1B1)*

The source category *1B1 Solid Fuels* consists of three sub – source categories: source category *1B1a Coal mining and Handling,* source category *1B1b Coal transformation* and source category *1B1c Other*.

The main process that emits more than 80 % of methane emissions from the category *1B1Solid Fuesl* category is underground 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. Coal mining (especially 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.

3.4.1.1 Source category description

1B1a Coal mining and Handling

In underhround 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.

1B1a1 Underground Mines

In the Czech Republic, mainly Hard Coal is mined in underground mines (i.e. Hard Coal: Coking Coal and Bituminous Coal). Presently, underground mines are in operation in the Ostrava-Karviná coal-mining area. In the past, Hard Coal was also mined in the vicinity of the city of Kladno. These mines were closed in 2003. Brown Coal is mined in only one underground mine in the Northern Bohemia area. Emissions from this mine are reported together with surface mining of Brown Coal – Lignite in subcategory *1B1a2 Surface Mines*.

1B1a11 Mining Activities

The data of CSO in the report CZECH_COAL.xls (CSO, 2009) can be used for control purposes.

Hard-coal mining is the principal source of fugitive emissions of CH_4. The mine ventilation must be regulated according to the amounts of gas released to keep its concentration on safe level. 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.

1B1a12 Post-Mining Activities

The activity data are the same as in category *1B1a11 Mining Activities*. It is assumed that the entire mined volume undergoes manipulation during which residual methane is released.

1B1a2 Surface Mines

1B1a21 Mining Activities

Brown Coal and Lignite are mined in surface mines in the Czech Republic. Brown Coal is mined primarily in the Northern Bohemia area, while Lignite mines are located in Southern Moravia.

1B1a22 Post-Mining Activities

The activity data are the same as in category *1B1a21 Mining Activities*. It is assumed that the entire mined volume undergoes treatment during which residual methane is released.

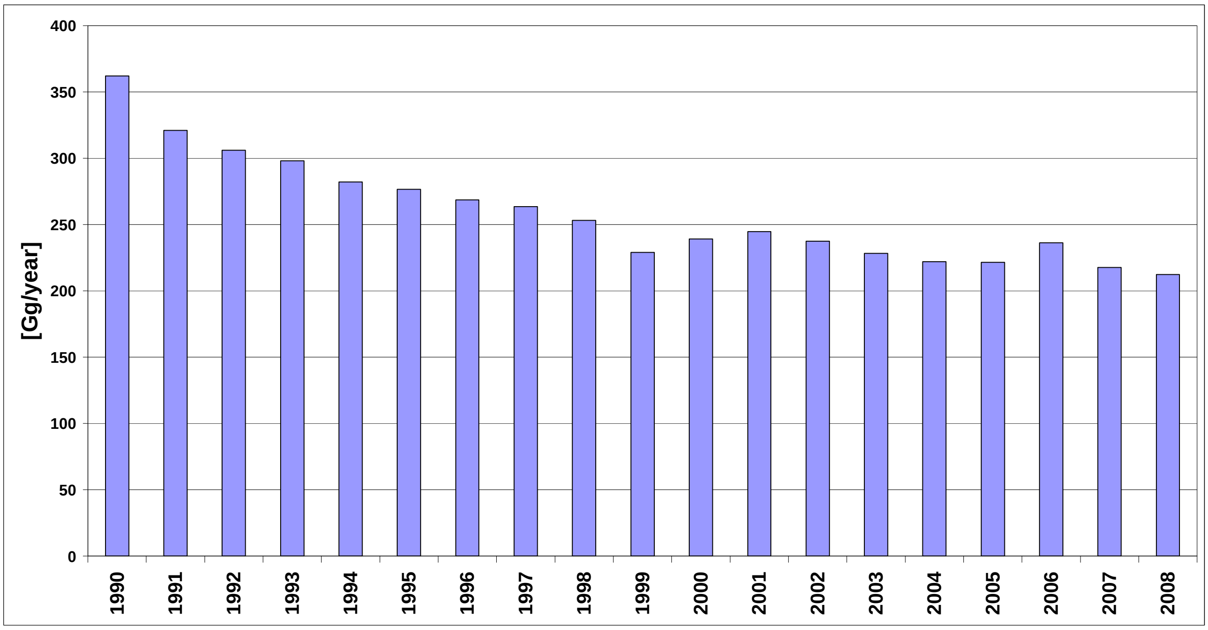


Fig. 3.4 Methane emissions trends from the sector Fugitive Emissions from Solid fuels *[Gg CH_4]*

1B1b Coal transformation

The subcategory includes

a) production of Coke from Coking Coal

Fugitive methane emissions from coal treatment prior to the actual coking process are listed under *1B1a12 Post-Mining Activities.* Emissions from the actual production of Coke are given under 2. Industry.

b) production of briquettes from Brown Coal

Fugitive methane emissions from coal treatment prior to the actual briquetting process are listed under *1B1a22 Post-Mining Activities.* CO_2 emissions from the actual production of briquettes are included in subcategory 1A2f.

For these reasons, none of the activity data or methane emissions are included in this subcategory (notation key IE). Fugitive CO_2 emissions are not estimated or are negligible and no known method is available for their determination (notation key NE). Fugitive N_2O emissions are not estimated because, according to the current state of knowledge, these emissions cannot occur (notation key NA).

1B1c Other

No other subcategory of fugitive methane emissions is known in the Czech Republic.

3.4.1.2 Methodological issues

1B1a1 Underground Mines

1B1a11 Mining Activities

National emission factors were determined for calculation of fugitive methane emissions in underground mines in the second half of the 1990's: the ratio between mining and the volume of methane emissions is given in Table 3.23, see (Takla and Nováček, 1997).

Table 3.23 Coal mining and CH_4 emissions in the Ostrava - Karvina coal-mining area

	Coal mining *[mil. t / year]*	CH_4 emissions *[mil. m³ / year]*	Emission factors *[m³ / t]*
1960	20.90	348.9	16.7
1970	23.80	589.5	24.7
1975	24.11	523.8	21.7
1980	24.69	505.3	20.5
1985	22.95	479.9	20.9
1990	20.06	381.1	19.0
1995	15.60	270.7	17.4
1996	15.10	276.0	18.3
Total	**167.31**	**3 375.3**	**20.2**
1990 till 1996	50.76	927.8	18.3

Only the values for 1990, 1995 and 1996 were used from this table to determine the emission factors. The average value of the emission factor of 18.3 m^3/t was recalculated to **12.261 kg/t** using a density of methane of 0.67 m^3/kg. This emission factor is used for coal mined in the Ostrava-Karviná coal-mining area. The emission factor set by estimation at 50 % of this value was used for the remaining Hard Coal from deep mines in other areas. This is valid for coal with minimum coal gas capacity (coal from the Kladno area to 2002 and coal from the Žacléř area from 1998).

1B1a12 Post-Mining Activities

Methane emissions in the subcategory of Post-Mining Activities are calculated using a uniform emission factor based on the default value of 1.64 kg CH_4/t coal; the activity data are employed at the same level as in subcategory *1B1a11 Mining Activities.*

Table 3.24 contains a summary of fugitive methane emissions during the actual underground mining of Hard Coal and during post-mining operations.

Table 3.24 Used emissions factors and calculation of CH_4 emissions from underground coal mining in 2008

	Ammount of Coal Produced *[million t]*	Emission Factor *[kg CH_4/t]*	Methane Emissions *[Gg CH_4]*
OKR) (tier III)*	12.662	12.26	155.25
Other (GEMEC - tier I)	0.000	6.7	0.0
Mining (I - III)	**12.662**	**12.26**	**155.25**
OKR) (tier I)*	12.662	1.64	20.78
Other (GEMEC - tier I)	0.000	0.6	0.0
Post-Mining (tier I)	**12.662**	**1.66**	**20.78**
Total sub-sector 1B1a1	**12.662**	**13.90**	**176.03**

** Ostrava-Karviná coal-mining area*

1B2a1 Surface Mines

1B2a11 Mining Activities

Activity data on the extraction of Brown Coal and Lignite are available in Mining Yearbooks 1995 – 2008 (last issue 2009). The data of CSO in the report CZECH_COAL.xls (CSO, 2009) can be used for control purposes.

During surface mining, escaping methane 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 (IPCC, 1997).

1B1a22 Post-Mining Activities

The activity data are the same as in category *1B1a21 Mining Activities*. Default IPCC emission factors are employed to calculate methane emissions from surface mining and from post-mining treatment (IPCC, 1997).

Table 3.25 illustrates the calculation of fugitive emissions of methane from surface coal mining activities.

Table 3.25 Emission factors employed and calculation of CH_4 emissions from surface coal mining in 2008

	Ammount of Coal Produced	Emission Factor	Methane Emissions
	[million t]	*[kg CH_4/t]*	*[Gg CH_4]*
Mining (tier I)	43.362	0.77	33.4
Post-Mining (tier I)	43.362	0.07	2.9
Total sub-sector 1B2a1	**43.362**	**0.84**	**36.3**

3.4.1.3 Uncertainty and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2008.

The uncertainties in the activity rate result primarily from inaccuracies in weighing of extracted coal. Uncertainties in determining the activity data are estimated at 5 %.

Uncertainties in calculating methane emissions further follow from the emission factors employed. The emission factors for determining emissions from deep mining of black coal are based on measurement of the methane concentrations in the air ventilated from underground mines in the second half of the 1990's. The precision of methane emissions varies at a level of 5 %. The uncertainty in the default emission factors is considered to be at a level of 80 %. Overall, the uncertainty in the emission factors in category 1B1 Solid fuels is estimated to equal 40 %.

Consistency of the time series is apparent from the graphs in Figures 3.8 and 3.9. Minor fluctuations are caused by climatic variations in the individual years. The trends towards a substantial decrease in emissions in the 1990's decreased during the first decade of the 21st century.

3.4.1.4 Source specific QA/QC and verification

General quality control and source-specific quality control (Tier 1 and Tier 2), in conformance with the requirements of the QSE handbook and its associated applicable documents, have been performed to the full extent.

QC activities at the level of Tier 1 were performed according to the QA/QC plan by the sectoral director. Routine control was performed in the framework of the following activities:

- activity data employed,
- emission factors employed,
- calculation procedures employed,
- transfer of numerical data from the working set to the CRF Reporter.

During control of the activity data, the CSO data were compared with the data from the Mining Yearbook Good agreement was found.

In control of the emission factors employed, the emission factors used in the Czech Republic methodology were compared with the emission factors of Slovakia, Poland and Germany in the context with the default emission factors. It was found that the emission factors employed for

calculation of emissions in the Czech Republic methodology correspond, in their range, to the emission factors employed in the other countries. Comparison of the emission factors used in the Czech Republic with the emission factors of the surrounding countries corresponds to the level of Tier 2.

Control of the transfer of numerical data from the working set to the CRF Reporter did not reveal any differences.

The final working set in EXCEL format was locked to prevent intentional rewriting of values and archived at the coordination workplace.

The protocols on the performed QA/QC procedures are stored in the archive of the sectoral director.

3.4.1.5 Source-specific recalculations

No recalculations are required.

3.4.1.6 Source-specific planned improvements

No improvements are planned at the present.

3.4.2 *Oil and Natural Gas (1B2)*

Source category 1B2 Oil and Natural Gas consists of four source subcategories: source category *1B2a Oil*, source category *1B2b Natural Gas*, *1B2c Venting and flaring* and source subcategory *1B2d Other*.

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. Crude Oil extraction and refining processes are less important.

Determination of methane emissions from the processes of refining of Crude Oil is based on the recommended (default) emission factors according to the IPCC methodology.

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 (Alfeld, 1998).

The graph in Fig.3.10 gives an overview of the trend in emissions in this category in the time series since 1990.

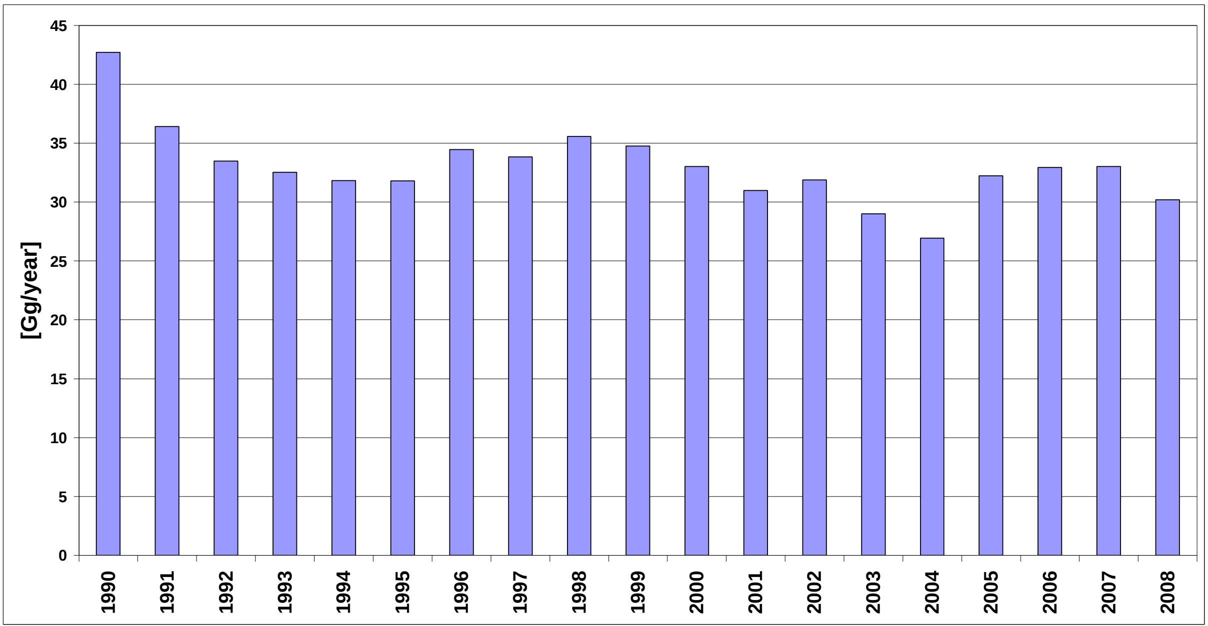


Fig. 3.5 Methane emissions trends from the sector Fugitive Emissions from Oil and Natural Gas *[Gg CH_4]*

3.4.2.1 Source category description

1B2a Oil

CH_4 emissions from Crude Oil transport and refining and from Crude Oil mining, which is performed in the Czech Republic in combination with mining of Natural Gas, are reported in this category. CO_2 emissions from the refinery resulting from combustion processes (including flaring) are included in *1A1b Crude Oil Refining*.

1B2a1 Exploration

Exploration is practically not performed in the Czech Republic.

Commentary:

In 2008, only 24 t of liquid Crude Oil were extracted in the framework of an exploratory pumping test. Emissions were not measured during this pumping test; the emission factor for CH_4 can vary amongst various values in dependence on the particular deposit.

The IPCC methodology does not give any default EF for any of the reported gases (CO_2, CH_4, N_2O).

When the EF for methane was used for Crude Oil mining and storage in open tanks without any treatment (these conditions correspond to the conditions during pumping tests at exploratory boreholes) at the Lanžhot centre for 11.68 t CH_4/1000 t raw Crude Oil, corresponding to emissions of 280 kg CH_4 in 2008.

In addition, this amount is highly dependent on the mining site and geological mining horizon. Because of the tiny amount of determined emissions in 2008, we consider this amount to be negligible and emissions will not be reported in future years.

1B2a2 Production

Crude Oil is mined in the Czech Republic in Southern Moravia. The following table gives the amount of mined Crude Oil in the territory of the Czech Republic over the past 3 years.

Table 3.26 Crude Oil mining in the CR in 2006 - 2008

Mining company	2006	2007	2008
MND Hodonín	256.3	221.6	200.8
UNIGEO	0.9		0.4
ČNS	9.6	14.0	14.3
MND Production		10.6	26.5
Total	**266.8**	**246.2**	**242.0**

1B2a3 Transport

Transport of Crude Oil in the territory of the Czech Republic is performed only in closed systems (pipeline transport). So far, emissions from this subsector have not been evaluated. In the context of internal control procedures, this fact was identified as an inadequacy and thus default emission factors were sought for CH_4 and CO_2 emissions and were used to calculate fugitive emissions in this subsector.

EF CH_4 – 0.00015 kt/PJ, EF CO_2 – 0.00001 kt/PJ. These emission factors were used to calculate fugitive emissions for the years since 1990.

1B2a4 Refining / Storage

Crude Oil is processed in the territory of the Czech Republic in two main refinery facilities. Table 3.15 gives the total volume of Crude Oil processed in the Czech Republic in the past 3 years.

Table 3.27 Total Crude Oil input to rafineries in CR in 2006 - 2008

	2006	2007	2008
Refinery Intake	**7 866**	**7 394**	**8 249**

1B2a5 Distribution of oil products

The final products after processing Crude Oil no longer contain dissolved methane or carbon dioxide and thus fugitive emissions are not considered in this subcategory. For completeness, activity data corresponding to the volume of processed Crude Oil in the individual years were recorded in CRF.

1B2a6 Other

No other operations are considered.

1B2b Natural Gas

1B2b1 Exploration

Emissions formed at exploratory boreholes are reported in this subcategory. This activity is not performed in the Czech Republic, or is completely random.

1B2b2 Production

Natural Gas is extracted in the Czech Republic in the area of Southern Moravia, accompanying extraction of Crude Oil, and in Northern Moravia, where it is derived from degassing of black coal deposits. The following table 3.28 gives the amount of extracted Natural Gas in the territory of the Czech Republic over the past 3 years.

Table 3.28 Extraction of Natural Gas in the CR in 2006 - 2008

Mining company	2006	2007	2008
DPB	113.6	113.6	110.6
MND Hodonín	94.3	102.7	69.4
UNIGEO	14.1	13.8	8.8
ČNS	0.5	0.9	1.0
MND Production		0.2	1.8
Carboniferous NG total	113.6	113.6	110.6
Crude Oil NG total	108.9	117.6	11.6
Total	**222.5**	**231.2**	**191.6**

This subcategory contains estimations of emissions formed during the actual technical operations during mining, with the exception of venting and flaring.

1B2b3 Transmission

A transit gas pipeline runs through the territory of the Czech Republic, transporting Natural Gas from Russia to the countries of Western Europe, with a length of 2,455 km. In addition to this central gas pipeline, a system of high-pressure gas pipelines is in operation in the territory of the Czech Republic, providing supplies of Natural Gas from the transit gas pipeline and underground gas storage tanks to centers of consumption. In 2008, the high-pressure gas pipelines had an overall length of 16,704 km. This length is gradually increasing. This subcategory also includes all the technical equipment on high-pressure gas pipelines. On the transit gas pipeline, this consists primarily of compressor stations and transfer stations, while measuring and regulation stations are located on domestic long-distance gas pipelines.

Emissions formed during controlled technical discharge of Natural Gas at compressor stations, during inspections and repairs to pipelines and emissions from pipeline accidents are estimated. These emissions are recorded by the gas companies. In addition, escapes of Natural Gas from leaks in the entire pipeline system, including technical equipment, are also evaluated.

1B2b4 Distribution

Emissions from distribution gas pipelines, with an overall length in 2008 of 59,089 km, and during consumption at the end consumer are reported in this category. The number of customers in 2008 is given in Table 3.29. The distribution networks are being continuously lengthened and the number of customers is increasing.

Table 3.29 Number of customers in 2008

Number of customers	**2008**
households	2 653 969
small customers	196 691
medium-sized customers	7 005
large customers	2 038

1B2b5 Other Leakage – 1B2b51 at industrial plants and power stations

Emissions from storage (injection and mining) of Natural Gas in the territory of the Czech Republic are reported in this subcategory. The total turnover (injection and mining) of Natural Gas in underground storage areas corresponded to 2,745 mil. m^3 in 2008.

1B2b5 Other Leakage – 1B2b52 in residential and comercial sectors

No emissions were identified in subcategory *1B2b52 Other leakage in the residential and commercial sectors* in the Czech Republic and thus the notation NO is employed.

Table 3.30 summarizes the activity data and emission factors used, including calculation of total methane emissions in this subcategory.

Table 3.30 Calculation of CH4 emissions from Oil in 2008

Category	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	10.16	5 287	53 742	0.054
Transport		*PJ oil refined*	*kg CH_4/PJ*		
transport of Crude Oil		349.4	146	51 046	0.051
Refining		*PJ oil refined*	*kg CH_4/PJ*		
processing of Crude Oil	1 - 2	349.4	1 150	401 790	0.402
				CH_4 from Oil	**0.507**

1B2c Venting and Flaring

In 2009, a survey was performed in companies concerned with mining Crude Oil and Natural Gas. It was confirmed that no discharge into the atmosphere or combustion in flares is performed in this subcategory. Notation key employed – NO.

3.4.2.2 Methodological issues

1B2a Oil

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

the IPCC methodology (IPCC, 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.

In general, it can be stated that fugitive greenhouse gas emissions occur in this subcategory only in operations in which Crude Oil saturated in carbon dioxide and methane is in contact with the atmosphere. All operations involving Crude Oil in the Czech Republic are hermetically sealed. Thus, fugitive emissions are formed only through leaks in the technical equipment. Following thermal treatment of Crude Oil, the resultant products no longer contain any dissolved gases and no fugitive emissions need be considered in subsequent operations.

1B2a1 Exploration

Activity data: number of mined boreholes – notation key NO, default emission factors have not been published for CO_2 and CH_4 – notation key NE – emissions are expected to be very low. N_2O emissions: notation key NA: N_2O emissions are practically not formed in exploratory work.

1B2b2 Production

Activity data for determining CH_4 emissions are taken from the Mining Yearbook and controlled using data from the CSO – IEA questionnaires. CH_4 emissions are determined as the product of annual Crude Oil mining and the emission factor. The emission factor has a value of 5,287 kg/PJ and was determined on the basis of published data in (Zanat *et al.,*1997). The emission factor was determined as the sum of the individual emission factors from pumping of raw Crude Oil and from storage of raw Crude Oil. These data were obtained by direct measurement. The resultant emission factor was increased by an estimate of fugitive emissions at mining boreholes (probes).

1B2a3 Transport

1B2a4 Refining / Storage

Methane emissions from refining are calculated using IPCC Tier 1 methodology (Table 4.2.4 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories). Emissions are calculated by multiplying the amount of Crude Oil input to rafinery by the emission factor. The emission factor value used was 1,150 kg/PJ.

The IPCC method does not give any EF for CO_2 or N_2O. Consequently, the notation key NE is used in CRF.

1B2a5 Distribution of oil products

The IPCC method does not give any EF for CO_2, CH_4 or N_2O – notation key – NE.

1B2a6 Other

Activity data: notation key: NO; CH_4 and CO_2 emissions – notation key NO.

1B2b Natural Gas

Leakages 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 leakages also have an economic impact both for the distribution company and for the end user, so this aspect is carefully monitored and, as soon as possible, immediately remedied. As a whole, the gas distribution in the CR is at a high technical level and it can be stated that all leakages 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 industry system (Alfeld, 1998). 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 general, it can be stated that the determined methane emissions in category *1B2 Gas* 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.

1B2b1 Exploration

Exploration is not performed in the Czech Republic and thus the notation key NO is used in the CRF Report for the emissions and activity data.

1B2b2 Production
1B2b3 Transmission
1B2b4 Distribution
1B2b5 Other Leakage – 1B2b51 storage of Natural Gas

Fugitive methane emissions are calculated in these subcategories using an internal calculation model based on the methodology proposed in 1997 in IGU (Alfeld, 1998). Calculations of emissions are supplemented by data from the national Integrated Pollution Register (IPR) and investigations at individual distribution companies on registered units of Natural Gas.

Table 3.31 Model calculation of CH_4 emissions in the Natural Gas sector (2008)

	EF		Activity data		emission
	value	units	Value	units	mil.m^3/year
production	0.20	% vol.	197.4	mil. m^3	0.395
high pressure pipelines	600	m^3/km.year	16 704	km	10.023
compressors	operational economic statistics of RWE TRANSGAS				3.706
storage	0.075	% vol.	2 745	mil. m^3	2.058
regulation stations	1 000	m^3/station	4 679	pcs	4.679
distribution network	300	m^3/km.year	59 089	km	17.727
final consumption	2	m^3/consumer	2 859 703	pcs	5.719
Total					**44.307**
	Emissions in Gg (0.67 kg/m^3)				**29 686**

Emissions calculated in this model are then transformed to the structure of the sectors and subsectors according to the IPCC methodology. The resultant data are given in Table 3.32.

Table 3.32 Calculation of CH4 emissions from Oil in 2008 in structure IPCC

Category	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/Processing		*PJ gas produced*	*kg CH_4/PJ*		
(domestic production NG)	3	6.72	39 354	264 505	0.265
Transmission and Distribution		*PJ gas transported*	*kg CH_4/PJ*		
(transit transport and high pree pipeline)	2	1 241.2	7 411	9 198 480	9.20
Distribution		*PJ gas distribeted*	*kg CH_4/PJ*		
(low pressure pipeline)		148.0	127 332	18 843 804	18.84
Other Leakage		*PJ gas stored*	*kg CH_4/PJ*		
(underground storage)	3	93.45	14 758	1 379 111	1.38
				TOTAL CH_4 from Gas	**29.69**

3.4.2.3 Uncertainty and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2008.

Uncertainties in determining the activity data are estimated at 5 %. This estimate is based on the precision of measurement of the volumes of Crude Oil, Crude Oil products and Natural Gas.

Uncertainties in calculating methane emissions further follow from the emission factors employed. The emission factors for determining emissions in extraction of Natural Gas and Crude Oil are based on specific measurements, accompanied by an error of approx. 10 %. Emission factors used to determine emissions in transport and distribution of Natural Gas are based on isolated measurements and estimates by experts in the gas industry. The uncertainty in these emission factors is considered to be at the level of 25 %. Determination of gas leaks in technical operations, starting-up of compressors and accidents, as appropriate, are evaluated on the basis of calculations with knowledge of the necessary technical parameters, such as the gas pressure, pipeline volume, etc. The uncertainties then correspond to knowledge of these technical parameters – 10 %. The other emission factors were taken from the IPCC methodology as default values, considered to have an uncertainty of 80 % in this methodology. Overall, the uncertainty in the emission factors in category 1B2 Oil and Natural Gas is estimated to equal 30 %.

Consistency of the time series is apparent from the graph in Figure 3.10. The fluctuations in total emissions in the individual years is caused by climatic fluctuations and the simultaneous action of factors of growth in consumption of both media and gradual improvement in the technical level of technical and technological means in the Crude Oil and Natural Gas industry.

3.4.2.4 Source specific QA/QC and verification

General quality control and source-specific quality control (Tier 1 and Tier 2), in conformance with the requirements of the QSE handbook and its associated applicable documents, have been performed to the full extent. performed to the full extent

QC activities at the level of Tier 1 were performed according to the QA/QC plan by the sectoral director. Routine control was performed in the framework of the following activities:

- activity data employed,
- emission factors employed,
- calculation procedures employed,
- transfer of numerical data from the working set to the CRF Reporter.

In control of the activity data, the CSO data were compared with the data from the Mining Yearbook (Mining Yearbook, 2009) and with data obtained by an investigation at the individual gas distribution companies. Good agreement was found.

In control of the emission factors employed, the emission factors used in the Czech Republic methodology were compared with the emission factors of Slovakia, Poland and Germany in the context with the default emission factors. It was found that the emission factors employed for calculation of emissions in the Czech Republic methodology correspond, in their range, to the emission factors employed in the other countries. Comparison of the emission factors used in the Czech Republic with the emission factors of the surrounding countries corresponds to the level of Tier 2.

Control of the transfer of numerical data from the working set to the CRF Reporter did not reveal any differences..

The final working set in EXCEL format was locked to prevent intentional rewriting of values and archived at the coordination workplace.

The protocols on the performed QA/QC procedures are stored in the archive of the sectoral director.

3.4.2.5 Source-specific recalculations

No recalculations were performed.

3.4.2.6 Source-specific planned improvements

Utilization of the Improved Methodology for determination of methane emissions in the gas industry in the Czech Republic to refine fugitive methane emissions in sector 1B2b – Natural Gas.

Specific attention will be paid to uncertainty determination and assessment.

4. Industrial Processes (CRF Sector 2)

This category includes 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 1A2f). However, the situation in iron and steel production is more complicated. Evaluation of the CO_2 emissions is based on consumption of metallurgical coke in blast furnaces, where coke is used dominantly as a reducing agent (iron is reduced from iron ores), even though the resulting blast furnace gas is also used for energy production, mainly in metallurgical plants. It should also be borne in mind that emissions occurring during petroleum refining belong in categories 1A1b or 1B2 (fugitive emissions).

4.1 Overview of sector

Basic information on emissions of greenhouse gases and the main sectors is given in Chapter 2. More specific information can be found at the beginning of each subsequent chapter or in the publication (Cenia, 2008).

Direct greenhouse gases in this sector consist mainly of CO_2 emissions in the production of iron and steel and mineral products (cement, lime, glass and ceramic production, limestone and dolomite use). N_2O emissions, which come from chemical industry (nitric acid production) and F-gas emissions and consumption are less important gases. Iron and steel, Cement production, F-gases Use, Limestone and Dolomite Use, Lime production and Nitric acid production can be considered to be *key categories* (KC) according to IPCC *good practice* (IPCC, 2000, IPCC, 2003). Tab. 4.1 gives a summary of the main sources of direct greenhouse gases in this sector (not only KC), shows share of national emissions in 2008 and lists type of key category analysis, which identified as a key source.

Tab. 4.1 Overview of significant sources in sector Industrial processes (2008)

Category	Character of category	Gas	% of total GHG*
2C1 Iron and steel	KC (LA, TA, LA*, TA*)	CO_2	5.3
2A1 Cement production	KC (LA, LA*)	CO_2	1.4
2F1-6 F-gases Use - ODS substitutes	KC (LA, TA, LA*, TA*)	HFCs, PFCs	0.9
2A3 Limestone and Dolomite Use	KC (LA, TA, LA*, TA*)	CO_2	0.7
2A2 Lime production	KC (LA, LA*)	CO_2	0.5
2B2 Nitric acid production	KC (LA, LA*)	N_2O	0.5
2B1 NH_3 production	non-KC	CO_2	0.4

* assessed without considering LULUCF

KC: key category, LA, LA*: identified by level assessment with and without considering LULUCF, respectively

TA, TA*: identified by trend assessment with and without considering LULUCF, respectively

4.2 Mineral Products (2A)

This category describes GHG emissions from the non-fuel emissions from cement and lime production, limestone and dolomite use, glass and ceramics production.

4.2.1 *Cement production (2A1)*

CO_2 emissions from cement production have decreased since 1990 having the lowest value in 2002. The decrease in the emissions during 1990's was caused by the transition from planed economy to

market economy. This led to decrease in industrial production and also emissions. Since 2003, the cement production began to recover and production increased. Decrease in emissions in 2008 was caused by the economic crisis and related construction constraints.

4.2.1.1 Source category description

Cement production is one of the traditional anthropogenic sources of carbon dioxide included in inventories; however, its importance is incomparably smaller than the total 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 1 300 °C. During this process, calcium carbonate is converted into lime (CaO - calcium oxide) and carbon dioxide. CO_2 emissions from combustion processes taking place in the cement industry (especially heating of rotary kilns) have been reported in IPCC category 1A2f. Limestone (and dolomite) contains also small amount of magnesium carbonate ($MgCO_3$) and fossil carbon (C), which will also calcinate or oxidize in the process causing CO_2 emissions.

4.2.1.2 Methodological Issues

CO_2 emissions from *2A1 Cement production* can be calculated according to the 2000 GPG from the production of cement (Tier 1) or clinker (Tier 2). New IPCC Guidelines (IPCC, 2006) describes a new approach based on direct data from individual operators of cement kilns (Tier 3). Since 2006 submission methodology equal to the Tier 3 has been employed. CO_2 emissions are based on data submitted by the cement kiln operators for preparation and standard operation of the EU ETS system, which includes all the cement kilns in Czech Republic. Information from individual kilns is reported to the competent authority. This data covers years 1990, 1996, 1998 - 2002 and 2005 - 2008. For other years the EF was extrapolated.

All operating cement plants in the Czech Republic are equipped with dust control technology and the dust is then recycled to the kiln. Only in one cement plant is a small part of the CKD discarded, for technical reasons. Use of dolomite or amount of magnesium carbonate in the raw material, as well as fissile carbon (C) content is known, all above mentioned variables are used for emissions estimates in the EU ETS system. For reasons of confidentiality, it is not possible to make public available all above mentioned data, but only emission estimates.

Data on cement clinker production is published by the Czech Cement Association (CCA) (CCA, 2009), which associates all Czech cement producers. Clinker production data together with extrapolated EF was used for years without direct data from cement kiln operators. IEF, which is calculated based on CO_2 emissions and clinker production, varies from 0.5267 to 0.5534 t CO_2 / t clinker.

4.2.1.3 Uncertainty and time consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment (see Tab. 1.3 in Chapter 1.7).

Time series consistency is ensured as the above mentioned methodology are employed identically across the whole reporting period from the base year 1990 to 2008.

4.2.1.4 Source-specific QA/QC and verification

General QA/QC procedures and various source specific approaches are used for QA/QC:

- Inter-annual changes of IEF are analyzed.
- The EU ETS emissions reports from individual installations are verified by independent verifiers.
- Total emissions generated as the sum of emissions from non-combustion processes reported by individual cement kiln operators to the competent authority are compared with the data provided by the Czech Cement Association. Discrepancies are discussed.

4.2.1.5 Source-specific recalculations

No recalculations are applicable for this year.

4.2.1.6 Source-specific planned improvements

It is planed to process all available information about uncertainty form the EU ETS and provide category and national specific uncertainty assessment.

4.2.2 *Lime production (2A2)*

CO_2 emissions from lime production have decreased considerably since 1990 having the lowest value in 2008 (742 Gg CO_2). The decrease in the emissions between 1990 and 1991 was caused by the transition from planed economy to market economy, closure of lime kilns together with decrease of industrial production. Since then, the lime production slightly vary about 1 100 kt/year.

4.2.2.1 Source category description

CO_2 in this category is emitted during the calcination step. Calcium carbonate ($CaCO_3$) in limestone and calcium / magnesium carbonates in dolomite rock ($CaCO_3$•$MgCO_3$) are decomposed to CO_2 and quicklime (CaO) or dolomite quicklime (CaO•MgO), respectively.

4.2.2.2 Methodological Issues

Emissions from lime production were calculated in accordance with 2000 GPG. Only CO_2 emissions generated in the process of the calcination step of lime treatment are considered under category 2A2. CO_2 emissions from combustion processes (heating of kilns and furnaces) are reported under category 1A2f. National EF reflects the production of lime and quick lime (0.7884 t CO_2 / t lime) (Vácha, 2004). Furthermore, it is taken into account the average purity (93%) (Vácha, 2004) of lime produced in Czech Republic.

Activity data are based on statistics from the Czech Lime Association (CLA, 2009), 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.

Tab. 4.2 shows comparison of CO_2 emissions calculated according to IPCC methodology and process-related emissions reported for EU ETS. ETS data closely corresponds to the IPCC methodology and national circumstances.

Tab. 4.2 Comparison of CO_2 emissions from lime production 2005 - 2008

	Lime produced *[t / year]*	Process-specific CO_2 emissions *[Gg]*	
		IPCC methodology	EU ETS
2005	1 040	763	738
2006	1 034	758	748
2007	1 083	794	772
2008	1 012	742	717

4.2.2.3 Uncertainty and time consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment (see Tab. 1.3 in Chapter 1.7).

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2008.

4.2.2.4 Source-specific QA/QC and verification

General QA/QC procedures and various source specific approaches are used for QA/QC:

- The EU ETS emissions reports from individual installations are verified by independent verifiers.
- Emission estimates are compared with the sum of emissions from non-combustion processes reported by individual lime kiln operators to the competent authority and with the data

provided by the Czech Lime Association. Discrepancy was discussed and preliminary result shows that the value of average purity is probably slightly above-estimated.

4.2.2.5 Source-specific recalculations

No recalculations are applicable for this year.

4.2.2.6 Source-specific planned improvements

It is planed to process all available information about uncertainty form the EU ETS and provide category and national specific uncertainty assessment.

4.2.3 *Limestone and Dolomite Use (2A3)*

Category *2A3 Limestone and Dolomite Use* include emissions from sulphur removal with limestone and emissions from limestone and dolomite use in sintering plants. Emissions from sulphur removal have increased since 1996, when the first sulphur-removal unit came into operation. All Czech thermal power plants are equipped with sulphur-removal units since 1999. Since 1999 this emissions varied among 0.5 to 0.6 Mt CO_2 according to electricity production from thermal (brown coal) power plant. Emission from limestone and dolomite use in sintering plants have fluctuated and was influenced by the transition from planed economy to market economy, restructuring and modernization of the iron and steel industry.

4.2.3.1 Source category description

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. Limestone and dolomite are added to sinter where they are calcined, the products subsequently acting as slag formers in blast furnaces.

4.2.3.2 Methodological Issues

CO_2 emissions from sulphur removal were calculated from coal consumption for electricity production, sulphur content and the effectiveness of sulphur removal units between 1996, when the first sulphur removal units came into operation, and 2005. In 2005, these data were verified with data from individual power plants, which were collected for EU ETS preparation and which cover the years 1999 – 2005. Data form EU ETS has been used since 2006. Fig. 4.1 shows comparison of both methodologies. Tab. 4.3 lists data for this category.

Emissions from limestone and dolomite use in sintering plants were new source, in 2006 submission, which was 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 (The Steel Federation, Inc - 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 (0.08 t CO_2 / t sinter). Tab 4.3 lists data for this category.

In the CRF tables emissions and activity data for sulphur removal with limestone and emissions from limestone and dolomite use in sintering plants are reported together in the category 2A3 Limestone and Dolomite Use.

Tab. 4.3 CO_2 emissions from Limestone and Dolomite Use in desulphurization unit, sinter plant, in 1990 – 2008 [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
2005	589	467
2006	587	483
2007	614	492
2008	607	411

4.2.3.3 Uncertainty and time consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment (see Tab. 1.3 in Chapter 1.7).

Time series consistency is ensured for the limestone and dolomite use in sintering plants as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2008. Time series for sulphur removal with limestone is not fully consistent as the methodology was changed. The Figure 4.1 shows differences between estimates based on coal consumption for electricity production, sulphur content and the effectiveness of sulphur removal and estimates provided for EU ETS.

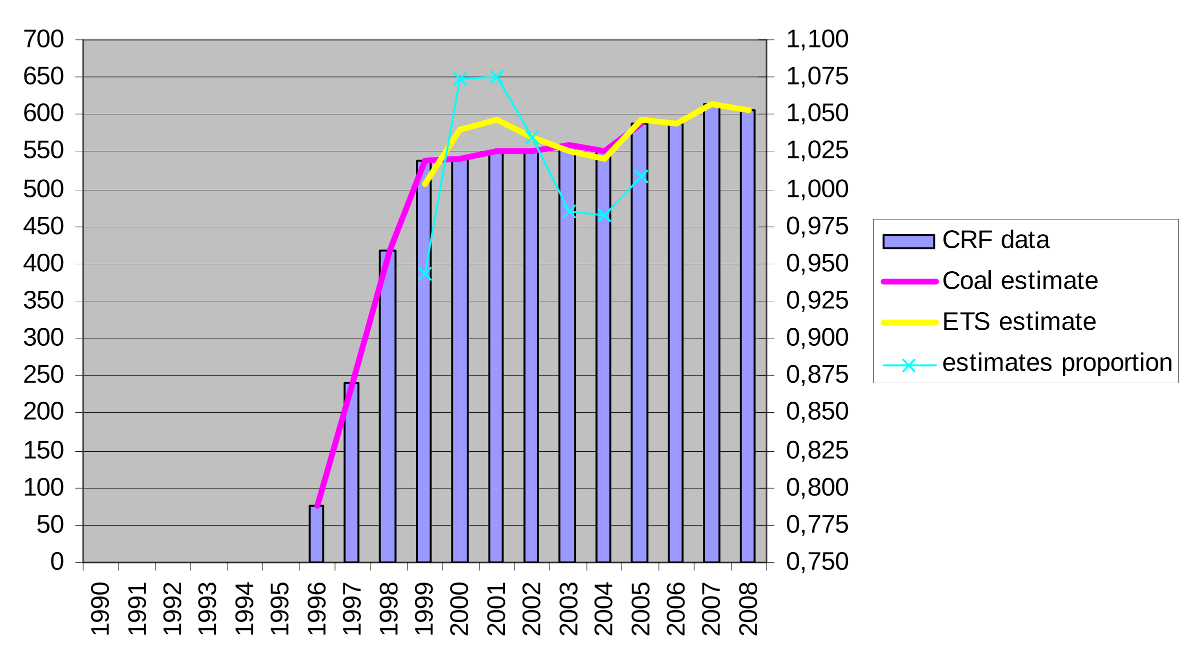


Fig. 4.1 Emission estimates comparison for Limestone and Dolomite Use in desulphurization unit, in 1990 – 2008 [Gg]

4.2.3.4 Source-specific QA/QC and verification

In the limestone and dolomite use category general QA/QC procedures are used.

4.2.3.5 Source-specific recalculations

No recalculations are applicable for this year.

4.2.3.6 Source-specific planned improvements

It is planed to process all available information about uncertainty form the EU ETS and provide category and national specific uncertainty assessment.

4.2.4 *Other (2A7)*

The *2A7 Other* category summarizes emissions from *Glass Production (2A7.1 – CO_2)* and from *Brick and Ceramics Production (2A7.2 – CO_2 and CH_4)*. CO_2 emissions from *2A7.1 Glass production* equaled 213 Gg in 2008. Emissions from *Brick and Ceramics Production (2A7.2)* accounted 154 kt CO_2 eq. in 2008.

4.2.4.1 Source category description

CO_2 emissions from *Glass Production (2A7.1)* are derived particularly from the decomposition of alkaline carbonates added to glass-making sand. CO_2 and CH_4 emissions from Brick and Ceramics Production, are derived particularly from the decomposition of alkaline carbonates, fossil and biogenic carbon based substances included in the raw materials.

4.2.4.2 Methodological Issues

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). Activity data are collected and published by the Association of the Glass and Ceramic Industry of the Czech Republic.

Emissions from *2A7.2 Brick and Ceramics Production* are derived particularly from the decomposition of alkaline carbonates fossil and biogenic carbon based substances 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 (fine ceramics, tiles, roofing tiles, and bricks) and the EF value.

4.2.4.3 Uncertainty and time consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment (see Tab. 1.3 in Chapter 1).

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2008.

4.2.4.4 Source-specific QA/QC and verification

In the 2A7 Other category general QA/QC procedures are used.

4.2.4.5 Source-specific recalculations

No recalculations are applicable for this year.

4.2.4.6 Source-specific planned improvements

It is planned to process all the available information about uncertainty from the EU ETS and to provide category and national specific uncertainty assessments. Also it is planned to verify emission estimates with data from the EU ETS system and other available sources.

4.3 Chemical Industry (2B)

4.3.1 *Source category description*

This category includes mainly CO_2 emissions from *2B1 Ammonia Production* and N_2O emissions from *2B2 Nitric Acid Production*. Besides, limited N_2O is also emitted from caprolactam production and a small amount of CH_4 is emitted from 2B5 (other), mainly from production of ethylene and styrene. Only N_2O emissions from *2B2 Nitric Acid Production* are identified in this category as a key source (level assessment).

4.3.2 *Methodological Issues*

CO_2 emissions from *2B1 Ammonia Production* (including hydrogen production by steam gasification followed by the shift reaction) are reported in the Industrial processes category.

Emissions are calculated from the corresponding amount of ammonia produced, using the technologically-specific emission factor 2.40 Gg CO_2 / Gg NH_3 (Markvart and Bernauer, 2005, 2006). This emission factor was derived from the relevant technical literature - *Ullman's Encyclopedia* (Wiley, 2005). A potential uncertainty in the emission factor for ammonia would not influence the total sum of CO_2 emissions because a corresponding amount of residual oil (masout) is not considered in the energy sector. The relevant activity data and corresponding emissions are given in Tab. 4.4.

Tab. 4.4 Activity data and CO_2 emissions from ammonia production in 1990 – 2008

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 2B1, *[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	2005
Residual fuel oil used for NH_3 product., *[TJ]*	10 407	8 864	10 144	8 538	7 449	9 696	9721	8478
Ammonia produced, *[kt]*	314.5	267.9	306.6	258.0	225.1	293.0	290.8	253.6
CO_2 from 2B1, *[Gg]*	755.5	643.6	736.5	619.9	540.8	703.9	698.7	609.3
Year	2006	2007	2008					
Residual fuel oil used for NH_3 product., [TJ]	8086	7575	8487					
Ammonia produced, [kt]	241.9	226.6	256.5					
CO_2 from 2B1, [Gg]	581.1	544.4	616.3					

Nitrous oxide emissions from *2B2 Nitric Acid Production* are 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. 4.5. 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. 4.5 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 give the value of N_2O emissions from the production of caprolactam: 0.27 Gg N_2O per annum. However, this amount is small compared with other sources. A recent study (Markvart and Bernauer, 2007) reports a small increase in this value to 0.305 Gg N_2O per annum since 2006. 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 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. 4.6 Emission factors for N_2O recommended by Markvart and Bernauer, for 2004 and thereafter

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	1.09	7.8 [a)]

[a)] EF without N_2O mitigation. Cases of N_2O mitigation in 2005 -2008 are shown in Tab. 4.7

In submissions 2006, 2007, 2008 and 2009, the technology-specific EF for conditions: 0.4 MPa, NSCR was considered as 2.72 kg N2O / t HNO3 (100 %). This value presented in the study (Markvart and Bernauer, 2005) was considered on the not fully representative set of data. New and more comprehensive set data, see (Markvart and Bernauer, 2009) revealed, that original value EF = 1.09 kg N2O / t HNO3 (100 %), which is presented in Tab. 4.5 and 4.6 is suitable for this technology for the whole period 1990 - 2008.

In the last quarter of 2005, a new N_2O mitigation unit based on catalytic decomposition of N_2O was experimentally installed for 0.7 MPa technology, which became the most important in the Czech Republic. As a consequence of this technology, the relevant EF decreased from 7.8 to 4.68 kg N_2O/t HNO_3 (100 %). Therefore, the mean value in 2005 for the 0.7 MPa technology was equal to 7.02 kg N_2O/t HNO_3 (100 %), (Markvart and Bernauer, 2006)

In 2006 - 2009, the mitigation unit described above was utilized in a more effective way, see (Markvart and Bernauer, 2007 - 2009). The decrease in the emission factor for 0.7 MPa technology as a result of installation of the N_2O mitigation unit and gradual improvement of the effectiveness is given in Tab. 4.7.

Tab. 4.7 Decrease in the emission factor for 0.7 MPa technology due to installation of the N_2O mitigation unit

Year	2004 [a)]	2005	2006	2007	2008
EF, kg N_2O / t HNO_3 (100 %)	7.8	7.02	5.94	4.37	4.82
Effectiveness of mitigation, %	-	10	23.9	43.9	38.2

[a)] EF without N_2O mitigation.

The emission factors used in the Czech Republic are compared with the EFs presented in the IPCC methodology (IPCC, 2000) in the Tab. 4.8.

Tab. 4.9 gives the N_2O emissions from production of nitric acid, including the production values. This table also gives the newly recalculated values for 2004 - 2007 (as explained above), together with the original values (in parenthesis).

Tab. 4.8 Comparison of emission factors for N_2O from HNO_3 production

Production process	N_2O Emission factor (kg N_2O/t 100% HNO_3)	Reference
Canada		(IPCC, 2000)
Plants without NSCR	8.5	
Plants with NSCR	<2	
USA		(IPCC, 2000)
Plants without NSCR	9.5	
Plants with NSCR	2	
Norway		(IPCC, 2000)
Process-integrated N_2O destruction	<2	
Atmospheric pressure plant	4–5	
Medium pressure plant	6–7.5	
Other countries		(IPCC, 2000)
Dual-pressure plant (European design)	8–10	
Older plants (pre-1975), without NSCR	10–19	
Czech Republic		(Markvart and Bernauer, 2009)
Atmospheric pressure plants	9.05	
Medium pressure plants with SCR	4.9	
Medium pressure plants with NSCR	1.09	
High pressure plants SCR (no N_2O decomposition)	7.8	
High pressure plants SCR (with N_2O decomposition)	4.82	

Tab. 4.9 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	3.27[a)] (3.46)
2005	532.2	3.09[a)] (3.26)
2006	543.1	2.76[a)] (2.95)
2007	554.2	2. 28[a)] (2.49)
2008	507.0	2.14

[a)] newly recalculated values

Estimation of CH_4 from the chemical industry (category 2B5) is based on the Tier 1 approach (IPCC, 1997). In order to improve the completeness, a detailed inquiry was performed to supplement the list

of chemicals in category 2B5. In this way, the actual production data and corresponding methane emissions were obtained for carbon black, styrene and dichlorethylene (so far reported as “NE”), but only for 2008. Data are not available for the previous years. It was confirmed that no methanol production is in operation (reported as “NO”). CH_4 emissions from ethylene production are traditionally reported for the whole 1990 - 2008 period and lie in the interval 0.3 - 0.5 Gg.

In 2008, sector *2B Chemical Industry* emitted 1.13 Gg of methane, mainly from ethylene (0.46 Gg) and styrene (0.60 Gg) production. This contribution (1.13 Gg in 2008) is not very important.

Emission estimates of precursors for the relevant subcategories have been transferred from NFR to CRF, as described in the previous chapters.

4.3.3 *Uncertainty and time consistency*

All uncertainty estimates for the activity data and emission factors have so far been based on expert judgment (see Tab 1.3 in Chapter 1). Their improvement is ongoing and some uncertainty values for HNO_3 production have been revised and used in this submission: uncertainty in activity data was lowered from 10% to 5% and uncertainty of the mean N_2O EF was lowered from 25% to 20%.

Time series consistency is ensured as these inventory approaches are employed identically across the whole reporting period from the base year of 1990 to 2008. Only CH_4 emissions from carbon black, ethylene and styrene are reported solely for 2008.

4.3.4 *QA/QC and verification*

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. CO_2 emissions from residual oil used for ammonia production are not considered in Energy sector.

According to the QA/QC plan, data and calculations provided by the external consultants (M. Markvart and B. Bernauer) are checked by the experts from CHMI and vice versa.

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

4.3.5 *Recalculations*

One recalculation in the 2004 - 2007 period was performed for N_2O emissions from HNO_3 production. Estimation of these emissions in the Czech Republic is based on the use of technology-specific emission factors taking into consideration the process conditions in Czech plants. The emission factors respect the three pressure levels employed (0.1, 0.4 and 0.7 MPa) and the relevant use of NOx and/or N_2O abatement technologies: selective catalytic reduction (SCR) of NOx, non-selective catalytic reduction (NSCR) of NOx, which also reduces emissions of N_2O, and recently-introduced N_2O mitigation based on catalytic N_2O decomposition for 0.7 MPa technology.

For 0.4 MPa technology in combination with NSCR, the emission factor 1.09 kg N_2O/t HNO_3 was used for 1990 – 2003 while, from 2004, this EF was increased to 2.72 kg N_2O/t HNO_3. However, new plant measurements revealed that the original EF of 1.09 kg N_2O/t HNO_3 is also suitable for the years after 2003.

Consequently, in the recalculation, the value EF = 1.09 kg N_2O/t HNO_3 was used for the whole time period since 1990 for the 0.4 MPa technology combined with NSCR. This recalculation improves the quality of the inventory in accordance with good practice and improves the time series consistency. The approaches used for the other technologies mentioned above remain unchanged.

4.3.6 *Source-specific planned improvements*

It is planed to continue improvement of the uncertainty data.

4.4 Metal Production (2C)

4.4.1 *Source category description*

This category includes mainly CO_2 emissions from *2C1 Iron and Steel Production*. Besides, small amount of CH_4 is emitted too. CO_2 emissions from iron and steel are identified as a key category. CO_2 emissions from the process of iron and steel production were originally reported in the energy category *1A2 Manufacturing Industries and Construction* together with energy related emissions from iron and steel. In the 2004 inventory submitted in 2006, these emissions were re-classified according to Good Practice (IPCC, 2000) as emissions from Industrial processes, 2C1. In this way, the relevant rearrangements have been applied to the whole data series.

Ferro-alloys are manufactured to a limited degree in the Czech Republic; this process can constitute an unsubstantial source of CO_2 emissions. Unfortunately, CSO does not monitor any data on this production process. Investigation revealed one smaller production plant, which reports that aluminium is used as a reducing agent; this does not lead to CO_2 emissions.

4.4.2 *Methodological Issues*

CO_2 emissions were determined for category 2C1 using a procedure corresponding to Tier 1 of the *Good Practice Guidance* for 2C1. This calculation was based on the amount of coke consumed in blast furnaces. The calculation was carried out using NCV = 28.51 MJ/kg in 2008 (NCV interval for period 1990 - 2008 is (27.8 - 28.8 MJ/kg) and using the carbon emission factor for coke, 29.5 t C / TJ, which is the IPCC *default* value (IPCC, 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. 4.10.

Tab. 4.10 Activity data and CO_2 emissions from iron and steel in 1990 - 2008

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 2C1, *[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**	**2005**
Coke consumed in blast furnaces, *[kt]*	2 483	1 964	2 321	2 174	2 270	2 499	2 851	2 466
CO_2 from 2C1, *[Gg]*	7 555	5 996	7 086	6 612	6 882	7 576	8 491	7 318
Year	**2006**	**2007**	**2008**					
Coke consumed in blast furnaces, *[kt]*	2 829	2 724	2 456					
CO_2 from 2C1, *[Gg]*	8 425	8 030	7423					

Estimation of CH_4 from metal production is based on the CORINAIR methodology. Metal production emits only 2.5 – 6.0 Gg of methane.

Emissions of methane in 2008 equaled 3.2 Gg, of which 1.7 Gg corresponds to the contribution of methane emissions from coke production. In this case, the relevant activity data correspond to the amount of coke produced from the Energy Balances of the CR are given in CRF Tables. In contrast, the activity data used for calculation of CO_2 emissions, which are given in Tab. 4., correspond to the amount of coke consumed in blast furnaces. These data were determined from the CSO material “Energy intensity of manufacture of selected products". It should be pointed out that these two series are not completely identical (e.g. part of the coke produced is used for other purposes and imported coke can also be used in blast furnaces).

Emission estimates of precursors for the relevant subcategories have been transferred from NFR to CRF, as described in previous chapters.

4.4.3 *Uncertainty and time consistency*

The uncertainty estimates were based on expert judgment (see Table 1.3 in Chapter 1). Their improvement is ongoing and is planned for inclusion in the next NIR.

Consistency of the time series is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year of 1990 to 2008.

4.4.4 *QA/QC and verification*

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. CO_2 emissions from coke used in blast furnaces are not considered in Energy sector.

Activity data available in the official CSO materials in relation to QA/QC were independently determined by experts from CHMI and KONEKO and were mutually compared. Experts at CHMI additionally checked most of the calculations carried out by experts at KONEKO and vice versa.

4.4.5 *Recalculations*

No recalculations were employed in this submission.

4.4.6 *Source-specific planned improvements*

It is planned to implement uncertainty assessment. Moreover, application of more advanced Tier 2 methodology for Iron and steel production is planned in the future. At the present time, options are being explored for obtaining the relevant data for this purpose.

4.5 Other Production (2D)

In this sector are reported only indirect GHGs and SO_2 from sectors Pulp and Paper; Food and Drink.

4.6 Production of Halocarbons and SF_6 (2E)

Halocarbons and SF_6 are not produced in Czech Republic.

4.7 Consumption of Halocarbons and SF_6 (2F)

4.7.1 *Source Category Description*

Emissions of F-gases (HFCs, PFCs, SF_6) 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 (CFCs, HCFCs, etc.) that could lead to by-product F-gases emissions and there is no aluminum and magnesium industry in the Czech Republic. F-gases emission in 2008 dropped compared to 2007 as result of finance crisis and lower production in air-conditioning, refrigeration and car industry.

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. SF_6 used in special applications (laboratory),
4. HFCs, PFCs and SF_6 used in semiconductor manufacturing,
5. HFCs and PFCs used as refrigerants in refrigeration and air conditioning equipment,
6. HFCs used as propellants in aerosols,
7. HFCs used as blowing agents,
8. HFCs used as extinguishing agents in fixed fire fighting systems.

No official statistics that would allow easy disaggregated reporting and / or use of the highest tiers are currently available in the Czech Republic. All the data are collected based on voluntary cooperation between sectoral experts and private companies.

For source consumption of F-gases, potential emissions increased from 169.4 Gg $CO_{2\ eq.}$ in 1995 to 3 177.0 Gg $CO_{2\ eq.}$ in 2008. This significant increase could be explained mainly due to a substantial increase in the use of HFCs. For the source consumption of F-gases, actual emissions increased from 76.1 Gg $CO_{2\ eq.}$ in 1995 to 1 337.0 Gg $CO_{2\ eq.}$ in 2008. This significant increase could be explained mainly due to a substantial increase in the use of HFCs in refrigeration. The marked sharp decrease between 2007 and 2008 is due to a production decrease as a result of financial crisis. Detailed information about actual and potential emissions is given in Table 4.11 and CRF Tables.

Tab. 4.11 HFCs, PFCs and SF_6 potential and actual emissions in 1995 - 2008 ***[Gg $CO_{2\ eq.}$]***

	Potential				Actual			
	HFCs	PFCs	SF6	Total	HFCs	PFCs	SF6	Total
1995	2.21	0.35	166.82	169.38	0.73	0.12	75.20	76.06
1996	134.51	4.22	183.07	321.80	101.31	4.11	77.52	182.94
1997	479.44	1.17	180.49	661.10	244.81	0.89	95.48	341.18
1998	577.87	1.17	126.02	705.07	316.56	0.89	64.19	381.63
1999	411.87	2.74	110.90	525.50	267.47	2.55	76.98	347.01
2000	674.32	9.45	206.02	889.79	262.50	8.81	141.92	413.23
2001	1 045.13	14.49	223.23	1 282.84	393.37	12.35	168.73	574.45
2002	1 092.41	17.91	211.85	1 322.17	391.29	13.72	67.72	472.73
2003	1 343.94	28.64	339.26	1 711.84	590.14	24.53	101.25	715.93
2004	1 215.00	20.98	208.00	1 443.98	600.30	17.33	51.89	669.51
2005	1 280.55	13.77	156.88	1 451.20	594.21	10.08	85.88	690.17
2006	2 573.99	30.33	161.90	2 766.21	872.35	22.56	83.07	977.98
2007	3 884.78	27.57	133.84	4 046.18	1 605.85	20.16	75.85	1 701.86
2008	3 053.38	38.25	85.32	3 176.95	1 262.45	27.48	47.04	1 336.98

4.7.2 *General Methodological Issues*

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* (IPCC, 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 obtain information from the customs statistics and from individual importers and exporters, about (a) the imported and exported amounts and (b) kinds of substances (or their mixtures), (c) the amounts and types of disposed F-gases and also (d) the areas of usage; consequently, all importers and exporters are additionally requested to complete a specific questionnaire on export and import of F-gases and to support the questionnaire by additional information on the quantity, composition and use. The most important importers and exporters also report the imported and/or exported type of F-gases and amounts directly to MoE. This is the third source of data, which is used only for control of potential emissions and partly for sectoral split. 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.

4.7.3 *Sector-Specific Methodological Issues*

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. Detailed information on the data and methodology used are included in a special report prepared by the external partner Mr. Řeháček in 2009 (Řeháček, 2009).

The most important category in view of actual emissions is Refrigeration and Air Conditioning Equipment, which is responsible for 84.3 % of actual F-gases emissions.

4.7.3.1 Refrigeration and Air Conditioning Equipment

In the CRF Tables, emissions from this category are divided into only two sub-categories: *2IIAF11 Domestic Refrigeration* and *2IIAF16 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 three Czechs car factories 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. This fact is also endorsed by the information on disposed refrigerants (Řeháček, 2009). The contribution of this sector to the total actual F-gases emissions was 1.8 % in 2008. It can be anticipated that emissions from this category will increase in the future.

Emissions from *Domestic Refrigeration* include emissions from servicing old equipment and emissions from production new air-conditioning equipment since 2007. 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 (Řeháček and Michálek, 2008). This sector has the highest share on the total actual emissions of F-gases, which equaled 82.5 % in 2008.

4.7.3.2 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 and HFC-245ca were 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 contribution of foam blowing and production of sound-proof windows to total emissions of F-gases equaled 0.3 and 0.6 %, respectively, in 2008.

4.7.3.3 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 2.2 % in 2008.

4.7.3.4 Aerosols / Metered Dose Inhalers and Solvents

Emissions from these categories (*2F4 Aerosols / Metered Dose Inhalers* and *2F5 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 equaled 6.3 and 0.3 %, respectively, in 2008.

4.7.3.5 Semiconductor Manufacture

Actual emissions from this category are calculated on the basis of Tier 1 methodology. Emissions from this category correspond to 3.6 % of the total actual 2008 emissions of F-gases. No data are available for more precise emission calculations and this category is not very important.

4.7.3.6 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 2.3 % of the total actual emissions of F-gases in 2008. 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.

4.7.3.7 Others

This category includes the *2F9 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 amount of F-gases in 2008 was not identified in this category. Potential and actual emissions are calculated in the same way in this sector.

4.7.4 *Uncertainty and time consistency*

The uncertainty estimates were based on expert judgment (see **Chyba! Nenalezen zdroj odkazů.** in Chapter 1). Their improvement 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 2008.

4.7.5 *QA/QC and verification*

Verification has been performed by comparison of data received from the customs authorities, from submitted questionnaires and from reports of important importers and/or exporters to MoE. Methodology and calculations are performed independently two times and compared. This comparison find some slight EF fault for SF_6 emissions.

4.7.6 *Recalculations*

No recalculations are applicable for this year.

4.7.7 *Source-specific planned improvements*

In the future, it is planned that data will be obtained about the lifetime of refrigeration and air-conditioning equipment. It is also planned to perform an uncertainty assessment.

In the current situation, only emissions from bulk import and export are calculated and reported; an inventory of F-gases in products is under preparation. First result were already published (Karbanová, 2008, Vacková and Vácha, 2008), but it is necessary to continue, verify data sources, methodology, results and prepare whole time-series estimates.

4.8 Acknowledgement

The authors would like to thank representatives form the Czech Ministry of the Environment, Department of Climate Change, Unit of Emission Trading for providing EU ETS data.

5. Solvent and Other Product Use (CRF Sector 3)

NMVOC emission shows a long-term decreasing trend. This is caused by 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 sources, 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.

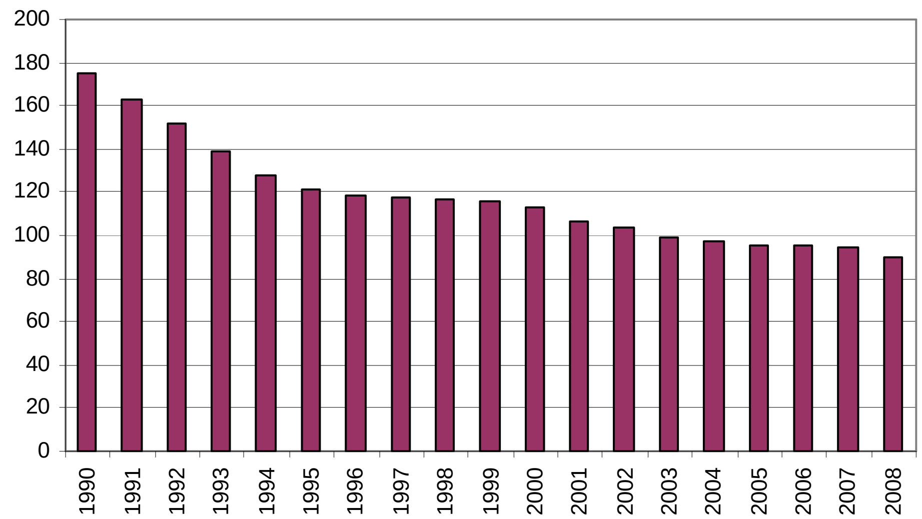


Fig. 5.1 Trend of NMVOC emissions from Solvent and Other Product Use ***[Gg NMVOC]***

5.1 Source category description

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 2008, CO_2 emissions were calculated at the level of 0.283 Mt CO_2.

This category (Solvent and Other Product Use) also includes N_2O emissions from use of this substance in the food industry (aerosol cans) and in health care (anaesthesia). These not very significant emissions corresponding to 0.75 Gg N_2O were derived from production in the Czech Republic (0.6 Gg N_2O) and from import of N_2O (0.15 Gg N_2O), see (Markvart and Bernauer B., 2009)

In the Czech Republic, no relevant data are available to distinguish between N_2O used in anaesthesia and for aerosol cans. Therefore, the existing split (50% for anaesthesia) is based only on a rough estimate.

5.2 Methodological aspects

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 2008 for this sector is based on a study prepared by SVÚOM Ltd. Prague (Geimplová and Thürner, 2009). 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 approximately 16.5 % to total NMVOC emissions.

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.

It is apparent from the Tab. 5.2 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.

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	-

5.3 Uncertainty and time consistency

The uncertainty estimates have not yet been reported. Their implementation is ongoing and is planned for inclusion in the following 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 2008.

5.4 QA/QC and verification

The emission data in this section were taken from the UNECE / CLRTAP inventories in NFR. Annual reports are available on the method of calculation for 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 were available to 2000, permitting assignment of consumption of the individual types of solvents and other preparations containing NMVOC to 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 that could not be identified in the individual subcategory *3B Decreasing and Dry Cleaning* were transferred to *Category 3D Other Solvent Use*, because they were missing in the overall balance.

5.5 Recalculations

No recalculations are applicable for this year.

5.6 Source-specific planned improvements

The value of the conversion factor (3.14) is slightly higher compared to other countries. It is planned to try to obtain background information for a country-specific value.

6. Agriculture (CRF Sector 4)

6.1 Overview of sector

Agricultural greenhouse gas emissions under Czech national conditions consist mainly of emissions from enteric fermentation (CH_4 emissions only), manure management (CH_4 and N_2O emissions) and agricultural soils (N_2O emissions only). The other IPCC subcategories – rice cultivation, prescribed burning of savannas, field burning of agricultural residues and "other" – do not occur in the Czech Republic.

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 nitrification-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.

The detailed information as data sources, used methodology, emission factors and parameters to estimate the agricultural emission inventory is presented in (Exnerova and Cienciala, 2009).

6.1.1 *Key categories*

For Agriculture, five of six relevant categories of sources were evaluated by analysis decribed in (IPCC, 2000 and IPCC 2003) as the key categories. However, categories 4B and 4D2 were identified as key categories only by trend assessment - for the first time and yielded values just over the borderline between key and non-key categories. An overview of sources, including their contribution to aggregate emissions, is given in Tab. 6.1.

Tab. 6.1 Overview of significant categories in this sector (2008)

Category		Character of category	Gas	% of total GHG*
4D1	Agricultural soils, direct emissions	KC (LA, TA, LA*, TA*)	N_2O	2.05
4A	Enteric fermentation	KC (LA, TA, LA*, TA*)	CH_4	1.71
4D3	Agricultural soils, indirect emissions	KC (LA, TA, LA*, TA*)	N_2O	1.30
4B	Manure management	KC (TA)	CH_4	0.33
4D2	Pasture, range and paddock manure	KC (TA,TA*)	N_2O	0.26
4B	Manure management	non-KC	N_2O	0.24

* assessed without considering LULUCF

KC: key category, LA, LA*: identified by level assessment with and without considering LULUCF, respectively

TA, TA*: identified by trend assessment with and without considering LULUCF, respectively

6.1.2 *Quantitative overview*

Agriculture is the third largest sector in the Czech Republic with 6.1 % of total GHG emissions (including land-use change and forestry) in 2008 (8 324 Gg $CO_{2\ eq.}$); 61.3 % of emissions is coming from Agricultural Soils, 29 % from Enteric Fermentation and 9.7 % from Manure Management.

The methane emissions from agriculture present almost 25 % of total national methane emissions, the N_2O emissions from agriculture present 70 % of total national N_2O emissions. During period 1990-2008 emissions from Agriculture decreased by almost 50 %. The quantitative overview and emission trends in reported period are provided in Tab. 6.2 and Fig.6.1.

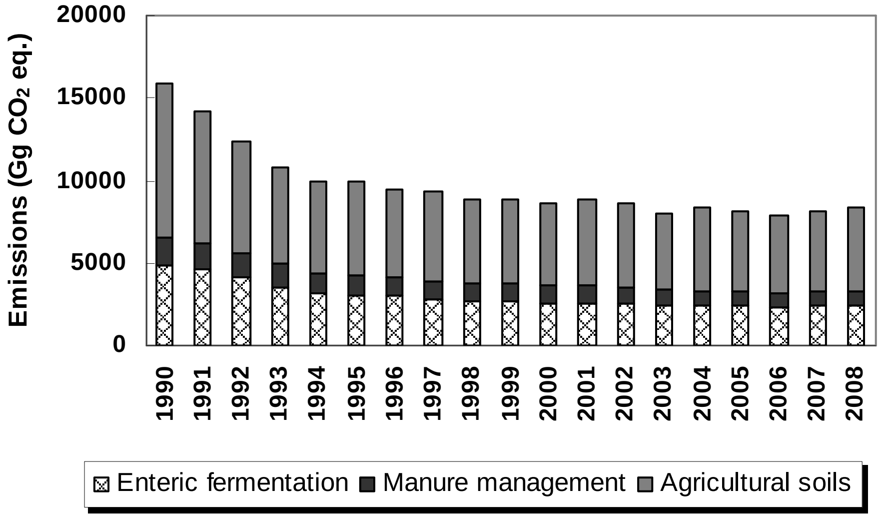


Fig. 6.1 The emission trend in agricultural sector during reporting period 1990 – 2008 (in Gg CO_2 eq.)

The trend series are 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 swine manure) is not as great, as there has been a smaller decrease in the number of head of swine. It would seem that conditions have partly stabilized somewhat in agriculture since 1994.

Tab. 6.2 Emissions of Agriculture in period 1990-2008 (sorted by categories)

Year	Total Emissions	Enteric Fermentation *(4A)*	Manure Management *(4B)*	Agricultural Soils *(4D)*
	[Gg CO_2 eq.]			
1990	**15 937**	**4 869**	**1 709**	**9358**
1991	**14 161**	**4 588**	**1 643**	**7930**
1992	**12 344**	**4 111**	**1 511**	**6722**
1993	**10 811**	**3 556**	**1 387**	**5868**
1994	**9 976**	**3 115**	**1 217**	**5645**
1995	**9 897**	**3 032**	**1 154**	**5711**
1996	**9 487**	**3 004**	**1 161**	**5322**
1997	**9 315**	**2 802**	**1 129**	**5384**
1998	**8 889**	**2 627**	**1 077**	**5185**
1999	**8 897**	**2 683**	**1 069**	**5144**
2000	**8 659**	**2 577**	**1 011**	**5071**
2001	**8 883**	**2 596**	**1 004**	**5283**
2002	**8 625**	**2 535**	**963**	**5127**
2003	**8 020**	**2 468**	**935**	**4617**
2004	**8 362**	**2 390**	**890**	**5083**
2005	**8 066**	**2 393**	**855**	**4818**

2006	**7 937**	**2 349**	**845**	**4744**
2007	**8 117**	**2 372**	**844**	**4901**
2008	**8 324**	**2 412**	**810**	**5103**

6.2 Enteric fermentation (4A)

6.2.1 *Source category description*

This chapter describes estimation of the CH_4 emissions from Enteric Fermentation. In 2008, 83.6 % of agricultural CH_4 emissions arose from this source category (the relevant values are given in Table 6.2). This category includes emissions from cattle (dairy and non-dairy cattle), swine, sheep, horses and goats. Buffalo, camels and llamas, and mules and asses do not occur in the Czech Republic. Enteric fermentation emissions from poultry have not been estimated, the IPCC Guidelines do not provide a default emission factor for this animal category.

6.2.2 *Methodological issues*

Emissions from enteric fermentation of domestic livestock have been calculated by using IPCC Tier 1 and Tier 2 methodologies presented in the *Revised IPCC Guidelines* (IPCC, 1997) and IPCC *Good Practice Guidance* (IPCC, 2000). Methane emissions for cattle, which are a dominant source in this category, have been calculated using the Tier 2 method, while for other livestock the Tier 1 method was used. The contribution of emissions from livestock other than cattle to the total emissions from enteric fermentation is not significant.

6.2.2.1 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.

The emission factor for methane from fermentation (EF) in kg/head p.a. according to the Revised Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 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 facto, 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 (CSO, 1990–2008), provides following categorization of cattle:

- Calves younger than 6 months of age (male and female)
- Young bulls and heifers (6-12 months of age)
- Bulls and bullocks (1 – 2 years, over 2 years)
- Heifers (1 – 2 years, over 2 years)
- Mature cows (dairy and sucker)

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 1990–2008 time period (see Hons and Mudrik, 2003).

According to the IPCC methodology, Tier 2 (IPCC, 1997 and IPCC, 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). The national zoo-technical inputs (noted above) were updated by expert from the Czech University of Agriculture in Prague in 2006. Examples of input data used (Hons and Mudrik, 2003, Mudrik and Havranek, 2006) are given below, Tab.6.3 - Tab.6.5.

Tab. 6.3 Weights of individual categories of cattle, 1990 – 2008, in kg

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004	2005 - 2008
Mature cows (dairy and sucker)	520	540	580	585
Heifers > 2 years	485	490	505	510
Bulls and bullocks > 2 years	750	780	820	840
Heifers 1-2 years	380	385	395	395
Bulls 1-2 years	490	510	530	540
Heifers 6-12 months	275	280	285	285
Bulls 6-12 months	325	330	335	340
Calves to 6 months	128	132	133	135

Tab. 6.4 Weight gains of individual categories of cattle, 1990 – 2008, in kg/day

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004	2005 - 2008
Heifers 1-2 years	0.69	0.74	0.73	0.83
Bulls 1-2 years	0.74	0.76	0.84	0.84
Heifers 6-12 months	0.55	0.63	0.70	0.70
Bulls 6-12 months	0.82	0.94	1.12	1.12
Calves to 6 months	0.58	0.62	0.68	0.68

Tab. 6.5 Feeding situation, 1990 – 2008, in % of pasture, otherwise stall is considered

Categories of cattle	1990 - 1994	1995 - 1998	1999 - 2004	2005 - 2008
Mature cows (dairy and sucker)	10	20	20	22
Heifers > 2 years	30	30	30	35
Bulls and bullocks > 2 years.	30	40	40	40
Heifers 1-2 years	30	40	40	40
Bulls 1-2 years	30	40	40	40
Heifers 6-12 months	30	40	40	40
Bulls 6-12 months	30	40	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. The daily milk production statistics (Tab. 6.6.), in which only milk from dairy cows is considered, increased to 18.59 liters/day/head in 2008, with an average fat content of 3.90 %. Milk from sucker cows is not included in this table; a relevant daily milk production of 3.5 l /day head was used for the calculation. The activity data of milk production comes from the official statistics (CSO) and were verified by an agricultural expert from CULS.

As the official statistics, specifically from CSO, 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”. The numbers of animal population are based on surveys of livestock (up to 1991 as at 1.1., from 1992 to 2002 as at 1.3., since 2003 as at 1.4.)

Details of the calculation are given in the above-mentioned study (Kolar, Havlikova and Fott, 2004) and the results are illustrated in Tab. 6.7. 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. On the other hand, CH_4 emission form enteric fermentation of cattle dropped during the 1990-2008 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

Tab. 6.6 Milk production of dairy cows and fat content (1990 – 2008)

	Dairy cows *[thousands]*	**Daily production** *[liters / day head]*	**Fat content** *[%]*
1990	1206.0	10.67	4.03
1991	1165.0	9.63	4.09
1992	1006.1	10.13	4.07
1993	902.0	10.18	4.10
1994	796.1	10.79	4.04
1995	732.1	11.34	4.02
1996	712.6	11.69	4.08
1997	656.3	11.29	4.02
1998	598.4	12.44	4.05
1999	583.3	12.85	4.03
2000	547.7	13.55	4.00
2001	528.7	14.00	4.03
2002	495.7	15.08	3.98
2003	489.7	15.77	3.98
2004	475.6	16.41	3.98
2005	437.9	17.13	3.90
2006	426.0	17.45	3.90
2007	412.0	18.08	3.90
2008	406.0	18.59	3.90

Tab. 6.7 Methane emissions from enteric fermentation, cattle (Tier 2, 1990 – 2008)

	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
2005	574	823	114.41	51.55	65.7	42.4	106.8
2006	564	810	114.95	50.72	64.8	41.1	104.7
2007	565	827	115.33	50.39	65.2	41.7	106.7
2008	569	833	115.88	51.87	65.9	43.2	109.1

6.2.2.2 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. The estimated values are presented for the whole period since 1990.

Sheep, goats, swine and horses

The Czech Statistical Office (CSO) publishes data on the number of goats, sheep, swine, horses and poultry annually in the Statistical Yearbooks (1990-2008).

Considering the rather small numbers in these animal categories, default coefficients from the IPCC method have been used for estimating methane emissions: 8 kg of methane annually per head for sheep, 5 kg of methane for goats, 1.5 kg of methane for swine and 18 kg of methane for horses.

Poultry

IPCC guidelines do not define or require estimates of quantities of methane from enteric fermentation.

6.2.3 *Uncertainty and time-series consistency*

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 (submitted before 2006).

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 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.

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. The nationally specific data like weight of individual categories of cattle, weight gains of these categories and recent feeding situation were revised in 2006. The new values were estimated in a similar way by our external experts (Mudrik and Havranek, 2006) for the next period.

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor equals 20 %.

The combined uncertainty, calculated according to IPCC GPG Tier 1 methodology, equals 20.6 %.

6.2.4 *Source-specific QA/QC and verification*

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

6.2.5 *Source-specific recalculations*

No recalculations have been performed.

6.2.6 *Planned improvements*

The relevant QA/QC procedures for agriculture will be implemented in accordance with the general QA/QC plan given in Chapter 1. The analysis of uncertainties is currently in progress.

6.3 Manure management (4B)

This chapter describes the estimation of CH_4 and N_2O emissions from animal manure. In 2008, 16.4 % of agricultural CH_4 emissions and 6.2 % of agricultural N_2O emissions were caused by this source category.

6.3.1 *Source category description*

From 1990 to 2008, emissions from Manure Management decreased by 53 % to 810 Gg CO2 eq. Emissions from cattle and swine dominate the trend. The reduction in the cow population is partly counterbalanced by an increase in cow efficiency (increasing gross energy intake and milk production).

This emission source covers manure management of domestic livestock. Both nitrous oxide (N_2O) and methane (CH_4) emissions from manure management of livestock (cattle, swine, sheep, horses, goats and poultry) are reported. The animal waste management systems (AWMS) are distinguished for N_2O emission estimations: liquid system, daily spread, solid storage & dry lot and other manure management systems. Nitrous oxide is produced by the combined nitrification-denitrification processes occurring in the manure nitrogen. Methane is produced in manure during decomposition of organic material by anaerobic and facultative bacteria under anaerobic conditions. The amount of emissions is dependent on the amount of organic material in the manure and climatic conditions.

Table 6.8 Emissions of Manure Management in reporting period 1990-2008.

Year	Emissions from *Manure Management*			
	CH_4 emissions		N_2O emissions	
	[Gg CH_4]	**[Gg CO_2 eq.]**	**[Gg N_2O]**	**[Gg CO_2 eq.]**
1990	**48.07**	**1009.44**	**2.26**	**700.00**
1991	**46.14**	**969.03**	**2.17**	**673.59**
1992	**42.31**	**888.58**	**2.01**	**622.53**
1993	**38.61**	**810.73**	**1.86**	**575.91**
1994	**33.83**	**710.53**	**1.63**	**506.70**
1995	**32.07**	**673.44**	**1.55**	**480.49**
1996	**32.22**	**676.64**	**1.56**	**484.54**
1997	**31.26**	**656.39**	**1.52**	**472.47**
1998	**29.74**	**624.48**	**1.46**	**452.33**
1999	**29.49**	**619.30**	**1.45**	**449.85**
2000	**27.88**	**585.53**	**1.37**	**424.98**
2001	**27.72**	**582.08**	**1.36**	**421.57**
2002	**26.60**	**558.52**	**1.31**	**404.76**
2003	**25.80**	**541.76**	**1.27**	**393.02**
2004	**24.57**	**516.03**	**1.20**	**373.51**
2005	**23.64**	**496.48**	**1.16**	**358.76**
2006	**23.35**	**490.25**	**1.14**	**354.45**
2007	**23.35**	**490.30**	**1.14**	**353.81**
2008	**22.47**	**471.83**	**1.09**	**337.86**

6.3.2 *Methodological issues*

6.3.2.1 Methane emissions

CH_4 emissions from manure management were identified as a *key source* only by trend assessment (TA); hence these emissions 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 (Tab.6.8). Similarly as for enteric fermentation, the obsolete national approach used in the past was abandoned because of lack of comparability with other countries. Related to the decreasing trend in animal population (especially cattle and swine, Fig. 2), the emissions from *Manure Management* declined during 1990-2008 by almost 50 %.

Table 6.8 IPCC default emission factors used to estimate CH_4 emissions from *Manure Management*

Livestock type	EF (kg/head/yr)
Dairy Cattle	**14**
Non-Dairy Cattle	**6**
Sheep	**0.19**
Goats	**0.12**
Horses	**1.39**
Swine	**3**
Poultry	**0.078**

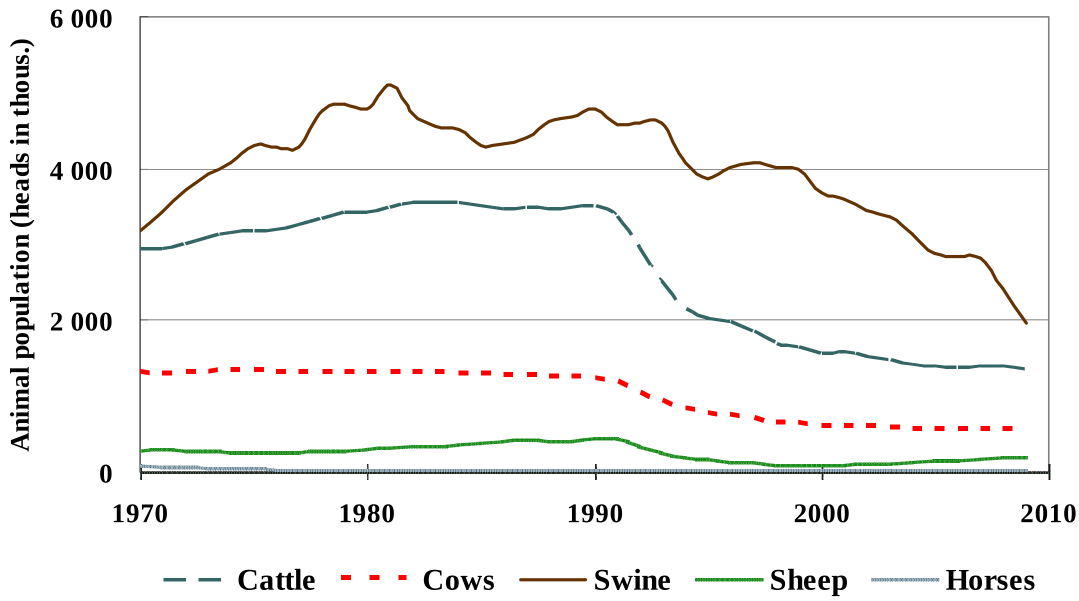


Fig. 2 Trend of individual animal population in period 1970 – 2008

6.3.2.2 Nitrous oxide emissions

N_2O emissions from manure management were identified as a non-key source, Tier 1 methodology is used for the emission estimation. Emissions are calculated on the basis of N excretion per animal and animal waste management system. Following the guidelines, all emissions of N_2O taking place before the manure is applied to soils are reported under Manure Management. The IPCC Guidelines method for estimating N_2O emissions from manure management entails multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system (Table 6.9). According to GPG (IPCC, 2000) the IPCC default values for dairy cattle, non-dairy cattle, and swine were taken from Tables B-3 through B-6 and the IPCC default values for all other animal species were taken from Table 4-21. The emissions are then summed over all the manure management systems.

Table 6.9 IPCC default N excretion values for livestock categories

Livestock type	Nitrogen Excretion Nex (kg/head/yr)	Type of AWMS				
		Liquid	Daily spread	Solid	Pasture	Other
		Fraction of Manure Nitrogen per AWMS (in %)				
Dairy Cattle	**100**	**40**	**20**	**20***	**19**	**1**
Non-Dairy Cattle	**70**	**50**	**0**	**4***	**38**	**8**
Sheep	**20**	**0**	**0**	**2**	**87**	**11**
Swine	**20**	**76**	**0**	**23**	**0**	**1**
Poultry	**0.6**	**13**	**0**	**1**	**2**	**84**
Horses	**25**	**0**	**0**	**0**	**96**	**4**
Goats	**25**	**0**	**0**	**0**	**96**	**4**

*Note: * Fractions of Manure Nitrogen from Burned forFuel (2 %) was added to the Solid type of AWMS*

6.3.2.3 Emission factors

To estimate N_2O emissions from manure management, the default emission factors for the different animal waste management systems were taken from the Good Practice Guidance, Table 4-22 (IPCC, 2000), see table 6.10.

Table 6.10 IPCC default emission factors of animal waste per different AWMS

AWMS	Emission Factor (**EF_3**) **(kg N_2O-N per kg N excreted)**
Liquid	**0.001**
Solid Storage	**0.02**
Pasture/Range/Paddock	**0.02**
Other Systems	**0.005**

6.3.3 *Uncertainty and time-series consistency*

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 the second of them was prepared at the level Tier 1.

The Czech team accepted critical remarks put forth by the International Review Teams (ERT). A concept, in accordance with the plan for implementing Good Practice, is based on option, that 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, the default emission factors for Western Europe were employed.

On the basis of the recommendations of the ERT, the estimation of manure management N_2O emissions from horses and goats is reported as two individual groups of animals (category *Other livestock* was regrouped to two categories), applying the IPCC Tier 1 method and the 1996 IPCC default values. The total emissions from the category “N_2O emissions from Manure Management” were not affected.

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor for estimation of CH_4 emissions equals 30 %; for estimation of N_2O emissions, this value equals 100 %.

The combined uncertainty for CH_4 emissions equals 30.4 % and that for N_2O emissions equals 100.12 %.

6.3.4 *Source-specific QA/QC and verification*

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

6.3.5 *Source-specific recalculations*

Until the 2009 submission, emissions were estimated using the Tier 1 method from the Revised 1996 IPCC Guidelines and default values form Table 4-21 for allocation of manure per AWMS for all animal categories. According to the ERT recommendation (in-country review 2009), the default parameters characterizing AWMS for dairy cattle, non-dairy cattle, and swine in this submission were taken from Tables B-3 through B-6 presented in the 1996 Guidelines (Reference Manual). The values for the other animal categories remained unchanged.

6.3.6 *Planned improvements*

Relevant QA/QC procedures for agriculture will be implemented in accordance with the general QA/QC plan given in Chapter 1. Currently, the analysis of uncertainties is in progress.

6.4 Agricultural Soils (4D)

6.4.1 *Source category description*

This source category includes direct and indirect nitrous oxide emissions from agricultural soils. Both these categories (direct and indirect) of N2O soil emissions are the key sources (Tab. 6.1). Nitrous oxide is produced in agricultural soil as a result of microbial nitrification-denitrification processes. The processes are influenced by chemical and physical characteristics (availability of mineral N substrates and carbon, soil moisture, temperature and pH). Thus, addition of mineral nitrogen in the form of synthetic fertilizers, animal manure applied to soils, crop residue, N-fixing crops enhance the formation of nitrous oxide emissions.

Nitrous oxide emissions from agriculture include these subcategories:

- direct emissions from agricultural soils (emissions from synthetic fertilizers, animal manure applied to soils, crop residue and N-fixing crops)
- emissions from pasture manure (PRP)
- indirect emissions coming from atmospheric deposition
- indirect emissions from nitrogenous substances flushed into water courses and reservoirs

In 2008, 94 % of total N_2O emissions from Agriculture originated from Agricultural Soils, while the rest originated from Manure Management. The trend in N_2O emissions from this category is decreasing: in 2008 emissions were 46 % below the base year level.

Table 6.11 and Figure 6.2 present the N_2O emissions of Agricultural soils by individual sub-category.

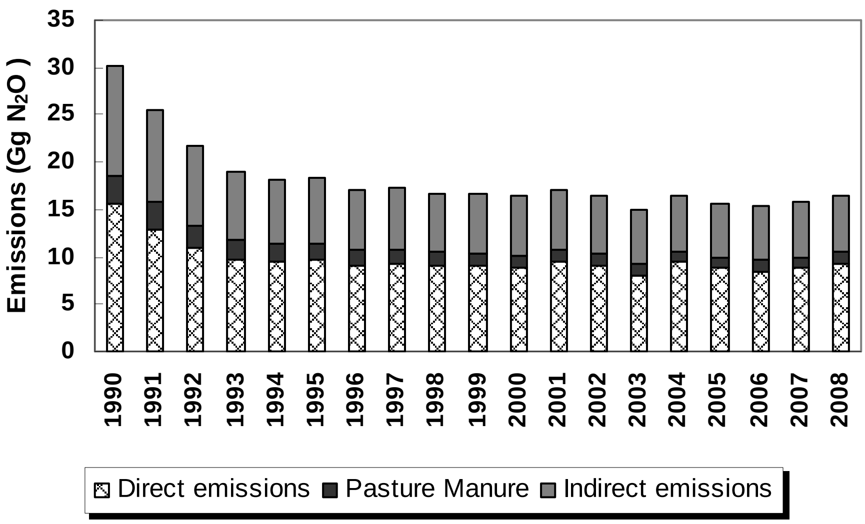


Fig. 6.2 Nitrous oxide emissions of Agricultural soils by individual sub-categories

Tab. 6.11 Emissions come from Agricultural Soils (4D category) in period 1990-2008.

N_2O emissions from soils *[Gg N_2O]*								
Year	**Total emissions**	**Direct emissions**				**Pasture Manure**	**Indirect emissions**	
		a	**b**	**c**	**d**		**Atmosph. deposition**	**Leaching**
1990	30.19	7.39	4.96	0.18	3.00	2.96	1.94	9.76
1991	25.58	5.26	4.76	0.24	2.67	2.82	1.70	8.13
1992	21.68	4.00	4.37	0.24	2.26	2.47	1.48	6.87
1993	18.93	3.19	3.98	0.27	2.24	2.08	1.29	5.89
1994	18.21	3.59	3.48	0.19	2.30	1.77	1.19	5.67
1995	18.42	4.05	3.31	0.17	2.23	1.66	1.19	5.81
1996	17.17	3.36	3.33	0.16	2.24	1.61	1.13	5.34
1997	17.37	3.64	3.23	0.12	2.33	1.51	1.12	5.41
1998	16.73	3.59	3.08	0.16	2.25	1.37	1.07	5.21
1999	16.59	3.54	3.05	0.14	2.32	1.33	1.06	5.15
2000	16.36	3.77	2.88	0.10	2.15	1.27	1.04	5.15
2001	17.04	3.99	2.87	0.11	2.44	1.28	1.06	5.29
2002	16.54	4.02	2.75	0.08	2.24	1.22	1.03	5.20
2003	14.89	3.39	2.66	0.09	1.92	1.18	0.95	4.70
2004	16.40	3.83	2.54	0.12	2.91	1.15	0.96	4.89
2005	15.54	3.65	2.44	0.14	2.56	1.14	0.93	4.69
2006	15.30	3.80	2.41	0.12	2.14	1.13	0.93	4.77
2007	15.81	3.95	2.41	0.09	2.37	1.16	0.95	4.88
2008	16.46	4.21	2.32	0.07	2.75	1.18	0.96	4.98

Note: a, b, c, d = individual sources of direct emissions; (a) Synthetic fertilizers, (b) Animal manure applied to soils, (c) N-fixing crops and (d) Crop residue

6.4.2 *Methodological issues*

Although nitrous oxide emissions from agriculture are key sources, emissions are estimated and analyzed by the Tier 1 approach of the IPCC methodology (IPCC, 1997). A set of interconnected spreadsheets in MS Excel has been used for the relevant calculations for several years. The emissions from nitrogen excreted to pasture range and paddocks by animals are reported under animal production in CRF table 4D2. The nitrogen from manure that is spread daily is consistently included in the manure nitrogen applied to soils.

6.4.2.1 Activity data

The standard calculation of Tier 1 required the following input information based on CSO data:

- number of heads of farm animals (dairy cows, other cattle, pigs, sheep, poultry, horses and goats),
- annual amount of nitrogen applied in the form of industrial nitrogen fertilizers - the application of agricultural fertilizers was previously intensive in this country, but decreased radically during the 1990s. The amount of nitrogen fertilizers applied in 1990 equaled over 418 kt decreased to 238 kt in 2008. This corresponds to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Sálusová et al., 2006).
- annual harvests of crops , pulses and soya beans (see Table 6.13).

Tab 6.13 Annual harvests of agricultural products (incl. crops, pulses and soybeans) in period 1990-2008

Year	*Crop production (in tons)*	*Pulses (excl. Soya) (in tons)*	*Soya beans (thous. tons)*
1990	8 946 879	152 000	2.2
1991	7 845 290	194 607	6.4
1992	6 564 898	203 472	3.7
1993	6 467 852	227 497	0.7
1994	6 777 231	163 229	0.7
1995	6 601 711	144 136	0.6
1996	6 644 145	135 553	0.5
1997	6 982 772	103 665	0.3
1998	6 668 920	133 382	0.3
1999	6 928 371	119 434	0.6
2000	6 454 237	84 946	2.3
2001	7 337 589	91 443	4.3
2002	6 770 829	65 124	6.4
2003	5 762 396	62 131	11.9
2004	8 783 801	88 261	12.9
2005	7 659 851	95 969	18.9
2006	6 386 078	87 510	17.8
2007	7 152 861	65 282	13.2
2008	8 369 503	47 905	9.4

All these data were taken from the Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990-2008).

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 Guidelines, 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 Guidelines, 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.

6.4.2.2 Emission factors and other parameters

IPCC default emission factors have been used for calculating N_2O emissions from agricultural soils. The emission factors for calculation of direct N_2O emissions from the agriculture soil category, direct emissions from atmospheric deposition and leaching were used according to Tab. 6.14.

On the basis of the report on the in-country review of the 2009 annual submission of the Czech Republic, the wrong location of the default fraction values in the CRF Tables was corrected. There were only technical discrepancies in the CRF tables; the right default parameters were used to estimate emissions (Table 6.13). The fraction of livestock N excreted and deposited onto soil during grazing (FracGRAZ) varied from 0.18 to 0.23 during the reported period of 1990-2008.

Tab. 6.13 IPCC default parameters/fractions used for emission estimation

Parameters/Fractions	Default values
$Frac_{GASM}$	**0.2**
$Frac_{NCR0}$	**0.015**
$Frac_{NCRBF}$	**0.03**
$Frac_R$	**0.45**
$Frac_{BURN}$	**0.0**

Tab. 6.14 Emission factors (EFs) for the calculation of Agricultural Soils

	Emissions (sources)	**Emission Factors**
Direct emissions	Synthetic fertilizer	EF_1=0.0125 kg N_2O-N/kg N
	Animal Waste	
	N-fixing crops	
	Crop residue	
Pasture, range & paddock manure	Grazing animals	EF_3=0.02 kg N2O-N/kg N
Indirect emissions	Atmospheric Deposition	EF_4=0.01 kg N_2O-per kg emitted NH_3 and NO_x
	Nitrogen Leaching	EF_5=0.025 kg N_2O - per kg of leaching N

6.4.3 *Uncertainty and time-series consistency*

In relation to the consistency of the emission series for N_2O (agricultural soils), it should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology of Revised 1996 IPCC Guidelines (IPCC, 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 year 2004) this year as part of the 2006 submission.

The quantitative overview and emission trends during period 1990-2008 are shown in Tab. 6.2. The trend in N_2O emissions from agricultural soils is summarized in Tab. 6.11. From 1990 till 2008 the total emissions from agricultural soils decreased by 45 % (rapidly during period 1990-1995, about 40 %), direct emissions decreased by 40 % and indirect emissions by 50 %. More than 60 % reduction was reached in the animal production.

Following the ERT, the Czech emission inventory team verified the activity data required for this category and found that the previously reported data based on expert judgment of areas could not be confirmed and verified from the official statistics. According to the new expert common consensus (RNDr. I. Skorepova, Ing. P. Fott, CSc., Doc. Ing. E. Cienciala, PhD, Ing. Z. Exnerova), there are no cultivated histosols on agricultural land in this country and hence also no data for this category. Organic soils mostly occur on forest land and they are reported in the LULUCF sector. During in-country review 2009 was confirmed that there are no cultivated histosols on agricultural land in the Czech Republic.

On the basis of the recommendations of ERT (in-country review 2009) and the ARR document,, several recalculations and corrections were performed in the emission inventory for agricultural soils in the 2010 submission (a detailed description is given in chapter 6.4.5).

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data for estimation of direct and indirect emissions from agricultural soils equals 20 %; for Pasture, Range and Paddock Manure (PRP) this value equals 10 %.

The uncertainty in the emission factor for estimation of direct and indirect emissions from agricultural soils equals 50 %; for estimation of emissions from PRP Manure this value equals 100 %.

The combined uncertainty for the direct and indirect emissions from agricultural soils equals 53.85 %; for N_2O emissions from PRP Manure this value equals 100.5 %.

6.4.4 *Source-specific QA/QC and verification*

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

6.4.5 *Source-specific recalculations*

On the basis of the recommendations of ERT (in-country review) and the ARR document, several recalculations and corrections were performed in the emission inventory for agricultural soils:

N_2O emissions from agricultural soils - Animal manure applied to soils

The recalculation employed the more suitable equation 4.23 from the IPCC Good Practice Guidance 2000 instead of the former equation from the Revised 1996 IPCC Guidelines, p. 4.93

N_2O emissions from agricultural soils - Crop residues

The Tier 1a method described in the IPCC Good Practice Guidance 2000 was used to estimate emissions in this category. The reasons for the recalculations were:

- The default value for $Frac_{BURN}$ (0.1) has been used although burning of crop residues does not occur in the CR; thus, in this submission, $Frac_{BURN}$ (0.0) was employed.
- Because of a technical error in the existing calculation spreadsheets, the residues from pulses have not been included in the calculation.
- The amount of crops has been transformed to the dry matter using default $Frac_{DM}$ equal to 0.85. This is in line with the Revised1996 IPCC Guidelines; however, according to the IPCC 2000 GPG, the crops $Frac_{DM}$ should not be employed if the simple Tier 1 (Tier 1a) method is used.

N_2O emissions from 4.D.1.3 N-fixing crops

The production of soya beans has been included (even though this production is very limited in the Czech Republic) to recalculate emissions from N-fixing crops.

The technical errors were revised in this submission:

- The emission factor for nitrogen symbolic fixation, which was erroneously reported in the 2002 was corrected
- The values reported in CRF tables for $Frac_{NCRO}$, $Frac_{NCRBF}$, $Frac_R$ and $Frac_{GRAZ}$ for all the years were revised (fraction parameters were used correctly to estimate emissions)
- The values of N_2O emissions from N from leaching and run-off (1997, 2003 and 2006) and volatized from fertilizers (1997 and 2006) were corrected.

6.4.6 *Planned improvements*

Relevant QA/QC procedures for agriculture will be implemented in accordance with the general QA/QC plan given in Chapter 1. Currently, the analysis of uncertainties is in progress.

6.5 Source-specific QA/QC and verification

Following the recommendation of the latest in-country review, a sector-specific QA/QC plan was formulated, tightly linked to the corresponding QA/QC plan of the National Inventory System, chapter 1.5. The plan describes the key procedures of inventory compilation, provides a table of personal responsibilities and a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates effective quality control of the Agriculture inventory.

The Institute of Forest Ecosystem Research (IFER) is the sector-solving institution for this category.

The agricultural greenhouse gas inventory is compiled by an experienced expert from the IFER, including performance of self-control. CULS and the AGROBIO company are other institutes contributing information used in the sector of Agriculture. Slovak agricultural experts (SHMI) also participate in debates on inventory improvements.

Potential errors and inconsistencies are documented and corrections are made if necessary. In addition to the official review process, emission inventory methods and results are internally reviewed by the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors.

To comply with QA/QC, is necessary to check

- The inclusion of all activity data for animal categories, selected harvests (crops, pulses, soya beans), amount of synthetic fertilizers (agricultural statistics)
- The consistency of time-series activity data and emission factors (agricultural statistics)
- The annual update of national zoo-technical data
- All the emission factors and used parameters/fractions

QA/QC includes checking of activity data, emission factors and methods employed. All the differences are discussed and, if necessary, also corrected. The procedure of inventory compiling is initiated by IFER, where all the necessary data, obtained from the Czech Statistical Office (CSO), are inserted into the excel spreadsheets. The excel files are verified by other IFER experts. Some more specific parameters, not available from CSO, are required to estimate the country-specific emission factors for cattle (Tier 2). The zoo-technical national data (specifically concerned with cattle breeding) are supplied by CULS and other experts. The appropriate values in the calculation spreadsheets are updated at IFER, replacing the older values. The verified data are transferred to the CRF Reporter, where the data are again technically verified. The CRF tables are sent to the NIS coordinator for final time-series checking and approval.

All the information used for the inventory report is archived by the author and by the NIS coordinator. Hence, all the background data and calculations are verifiable.

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

7.1 Overview

The emission inventory of the *5 Land Use, Land Use Change and Forestry* (LULUCF) sector includes emissions and removals of greenhouse gases (GHG) resulting from land use, land-use change and forestry. The inventory is based on application of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003, further also abbreviated as GPG for LULUCF) and the reporting format adopted by the 9th Conference of Parties to UNFCCC. The application of GPG for LULUCF in the national emission inventory entails manifold specific requirements on the inventory of the sector, which have been implemented gradually. The current inventory of the LULUCF sector represents an advanced phase of this implementation. It employs a refined system of land use identification at the level of the individual cadastral units, which was also utilized for determination of land-use changes. This inventory submission contains additional methodological improvements and reflects the suggestions following from the latest reviews of the LULUCF emission inventory. Where feasible, the methodological elements from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2006) for the Agriculture, Forestry and Other Land Use (AFOLU) were also used. Although the current submission will still undergo further development and consolidation, it already represents a solid system for providing information on GHG emissions and removals in the LULUCF sector, as well as for providing the additional information on the LULUCF activities required under the Kyoto protocol.

The current inventory includes CO_2 emissions and removals, and emissions of non-CO_2 gases (CH_4, N_2O, NO_X and CO) from biomass burned in forestry and disturbances associated with land-use conversion. The inventory covers all six major LULUCF land-use categories, namely *5A Forest Land, 5B Cropland, 5C Grassland, 5D Wetlands, 5E Settlements and 5F Other Land*, which were linked to the Czech cadastral classification of lands. The emissions and/or removals of greenhouse-gases are reported for all mandatory categories. The current submission covers the whole reporting period from the base year of 1990 to 2008 (Fig. 7.1).

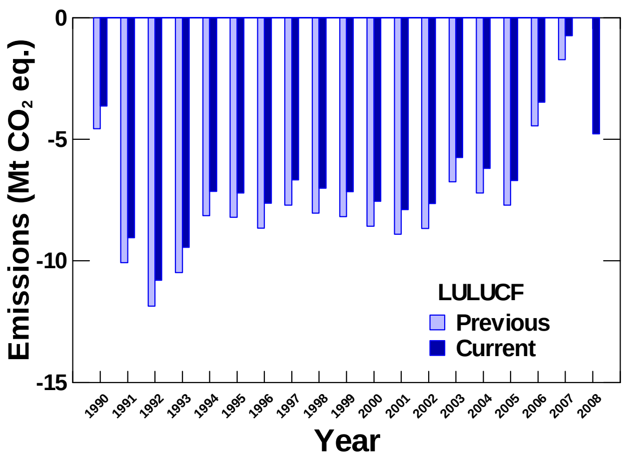


Fig. 7.1 Current and previously reported assessment of emissions for the LULUCF sector. The values are negative, hence representing net removals of green-house gases.

7.1.1 *Estimated emissions*

Tab. 7.1 provides a summary of the LULUCF GHG estimates for the base year 1990 and the most recently reported year 2008. In 2008, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equaled -4.778 Mt CO_2 eq., thus representing a net removal of GHG gases. In relation to the estimated emissions in other sectors in the country for the inventory year 2008, the removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 3.4 %. Correspondingly, for the base year of 1990, the total emissions and removals in the LULUCF sector equaled -3.630 Mt CO_2.eq. In relation to the emissions generated in all other sectors, the inclusion of the LULUCF estimate reduces the total emissions by 1.9 % for the base year of 1990. It is important to note that the emissions within the LULUCF sector exhibit high inter-annual variability (Fig. 7.2) 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.

Tab. 7.1 GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2008.

Sector/category	Emissions 1990 Gg CO_2 eq.	Emissions 2008 Gg CO_2 eq.
5 Total LULUCF	**-3 630**	**-4 778**
5A Forest Land	**-4 947**	**-4 682**
5A1 Forest Land remaining Forest Land	-4 667	-4 400
5A2 Land converted to Forest Land	-280	-283
5B Cropland	**1 337**	**172**
5B1 Cropland remaining Cropland	1089	69
5B2 Land converted to Cropland	247	102
5C Grassland	**-128**	**-384**
5C1 Grassland remaining Grassland	59	5
5C2 Land converted to Grassland	-187	-389
5D Wetlands	**23**	**22**
5D1 Wetlands remaining Wetlands	(0)	(0)
5D2 Land converted to Wetlands	23	22
5E Settlements	**86**	**95**
5E1 Settlements remaining Settlements	(0)	(0)
5E2 Land converted to Settlements	86	95
5F Other Land	**(0)**	**(0)**

Note: Emissions of non-CO_2 gases (CH_4 and N_2O) are also included.

7.1.2 *Key categories*

Tab. 7.2 Key categories of the LULUCF sector (2008)

Category	Character of category	Gas	% of total GHG
5A1 Forest Land remaining Forest Land	KC (LA, TA)	CO_2	-3.34
5B1 Cropland remaining Cropland	KC (TA)	CO_2	0.05

KC: key category, LA - identified by level assessment, TA - identified by trend assessment

% of total GHG: relative contribution of category to net GHG (including LULUCF)

Of the main categories listed in Tab. 7.1, two of them were identified as key categories according to the IPCC Good Practice (Good Practice Guidance, IPCC 2000, Good Practice Guidance for LULUCF, IPCC 2003). Of these LULUCF categories, the largest effect on the overall emission inventory in the country is attributed to *5A1 Forest Land remaining Forest Land*. With a contribution of -3.1 %, it is the only LULUCF category identified by the level assessment for the year 2008 (Tab. 7.2). It was also identified as a key category by the trend assessment. The emissions of this category are determined by the changes in biomass carbon stock. Additionally, one LULUCF categories was identified by the trend assessment (Tab. 7.2), namely *5B1 Cropland remaining Cropland*. In *5B1*, the trend analysis

reflected the effect of liming on emissions from agricultural soils, which decreased rapidly in early 1990s.

7.2 General methodological issues

7.2.1 *Methodology for representing land-use areas*

The 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 remaining in the given category during the inventory year, and lands that are newly converted into the category from a different one. Accordingly, GPG for LULUCF outlines the appropriate methodologies for estimation of emissions.

Consistent representation of land areas and identification of land-use changes constitute the key steps in the inventory of the sector in accordance with GPG for LULUCF. The adopted land-use representation and land-use change identification system was build gradually since the 2007 NIR submission. It was radically improved in the 2008 NIR submission and further refined in 2009 inventory submission.

Initially, the identification of land-use categories was based on two key data sources. Information on areas of the individual land-use categories was obtained from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). It provided annually updated cadastral information, published as aggregated data in the statistical yearbooks. The second data source utilized previously was the Land Cover Database of the Pan-European CORINE project (reference years 1990 and 2000), administered by the Czech Ministry of the Environment. The combination of COSMC cadastral data and CORINE land-use change trends permitted estimation of land-use changes. Although this method was endorsed by the 2007 in-country review, the aggregated land-use information did not provide sufficient spatial details and the CORINE-derived trends remained uncertain for several reasons.

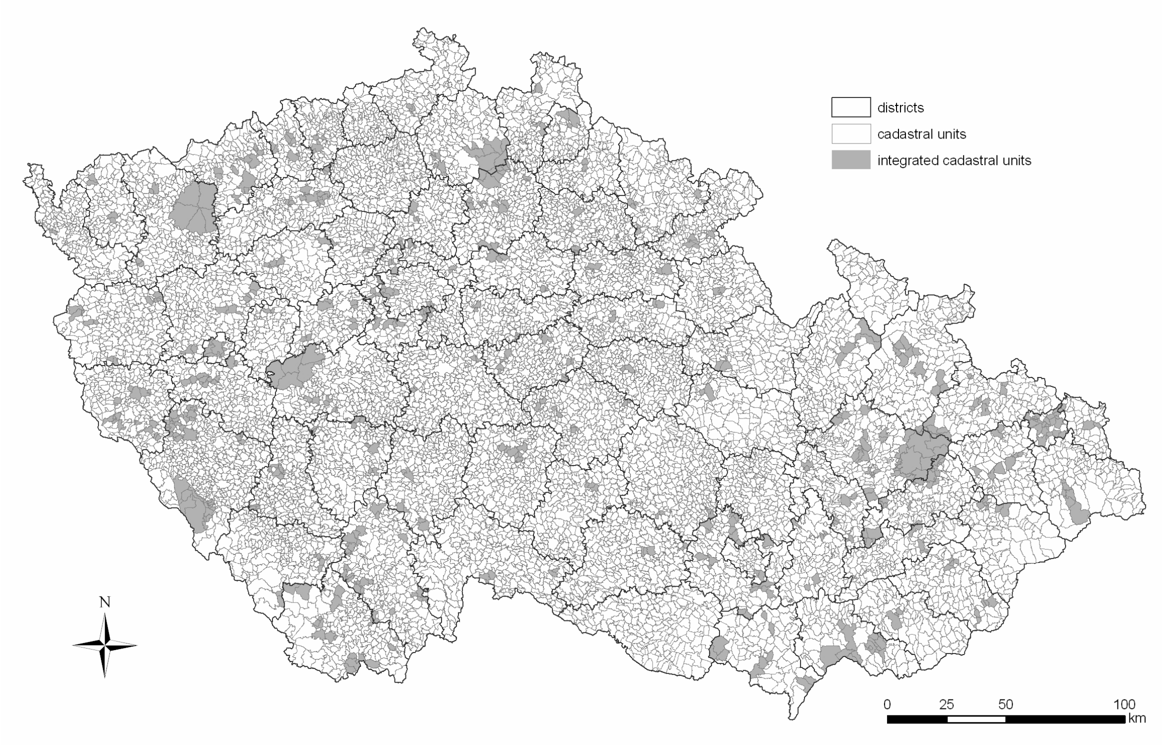
Since the 2008 NIR submission, land-use representation and the land-use change identification system have been based exclusively on the annually updated COSMC data, elaborated at the level of about 13 thousands individual cadastral units. This system was built in several steps, including 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time series. These steps are described below. The result is a system of consistent representation of land areas having the attributes of both Approach 2 and Approach 3 (GPG for LULUCF), permitting accounting for all land-use transitions in the annual time step.

7.2.1.1 Source data compilation

The methodology requirements and principles associated with the approaches recommended by the GPG for LULUCF (IPCC 2003) imply that, for the reported period of 1990 to 2008, the required land use should be available for the period starting from 1969. Information on land use was obtained from the Czech Office for Surveying, Mapping and Cadastre (COSMC), which administers the database of "Aggregate areas of cadastral land categories" (AACLC). The AACLC data were compiled at the level of the individual cadastral units (1992-2008) and individual districts (1969-2008). There are over 13 000 cadastral units, the number of which varied due to separation or division for various administrative reasons. In the period of 1992 to 2008, the total number of cadastral units varied between 13 027 and 13 079.

To identify the administrative separation and division of cadastral units, these were crosschecked by comparing the areas in subsequent years using a threshold of one hectare difference. Neighboring cadastral units mutually changing their areas in subsequent years were integrated. Until the reported year of 2006, this concerned a total of 706 former and/or current units that were integrated into 235 newly labeled units. This resulted in a total of 12 624 cadastral units, for which the annual land-use change was specifically estimated (see below). The land use system was further refined for 2007. Thereon, the eventual integration of cadastral units is performed on an annual basis and hence concerns only those cadastral units where some land was exchanged between two subsequent years. For 2008, this decreased the number of integrated cadastral units from 235 to only 28, which affected

a total of 61 cadastral units. This further increased the spatial resolution of the system, as the land use change identification could be analyzed for 12 994 individual units in 2008 as compared to 12 624 units for the previous years (Fig. 7.2).



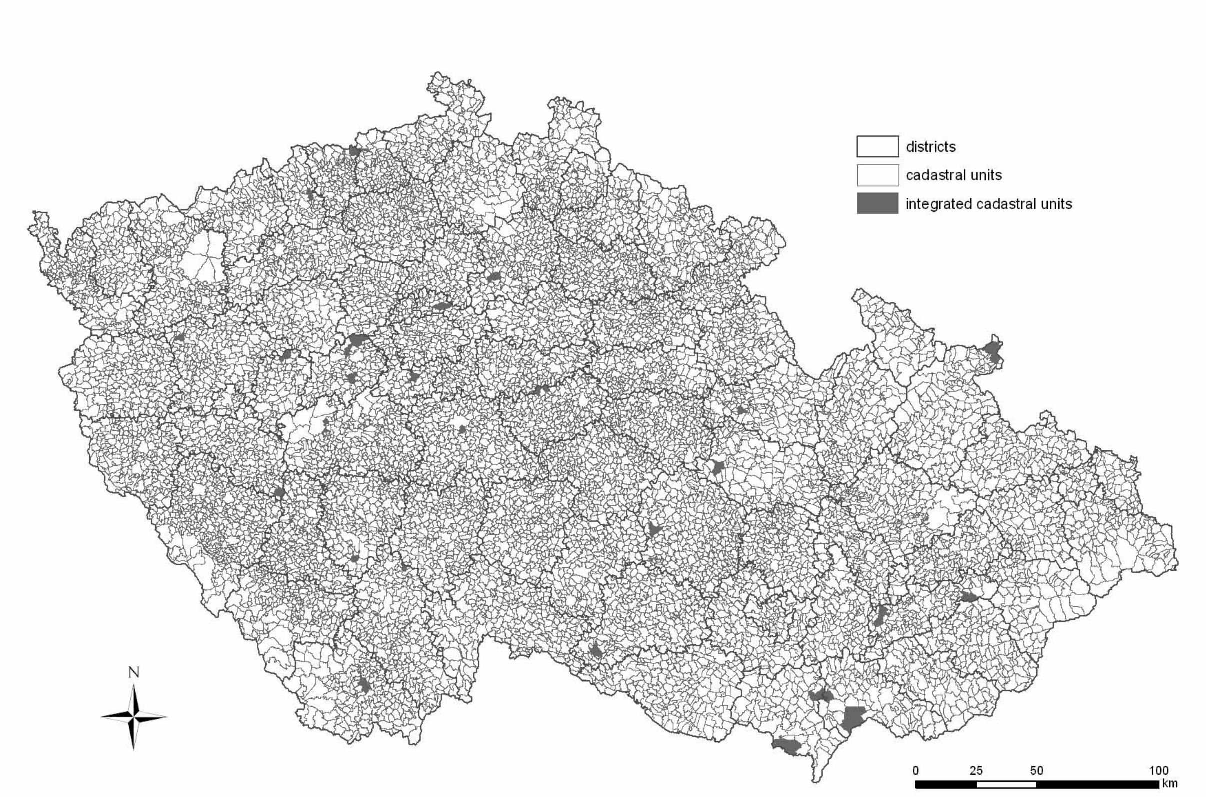


Fig. 7.2: Cadastral units (grey lines), integrated cadastral units (shading) and district borders (black lines) as used until year 2006 (top) and the currently refined situation for year 2008 (bottom).

To obtain information on land-use and land-use change prior 1993, a complementary data set from COSMC at the level of 76 district units was prepared. It actually covered the period since 1969. It was required for application of the IPCC default transition time period of 20 years for carbon stock change in soils. The overlapping time period of 1993 to 2006 was utilized to correct the land-use change assessment based on the coarser, i.e., district data (see below for details). The spatial coverage of cadastral and district units is also shown in Fig. 7.2.

7.2.1.2 Linking land-use definitions

The analysis of land use and land-use change is based on the data from the "Aggregate areas of cadastral land categories" (AACLC), centrally collected and administered by COSMC and regulated by Act No. 265/1992 Coll., on Registration of proprietary and other material rights to real estate, and Act No. 344/1992 Coll., on the real estate cadastre of the Czech Republic (the Cadastral Act), both as amended by later regulations. AACLC distinguishes ten land categories, six of them belonging to land utilized by agriculture (arable land, hop-fields, vineyards, gardens, orchards, grassland) and four under other use (forest land, water surfaces, built-up areas and courtyards, and other land). Additionally, the land register included information on land use for every land parcel. Different AACLC land categories may have identical use. Both land categories and land use in the COSMC database were linked so as to most closely match the default definitions of the six major land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land) as given by GPG for LULUCF (IPCC 2003). The specific definition content can be found in the respective Chapters 7.3 to 7.8 devoted to each of the major land-use categories.

7.2.1.3 Land-use change identification

The critical issue of any LULUCF emission inventory is the determination of land-use change. This inventory identifies and quantifies land-use change by balancing the six major land-use areas for each of the individual or integrated cadastral units (12 994 units in year 2008) on an annual basis using the subsequent years of the available period. The approach is exemplified in Fig. 7.1. In the example of the cadastral unit of Jablunkov, it can be observed that, during 2006, three land-use categories lost their land, while one exhibited an increase. This identifies three types of land-use conversion with specific areas corresponding to the proportion of the loss of all the contributing categories. Similarly, if the converted land were to be attributed to two or more land-use categories, it would be accordingly distributed in proportion to the increase in their specific areas. Since this task is computation-intensive, involving tens of thousands of matrix manipulations, it is handled by a specific software application developed for this purpose using the MS-Access file format. All identified land-use transfers are summarized by each type of land-use change on an annual basis to be further used for calculation of the associated emissions.

YEAR	ID_CU (Name)	Cropland	Forestland	Grassland	Otherland	Settlements	Wetlands	ALL
2005	656305 (Jablunkov)	2880337	1737355	3480215	302322	1649308	336775	10386312
2006	656305 (Jablunkov)	2806120	1737355	3473992	302322	1729860	336666	10386315
Difference		-74217	0	-6223	0	80552	-109	3
	Increment					100%		80552
	Loss	92.1%		7.7%			0%	-80549
	Estimation	74220		6223			109	
	Conversion type	**Area (m2)**						
	Cropland_Settlements	74220						
	Grassland_Settlements	6223						
	Wetlands_Settlements	*109*						

Fig. 7.1: Example of land-used change identification for year 2006 and cadastral unit 656306 (Jablunkov); all spatial units are in m^2.

7.2.1.4 Complementing time series

The above described calculation of land-use change could only be performed for the years 1993 to 2008, because the data on land-use for the individual cadastral units has only been available since 1992. For the years preceding 1993, i.e., for land-use change attributed to the years 1970 to 1992, an identical approach as described above was used, but with aggregated cadastral input data at the level on the individual districts. The effect of an increased scale and data aggregation always results in a lower area of identified land-use change. This is probably due to within-domain compensation of area losses and increments. To compensate this effect for the 1970 to 1992 data series, a correction was applied to the estimates, based on district data input. The correction was based on a linear regression function between *R* (the ratio of identified land conversions at the level of the districts and individual cadastral units) and the logarithmically transformed areas from the data at the district level. The corrections were derived at the level of the major land-use categories, using the annual data from the period of 1993 to 2006, for which the land-use conversions could be estimated independently at both spatial levels, i.e., districts and individual cadastral units. More details, including the statistics and estimated parameters of the regression equation, are given in Cienciala and Apltauer (2007). The correction procedure was the final step in land-use database operations required to provide a consistent data-series on annual land-use conversions for the 1970 to 2008 period.

7.2.2 *Land-use change – overall trends and annual matrices*

The overall trends in the areas of the major land-use categories in the Czech Republic for the 1970 to 2008 period are shown in Fig. 7.2. The largest quantitative change is associated with the Cropland and Grassland land-use categories.

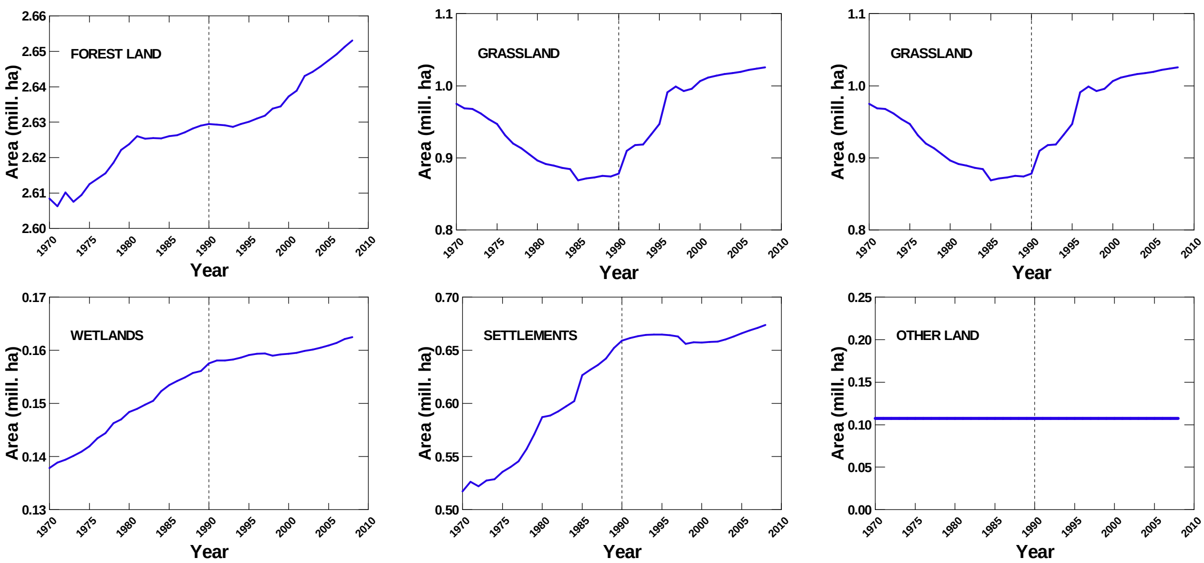


Fig. 7.2 Trends in areas of the six major land-use categories in the Czech Republic between 1970 and 2008 (based on information from the Czech Office for Surveying, Mapping and Cadastre).

An insight into the net trends shown in Fig. 7.2 is provided by analysis of land-use changes as described in Section 7.1.2. Tab. 7.3 shows a product of that analysis, namely the areas of land-use change among the major land-use categories over the 1990 to 2008 period in the form of land-use change matrices for the individual years. It is important to note that the annual totals for the individual years in the matrices do not necessarily correspond to the areas that appear in the CRF Tables, which accounts for the progressing 20-year transition period that began in 1970. This is a Tier 1 assumption of GPG for LULUCF for estimation of changes in soil carbon stock. This also implies that the areas relevant to the biomass pool are not the same as those for the soil pools; this is important for interpretation of the emission factors estimated from the land-use change areas accumulated over 20-

year periods. Secondly, for Forest Land, the available input information at a detailed (cadastral, district) level did not permit separation of the fraction of permanently unstocked Forest Land devoted to use other than growing forests. This small fraction of Forest Land was separated ex-post after estimating land-use changes and summing over the whole country, when it was assigned to Grassland.

Tab. 7.3 Land-use matrices describing initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories for years 1990 to 2008.

Year 1990		**Initial (1989)**						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1990)	Forest Land	**2 628.2**	0.5	0.7	0.0	0.0	0.0	2 629.5
	Grassland	0.1	**867.3**	10.8	0.0	0.0	0.0	878.2
	Cropland	0.1	1.2	**3 453.4**	0.1	0.2	0.0	3 455.0
	Wetland	0.0	0.4	0.4	**155.9**	0.8	0.0	157.5
	Settlements	0.3	3.7	3.7	0.1	**651.2**	0.0	658.9
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 628.7	873.1	3 469.0	156.1	652.2	107.2	**7 886.4**

Year 1991		**Initial (1990)**						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1991)	Forest Land	**2 628.8**	0.1	0.4	0.0	0.0	0.0	2 629.3
	Grassland	0.4	**876.4**	32.6	0.0	0.3	0.0	909.8
	Cropland	0.3	0.5	**3 419.4**	0.0	0.2	0.0	3 420.4
	Wetland	0.1	0.1	0.6	**157.4**	0.0	0.0	158.1
	Settlements	0.2	0.3	3.4	0.0	**657.7**	0.0	661.6
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 629.6	877.4	3 456.4	157.4	658.2	107.2	**7 886.4**

Year 1992		**Initial (1991)**						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1992)	Forest Land	**2 628.7**	0.1	0.2	0.0	0.0	0.0	2 629.1
	Grassland	0.2	**907.3**	10.2	0.1	0.0	0.0	917.9
	Cropland	0.1	0.7	**3 409.9**	0.0	0.2	0.0	3 410.9
	Wetland	0.0	0.1	0.2	**157.8**	0.0	0.0	158.1
	Settlements	0.3	0.4	2.0	0.1	**660.5**	0.0	663.3
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 629.5	908.6	3 422.4	158.0	660.7	107.2	**7 886.4**

Year 1993		**Initial (1992)**						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1993)	Forest Land	**2 628.2**	0.1	0.1	0.0	0.2	0.0	2 628.6
	Grassland	0.1	**916.6**	1.6	0.0	0.3	0.0	918.6
	Cropland	0.2	0.6	**3 407.9**	0.0	0.4	0.0	3 409.1
	Wetland	0.0	0.1	0.0	**157.9**	0.3	0.0	158.3
	Settlements	0.5	0.4	1.2	0.1	**662.3**	0.0	664.6
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 629.1	917.8	3 410.9	158.1	663.4	107.2	**7 886.4**

Year 1994		Initial (1993)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1994)	Forest Land	**2 628.1**	0.2	0.2	0.1	0.9	0.0	2 629.5
	Grassland	0.1	**917.2**	14.8	0.0	0.4	0.0	932.5
	Cropland	0.1	0.7	**3 392.7**	0.0	0.4	0.0	3 394.0
	Wetland	0.0	0.1	0.0	**158.1**	0.4	0.0	158.6
	Settlements	0.4	0.4	1.3	0.1	**662.6**	0.0	664.8
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 628.7	918.6	3 409.1	158.4	664.7	107.2	**7 886.7**

Year 1995		Initial (1994)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1995)	Forest Land	**2 629.0**	0.4	0.3	0.0	0.5	0.0	2 630.1
	Grassland	0.1	**930.9**	15.4	0.0	0.5	0.0	946.9
	Cropland	0.2	0.8	**3 376.9**	0.1	0.6	0.0	3 378.5
	Wetland	0.0	0.1	0.1	**158.4**	0.4	0.0	159.1
	Settlements	0.3	0.4	1.2	0.1	**662.8**	0.0	664.8
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 629.5	932.5	3 393.9	158.6	664.8	107.2	**7 886.6**

Year 1996		Initial (1995)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1996)	Forest Land	**2 629.2**	0.4	0.9	0.0	0.5	0.0	2 631.0
	Grassland	0.3	**943.7**	45.4	0.1	1.3	0.0	990.9
	Cropland	0.2	2.2	**3 330.8**	0.1	0.8	0.0	3 334.0
	Wetland	0.0	0.1	0.1	**158.8**	0.3	0.0	159.3
	Settlements	0.4	0.5	1.4	0.1	**661.8**	0.0	664.2
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 630.1	946.9	3 378.6	159.1	664.7	107.2	**7 886.7**

Year 1997		Initial (1996)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1997)	Forest Land	**2 630.1**	0.4	0.3	0.0	0.9	0.0	2 631.8
	Grassland	0.2	**987.2**	10.2	0.1	1.1	0.0	998.8
	Cropland	0.2	2.6	**3 322.2**	0.1	1.3	0.0	3 326.4
	Wetland	0.0	0.1	0.1	**159.0**	0.2	0.0	159.4
	Settlements	0.4	0.6	1.1	0.1	**660.8**	0.0	662.9
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 630.9	990.9	3 334.0	159.3	664.3	107.2	**7 886.6**

Year 1998		Initial (1997)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1998)	Forest Land	**2 630.3**	0.7	0.5	0.1	2.3	0.0	2 633.8
	Grassland	0.4	**983.6**	5.8	0.3	2.8	0.0	992.9
	Cropland	0.4	13.4	**3 318.3**	0.4	4.5	0.0	3 337.0
	Wetland	0.1	0.2	0.1	**158.2**	0.4	0.0	159.0
	Settlements	0.5	0.9	1.5	0.3	**652.9**	0.0	656.1
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 631.7	998.8	3 326.2	159.3	662.8	107.2	**7 886.0**

Year 1999		Initial (1998)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1999)	Forest Land	**2 632.9**	0.5	0.3	0.0	0.7	0.0	2 634.5
	Grassland	0.1	**991.1**	4.1	0.0	0.4	0.0	995.7
	Cropland	0.1	0.9	**3 330.6**	0.0	0.6	0.0	3 332.2
	Wetland	0.1	0.1	0.2	**158.7**	0.1	0.0	159.2
	Settlements	0.6	0.6	1.9	0.1	**654.4**	0.0	657.5
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 633.8	993.1	3 337.1	159.0	656.2	107.2	**7 886.4**

Year 2000		Initial (1999)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2000)	Forest Land	**2 633.8**	0.5	0.5	0.1	2.4	0.0	2 637.3
	Grassland	0.1	**992.9**	13.1	0.1	0.4	0.0	1 006.6
	Cropland	0.1	1.7	**3 316.6**	0.1	0.3	0.0	3 318.8
	Wetland	0.1	0.1	0.2	**158.9**	0.1	0.0	159.3
	Settlements	0.4	0.5	1.9	0.1	**654.3**	0.0	657.2
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 634.5	995.8	3 332.2	159.3	657.5	107.2	**7 886.5**

Year 2001		Initial (2000)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2001)	Forest Land	**2 636.8**	0.5	0.4	0.0	1.1	0.0	2 638.9
	Grassland	0.1	**1 004.8**	6.0	0.0	0.5	0.0	1 011.4
	Cropland	0.1	0.8	**3 310.3**	0.0	0.3	0.0	3 311.6
	Wetland	0.0	0.1	0.1	**159.2**	0.1	0.0	159.6
	Settlements	0.3	0.4	1.9	0.1	**655.1**	0.0	657.8
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 637.3	1 006.6	3 318.7	159.4	657.2	107.2	**7 886.5**

Year 2002		Initial (2001)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2002)	Forest Land	**2 638.4**	0.9	1.1	0.0	2.5	0.0	2 643.1
	Grassland	0.1	**1 009.3**	3.7	0.0	0.9	0.0	1 014.0
	Cropland	0.0	0.3	**3 303.9**	0.1	0.1	0.0	3 304.5
	Wetland	0.1	0.1	0.2	**159.4**	0.2	0.0	159.9
	Settlements	0.3	0.8	2.6	0.1	**654.3**	0.0	658.1
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 638.9	1 011.4	3 311.6	159.6	658.0	107.2	**7 886.8**

Year 2003		Initial (2002)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2003)	Forest Land	**2 642.1**	0.6	0.7	0.0	0.7	0.0	2 644.2
	Grassland	0.1	**1 011.2**	4.6	0.0	0.3	0.0	1 016.3
	Cropland	0.1	1.5	**3 296.9**	0.0	0.1	0.0	3 298.6
	Wetland	0.0	0.1	0.2	**159.7**	0.1	0.0	160.1
	Settlements	0.5	0.6	2.1	0.1	**656.9**	0.0	660.2
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 642.9	1 014.0	3 304.5	159.9	658.1	107.2	**7 886.7**

Year 2004		Initial (2003)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2004)	Forest Land	**2 643.5**	0.8	0.8	0.0	0.6	0.0	2 645.7
	Grassland	0.1	**1 013.8**	3.1	0.0	0.4	0.0	1 017.4
	Cropland	0.1	0.7	**3 291.9**	0.0	0.2	0.0	3 292.8
	Wetland	0.0	0.2	0.2	**159.9**	0.1	0.0	160.5
	Settlements	0.5	0.9	2.7	0.1	**658.9**	0.0	663.1
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 644.2	1 016.4	3 298.7	160.1	660.2	107.2	**7 886.8**

Year 2005		Initial (2004)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2005)	Forest Land	**2 645.1**	0.9	0.9	0.0	0.6	0.0	2 647.4
	Grassland	0.1	**1 015.1**	4.0	0.0	0.3	0.0	1 019.5
	Cropland	0.1	0.4	**3 284.9**	0.0	0.2	0.0	3 285.7
	Wetland	0.0	0.2	0.2	**160.4**	0.1	0.0	160.9
	Settlements	0.4	0.8	2.7	0.1	**661.9**	0.0	666.0
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 645.7	1 017.4	3 292.8	160.5	663.1	107.2	**7 886.7**

Year 2006		Initial (2005)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2006)	Forest Land	**2 647.0**	0.7	1.0	0.0	0.4	0.0	2 649.1
	Grassland	0.1	**1 017.6**	4.0	0.0	0.2	0.0	1 021.9
	Cropland	0.1	0.4	**3 277.5**	0.0	0.2	0.0	3 278.2
	Wetland	0.0	0.2	0.3	**160.7**	0.2	0.0	161.4
	Settlements	0.3	0.7	2.8	0.1	**664.9**	0.0	668.8
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 647.4	1 019.5	3 285.6	160.9	665.9	107.2	**7 886.7**

Year 2007		Initial (2006)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2007)	Forest Land	**2 648.8**	0.6	0.9	0.0	0.9	0.0	2 651.2
	Grassland	0.1	**1 019.9**	3.5	0.0	0.2	0.0	1 023.7
	Cropland	0.0	0.5	**3 270.4**	0.0	0.2	0.0	3 271.2
	Wetland	0.0	0.2	0.3	**161.2**	0.4	0.0	162.1
	Settlements	0.3	0.7	3.0	0.1	**667.1**	0.0	671.2
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 649.1	1 021.9	3 278.1	161.4	668.8	107.2	**7 886.7**

Year 2008		Initial (2007)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (2008)	Forest Land	**2 650.8**	0.5	0.8	0.1	0.9	0.0	2 653.0
	Grassland	0.0	**1 021.8**	3.3	0.0	0.1	0.0	1 025.4
	Cropland	0.1	0.4	**3 263.6**	0.0	0.2	0.0	3 264.4
	Wetland	0.0	0.2	0.3	**161.9**	0.1	0.0	162.5
	Settlements	0.3	0.7	3.1	0.1	**669.8**	0.0	674.0
	Other Land	0.0	0.0	0.0	0.0	0.0	**107.2**	107.2
	Area (kha)	2 651.2	1 023.6	3 271.1	162.1	671.2	107.2	**7 886.5**

7.2.3 *Methodologies 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). Additionally, the 2006 Guidelines for National Greenhouse Gas Inventories – Agriculture, Forestry and Other Land Use (IPCC 2006) were consulted whenever appropriate. The following text describes the inventory for the individual land-use categories, noting vital information on the category within the conditions of the Czech Republic, the methodology employed, uncertainty and time consistency, QA/QC and verification, recalculations and source-specific planned improvements.

7.3 Forest Land (5A)

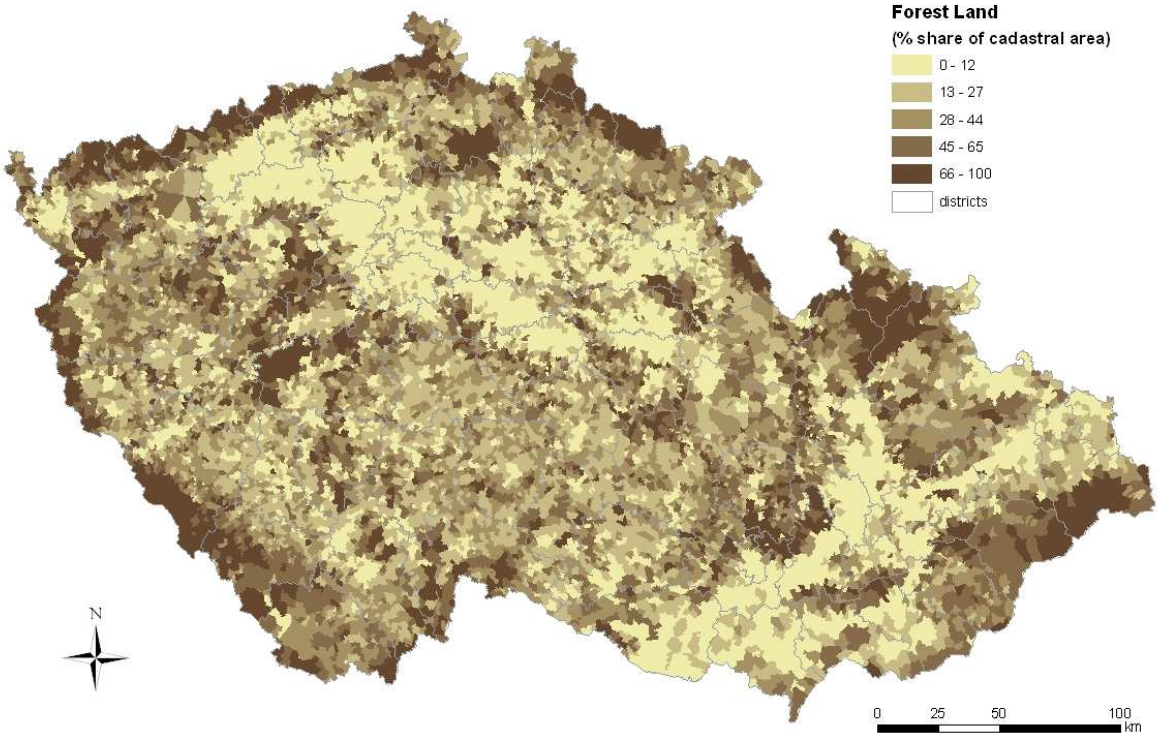


Fig. 7.3 Forest Land in the Czech Republic – distribution calculated as a spatial share of the category within cadastral units (as of 2008).

7.3.1 *Source category description*

The Czech Republic is a country with a long forestry tradition. Practically all the forests 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, Forest Land is defined as land with woody vegetation and with tree crown cover of at least 30 %, over an area exceeding 0.05 ha containing trees able to reach a minimum height of 2 m at maturity[9]. This definition of forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines. The permanently unstocked area of cadastral forest land has predominantly the attributes of Grassland, and therefore it was ascribed to

[9] These parameters, together with the minimum width of 20 m for linear forest formations, were given in the Czech Initial Report under the Kyoto Protocol.

that category. Hence, Forest Land in this emission inventory corresponds to the national definition of timberland (Czech Forestry Act 84/1996). In 2007, the stocked forest area (timberland) qualifying under the category of Forest Land in this emission inventory equaled 2 598 thousand ha, representing 98 % of the cadastral forest land in the Czech Republic. The permanently unstocked area represents 2 % of the forest land according to cadastral data and it was linked by this proportion to the area of Forest Land for the whole time series since 1969.

Forests (cadastral forest land) currently occupy 33.6 % of the area of the country (MA 2009). The tree species composition is dominated by conifers, which represent 74.4 % of the timberland area. The four most important tree species in this country are spruce, pine, beech and oak, which account for 52.4, 17.0, 7.0 and 6.8 % of the timberland area, respectively (MA 2009). Broadleaved tree species have been favored in new afforestation since 1990. The proportion of broadleaved tree species increased from 21 % in 1990 to about 24.5 % in 2008. The total growing stock (merchantable wood volume) in forests in the country has increased during the reported period from 564 mil. m^3 in 1990 to 676.4 mil. m^3 (under bark) in 2008 (MA 2009).

Several sources of information on forests are available in the Czech Republic. The primary source of activity data on forests used for this emission inventory is the forest taxation data in Forest Management Plans (further denoted as FMP), which are administered centrally by the Forest Management Institute (FMI), Brandýs n. L. With a forest management plan cycle 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. The second source of information consists in the data from the first cycle of the statistical (sample based, tree level) forest inventory performed during 2001-2004 by FMI. The results of this forest inventory were published in 2007 (FMI, 2007)[10]. The most recent statistical information on forests at a county level gives the Czech landscape inventory (CzechTerra), a project funded by the Ministry of Environment (Černý 2009, SP/2d1/93/07)[11]. This emission inventory is dominantly based on the FMP data, which have also been used for all the international reporting on forests of the Czech Republic to date. Whenever feasible, the information from other inventory programs mentioned above and/or other sources was also utilized.

FMP data were aggregated in line with the country-specific approaches at the level of the 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 intervals). For these categories, growing stock (merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm), the corresponding areas and other auxiliary information were available for each inventory year. It can be observed in Fig. 7.4 that the average growing stock has increased steadily for all tree species groups since 1990 in this country. In addition to the four major categories by predominant tree species, clear-cut areas are also distinguished, forming another, specific sub-category of Forest Land as reported in this submission. A clear-cut area is defined as a temporarily unstocked area following final or salvage harvest of forest stands. It ceases to exist once it is reforested, which must occur within two years according to the Czech Forestry Act. There is no detectable carbon stock change for this category and it is introduced solely for the purpose of consolidated, transparent and consistent reporting of forest land. In 2008, clear-cut areas represented 1.0 % of Forest Land.

The annual harvest volume constitutes the other key information related to forestry. This value is available from the Czech Statistical Office (CSO). CSO collects this information on the basis of about

[10] The first cycle of the statistical (sample based, tree level) forest inventory was performed during 2001-2004 by the Forest Management Institute (FMI), Brandýs n. Labem. These data indicate significantly higher growing stock volumes (328 m^3/ha under bark, excluding standing dead trees) than those reported so far for this country on the basis of data from forest management plans.This was mainly prescribed to methodological differences between the stand-wise inventory used for forest management planning and the tree-level, sample based statistical forest inventory (e.g., Černý *et al*. 2006; FMI 2007). However, only one inventory cycle of sample based inventory it is not readily usable for detecting carbon stock change in forests.

[11] The preliminary results of the CzechTerra project indicate a mean growing stock volume of 309 m^3/ha under bark (IFER 2009, unpublished results), i.e., significantly lower than the estimates of the FMI (2007).

600 country respondents (relevant forest companies and forest owners) and encompasses commercial harvest and fuel wood, and included 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 in 1990 to 16.2 mil. m^3 in 2008, down from 18.5 mil. m^3 harvested in 2007 (all data refer to underbark volumes). Additionally, harvest loss of 5 and 15 % is applied to final and salvage logging volumes, respectively. The salvage logging operations concern primarily stands of coniferous species, which are commonly hit by windstorms, snow and bark-beetle calamities in this country.

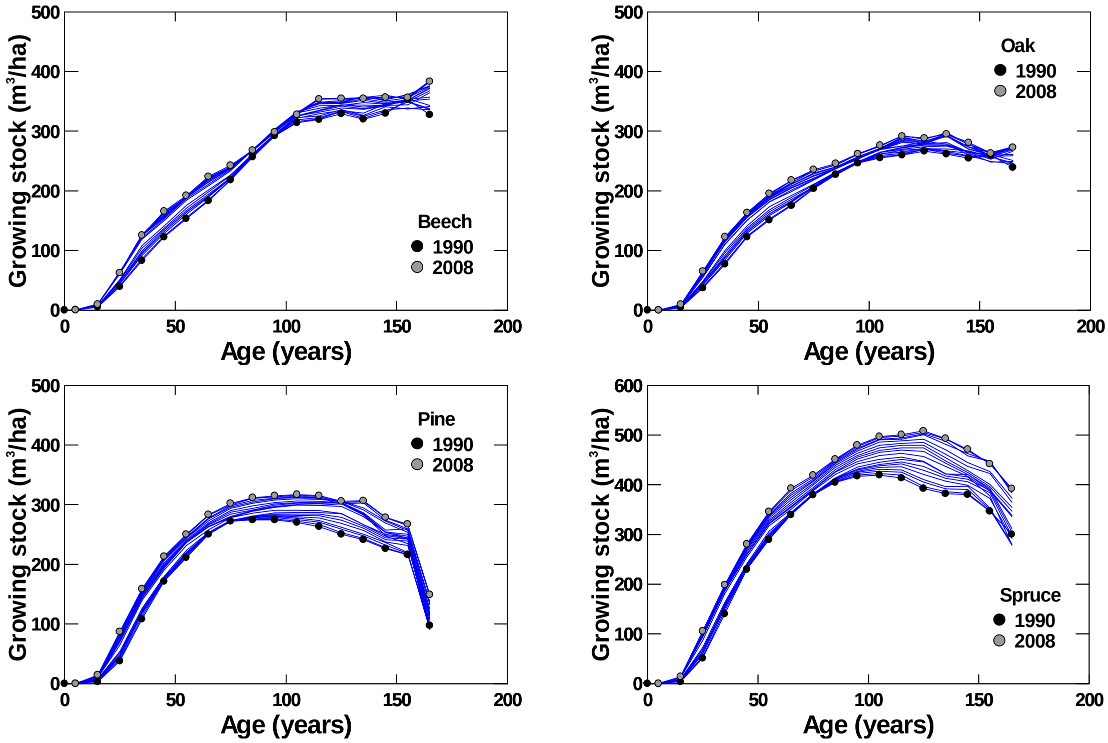


Fig. 7.4 Activity data - average growing stock volume against stand age for the four major groups of species during 1990 to 2008; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2008.

7.3.2 *Methodological aspects*

Category *5A Forest Land* includes emissions and sinks of CO_2 associated with forests and non-CO_2 gases generated by burning in forests. This category is composed of *5A1 Forest Land remaining Forest Land*, and *5A2 Land converted to Forest Land*. The following text describes the major methodological aspects related to emission inventories of both forest sub-categories.

The methods of area identification described in Section 7.1.2 distinguish the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory *5A1 Forest Land remaining Forest Land*. The other part represents subcategory *5A2 Land converted to Forest Land*, i.e., the forest areas “in transition” that were converted from other land-use categories over the 20 years prior to the reporting year. The areas of forest subcategories, i.e., *5A1* and *5A2* accumulated over a 20-year rolling period can be found in the corresponding CRF Tables. The annual matrices of identified land-use and land-use changes are given in Tab. 7.3 above.

7.3.2.1 Forest Land remaining Forest Land

Carbon stock change in category *5A1 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[12] according to Eq. 3.3.2 of GPG for LULUCF. This method is based on separate estimation of increments and removals, and their difference.

The reported growing stock of merchantable volume from the database of FMP formed 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 (I_v) data. In the Czech Republic, these values have been traditionally calculated by FMI (FMP database administrator) and reported to the national and international statistics. The calculation is performed at the level of the individual stands and species using the available growth and yield data and models. The increment data were partly revised in the earlier NIR (2008) to unify two different base information sources (Schwappach 1923; Černý *et al*. 1996) for increment estimates and to apply only the latest source across the entire reporting period. This was to comply with the GPG for LULUCF requirements of consistent time series. No change, apart from entering the increment of latest reported year, was made to the increment in this inventory submission (Fig. 7.5).

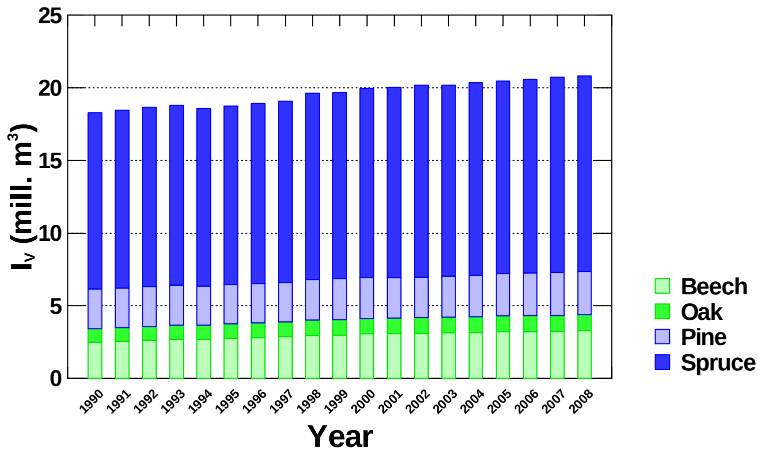


Fig. 7.5 Current annual increment (I_V; m^3 underbark) by the individual tree species groups as used in the reporting period 1990 to 1999.

The merchantable volume increment (I_v) is converted to the biomass increment (G_{Total}), biomass conversion and expansion factors applicable for increment ($BCEF_i$) using Eqs. 2.9 and 2.10 (AFOLU 2006) as follows:

$$\Delta C_G = \sum_j (A_j * G_{Total_j} * CF_j) \quad (1)$$

where A_j and CF_j represent the actual stand area (ha) and carbon fraction of dry matter (t C per t dry matter), respectively, for each major tree species type *j* (beech, oak, pine, spruce), while G_{Total} is calculated for each *j* as follows:

$$G_{Total} = \sum \{ I_V * BCEF_i * (1 + R) \} \quad (2)$$

where *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 increment.

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

Tab. 7.4 Input data and factors used in carbon stock increment calculation (1990 and 2008 shown) for beech, oak, pine and spruce species groups, respectively.

Variable or conversion factor	Unit	Year 1990	Year 2008
Area of forest land remaining forest land (*A*)	kha	372; 152; 455; 1504	455; 173; 434; 1472
Biomass conv. & exp. factor, incr. ($BCEF_i$)	Mg m^{-3}	0.74; 0.86; 0.52; 0.60	0.74; 0.85; 0.53; 0.60
Carbon fraction in biomass (*CF*)	t C/t biomass	0.50	0.50
Root/shoot ratio (*R*)	-	0.20	0.20
Volume increment (I_v)	m^3	6.55; 5.96; 5.84; 7.89	7.10; 6.32; 6.75; 9.02

In Tab. 7.4, *A* represents only the areas of *5A1 Forest Land remaining Forest Land*, updated annually. The applied biomass conversion and expansion factors applicable for the increment ($BCEF_i$) and growing stock volumes ($BCEF_h$) are based on national allometric studies (Cienciala *et al*. 2006a, 2006b, 2008a) or biomass compilations that include data from the Czech Republic (Wirth *et al*. 2004, Wutzler *et al*. 2008). Since the biomass conversion and expansion factors are age-dependent (Lehtonen *et al*. 2004, 2007), they respect the actual age-class distribution of the dominant tree species. Hence, the $BCEF_i$ values shown in Table 7.4 are weighted means considering the actual volumes of the individual age classes for each of the major tree species. Besides the allometric equations noted above, the source dendrometrical material used for derivation of the country-specific $BCEF_i$ values were the data of the landscape inventory program CzechTerra (Černý 2009). Its first cycle was completed in 2009 and these dendrometrical data hence represent the most current information on the Czech Forests available in the country. The tree level data together with the information of age was used to assess the median $BCEF_i$ values for each age class and major tree species. *CF* of 0.50 is a generally accepted default constant, which is also recommended by IPCC (2003). *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), as well as to the evidence apparent from the parameterized allometric equations for the major tree species (Wirth *et al*. 2004, Wutzler *et al*. 2008). I_v is the annually updated volume increment estimated per hectare and species group as described above.

The estimation of carbon drain (*L*; Eq. 2) in the category *5A1 Forest Land remaining Forest Land* basically follows Eqs. 3.2.6, 3.2.7 and 3.2.8 (IPCC 2003). It uses the annual amount of total harvest removals (*H*) reported by the CSO for individual tree species in the country. *H* covers thinning and final cut, as well as the amount of fuel wood, which is reported as an assortment under the conditions of Czech Forestry. To include a potentially unaccounted-for loss associated with *H*, the factor F_{HL} was applied to *H*; it was calculated from annual harvest data and the share of salvage logging, assuming 5 % loss under planned forest harvest operations and 15 % for accidental/salvage harvest applicable for coniferous species. Hence, the harvest volumes entering the actual emission calculation (*H* in eq. 3 below) include the correction by the above described factor, F_{HL}. The calculation of the carbon drain (*L*; loss of carbon) otherwise also follows Eq. 2.12 (AFOLU 2006) as

$$L_{wood-removals} = H * BCEF_h * (1 + R) * CF \quad (3)$$

where $BCEF_h$ represents a biomass expansion and conversion factor applicable to harvested volumes, derived from national studies or regional compilations that include the data from the Czech Republic as noted and mentioned above. The application of $BCEF_h$ considers the share of the planned harvested volume and the actual salvage logging that was not planned. In the case of planned harvest volumes, the age-dependent $BCEF_h$ values also consider the mean felling age, which is taken from the national reports of the Ministry of Agriculture. For salvage logging, $BCEF_h$ represents the volume-weighted mean of all age classes for the individual dominant tree species, as the actual stand age of those harvested volumes is unknown. The other factors (*CF*, *R*) are identical to those described under Tab. 7.4. The specific values of input variables and conversion factors used to calculate *L* are listed in Table 7.5.

Tab. 7.5 Specific input data and factors used in calculation of carbon drain (1990 and 2007 shown) for beech, oak, pine and spruce species groups, respectively.

Variable or conversion factor	Unit	Year 1990	Year 2007
Harvest volume (*H*)	mill. m^3	0.84; 0.31; 1.33; 10.84	0.92; 0.31; 1.16; 16.11
Biomass expansion factor ($BCEF_h$)	Mg m^{-3}	0.69; 0.81; 0.52; 0.59	0.69; 0.81; 0.52; 0.59

The impact of disturbances (Eq. 2.14, AFOLU 2006) 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 is flexibly allocated to the desired amount of planned wood removals, and is thereby 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) GPG for LULUCF assumption of zero change in these carbon pools. This is a safe assumption, as the country did not experience significant changes in forest types, disturbance or management regimes within the reporting period.

The above assumption also applies to the soil carbon pool, in which the net carbon stock change was considered to equal zero (Tier 1, IPCC 2003). This concerns both mineral and organic soils. The organic soils occur only in the areas of the Spruce sub-category on *5A1 Forest Land remaining Forest Land*. They represent protected peat areas in mountainous regions dominated by spruce stands, with no or specific management practices. No such areas occur under other the sub-categories by the predominant species of Beech, Oak and Pine.

Emissions in category *5A1 Forest Land remaining Forest Land* include, in addition to CO_2, also other greenhouse gases (CH_4, CO, N_2O and NO_X) resulting from burning. This encompasses both prescribed fires associated with burning of biomass residues and also emissions due to wildfires. The emissions from burning of biomass residues were 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, part of the biomass residues is burned in connection with final cut. The expert judgment employed in this inventory revision considers that 30 % of the biomass residues including bark is burned. This biomass fraction was quantified on the basis of the annually reported amount of final felling volume of broadleaved and coniferous species, $BCEF_h$ and *CF* as applied to harvest removals (above). The amount of biomass burned (dry matter) was estimated as 585 Gg in 1990 and 849 Gg in 2008.

The emissions of greenhouse gases due to wildfires were estimated on the basis of known areas burnt annually by forest fires and the average biomass stock in forests according to Eq. 3.2.9 (IPCC 2003). This equation used a default factor of biomass left to decay after burning (0.45; Table 3A.1.12). The associated amounts of non-CO_2 gases (CH_4, CO, N_2O and NO_X) were estimated according to Eq. 3.2.19. The amount of biomass (dry matter) burned in wildfires was estimated as 10.2 Gg in 1990 and 6.3 Gg in 2008. The most extreme year of the reporting period was 1997, when about 228 Gg of biomass was burned due to wildfires. The full time series and the associated emissions of non-CO_2 gases can be found in the corresponding CRF tables.

There are no direct N_2O emissions from N fertilization on Forest Land, as there is no practice of nitrogen fertilization of forest stands in the Czech Republic. Similarly, non-CO_2 emissions related to drainage of wet forest soils are not reported, as this activity no longer occurs in practice.

7.3.2.2 Land converted to Forest Land

The methods employed to estimate emissions in the *5A2 Land converted to Forest Land* 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.

For estimation of the net carbon stock change in living biomass on Land converted to Forest Land by the Tier 1 method (IPCC 2003), the carbon increment is proportional to the extent of afforested areas and the growth of biomass. The revised methodology of land-use change identification (Section 7.1.2) provides areas of all conversion types updated annually. Land areas are considered to be under conversion for a period of 20 years, according the Tier 1 assumption of GPG for LULUCF. Under the

conditions in this country, all newly afforested lands are considered as intensively managed lands under the prescribed forest management rules as specified by the Czech Forestry Act.

Until 2006, the increment applicable to age classes I and II (stand age up to 20 years) was estimated from the actual wood volumes and areas that were available per major species groups. Using the available activity stand level data categorized by species and age classes and the national growth and yield model SILVISIM (Černý 2005), the wood increment was derived for all the age classes above 20 years. For age class one (1-10 years), the increment was simply calculated from the reported areas and volumes, assuming a mean age of five years. The increment of age class two (11 to 20 years) was estimated from linear interpolation between the increment of age classes I and III. For the year 2007 and forward, increment is derived for individual tree species using the ratio of increment for individual tree species to the total stand increment estimated from the period 2000 to 2006.

Since the specific species composition of the newly converted land is unknown, the increment estimated for the major tree species was averaged using the weight of actual areas for the individual tree species known from the unchanged (remaining) forest land. Expressed in terms of aboveground biomass, the estimated aggregated mean increment for 2008 was 3.04 t/ha, a value matching that for temperate coniferous (3 t/ha) and somewhat lower than that for broadleaved (4 t/ha) forests given as defaults in GPG for LULUCF. The estimation of increment in terms of aboveground biomass is facilitated by the age and species dependent $BCEF_i$ values as described in Section 7.3.2.1 above. The estimated species-specific values of $BCEF_i$ applicable for young trees until 20 years were 0.99, 1.25, 0.65 and 0.93 for beech, oak, pine and spruce, respectively.

The carbon loss associated with biomass in the category of Land converted to Forest Land was assumed to be insignificant (zero). This is because the first significant thinning occurs in older age classes, which is implicitly accounted for within the category Forest Land remaining Forest Land.

The net changes of carbon stock in dead organic matter were assumed to be insignificant (zero), in accordance with the assumptions of the Tier 1 method (IPCC 2003).

The net change of carbon stock in mineral soils was estimated using the country-specific Tier 2/Tier 3 method. It was based on the vector map of topsoil organic carbon content (Macků *et al*. 2007, Šefrna and Janderková 2007; Fig. 7.6). The map constructed for forest soils utilized over six thousand soil samples, linking the forest ecosystem units - stand site types and ecological series available in maps 1:5 000 and 1:10 000, as used in the Czech system of forest typology (Macků *et al*. 2007). This represents the soil organic carbon content to a reference depth of 30 cm, including the upper organic horizon. The carbon content on agricultural soils was prepared so as to match the forest soil map in terms of reference depth and categories of carbon content, although based on interpretation of coarser 1:50 000 and 1:500 000 soil maps (Šefrna and Janderková 2007). The polygonal source maps were used to obtain the mean carbon content per individual cadastral unit (n=12 994 in 2008), serving as reference levels of soil carbon stock applicable to forest and agricultural soils. Since agricultural soils include both Cropland and Grassland land-use categories, the bulk soil carbon content obtained from the map was adjusted for the two categories. This was performed by applying a ratio of 0.85 relating the soil carbon content between Cropland and Grassland (J. Šefrna, personal communication 2007) and considering the actual areas of Cropland and Grassland in the individual cadastral units. This system permitted estimation of the soil carbon stock change among categories *5A Forest Land, 5B Cropland* and *5C Grassland*. The estimated quantities of carbon stock change at the level of the individual spatial units entered 20-year accumulation matrices distributing carbon into fractions over 20 years (Tier 1, IPCC 2003). These quantities, together with the accumulated areas under the specific conversion categories, were used for estimation of emissions and removals of CO_2.

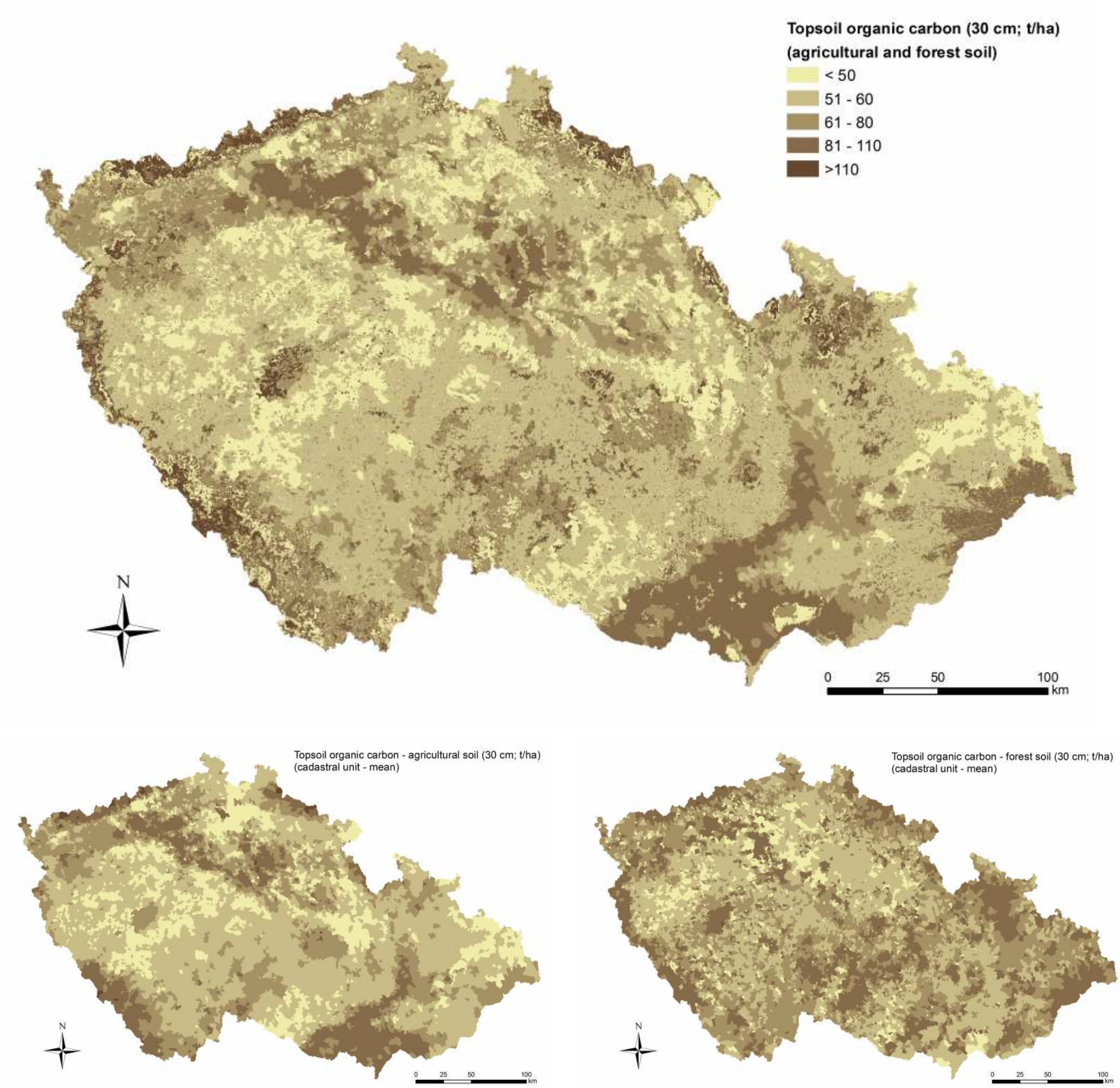


Fig. 7.6 Top - topsoil (30 cm) organic carbon content map adapted from Macků *et al*. (2007), Šefrna and Janderková (2007); bottom –topsoil carbon content for agricultural (left) and forest (right) soils estimated as cadastral unit means from the source maps. The unit (t/ha) and unit categories are identical for all maps.

The net changes of carbon stock in organic soils, occurring only in the sub-category of stands dominated by spruce, were assumed to be insignificant (zero). This is in accordance with the general assumption of the Tier 1 method applicable for forest soils, as no other specific methodology is available for organic soils besides the drained ones (IPCC 2003).

Non-CO_2 emissions from burning are not estimated for category *5A2 Land converted to Forest Land*, as there is no such practice in this country. The same applies to the N_2O emissions from nitrogen fertilization, which is not employed in this country.

7.3.3 *Uncertainty and time consistency*

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2008.

The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC 2003), employing the following equations:

$$U_{Total} = \sqrt{U_1^{\ 2} + U_1^{\ 2} + ... + U_n^{\ 2}} \quad (4)$$

where U_{total} is the percentage uncertainty in the product of the quantities and U_i denotes the percentage uncertainties with each of the quantities (Eq. 5.2.1, IPCC 2003).

For the quantities that are combined by addition or subtraction, we used the following equation to estimate the uncertainty:

$$U_E = \frac{\sqrt{(U_1 * E_1)^2 + (U_2 * E_2)^2 + ... + (U_n * E_n)^2}}{|E_1 + E_2 + ... + E_n|} \quad (5)$$

where U_E is the percentage uncertainty of the sum, U_i is the percentage uncertainty associated with source/sink *i*, and E_i is the emission/removal estimate for source/sink *i* (Eq. 5.2.2, IPCC 2003).

It should be noted, however, that Eq. 5 as exemplified in GPG for LULUCF, is not well applicable for the LULUCF sector. Summing negative (removals) and positive (emission) members (E_i) in denominator of Eq. 5 may easily produce huge uncertainties and theoretically lead to a division by zero, which is not possible. In this respect, this approach is not correct and hence the reported aggregated uncertainties in the LULUCF sector should be interpreted with care, focusing rather to individual uncertainty components prior combining them in Eq. 5.

The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006) that concern areas of land use (3 %), biomass increment (6 %), amount of harvest (20 %), carbon fraction in dry wood mass (2 %), root/shoot factor (30 %), and factor ($1\text{-}f_{BL}$; 75 %), used in calculation of emissions from forest fires. The uncertainty applicable to *BCEF* was 22 %, which was derived from the work of Lehtonen *et al*. (2007). The uncertainty associated with fractions of unregistered loss of biomass under felling operations was set by expert judgment at 30 %.

Adopting rigorously the prescribed methods of combining uncertainties resulted in large overall uncertainties for 2008. For categories *5A1 Forest Land remaining Forest Land* and *5A2 Land converted to Forest Land*, it reached 273 and 56 %, respectively. The large uncertainly was primarily determined by combining uncertainties for spruce-dominated stands in the category biomass carbon stock change that was estimated using the default method. The uncertainties for the major components to be combined, i.e., biomass growth and biomass loss, reached 38 and 56 %, respectively. However, as the corresponding absolute values of removals and emissions were of similar magnitude but with opposite signs when entering the denominator of Eq. 5, it resulted in the above reported large combined uncertainty.

7.3.4 *QA/QC and verification*

Following the recommendation of the latest in-country review, a sector-specific QA/QC plan was formulated, tightly linked to the corresponding QA/QC plan of the National Inventory System. The plan describes the key procedures of inventory compilation, provides a table of personal responsibilities a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates an effective quality control of the LULUCF inventory.

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 the 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. The QA/QC procedures generally cover the elements listed in Table 5.5.1 of GPG for LULUCF (IPCC 2003).

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.

Apart from official review process, emission inventory methods and results are internally reviewed among the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors. Whenever feasible, the methods are subject to peer-review in case of the cited scientific publications, and expert team reviews within the relevant national research projects.

7.3.5 *Recalculations*

The category of Forest Land was recalculated for the whole time period since 1990. This was performed on the solely initiative of the inventory team, which refined the age-dependent biomass expansion and conversion factors on the basis of the newly acquired data of the CzechTerra project (Černý 2009). It affected the estimation of emissions and removals of greenhouse gases for the categories *5A1 Forest Land remaining Forest Land*, as well as the category *5A2 Land converted to Forest Land*. Overall for the category *5A Forest Land*, the estimated removals decreased on average by 12.9 % compared to the previous estimates (Fig. 7.11).

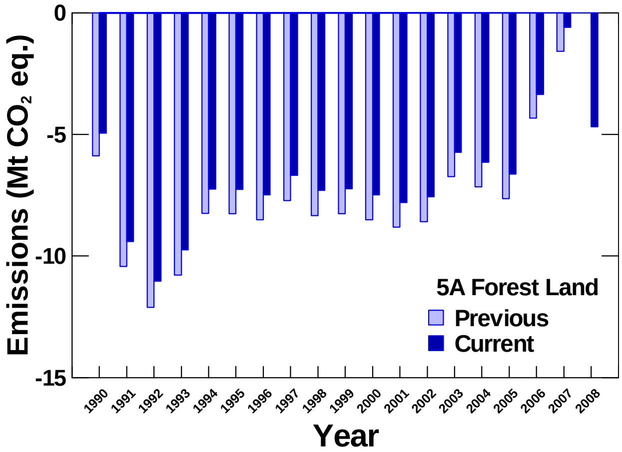


Fig. 7.7 Current and previously reported assessment of emissions for category 5A Forest Land. The values are negative, hence representing net removals of green-house gases.

7.3.6 *Source-specific planned improvements*

The current revision applicable for Forest Land and associated land-use change introduced improvements following the suggestions of the two last in-country reviews, such as reporting emissions/removals by sub-categories of major tree species groups, revised categorization of land-use and an improved land-use determination system. Nonetheless, the category will require additional efforts to further consolidate the current estimates. This includes a further improvement of the uncertainty assessment (exploring the Monte-Carlo approaches) and further formalization and enhancement of QA/QC procedures. Over a longer term, utilization of the stock change method in as explored in Cienciala *et al*. (2006a) will be considered. This involves an assessment of how the data from the recently initiated statistical landscape inventory (CzechTerra, Černý 2009) could be utilized. Additionally, emissions from liming occurring on forest land will be included in the next submission. Although quantitatively small, it will be included in similar way as for 2008 in the current KP LULUCF submission of the Czech Republic (see Chapter 11.3.1.1), once the necessary activity data for the entire reporting period (i.e., since 1990) will be available.

7.4 Cropland (5B)

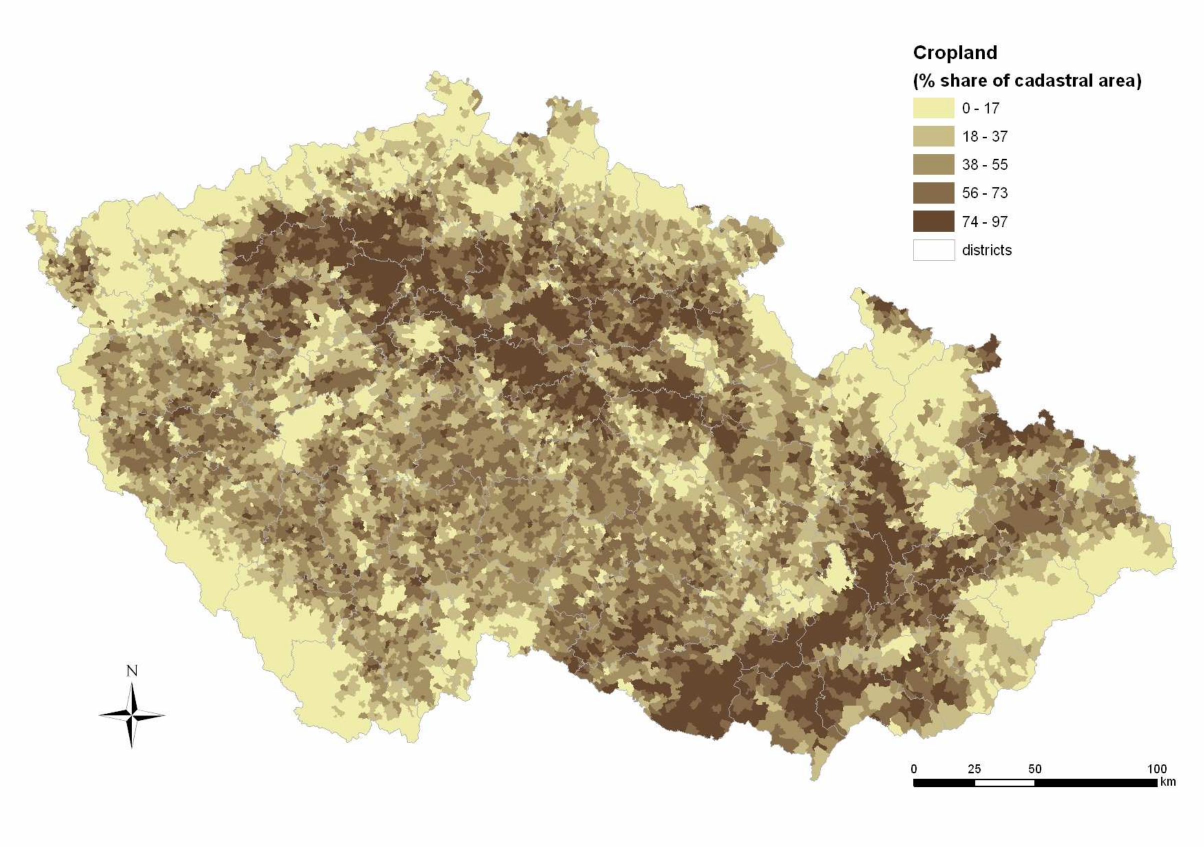


Fig. 7.8 Cropland in the Czech Republic – distribution calculated as a spatial share of the category within cadastral units (as of 2008).

7.4.1 *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. These categories correspond to five of the six real estate categories on agricultural land from the database of "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC.

Cropland is spatially the largest land-use category in the country. Simultaneously, the area of Cropland has constantly decreased since the 1970s, with a particularly strong decreasing trend since 1990 (Fig. 7.2). While, in 1990, Cropland represented approx. 44 % of the total area of the country, this share decreased to nearly 41 % in 2008. It can be expected that this trend will continue. Agricultural methods are gradually becoming more effective and the current area of arable land is excessive. The conversion of arable land to grassland is also actively promoted by state subsidies. In addition, there is a growing demand for land for infrastructure and settlements. The current estimate of probable excess lands qualifying for conversion to other land-use in the near future is about 600 000 ha. Conversion to grassland concerns mainly the lands of less productive regions of alpine and sub-alpine regions.

7.4.2 *Methodological aspects*

The emission inventory of Cropland concerns sub-categories *5B1 Cropland remaining Cropland* and *5B2 Land converted to Cropland*. The emission inventory of Cropland considers changes in living biomass and soil. In addition, CO_2 emissions resulting from application of agricultural limestone and N_2O emissions associated with soil disturbance during land-use conversion to cropland are quantified for this category.

7.4.2.1 Cropland remaining Cropland

For category *5B1 Cropland remaining Cropland*, the changes in biomass can be estimated only for perennial woody crops. Under the conditions in this country, this might be applicable to the categories of vineyards, gardens and orchards. Hence, to estimate emissions associated with biomass on Cropland, we applied a default factor for the biomass accumulation rate (2.1 t C/ha/year, Table 3.3.2, IPCC 2003) and estimated changes in the areas concerned.

The carbon stock changes in soil in the category Cropland remaining Cropland are given by changes in mineral and organic soils. Organic soils basically do not occur on Cropland; they occur as peatland in mountainous regions on Forest Land. While organic soils practically do not occur on Cropland, emissions were estimated for mineral soils. Based on the average carbon content on Cropland estimated from the detailed soil carbon maps (Fig. 7.8), we applied the default relative stock change factors for land use (F_{LU}; 1.0), management (F_{MG}; 1.08) and input of organic matter (F_I; 1.0), respectively (Table 5.5; IPCC 2006). These differentiate management activities on individual Cropland subcategories, in our case arable land, hop fields and the sub-categories containing perennial woody crops. The average soil carbon on typical arable cropland, estimated as the area-weighted average from individual cadastral units, was 59 t/ha, while it was estimated as 63.7 t/ha for soils with woody vegetation, such as in orchards. The changes in soil carbon stock, associated with the annually changing proportion of land areas of cropland sub-categories, result in emissions/removals. These are calculated after redistribution of the estimated carbon stock change over a 20-year rolling period.

The Cropland category also includes emissions due to liming, which were estimated from the reported limestone use and application area. 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 limestone application also lead to evolution of CO_2, which must be quantified. Of the reported total limestone use in agriculture, 95 % was ascribed to Cropland (the reminder to Grassland), based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005). 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/t $CaCO_3$. Separate data are not available for limestone and dolomite, hence the aggregate estimates for total lime applications are reported.

The application of agricultural limestone was previously intensive in this country, but decreased radically during the 1990s. Hence, the amount of limestone applied in 1990 equaled over 2.5 mil. tonnes, but decreased to less than 200 000 tonnes annually during the most recent years (see the corresponding CRF Tables). This dramatic decrease makes the entire category of *5B1 Cropland remaining Cropland* a key category identified by trend, although its quantitative contribution to national emissions in recent years is marginal and reached 0.05 % in 2008. The activity data on liming were repeatedly verified. They correspond to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Salusová *et. al*. 2006).

Non-CO_2 greenhouse gas emissions from burning do not occur in category *5A2 Land converted to Forest Land*, as there is no such practice in this country.

7.4.2.2 Land converted to Cropland

Category *5B2 Land converted to Cropland* includes land conversions from other land-use categories. Cropland has generally decreased in area since 1990, by far most commonly converted to Grassland. However, the adopted land-use identification system was also able to detect some land conversion in the opposite direction, i.e., to Cropland.

The estimation of carbon stock changes in biomass in the category *5B2 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), which follows Tier 1 assumptions of GPG for LULUCF and the recommended default values for the temperate zone. For biomass carbon stock on Forest Land prior conversion, the annually updated average growing stock volumes, species-specific volume-weighted biomass conversion and expansion factors ((*BCEF*), and other factors such as the below-ground biomass ratio were used as described the *5A Forest Land* category in Section 7.2.2.1 above. For biomass carbon stock on Grassland prior the conversion, the default factors of 6.8 t/ha for above-ground and below-ground biomass were used

(Table 6.4, IPCC 2006). A biomass content of 0 t/ha was assumed after land conversion to *5B Cropland*.

The estimation of net carbon stock change in dead organic matter concerns the land use conversion from Forest Land. In this case, the input information on standing and lying deadwood was obtained from the recently (2008 to 2009) conducted field campaign of the Czech landscape inventory CzechTerra (Černý 2009). It provides data on the mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood classified in four categories according to decomposition degree. These categories are defined as follows: i) basically solid wood; ii) peripheral layers soft, central hard; iii) peripheral layers hard, central soft; iv) totally rotten wood. The amount of carbon held in lying deadwood was estimated as the product of the wood volume, density weighted by mean growing stock volume of major tree species (0.433 t/m^3), reduction coefficients of 0.8, 0.5, 0.5, 0.2 (Cerny *et al*. 2002; Carmona *et al*. 2002) applicable to the above described decomposition categories, respectively, and the carbon fraction in the wood (0.5 t C/t biomass). A default, conservative assumption that no deadwood is present following the land use change was adopted in this calculation.

The estimation of the carbon stock change in soils for the category *5B2 Land converted to Cropland* in the Czech Republic concerns mineral soils. The soil carbon stock changes following the conversion from Forest Land and Grassland were quantified by the country-specific Tier 2/Tier 3 approach is described in detail in Section 7.2.2.2 above.

The Land converted to Cropland category represents a source of non-CO_2 gases, namely emissions of N_2O due to mineralization. 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.

Other non-CO_2 emissions may be related to those from burning. However, this is not common practice in this country and no other non-CO_2 emissions besides the above described are reported in the LULUCF sector.

7.4.3 *Uncertainties and time series consistency*

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2007, which applies also for the land use category of Cropland. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006). The following uncertainty default values were used: land use areas 3 %, biomass accumulation rate 75 %, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 100 %, average growing stock volume in forests 8 %, stock change factor for land use 50 %, stock change factor for management regime 5 %, amount of lime 10 %, emission factor for liming 5 % and reference biomass carbon stock prior and after land-use conversion 75 %. The uncertainty applicable to *BCEF* was 22 %, which was derived from the work of Lehtonen *et al*. (2007).

For 2008, the total estimated uncertainty for category *5B1 Cropland remaining Cropland* was 12 %. The corresponding uncertainty for category *5B2 Land converted to Cropland* was 52 %. The overall uncertainty for category *5B Cropland* was estimated to be 30 %. Similarly as noted in Section 7.3.3 above, combining uncertainties in the category involved a questionable combination of negative and positive components in denominator of Eq. 5.

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. The 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. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.4.5 *Recalculations*

The category of Cropland was recalculated for the entire reporting period. This was due to the application of a refined set of species-specific biomass conversion and expansion factors, as well as the inclusion of emissions from deadwood component. These changes affected the emission estimates solely for the land-use conversions involving forest land. Since such situations are rare and involve insignificant areas, the difference in emission estimates between the previous and current NIRs for the category 5B2 Land converted to Cropland is marginal. Combined with the category 5B1 Cropland remaining Cropland, the overall effect of recalculation on the estimated emission of the category 5B Cropland for the entire reporting period is practically zero and the current and previous estimates are basically identical, as shown in Fig. 7.10.

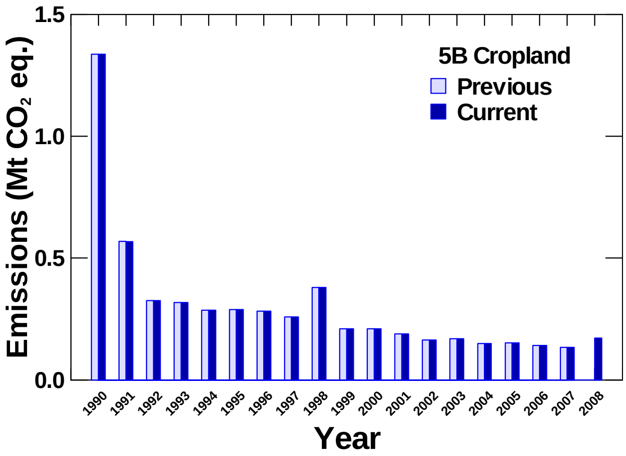


Fig. 7.9 Current and previously reported assessment of emissions for category 5B Cropland.

7.4.6 *Source-specific planned improvements*

Similarly as for other categories, additional efforts will be exerted to further consolidate the current estimates for Cropland. Specific attention will be paid to uncertainty assessment (exploring alternative approaches of combining uncertainties) and further enhancement and formalization of the QA/QC procedures.

7.5 Grassland (5C)

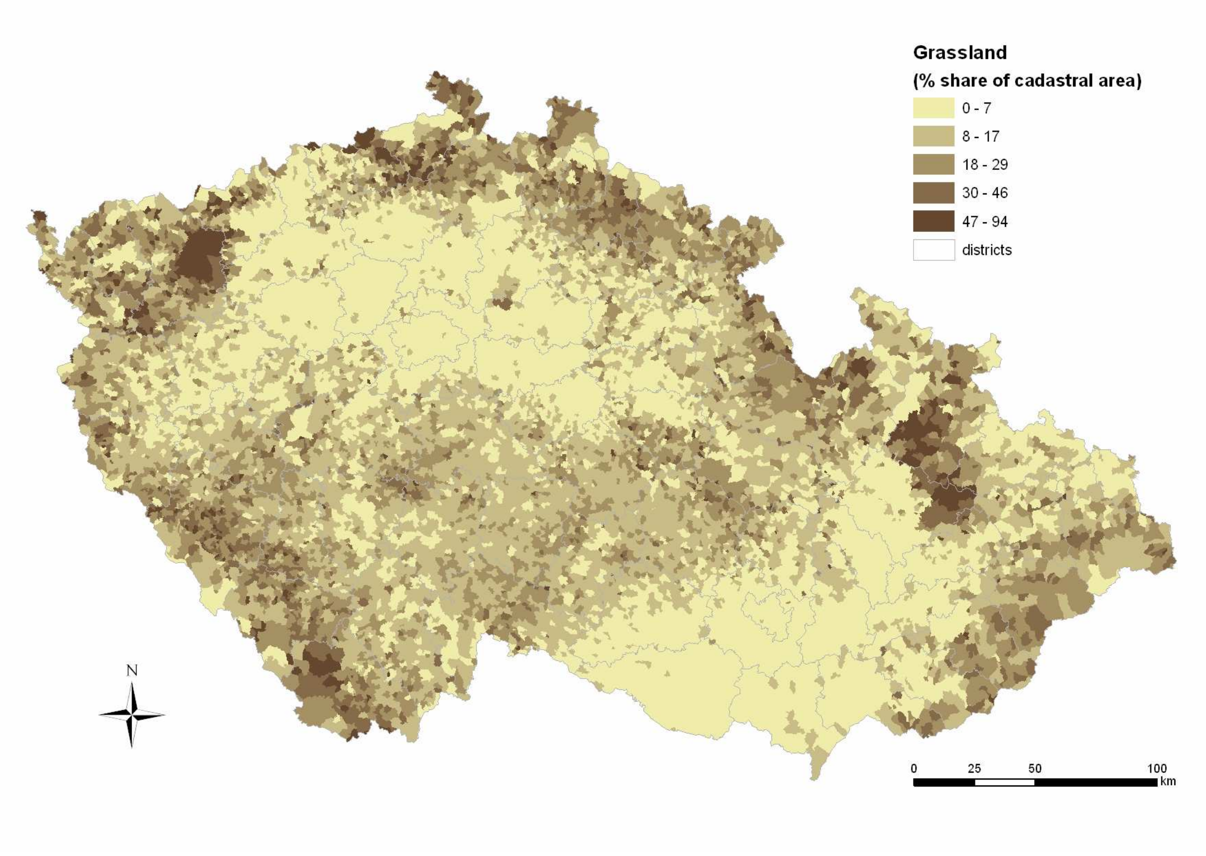


Fig. 7.10 Grassland in the Czech Republic – distribution calculated as a spatial share of the category within cadastral units (as of 2008).

7.5.1 *Source category description*

Through its spatial share of almost 14 % in 2008, the category of Grassland ranks third among land-use categories in the Czech Republic. Its area has been growing rapidly since 1990 (Fig. 7.2). Grassland as defined in this inventory corresponds to the grassland real estate category, one of the six such categories of agricultural land in the database of "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC. This land is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral Forest Land is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).

The importance of Grassland will probably increase in this country, both for its production role and for preserving biodiversity in 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 should be converted from Cropland, the share of which is still considered excessive. After implementation of subsidies in the 1990s, the area of Grassland has increased by almost 16 % (in 2008) since 1990.

7.5.2 *Methodological aspects*

The emission inventory of *5C Grassland* concerns sub-categories *5C1 Grassland remaining Grassland* and *5C2 Land converted to Grassland*. Similarly to *5B Cropland*, the emission inventory of *5C Grassland* considers changes in living biomass and soil. In addition, the effect of application of agricultural limestone is quantified for this category.

7.5.2.1 Grassland remaining Grassland

For category *5C1 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 emissions estimates from changes in soil carbon stock were estimated for category *5C1*. These changes are due to an effect of different management regimes and the changing proportion of the concerned subcategories of *5C1*. Specifically, the changes are estimated for permanently unstocked cadastral Forest Land, which has the attributes of unmanaged grassland and is treated accordingly in the emission estimates (see Section 7.3.1). Other land belonging to the category of Grassland is considered as typically managed grassland. The reference soil carbon stock for this category is estimated as area-weighted mean for all the individual cadastral units. The analogous mean carbon content for the category of unmanaged grassland is determined using the corresponding factors (Table 5.5; IPCC 2006). These included the stock change factor for land use (F_{LU}; 1.0), stock change factor for the management regime (F_{MG}; 0.95) and stock change factor for input of organic matter (F_I; 1.0). The estimated area-weighted average soil carbon stock for classically managed grassland was equal to 69 t C/ha, while that for unmanaged grassland was 65.5 t/ha. This is estimated for the whole reporting period and the soil carbon stock change was derived from the difference between the consecutive years. The changes in soil carbon stock associated with the annually changing proportion of land areas of cropland sub-categories result in emissions/removals. These are calculated after redistribution of the estimated carbon stock change over a 20-year rolling period.

Other explicitly quantified effect on soil carbon that results in CO_2 emissions is that of limestone application. This was quantified as described in Section 7.3.2.1 for *5B Cropland*. The applicable amount of limestone was set at 5 % of the reported limestone use on agricultural lands, based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005).

Non-CO_2 gases on category *5C1 Grassland remaining Grassland* do not concern the LULUCF sector in the Czech Republic.

7.5.2.2 Land converted to Grassland

For category *5C2 Land converted to Grassland*, the estimation concerns carbon stock changes in living biomass and soils.

For living biomass, the calculation used Eq. 3.4.13 (IPCC 2003) with the assumed carbon content before the conversion of *5B Cropland* set at 5 t C/ha (Table 3.4.8; IPCC 2003) and that of Forest Land calculated from the mean growing stock volumes as described in Section 7.3.2.2 above. The biomass carbon content immediately after the conversion was assumed to equal zero and carbon stock from one-year growth of grassland vegetation following the conversion was assumed to be 6.8 t C/ha (Table 3.4.9; IPCC 2003).

For dead organic matter, emissions are reported due to changes in deadwood that concern the category *5C21 Forest Land converted to Grassland*. Apart from the actual areas concerned, the emission estimation is identical as described in Section 7.4.2.2 above.

The estimation of carbon stock change in soils for category *5C2 Land converted to Grassland* in the Czech Republic concerns the changes in mineral soils. The soil carbon stock changes following the conversion from *5A Forest Land* and *5B Cropland* were quantified by the country-specific Tier 2/Tier 3 approach described in detail in Section 7.2.2.2 above.

7.5.3 *Uncertainties and time series consistency*

Similarly as for other land-use categories, the methods used in this inventory for Grassland were consistently employed across the whole reporting period from the base year of 1990 to 2008. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty default values were used: land use areas 3 %, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 100 %,

average growing stock volume in forests 8 %, stock change factor for land use 50 %, stock change factor for management regime 5 %, amount of lime 10 %, emission factor for liming 5 % and reference biomass carbon stock prior to and after land-use conversion 75 %. The uncertainty applicable to *BCEF* was 22 %, which was derived from the work of Lehtonen *et al*. (2007).

For 2008, the total estimated uncertainty for category *5C1 Grassland remaining Grassland* reached 12 %. The corresponding uncertainty for category *5C2 Land converted to Grassland* reached 14 %. The overall combined uncertainty for category *5C Grassland* also reached 14 %.

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. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.5.5 *Recalculations*

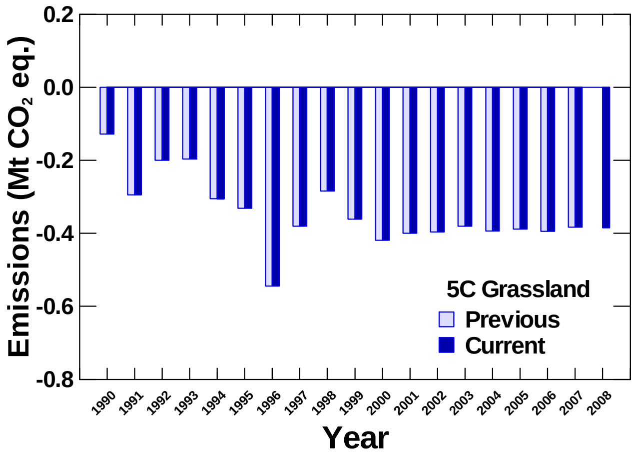


Fig. 7.11 Current and previously reported assessment of emissions for category 5C Grassland. The values are negative, hence representing net removals of green-house gases.

Similarly as for category *5B Cropland*, category *5C Grassland* was recalculated for the entire reporting period. This was due to the application of a refined set of species-specific biomass conversion and expansion factors, as well as the inclusion of emissions from deadwood component. These changes affected the emission estimates solely for the land-use conversions involving forest land. The emission estimates remain negative, i.e., represent a sink of GHGs for the entire reporting period. The new estimates for the category *5C Grassland* changed only slightly, giving smaller sink by about 0.1 % at most. The effect is small because of only slight change in the applied conversion and expansion factors and due to overall marginal contribution of the land conversion concerned within the entire category *5C Grassland*. Therefore, the current and previous estimates are basically identical, as shown in Fig. 7.12.

7.5.6 *Source-specific planned improvements*

Further efforts to consolidate the emission estimates are expected for the category of Grassland. Specific attention will be paid to a refinement of the uncertainty assessment and overall formalization and enhancement of the QA/QC procedures.

7.6 Wetlands (5D)

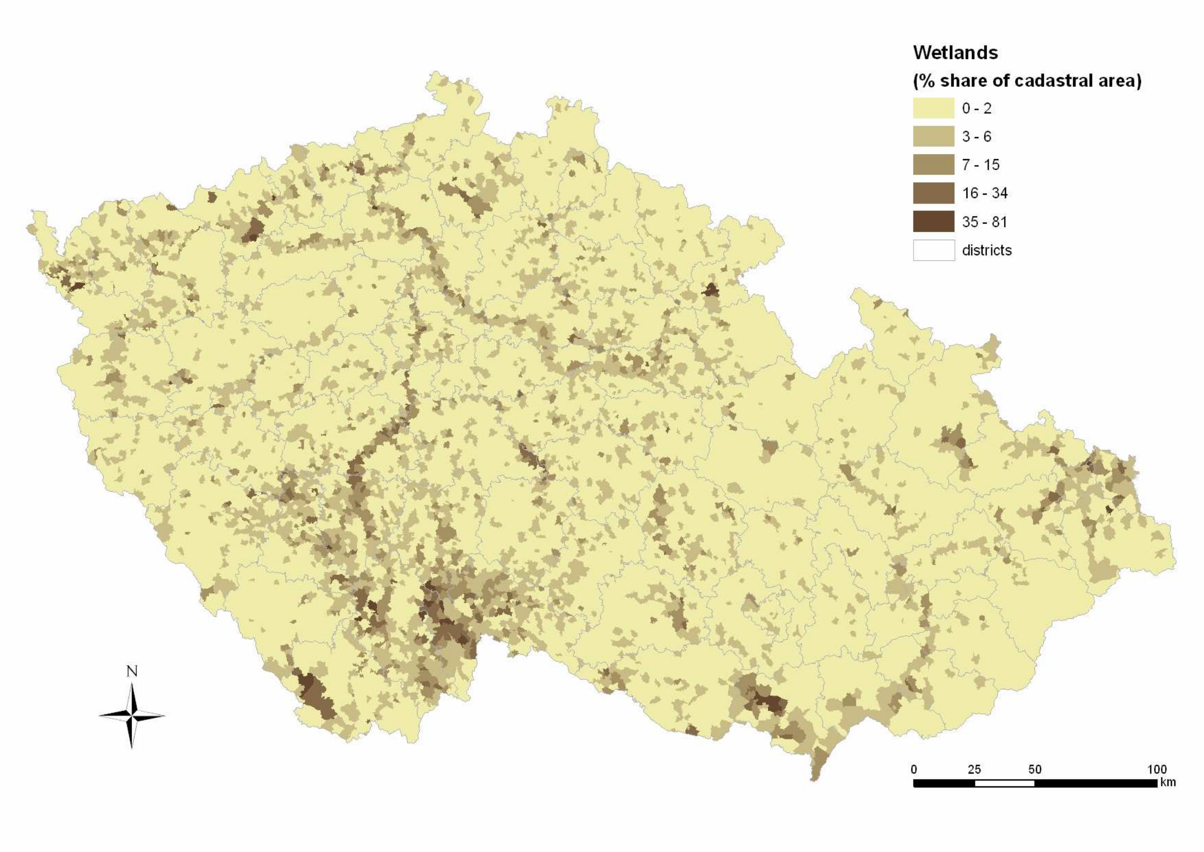


Fig. 7.12 Wetlands – distribution calculated as a spatial share of the category within cadastral units (as of 2008).

7.6.1 *Source category description*

Category *5D Wetlands* as classified in this emission inventory includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and swamps. These areas correspond to the real estate category of water area of the "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC. It should be noted that there are about 11 wetlands identified as Ramsar[13] sites in this country. However, these areas are commonly located in several IPCC land-use categories and are not directly comparable with the actual content of the 5D emission category.

The area of *5D Wetlands* currently covers 2.1 % of the total territory. It has been growing steadily since 1990 (Fig. 7.2) with an even stronger trend since 1970. It can be expected that this trend will continue and that the area of Wetlands will increase further. This is mainly due to programs aimed at increasing the water retention capacity of the landscape[14].

7.6.2 *Methodological aspects*

The emission inventory of sub-category *5D1 Wetlands remaining Wetlands* can address the areas in which the water table is artificially changed, which correspond to peat-land draining or lands affected by water bodies regulated through human activities (flooded land). Both categories are insignificant

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

[14] 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)

under the conditions in this country. Hence, the emissions for *5D1 Wetlands remaining Wetlands* were not explicitly estimated and they can safely be considered negligible.

Sub-category *5D2 Land converted to Wetlands* encompass conversion from *5A Forest Land*, 5B *Cropland* and *5C Grassland*. This is a very minor land-use change identified in this country, which corresponds to the category of land converted to flooded land. The emissions associated with this type of land-use change are derived from the carbon stock changes in living biomass and in the case of conversion from Forest land, also deadwood. The emissions were generally 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 equaled zero, while the mean biomass stock prior to the conversion in the *5A Forest Land*, 5B *Cropland* and *5C Grassland* categories was estimated and/or assumed identically as described above in Sections 7.3.2.2 and 7.4.2.2. The latter section also describes the estimation of emissions related to deadwood component, which was applied identically in this land use category.

7.6.3 *Uncertainties and time series consistency*

The methods used in this inventory for Wetlands were consistently employed across the whole reporting period from the base year of 1990 to 2008. Similarly as for the other land-use categories, the uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty default values were used: converted land use areas 3 %, average growing stock volume in forests prior conversion 8 %, average biomass stock in cropland and grassland prior conversion 75 %, biomass carbon stock after land-use conversion 75 %, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 100 %. The uncertainty applicable to *BCEF* was 22 %, which was derived from the work of Lehtonen *et al*. (2007).

Since the emission estimate concerns only category *5D2 Land converted to Wetlands*, the uncertainty is estimated for this category. For 2008, the estimated uncertainty for category *5D2* was 78 %.

7.6.4 *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. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.6.5 *Recalculations*

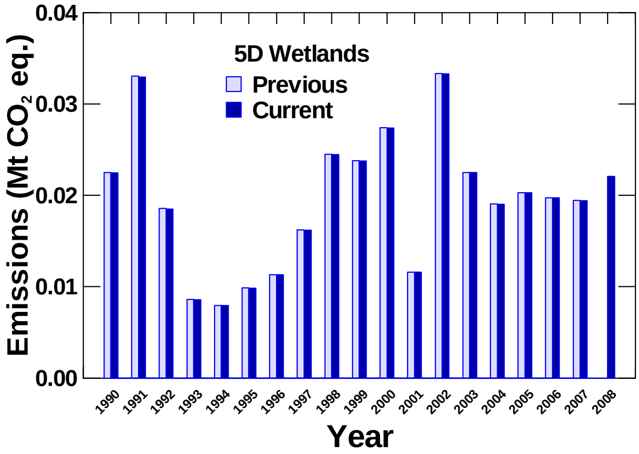


Fig. 7.13 Current and previously reported assessment of emissions for the category 5D Wetlands.

The category of *5D Wetlands* is a tiny source of emissions, reflecting the steadily increasing area of this category. The current recalculation resulted in insignificantly decreased emissions, namely by 0.1 % during the reported period. The reasons for these changes lie in the refined biomass conversion and expansion factors and inclusion of emissions due to deadwood component employed in the category concerning Forest Land converted to Wetlands. However, the current and previous total estimates for category *5D Wetlands* are almost identical, as shown in Fig. 7.14.

7.6.6 *Source-specific planned improvements*

For the category of *5D Wetlands*, attention will also be paid to a further improvement of the uncertainty assessment and to overall formalization and enhancement of the QA/QC procedures.

7.7 Settlements (5E)

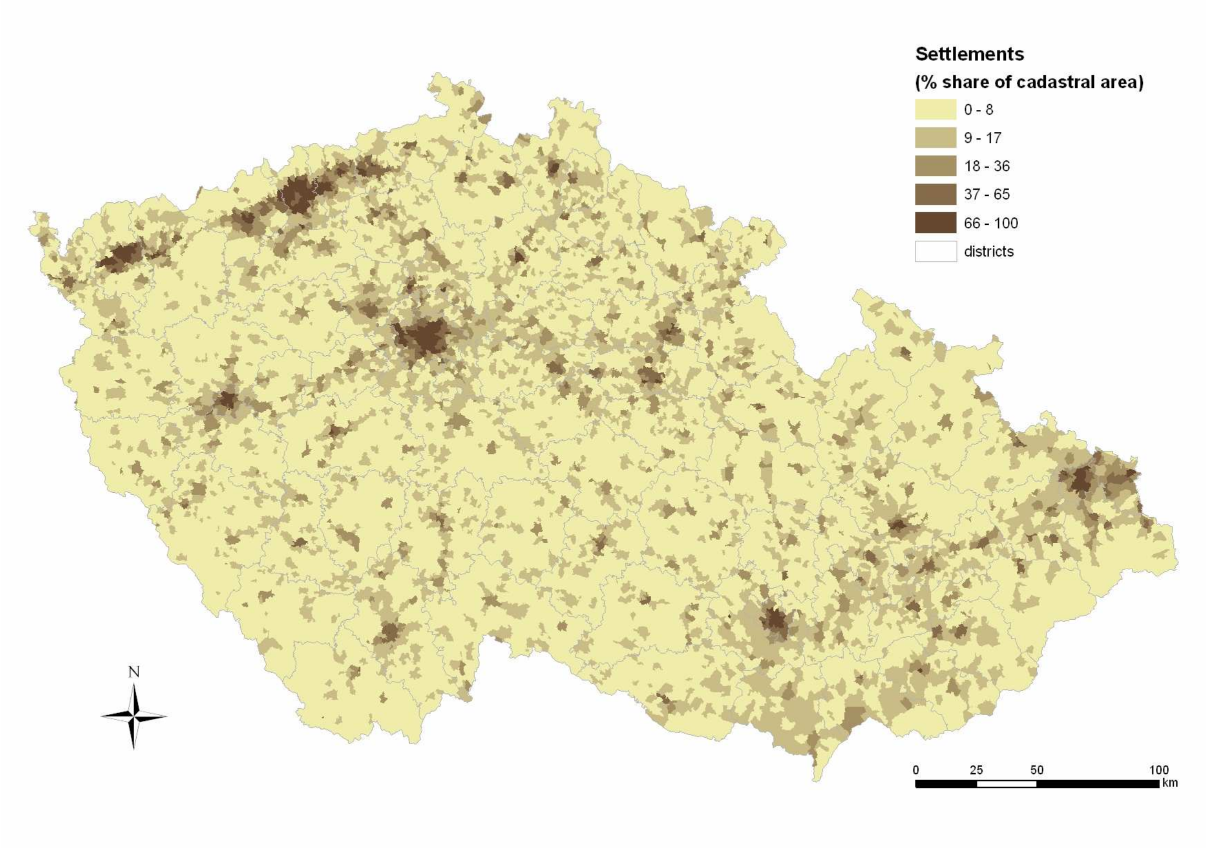


Fig. 7.14 Settlements – distribution calculated as a spatial share of the category within cadastral units (as of 2008).

7.7.1 *Source category description*

Category *5E Settlements* is defined by IPCC (2003) as all developed land, including transportation infrastructure and human settlements. For this emission inventory, the area definition under category *5E Settlements* was revised to better match the IPCC (2003) default definition. The category currently includes two categories of the database "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC, namely "Built-up areas and courtyards" and "Other lands". Of the latter AACLC category, all types of land-use were included with the exception of "unproductive land", which corresponds to category *5F Other Land*. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks, previously included in category *5F Other Land*.

The category of Settlements as defined above currently represents about 8.6 % of the area of the country. The area of this category has increased since 1990 and especially during the most recent years (Fig. 7.2).

7.7.2 *Methodological aspects*

The emission inventory for this category concerns primarily *5E2 Land converted to Settlements*. As for category *5E1 Settlements remaining Settlements*, emissions of CO_2 were considered insignificant as no change in biomass, dead organic matter and soil carbon pools is assumed (Tier 1, IPCC 2006). Emissions quantified in this inventory concern the category *5E2 Forest Land converted to Settlements*. The emissions result mainly from the biomass carbon stock change, which was quantified using Eq. 3.6.1 (IPCC 2003). The carbon stock prior conversion was estimated as described in Section 7.3.2.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of GPG

for LULUCF. Additional contribution to emissions is from deadwood component. It was estimated identically as described in Section 7.4.2.2 above, using the actual areas of the land use change concerned.

7.7.3 *Uncertainties and time series consistency*

The methods used in this inventory for *5E Settlements* were consistently employed across the whole reporting period from the base year of 1990 to 2008. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty default values were used: land use areas 3 %, reference biomass carbon stock prior and after land-use conversion 75 %, average growing stock volume in forests 8 %, and average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 100 %. The uncertainty applicable to *BCEF* was 22 %, which was derived from the work of Lehtonen *et al*. (2007).

The emission estimate concerns only category *5E2 Land converted to Settlements*; therefore, the uncertainty is estimated only for this category. For 2007, the estimated uncertainty for the category *5D2* was 127 %.

7.7.4 *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. The 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. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.7.5 *Recalculations*

The category of Settlements is a source of emissions. This is a result of the increasing area of this category at the expense of other land-use categories. The current recalculation was performed due to the adoption of the refined biomass expansion and conversion factors affecting emission estimates involving land-use conversions from Forest Land. The currently estimated emissions are marginally smaller, namely on average by 0.2 %, as compared to the previous estimates for the entire reporting period (Fig. 7.16).

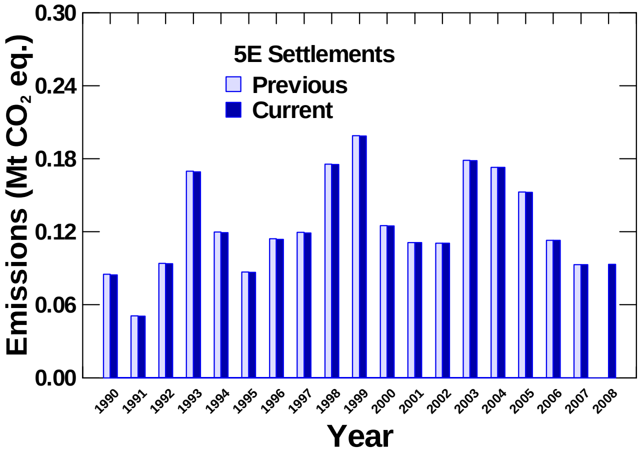


Fig. 7.15 Current and previously reported assessment of emissions for the category 5E Settlements.

7.7.6 *Source-specific planned improvements*

Further efforts to consolidate the emission estimates are expected for the category of Settlements. This will include an assessment of how the data from the recently initiated statistical landscape inventory (CzechTerra, Černý 2009) could be utilized. Attention will also be paid to further improvement of the uncertainty assessment and overall formalization and enhancement of the QA/QC procedures.

7.8 Other Land (5F)

7.8.1 *Source category description*

Since NIR 2008 submission, the category *5F Other Land* represents unmanaged (unmanageable) land areas, matching the IPCC (2003) default definition. These areas were assessed from the database of "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC. It is a part the AACLC category "other lands" with the specific land use category "unproductive land", assessed from the 2006 land census of COSMC. This category represents 1.0 % of the territory of the country and it is considered to be constant, not involving any land-use conversions.

7.8.2 *Methodological aspects*

Change in carbon stocks and non-CO_2 emissions are not considered for *5F1 Other Land remaining Other Land* (IPCC 2003). Since no land-use conversion involving "other land" is assumed by this inventory, no emissions were considered in the entire category *5F Other Land*.

7.8.3 *Uncertainties and time series consistency*

The uncertainty estimates are not reported here. Time series consistency is ensured as the inventory approaches and/or assumptions are applied identically across the whole reporting period from the base year 1990 to 2008.

7.8.4 *QA/QC and verification*

The activity data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

The QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, limited to those relevant for this specific land-use category.

7.8.5 *Recalculations*

No recalculations concern category *5F Other Land*.

7.8.6 *Source-specific planned improvements*

There are no short-term plans concerning this category.

7.9 Acknowledgement

The authors would like to thank Vladimír Henžlík, formerly at the Forest Management Institute in Brandýs n. Labem, for some of the activity data and his expert advice. Thanks are also due to Jan Hána, Forest Management Institute in Brandýs n. Labem, for compiling the required increment data concerning forests. Some of the analyses required for this inventory were performed within the project CzechCARBO (VaV/640/18/03), while some of the critical data were obtained from the project CzechTerra (SP/2d1/93/07), both funded by the Czech Ministry of the Environment.

8. Waste (CRF sector 6)

8.1 Overview

Waste sector consists from several categories. Main source category of this sector is 6A methane emission from solid waste disposal sites. In 2008 this category emitted 115 Gg of methane (2429 Gg of CO_2 ekv). Second source category is 6B emissions form wastewater, which is calculated as a sum of four subcategories – emissions of methane from industrial wastewater treatment, domestic wastewater treatment, on site treatment and emissions of nitrous oxide from wastewater. These subcategories summed up in 2008 emitted 24.5 Gg of methane and 0.66 Gg of N_2O. Last source category in this sector is incineration of municipal, clinical and hazardous waste which produced in total 456 Gg of fossil CO2 ekv. this inventory year. In total sector 6 produced 3604 Gg of CO_2.

Tab. 8.1 Overview of significant categories in this sector (2008)

Category	Character of category	Gas	% of total GHG*
6A Solid Waste Disposal on Land	KC (LA, TA, LA*, TA*)	CH_4	1.7
6B Waste Water Handling	non-KC	CH_4	0.4
6C Waste Incineration	KC (TA, TA*)	CO_2	0.3
6B Waste Water Handling	non-KC	N_2O	0.1

* assessed without considering LULUCF

KC: key category,LA, LA*: identified by level assessment with and without considering LULUCF, respectively

TA, TA*: identified by trend assessment with and without considering LULUCF, respectively

Since beginning 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) (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).

8.2 Solid Waste Disposal on Land (6A)

8.2.1 *Source category description*

Treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of CO_2 released from waste. These CO_2 emissions are not included in national totals, because the carbon is of biogenic origin and net emissions are accounted for under land use change and forestry.

This category produces emissions of other micropollutants such as non-methane volatile organic compounds (NMVOCs) as well as smaller amounts of nitrous oxide (N_2O), nitrogen oxides (NO_x) and carbon monoxide (CO). In this report only CH_4 is addressed.

8.2.2 *Methodological issues*

Key activity data for methane quantification from 6.A is amount of waste disposed in to landfills. Share on total is shown in Tab. 8.1 Overview of significant categories in this sector (2008). Annual disposal is shown in Fig. 8.1 Waste disposal in to landfills 1950-2008, Czech Republic.. Data for annual disposal are from mixed sources because for correct application of FOD model one needs data from 1950 to present days. These data are not available in the country therefore assumptions about past must be used. These assumptions are described in the working paper published on this issue (Havránek, 2007).

Tab. 8.2 Municipal waste utilization and disposal practices in the Czech Republic *[Gg]*, 2008[15]

Total disposal and utilisation	Utilisation of waste as a fuel (R1)	Recovery of organic substances (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 categories
4293	**364**	**97**	**106**	**56**	**3426**	**10**	**1**	**2**	**4**	**227**
100%	**8%**	**2%**	**3%**	**2%**	**80%**	**0%**	**0%**	**0%**	**0%**	**5%**

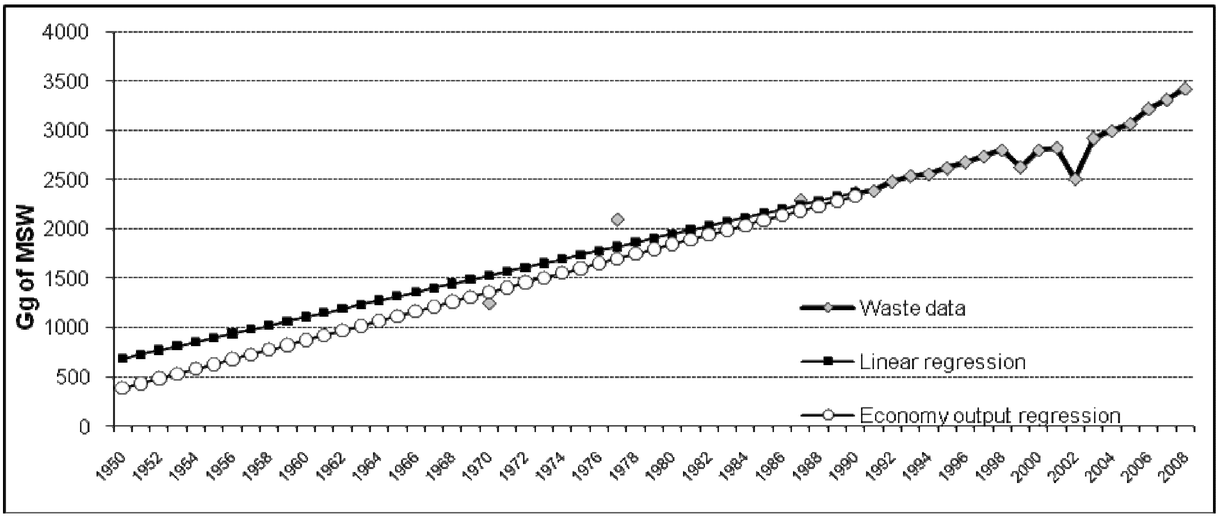


Fig. 8.1 Waste disposal in to landfills 1950-2008, Czech Republic.

The method we are using for estimation of methane emissions from this source category is tier 2 FOD approach (First order decay model). In new methodology it is actually basic tier for this category. First order decay (FOD) model assumes gradual decomposition of waste disposed to landfill. For calculation of GHG emissions from we used IPCC Spreadsheet for Estimating Methane emissions from Solid Waste Disposal Sites which is part of new methodology guidelines IPCC, 2007 (referred further on as IPCC model, 2006).

Waste composition

Waste composition is also problematic for the same reason as the amount of waste. No data are available on the waste composition in 1950 and there are also no data that can be quoted and taken as representative for the country in the following years. Some measurements have been performed but seem to be rather local and the general Municipal Solid waste (MSW) composition can differ substantially. Therefore, we assumed that the waste composition (waste stream percentages) is same as the reference IPCC values for Eastern Europe. We also assume (due to the lack of national data) that

[15] Preliminary data

this composition was similar throughout the entire time series. The composition distribution is given in Tab. 8.3 Default waste composition for the Eastern Europe (IPCC model, 2006).

Tab. 8.3 Default waste composition for the Eastern Europe (IPCC model, 2006)

Food	30 %	Textile	4.5 %
Garden	0 %	Nappies	0 %
Paper	22 %	Plastics, other inert	36 %
Wood	7.5 %		

Based on own expertise and on in country review suggestion we are actively trying to obtain representative country specific data to get more precise results for this category. We are aware that knowledge of waste composition is crucial for this key category.

Organic carbon

Information on the waste composition is useful only if we know how much organic carbon a particular waste stream contains. For this estimation, the author used the default values suggested by IPCC. The default value was also used for the fraction of Degradable Organic Carbon (DOC) that actually decomposed (DOC_f = 0.5).

Methane generation rate

The methane generation rate (k) is closely related to the particular substance and the available moisture. For the FOD equation, the author used the rates for particular waste streams (wood, paper etc.) based on the default IPCC values for defined climatic conditions (see Tab. 8.4 Degradable organic carbon fraction – wet waste (IPCC model, 2006)).

Tab. 8.4 Degradable organic carbon fraction – wet waste (IPCC model, 2006)

	Range	Default	Used values
Food waste	0.08-0.20	0.15	0.15
Garden	0.18-0.22	0.2	0.2
Paper	0.36-0.45	0.4	0.4
Wood and straw	0.39-0.46	0.43	0.43
Textiles	0.20-0.40	0.24	0.24
Disposable nappies	0.18-0.32	0.24	0.24

The average annual temperature in the Czech Republic is about 7 °C. The annual precipitation is higher than potential evapotranspiration. Therefore, the author used the values for a wet temperate climate, which are given in Tab. 8.5 IPCC Climate Zone Definitions (IPCC model, 2006).

Tab. 8.5 IPCC Climate Zone Definitions (IPCC model, 2006)

	Mean annual temperature	Mean annual precipitation	Mean annual precipitation / Potential evapotranspiration
Dry temperate	0 - 20°C		<1
Wet temperate	0 - 20°C		>1
Dry tropical	> 20°C	<1000 mm	
Moist and wet tropical	> 20°C	>1000 mm	

Methane correction factor

Methane correction factor (MCF) is a value that expresses overall management of the landfills in the country. Better-managed and deeper landfills have larger MCF values. Shallow SWDS ensure that there is far more oxygen penetrating into the landfill body to aerobically decomposes DOC. The suggested IPCC values are given in a Tab. 8.6 Methane correction values (IPCC, 1996). Because landfill management has changed during the period of interest, Tab. 8.7 Used MCF values in time,

1950-2008 includes various assumptions associated with this factor. Data on MCF before 1993 are based on expert judgment. No data about unmanaged SWDS were available for 1993, so no data were included for this year.

Tab. 8.6 Methane correction values (IPCC, 1996)

	MCF
Unmanaged, shallow	0.4
Unmanaged, deep	0.8
Managed	1.0
Managed, semi-aerobic	0.5
Uncategorised	0.6

Tab. 8.7 Used MCF values in time, 1950-2008

	MCF
1950 – 1959	0.6
1960 – 1969	0.6
1970 – 1979	0.8
1980 – 1989	0.9
1990 – 2008	1.0

Oxidation factor

As methane moves from the anaerobic zone to the aerobic and semi-aerobic zones close to the landfill surface, part of it becomes oxidized to CO_2. There is no conclusive agreement in the scientific community on how intensive the oxidation of methane is. Oxidation is indeed site-specific due to the effects of local conditions (including fissures and cracks, compacting, landfill cover etc.). No representative measurement or estimations of oxidation factor are available for the Czech Republic. Some studies are quoted in Straka, 2001 that mention a non-zero oxidation factor, but these figures seem to be site-specific and therefore cannot be used as representative for the whole country. However, the methodology (IPCC, 2000) suggests that an oxidation factor higher than 0.1 should not be used if no site measurements are available (a larger value adds uncertainty). The author used the recommended oxidation factor of 0.1 in our assessment.

Delay time

When waste is disposed in SWDS, decomposition (and methanogenesion) does not start immediately. The assumption employed in the IPCC model is that the reaction starts on the first of January in the year after deposition, which is equivalent to an average delay time of six months before decay to methane commences. It is good practice to assume an average delay of from two to six months. If a value greater than six months is chosen, evidence to support this must be provided. The Czech Republic has no representative country-specific value for delay time, so the author used a default value of 6 months.

Fraction of methane

This parameter indicates the share (mass) of methane in the total amount of *Landfill Gas* (LFG). In previous calculations of methane emissions from SWDS (NIR, 2004), a value 0.61 was used. This figure was based on measurement of a limited number of sites (Straka, 2001). This value is higher than the range of 0.5-0.6 suggested by IPCC. In this work, we revised these values based on new evidence (MTI, 2005). MTI receives annual reports from landfills capturing their LFG; SWDS report the gross calorific value of their captured LFG. We used this value for comparison with the gross calorific value of pure methane, yielding a value 0.55, which was used in the quantification.

Recovered methane

Methane that is collected by an artificial system and incinerated (e.g. for energy purposes) is not considered as an emission of GHG (due to the biogenic origin of the carbon). Recovered methane (R) is used in the equation in Appendix 1. There is no default value for R, so the author used country estimates based on Straka, 2001 and MPO, 2008[16]. Values for particular years are shown in Table 7 of calculation spreadsheet, CH_4 recovery column.

Total emissions of methane are based on the equation from the IPCC CH_4 model. Detailed time series from 1950 with breakdown into individual waste components is given in the paper by Havranek 2007, together with the other model outputs. Tab. 8.8 Emissions of methane from SWDS *[Gg]*, Czech Republic, 1990-2008 gives the trends in emissions of methane from SWDS following recalculation.

Tab. 8.8 Emissions of methane from SWDS *[Gg]*, Czech Republic, 1990-2008

	CH_4 generation	CH_4 recovery	CH_4 oxidized	CH_4 emission
1990	91	-3	-9	79
1991	95	-3	-9	83
1992	99	-4	-10	86
1993	103	-4	-10	89
1994	107	-4	-10	93
1995	110	-4	-11	96
1996	114	-6	-11	97
1997	118	-12	-11	95
1998	121	-13	-11	97
1999	125	-14	-11	100
2000	127	-13	-11	102
2001	130	-14	-12	105
2002	133	-16	-12	106
2003	135	-16	-12	107
2004	138	-16	-12	109
2005	141	-17	-12	112
2006	145	-19	-13	113
2007	149	-21	-13	115
2008	153	-24	-13	115

8.2.3 *Uncertainties and time-series consistency*

Due to lack of country specific data there is uncertainty of the default values. In Havranek, 2007 there is sensitivity analysis for several key factors and assumption, but overall quantification of uncertainties is lacking. This is considered a high priority and will be conducted in following years as soon as budget constrains allows that. Biggest uncertainty is due to lack of country specific data about waste composition. Due to application of new tier and whole subcategory recalculation we may state that this category is methodologically consistent. Inconsistencies in data sources are inherent to long time of activity data series and can’t be solved other way than uncertainty assessment in total emission

8.2.4 *QA/QC and verification*

Activity data coming from national agencies and ministries are subjects of internal QA/QC mechanisms. Recalculation that is fully described in (Havranek, 2007) was approved by in country review team in 2007.

[16] Data up to 2001 are based on Straka, 2001, year 2002 is expert estimate based on trend and from 2003 methane recovery is based on annual survey of ministry of trade and industry (e.g. MPO, 2008).

8.2.5 *Recalculations*

No recalculation took place in this category this year.

8.3 Waste-water Handling (6B)

8.3.1 *Source category description*

This category has CRF code 6B and consists of four separately calculated sub-categories – emissions of methane from *6B1 Industrial Wastewater*, *6B2 Domestic and Commercial Waste Water* and *6B3 Other (Treatment on site)* and emissions of nitrous oxide from *6B2 Domestic and Commercial Waste Water*.

8.3.2 *Methodological issues*

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 wastewater and sludge is given as BOD_5 (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 the *Revised 1996 IPCC Guidelines*, 1997 for calculation of methane emissions from industrial wastewater and is always larger than BOD.

The current IPCC methodology employs BOD for evaluation of municipal wastewaters and sludge and COD for industrial wastewaters. The new method is also extended to include determination of emissions from sludge that are primarily the products of various methods of treatment of wastewaters and, under anaerobic conditions, may contribute to methane production and methane emissions. The amount of nitrous oxide emitted from wastewaters is a function of protein consumption in the population rather than BOD or COD.

8.3.2.1 Industrial wastewater (6B1)

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 (IPCC, 1997; IPCC, *2000)*. The necessary activity data were taken from the material of CZSO (*Czech Statistical Office - Statistical Yearbook*) and the other parameters required for the calculation were taken from the IPCC *Good Practice (*IPCC, 2000*)*. On the basis of information on the total amount of industrial wastewater of 174 mil.m^3 (actually only 171 mil.m^3 were treated) (Source CENIA, *Environmental Statistical Yearbook*) we are able to correct our overestimation of possible waste water generation of industry (10 mil.m^3), which were assigned an average concentration of 3 kg COD/m^3. In previous years this factor was positive first time in 2008 this correction factor started to be negative. In addition, it was estimated, in accordance with (IPCC, 1997), that the amount of sludge equals 10% of the total pollution in industrial water (25% was assumed in Meat & Poultry, Paper and Pulp and in Vegetables, Fruits & Juices category) these estimates are based on Dohanyos and Zábranská, 2000; Zábranská, 2004, see Tab. 8.9 Estimation of COD generated by individual sub-categories 2008.

Tab. 8.9 Estimation of COD generated by individual sub-categories 2008

	Production [kt/year]	COD/m³ [kg /m³]	Wastewater/t [m³/t]	Share of sludge [%]	COD of sludge [t]	COD of wastewater [t]
Alcohol Refining	16	11.0	24.00	0.10	423	3804
Dairy Products	1118	2.7	7.00	0.10	2113	19017
Malt & Beer	3281	2.9	6.30	0.10	5994	53950
Meat & Poultry	504	4.1	13.00	0.25	6716	20147
Organic Chemicals	168	3.0	67.00	0.10	3383	30445
Pet. ref./Petrochemicals[17]	0	1.0	0.60	0.10	0	0
Plastics and Resins	600	3.7	0.60	0.10	133	1199
Pulp & Paper	755	9.0	162.00	0.25	275198	825593
Soap and Detergents	29	0.9	3.00	0.10	7	67
Starch production	83	10.0	9.00	0.10	748	6733
Sugar Refining	421	3.2	9.00	0.10	1213	10920
Textiles(natural)	36	0.9	172.00	0.10	556	5002
Vegetable Oils	122	0.9	3.10	0.10	32	289
Vegetables, Fruits & Juices	119	5.0	20.00	0.25	2985	8954
Wine & Vinegar	59	1.5	23.00	0.10	204	1839
Unidentified wastewater	- 10109	3.0	1.00	0.10	-3033	-27294
Total					296 704	976 622

Tab. 8.10 Parameters for CH_4 emissions calculation from industrial wastewater 1990-2008

	MCF	**1990**	**1993**	**1996**	**1999**	**2002**	**2005**	**2008**
Non-treated	0.05	29 %	18 %	13 %	5 %	7 %	3 %	1 %
Aerobic treatment of water	0.06	67 %	73 %	70 %	70 %	65 %	68 %	69 %
Anaerobic treatment of water	0.70	4 %	8 %	17 %	25 %	28 %	29 %	30 %
Aerobic treatment of sludge	0.10	40 %	40 %	40 %	40 %	30 %	27 %	27 %
Anaerobic treatment of sludge	0.30	60 %	60 %	60 %	60 %	70 %	73 %	73 %

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 Estimation of COD generated by individual sub-categories 2008 describes this trend. The conversion factor for anaerobic treatment is 0.06 and, for aerobic treatment 0.7.

In contrast to a quite stable for technologies for treating wastewater (6.B.2), ratio used for sludge keeps shifting in favor 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 6.B.2, 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

[17] Due to changes in statistical data we are unable to identify Pet. ref./Petrochemicals

on national standards and regulations presented in subchapter below (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. 8.11 Emissions of CH_4 (Gg) from 6B1, 1990-2008, Czech Republic

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008
CH_4 production	49.8	63.5	66.4	77.4	75.4	77.4	76.9	80.6	80.9	78.0
Oxidized CH_4	25.3	50.3	55.5	64.5	63.0	65.0	64.7	67.9	68.1	65.9
Total CH_4 emissions	24.5	13.3	10.9	12.9	12.3	12.2	12.1	12.7	12.3	12.1

8.3.2.2 Municipal and commercial wastewater treatment (6B2) and treatment on site (6B3)

The basic activity data (and their sources) for determining emissions from these subcategories are as follows:

- the number of inhabitants (source Czech Statistical Office);
- the organic pollution produced per inhabitant (source IPCC default value);
- the conditions under which the wastewater is treated. (source Czech Statistical Office, with some specific national factors);
- the amount of proteins in the diet of the population (source FAO).

Calculations for conditions in this country are based on pollution production per inhabitant of 18.25 kg BOD p.a. (IPCC, 1997), of which approx. 33% is present in the form of insoluble substances, i.e. is separated as sludge. This factor was slightly changed in 2003 year mainly due to increasing water savings in water use (aprox. 10-20%). 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 Methane correction values (IPCC, 1996) gives shows amount for the time series.

According to the IPCC Good Practice (IPCC, 2000), the maximum theoretical methane production B0 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 1990-2004, given in Table 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 (IPCC, 1997; IPCC, 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 is assumed to be insignificant (the estimate by expert judgment is less than 1% of the total amount) (Zábranská, 2004).

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 (Dohányos and Zábranská, 2002) and related to a new study (Zábranská, 2004).

Tab. 8.12 Population connection to sewers and share of treated water, 1990-2008, Czech Republic

	Total population (thous. pers.)	Sewer connection (%)	Water treated (%)		Total population (thous. pers.)	Sewer connection (%)	Water treated (%)
1990	10 362	72.6	73.0	**1999**	10 282	74.6	95.0
1991	10 308	72.3	69.6	**2000**	10 272	74.8	94.8
1992	10 317	72.7	78.7	**2001**	10 224	74.9	95.5
1993	10 330	72.8	78.9	**2002**	10 201	77.4	92.6
1994	10 336	73.0	82.2	**2003**	10 202	77.7	94.5
1995	10 330	73.2	89.5	**2004**	10 207	77.9	94.9
1996	10 315	73.3	90.3	**2005**	10 234	79.1	94.6
1997	10 303	73.5	90.9	**2006**	10 267	80.0	94.2
1998	10 294	74.4	91.3	**2007**	10 323	80.8	95.8
				2008	10 486	81.1	95.3

(Source: CSO)

Tab. 8.13 Methane conversion factors (MCF) and share of individual technology types [%], 1990-2008

	MCF	**1990**	**1993**	**1996**	**1999**	**2002**	**2005**	**2008**
On-site treatment[18]	0.15	100	100	100	100	100	100	100
Discharged into rivers	0.05	27	21	10	5	7	5	5
Aerobic water	0.05	48	54	65	70	68	72	73
Anaerobic water	0.50	25	25	25	25	25	23	23
Aerobic sludge	0.10	45	40	35	30	20	15	15
Anaerobic sludge	0.50	55	60	65	70	80	85	85

The method of quantification is described in the IPCC guidelines as a tier 1 approach and in this subcategory we follow it without any modification. The amount of methane emitted from 6B2 is given by the equation:

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

Where *tos* is the part of the wastewater treated on site, *wwt* is the part treated as wastewater and *sld* is the part treated as sludge. R is the recovered methane (flared or used as gas fuel). Each part (*tos*, *wwt*, *sld*) is calculated as the share of this part in the organic pollution (according to Tab. 8.13 Methane conversion factors (MCF) and share of individual technology types [%], 1990-2008), multiplied by an emission factor.

Particular MCFs are calculated as a weighted average – thus, the *wwt* emission factor is, in fact, the maximum methane capacity multiplied by the weighted average of MCF for aerobic, anaerobic and river discharge treatment options. The results for 2008 are presented in Tab. 8.14 Emissions of CH_4 and N_2O *[Gg]* from 6B2 and 6B3, 1990-2008, Czech Republic.

[18] Amount of organic pollution associated to this technology is average pollution per capita multiplied by amount of people not connected to sewers (Tab. 8.12)

Tab. 8.14 Emissions of CH_4 and N_2O *[Gg]* from 6B2 and 6B3, 1990-2008, Czech Republic

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008
CH_4 production	22.3	23.9	24.9	25.1	27.0	27.0	27.3	27.5	27.7	28.1
Oxidized CH_4	7.4	9.7	11.1	11.4	14.8	14.8	15.1	15.3	15.5	15.8
Total CH_4 emissions	14.9	14.3	13.9	13.8	12.3	12.3	12.2	12.2	12.2	12.4
Total N_2O emissions	0.52	0.65	0.64	0.64	0.64	0.64	0.64	0.65	0.65	0.66

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 the *Revised 1996 IPCC Guideline* (IPCC, 1997) would then equal:

$$\mathbf{N_2O\ emissions = 10\,323\,000 \times 25 \times 0.16 \times 0.01 \times 44 / 28 / 1\,000\,000 = 0.65\ Gg}$$

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

8.3.3 *Uncertainties and time-series consistency*

This particular category is methodologically consistent and each year is quantified using same method. Data sources for methane activity data are the same and therefore we may assume activity data consistency in time as well. There is very few national specific factors used (mainly share of each treatment technology in the country) and most of activity data are based on statistics of central statistical office.

Consistency of time series can be disturbed by non-continuous change in technology share which is based on particular studies in time and as happened in case of industrial water by change of activity data from survey, where statistical office may deny access to data that are part of business secret.

Consistency of N_2O quantification is disturbed by switch of activity data source in 2000 (global nutrition values were substituted by country specific protein consumption) which led to slight increase in this subcategory. There is plan to smooth the trend and recalculate this according to new data, but due to overall insignificance of this sub-category is on low priority at the moment.

Uncertainty of the most factors (default IPCC values) is determined in IPCC guidelines. Whole uncertainty of the source category is not quantified yet and there is outlook to implement software tool to do this in following years.

8.3.4 *QA/QC and verification*

Activity data are taken from official channels (Czech Statistical Office). Quality assurance of the activity data is guaranteed by the data provider - the Czech Statistical Office; the use of standardized comprehensive methodology harmonized with the EU is guaranteed. However, this office does not calculate or publish inaccuracy or uncertainty values for their data.

8.3.5 *Recalculations*

There were no recalculations from the last NIR.

8.4 Waste incineration (6C)

8.4.1 *Overview*

This category contains emissions from waste incineration in the Czech Republic. Types of waste incinerated include municipal solid waste (MSW), industrial waste, hazardous waste, clinical waste and sewage sludge. Waste incineration is defined as the combustion of waste in controlled incineration facilities. Modern waste incinerators have tall stacks and specially designed combustion chambers, which ensure high combustion temperatures, long residence times, and efficient waste agitation while introducing air for more complete combustion. This category includes emissions of CO_2, CH_4 and N_2O from such practices.

In 2002, there was change in waste statistics which led to shift of almost the whole waste disposal category D10 (combustion on land) to waste use category R1 (used as a fuel). As the statistics were not recalculated for the previous years (prior to 2002), waste emissions should be reported in 6C using the methodology up to 2002 and, from 2003, should be reported under 1A energy. This would raise a serious consistency issue. To resolve this and also because of expert competences, we have retained waste incineration in subsector 6C. Tab. 8.2 gives a more detailed breakdown of waste management categories in 2008.

8.4.2 *Source category description*

Incineration of municipal solid waste does not have a long tradition in the Czech Republic. The first incinerator plant was built in 1989 in Brno (SAKO a.s.). Since then, two other incinerators have been built - one in Liberec (TERMIZO) and the newest one in 1998 in Prague (Pražské služby a.s.). The total capacity of municipal waste incinerators in the Czech Republic is given in Tab. 8.15 Capacity of municipal waste incineration plants in the Czech Republic, 2007.

Tab. 8.15 Capacity of municipal waste incineration plants in the Czech Republic, 2007

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

There are also 76 other facilities incinerating or co-incinerating industrial waste with a total capacity 600 Gg of waste. Most of this capacity is not used.

8.4.3 *Methodological issues*

Consistent with the 1996 *Guidelines* (IPCC, 1997), only CO_2 emissions resulting from oxidation, during incineration and open burning of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered in net emissions and should be included in the national CO_2 emissions estimate.

Estimation of CO_2 emissions from waste incineration is based on the tier 1 approach (IPCC, 2000). It assumes that total fossil carbon dioxide emissions are dependent on the amount of carbon in waste, on the fraction of fossil carbon and on the combustion efficiency of waste incineration. As no country-specific data were available for the necessary parameters the calculation default data was taken from the *IPCC Good Practice Guidance* (IPCC, 2000), see Tab. 8.16 Default data used for emission of CO2 from waste incineration (Good Practice *Guidance*, 2000). Data for 2003 are given in Tab. 8.17 Various waste type incinerated (*ČSÚ, MoE, hazardous waste disposal in 2008*) and the model equation for the category of municipal waste is given in a box below the table.

Tab. 8.16 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. 8.17 Various waste type incinerated (*ČSÚ, MoE, hazardous waste disposal in 2008*)

	Gg of waste
Municipal Solid Waste	366
Clinical Waste	1
Hazardous Waste	146

Because we are updating whole 6C category we updated also default emission factors for tier 1 according to proposed methodological update IPCC, 2006. The suggested default emission factor for continuous furnace incineration of waste is between 50 kg of N_2O per Gg of incinerated MSW. During update we also estimated N_2O emissions from hazardous waste incineration. Here we used suggested emission factor 100kg of N_2O per Gg of incinerated HW. Data on incinerated waste were taken from Tab. 8.17 Various waste type incinerated (*ČSÚ, MoE, hazardous waste disposal in 2008*).

$$\mathbf{N_2O\ emissions = MSW \times EF / 1E6 = 366 \times 50 / 1000000 = 0.02\ Gg\ of\ N_2O}$$

$$\mathbf{N_2O\ emissions = HW \times EF / 1E6 = 146 \times 100 / 1000000 = 0.01\ Gg\ of\ N_2O}$$

Using GWP of 310 for N_2O, MSW equals to **5.68 Gg** and HW equals to **4.55 Gg** of CO_2 equivalents.

The in-country review raised concerns about the completeness of the 6C category, because we assumed (based on expert judgment) that emissions of methane during waste incineration are negligible. The proposed IPCC, 2006 methodology contains a default method for estimation of methane. We used this method to estimate CH_4 emissions from MSW and HW incineration. The suggested default emission factors are 0.2 kg of methane per Gg of MSW. For HW, we used 0.56 kg per Gg of HW based on Japanese values for incineration of oils. The following formula was used for the estimation.

$$\mathbf{CH_4\ emissions = MSW \times EF /1E6 = 366 \times 0.20 /1000000 = 0.000073\ Gg\ CH_4}$$

$$\mathbf{CH_4\ emissions = MSW \times EF /1E6 = 366 \times 0.56 /1000000 = 0.000082\ Gg\ CH_4}$$

We recalculated time series according to methodological changes described above up to 2003.

Tab. 8.18 Emissions of GHG *[Gg CO_2 ekv.]* from 6C, 2003-2008

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
CO_2 emissions	368.3	326.5	358.5	386.5	413.4	445.9
CH_4 emissions	0.003	0.002	0.003	0.003	0.003	0.003
N_2O emissions	9.1	8.1	8.8	9.2	9.7	10.2

8.4.4 *Uncertainties and time-series consistency*

This year we updated the EFs based on the best available knowledge and improved the completeness of all of category 6C. We plan to recalculate the whole time series up to 1990 to improve the methodological consistency of this source category. This task has high priority but we are hampered by lack of readily available activity data up to 1990. We plan to resolve this issue in the 2011 submission.

We have quantified the uncertainties for this category using Monte-Carlo simulation but, because only Tier 1 methodology was used, uncertainties appeared in the default EF values. The results were reported in the 2009 In-country review. The In-country review team suggested not to focus on uncertainty quantification unless national values become available.

8.4.5 *QA/QC and verification*

The QA/QC plan of the National inventory system was used for the whole waste category. For this particular subcategory, the activity data were taken from the official sources (Czech Statistical Office). Quality assurance of the activity data is guaranteed by the data provider - the Czech Statistical Office; the use of standardized comprehensive methodology harmonized with the EU is guaranteed. However, this office does not calculate or publish the inaccuracy or uncertainty of their data. We cross-checked the data on incineration of MSW with the relevant companies.

8.4.6 *Recalculations*

Recalculations were available from last year. The time series was recalculated from 2003 to 2007 according to the changes described in the methodology section of this subsection. The completeness of the subcategory has been improved, as more GHG that were omitted in previous inventories have been included. The accuracy was increased as we updated the emission factors according to the newest methodological update (IPCC, 2006). The consistency was improved because part of the time series was recalculated according to the methodological changes in last year’s report. We are aware that consistency is the main issue in this subcategory and recalculation needs to be completed in the 1990-2002 time series according to the methodological changes. This work has high priority.

9. Other (CRF sector 7)

No sector 7 is defined in the Czech Inventory.

10. Recalculations and Improvements

The driving forces in applying recalculations in the Czech greenhouse gas inventory are provided by the implementation of the guidance given in the IPCC Good Practice Guidance reports (IPCC 2000; IPCC 2003) and the recommendations from the UNFCCC inventory reviews. Recalculations of previously submitted inventory data are performed following the above-mentioned IPCC manuals only to improve the GHG inventory.

Even though a QA/QC system helps to eliminate potential error sources, it is sometimes necessary to make some revisions (called recalculations) under the following circumstances:

- An emission source was not considered in the previous inventory.
- A source/data supplier has delivered new data. This could be because the previous data were only preliminary data (by estimation, extrapolation) or because the method of data collection has been improved.
- Some errors in data transfer or processing have been identified: wrong data, unit-conversion, software errors, etc.
- Methodological changes - when a new methodology must be applied to fulfill the reporting obligations for one of the following reasons:
  - to decrease uncertainties,
  - an emission source becomes a key source,
  - consistent input data needed for applying the methodology is no longer accessible,
  - input data for more detailed methodology is now available,
  - the methodology is no longer appropriate.

10.1 Overview of former recalculations

10.1.1 *Former recalculations before the "in-country review" in 2007*

Summary of recent recalculations and revisions for the 1990-2004 period reported in the 2006 submission (immediately before the Initial Report)

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 1A Fuel Combustion Activities to category 2 Industrial processes, specifically 2C1 and 2B1)
- Recalculation of emissions of methane from 4 Agriculture (enteric fermentation and manure management) using the procedures described in the IPCC *Good Practice Guidance* (IPCC, 2000)
- Rearrangement of CO2 emissions from sulphur removal from coal combustion from category 1B1c to category 2A3 Limestone and Dolomite Use.
- Adding a new source (gap filling) to category 2A3 Limestone and Dolomite Use – emissions from limestone and dolomite use in sinter plants.
- Recalculation of CO_2 emissions from category 2A1 Cement Production using Tier 2 methodology based on the cement clinker production data.
- Recalculation of CO_2 emissions from category 2A2 Lime Production using data on lime and hydrated lime production and lime use.
- Adding a new source (gap filling) to category 2A7.2 Brick and Ceramics – emissions from decarbonization and fossil-organic material oxidation.

- Revision and recalculation of CO_2 series for 2A7.1 Glass Production.
- Use of new Tier 2 methodology – "Actual emissions" for all the 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 5A Changes in Forest and Other Woody Biomass Stocks, currently within LULUCF category 5A Forest Land, Carbon Stock Change; ii) recalculations of CH_4 and N_2O emissions from controlled burning, which was previously included in LUCF category 5F Other Land), currently under LULUCF category 5A Forest Land, Biomass Burning
- Revision and recalculation of CH_4 series for 1B2b (Fugitive emissions – Natural gas)

Recalculations and revisions for the 1990-2005 period reported in the 2007 submission

Only a few recalculations were carried out in the 2007 submission, which mostly had only a slight effect on the resulting emissions:

Energy

In the energy sector (1A), the activity data not yet reported for 1996 and 1997 were submitted this year (2007 submission). At the same time, complete recalculations were performed for the emissions in 1996 and 1997 for sector 1A using the definitive energy balance. This leads to differences in the total (aggregated) GHG emissions (excluding LULUCF) of 3.7 % for 1996 and -3.5% for 1997.

Industrial processes

In this submission only a small correction in SF_6 emissions from the subcategory "Sound-Proof Windows" was performed due to improvement of the relevant EF. The differences from the former values were, in all cases, less than 1 kt CO_2 eq per year.

LULUCF

A new item included in this inventory consisted in estimation of the emissions associated with burning from wildfires. These emissions involve the quantities of CO_2 and non-CO_2 gases (CH_4, N_2O) generated in category *5A1 Forest Land remaining Forest Land*, and are correspondingly pronounced in higher categories. A minor adjustment was made in estimation of the soil carbon stock change for all land use conversions involving cropland due to the adjusted factor used in the calculations.

10.1.2 *Recalculations taking into consideration the "in-country review" in 2007*

To summarise what is important concerning recent and new recalculations - there were two important "waves" of recalculations: (i) in the 2006 submission before the Initial Report under the Kyoto Protocol (the *Czech Republic's Initial Report under the Kyoto Protocol*, 2006) and (ii) in the 2008 submission, as a consequence of the "in-country" UNFCCC review that took place in March 2007. The second item (ii) is discussed in the following paragraphs.

As a result of the above-mentioned review, the Czech Republic was asked by the Expert Review Team (ERT) to perform extra instant revisions (during 6 weeks) to prevent possible adjustment:

- To use the country-specific emission factor for CO_2 for coals instead of the default values to be in accordance with the IPCC Good Practice Guidance
- To use the IPCC default emission factors for CH_4 and N_2O for stationary fuel combustion instead of the former national values because of lack of transparency
- To apply the Tier 2 approach (FOD) instead of Tier 1 for CH_4 emissions from landfills to prevent possible overestimation of the base year (the amount of municipal waste land-filled has gradually increased since the 1960s).

These invitational revisions and other recommendations of ERT were taken into account in this (2008) submission and the relevant values were inserted in the CRF for the respective time interval (for the invitational revisions mentioned above, all the data have been inserted for the period since 1990).

To be more specific, important new recalculations were performed in the following sectors:

Energy

In accordance with the ERT requirement, the recommended recalculations based on the official data from the final CSO balance have been performed since 1998. Simultaneously, older data previous to 1998 were also controlled and minor corrections were introduced in some cases.

In addition, thorough recalculation has been performed in the transport sector (1A3) since 2000, to be fully consistent with the CDV methodology. Simultaneously, it was necessary to ensure interconnection with the former methodology used in 1990 – 1995. For air transport, the activity data from CSO was harmonized with the data from the statistics for air transport, newly establishing the borderline between national and international air transport.

Industrial processes

In subsector 2C (production of iron and steel), two kinds of data related to coke were differentiated in accordance with ERT: to begin with, data corresponding to coke consumption in blast furnaces, employed for determination of CO_2 and also data for production of coke in coking chambers, related to methane emissions.

Agriculture

Recalculations for 4.D.1.5 “Cultivation of Histosols” were performed in the 2008 submission. Following the 2006 in-country review, the Czech emission inventory team verified the activity data required for this category and found that the previously reported data based on expert judgment of areas could not be confirmed and verified from the official statistics. According to the new expert common consensus, there are no cultivated histosols on agricultural land in the country and hence also no data for this category.

LULUCF

Practically all the items concerning the LULUCF sector were recalculated for this submission. This was required due to the implementation of the refined land use identification system, providing improved area estimates for all the land-use categories and for the entire reporting period. Additionally, several land-use definitions and factors used in the emission estimation procedures were revised. This inventory also consequently employs the 20-year default rolling period for converted lands. The effects of these revisions on emission estimates are shown in relation to the previous estimates in the graphs and are discussed in the text under the corresponding LULUCF chapters.

Waste

On the basis of the recommendations of the international ERT inspection team, the methodology was changed from Tier 1 to Tier 2 for calculation of methane emissions from category *6A Solid Waste Disposal on Land*. The new method calculates the dynamics of the decomposition processes in landfills and thus provides not only better estimates of current conditions, but also reliable models for future developments. The entire time series was recalculated according to the new methodology.

10.1.3 *Recalculations performed in the 2009 submission*

Energy – stationary sources

As refined activity data were obtained for 2006 from the final energy balance, recalculation was performed for practically all stationary sources in 2006. However, the recalculation was not related to the emission factors employed, but only new activity data were used.

Energy – mobile sources

In the framework of the submission, in addition to calculation of emissions of greenhouse gases from mobile sources for 2007, complete recalculation of the time series of emissions from mobile sources was performed retroactively for 2000 – 2006. The recalculations were performed because of the

availability of new, more exact input data on fuel consumption and fuel calorific value. These data are determined in the framework of statistical surveys by the Czech Statistical Office. Another reason lay in the necessary recalculation of the emission factors for the individual defined categories of vehicles from g/MJ to g/kg of fuel, as the database of emission factors of the Centrum dopravního výzkumu, v.v.i. (Transport Research Centre) contains mainly data related to units of fuel consumed.

The new calorific values for fuels did not differ much from the original values (for example, automotive gasoline now has a calorific value of 43.8 MJ/kg, while this was formerly 43.32 MJ/kg), but contributed to better data consistency with the time series, manifested in homogenization of the "implied emission factor" parameter.

The calculated greenhouse gas emissions per unit of consumed energy have better values when based on this recalculation, as the inter-annual differences in these values decreased for the individual greenhouse gases. Both the energy consumptions and the emissions of carbon dioxide, methane and nitrogen monoxide were recalculated.

Industrial processes

The recalculations for 2.A.2 Lime production were performed in the 2009 submission. Following the 2006 in-country review and 2008 centralized review, the Czech emission inventory team has carefully checked all the parameters of the emission estimates and decided that removals will not be taken into account. The methodology is based on the IPCC GPG supplement with national EFs, which reflects production of lime and quick lime (0.7884 t CO2 / t lime) and the average purity (93%). Emission estimates were checked against the EU ETS data.

Agriculture

On the basis of the recommendations of ERT, the units of milk production were changed to the required units (liters/day/head) for the entire reported period of 1990-2007 in 4.A./Cattle CRF Tables.

The sub-category *Other livestock (Manure Management* category*)* was regrouped to two categories as required by ERT. Now the N_2O emissions from horses and goats are reported as emissions from two individual groups of animals, applying the IPCC Tier 1 method and the 1996 IPCC default values. The total emissions from this category were not affected.

In accordance with the verification, older data previous to 2006 were verified and minor corrections were introduced in some cases:

1. In sub-category 4.D.1.3.N-fixing Crops, year 2002, the value of N_2O emissions was corrected to 0.06521625
2. In sub-category 4.A. Cattle/Non-dairy cattle, the values of Average gross energy intake for 2005 and 2006 were corrected.

LULUCF

Category *5A* Forest Land was recalculated for the whole time period, which affected both sub-categories *5A1* and *5A2*. This was required due to the further refined land-use change identification system and application of revised age-dependent biomass expansion and conversion factors.

Category *5B* Cropland was recalculated for the whole time series. This was required due to application of an improved set of biomass conversion and expansion factors, which affected the emission estimates for land-use conversions involving forest land.

Category *5C* Grassland was also recalculated for the whole time series. This was required due to the newly reported emissions from mineral soils in category *5C1* and the improved biomass expansion and conversion used in the land-use conversions including Forest Land.

Categories *5D* Wetlands and *5E* Settlements were recalculated for the whole time period. This was required due to the improved biomass expansion and conversion used in the land-use conversions involving Forest Land.

10.2 New recalculations performed in this submission (2010)

Recalculations in sector 1 “Energy”

1. Recalculation in sectors 1A1, 1A2, 1A3e, 1A4 and 1A5 since 2003

The recalculation involves improvement and specification of activity data by using questionnaires elaborated by the Czech Statistical Office (CSO) for IEA and Eurostat, while the emissions and oxidation factors remain unchanged. This recalculation was facilitated by concluding a Memorandum of understanding between CHMI and CSO on data exchange, which made the questionnaires mentioned above available for the inventory team. In the past, the activity data were taken from the annually published “Energy balances of the Czech Republic” and were less suitable for conversion to UNFCCC/CRF categorisation.

The year 2003 was chosen as the starting year because data for detailed splitting for 1A2 (i.e. 1A2a, 1A2b,…,1A2f) have been available since 2003.

The reasons for this recalculation were discussed during the recent “In-country review” (October 2009, Prague) with the Expert Review Team (ERT) that supported this concept. In addition, the last EU check called “Consistency Report CZ 2009” found obvious inconsistencies in 1A2 category allocation.

2. Recalculations in the reference approach since 2003

The starting year 2003 was chosen for recalculation in order to ensure that the data are consistent with data mentioned above. Similarly as in the sectoral approach, all the activity data were taken from questionnaires elaborated by the Czech Statistical Office (CSO) for IEA and Eurostat

In addition to previous submissions, the following data were inserted:

Other kerosene

Naphtha

Bitumen

Lubricants

Petroleum coke

Refinery feedstocks

Anthracite

Other fuels

3. Recalculation (addition of a missing fuel type) in sub-sector 1A2f since 2003

The reasons for this recalculation were discussed during the recent “In-country review” (October 2009, Prague) with the Expert Review Team (ERT), which suggested the addition of a missing fuel type “Other fuels” used mainly in cement kilns to improve the completeness of the process.

4. Recalculation of CH_4 emission in sub-sector 1A3e since 1990

The reasons for this recalculation were discussed during the recent “In-country review” (October 2009, Prague) with the Expert Review Team (ERT), which suggested substitution of the non-transparent CH_4 EF by the IPCC default value.

5. Recalculation of emissions in 1B2c (Venting and flaring)

In the 2009 submission, the emissions from venting and flaring in the production were first reported for the year 2007. Our inquiry amongst producers showed that this activity does not occur in the Czech Republic (NO).

6. Recalculation of emissions (addition of missing gas) in 1B2b (Fugitive emissions - Natural gas) since 1990

Based on the above inquiry, the value of the CO_2/CH_4 ratio in Natural gas was found and thus it was possible to estimate the relevant emissions of CO_2 in sub-sector 1B2b and thus to improve completeness.

Recalculations in sector 2 "Industrial processes"

One recalculation in the period 2004 - 2007 was performed for N_2O emissions from HNO_3 production. Estimation of these emissions in the Czech Republic is based on the use of technology-specific emissions factor taking into consideration process conditions in Czech plants. The emission factors respect the three levels of pressure employed (0.1, 0.4 and 0.7 MPa) and relevant cases of NO_x and/or N_2O abatements: selective catalytic reduction (SCR) of NO_x, non-selective catalytic reduction (NSCR) of NO_x that also reduces emissions of N_2O, and recently introduced N_2O mitigation based on catalytic N_2O decomposition for 0.7 MPa technology.

For 0.4 MPa technology in combination with NSCR, an emission factor of 1.09 kg N_2O/t HNO_3 was used for 1990 - 2003 while, starting from 2004, this EF was increased to 2.72 kg N_2O/t HNO_3. However, new plant measurements revealed that the original EF 1.09 kg N_2O/t HNO_3 is suitable even for the years after 2003.

Consequently, in the recalculation, EF = 1.09 kg N_2O/t HNO_3 was used over the whole time period since 1990 for the 0.4 MPa technology combined with NSCR. This recalculation improves the quality of the inventory in accordance with good practice and improves the time series consistency. The approaches used for the other technologies mentioned above remain unchanged.

Recalculations in sector 4 "Agriculture"

The following recalculations regarding N_2O emissions were performed for the whole time period since 1990 as a consequence of discussions with the expert review team (ERT) during the "in-country review" in October 2009:

<u>1. N_2O from manure management (non-KC)</u>

According to the recommendation from the IPCC Good Practice Guidance 2000, the default parameters characterizing AWMS for dairy cattle, non-dairy cattle, and swine were taken from Tables B-3 through B-6 in the 1996 Guidelines (Reference Manual) instead of the existing values taken from Table 4-21. The values for the other animals remained unchanged.

<u>2. N_2O emissions from agricultural soils - Animal manure applied to soils (KC)</u>

In the recalculation, the more suitable equation 4.23 from the IPCC Good Practice Guidance 2000 was used instead of the existing equation from the Revised 1996 IPCC Guidelines, p. 4.93

<u>3. N_2O emissions from agricultural soils - Crop residues (KC)</u>

The Tier 1a method described in the IPCC Good Practice Guidance 2000 was used to estimate emissions in this category. The reasons for this recalculation were:

- The default value for $Frac_{BURN}$ (0.1) has been used although burning of crop residues does not occur in the CR.
- Because of the small error in the existing calculation spreadsheets, the residues from pulses have not been included in the calculations.
- The amount of crops has been transformed to dry matter using a default $Frac_{DM}$ value of 0.85. This is in accordance with the Revised 1996 IPCC Guidelines but, according to the IPCC 2000 GPG, the crops $Frac_{DM}$ should not be employed if the simple Tier 1 (Tier 1a) method is used.

<u>4. N_2O emissions from 4.D.1.3 N-fixing crops</u>

In recalculation of emissions from N-fixing crops, the production of soya beans has also been included (even though this production is very limited in the Czech Republic).

Recalculations in sector 5 “LULUCF”

All recalculations in LULUCF sector were performed for the whole time period since 1990.

1. Several LULUCF categories were recalculated following the revision of biomass conversion and expansion factors (BCEFs). These factors were revised utilizing the new data from the Czech landscape inventory (CzechTerra). This statistical inventory covers the entire territory of the country and its first cycle was conducted during the years 2008 and 2009. The application of the new BCEFs affects all the LULUCF categories related to forest land, namely:

- 5.A.1. Forest Land remaining Forest Land
- 5.A.2. Land converted to Forest Land (all relevant sub-categories)
- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

2. This inventory submission additionally contains estimates of carbon stock change in dead organic matter following the conversion of Forest land to other land use categories. This implementation concerns the following categories:

- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

10.3 Response to the review process and planned improvements in the inventory

The 2008 submission was subjected to the Centralised review organised by UNFCCC on September 2008. ERT team concluded that the 2008 inventory submission showed significant improvement and covers most sectors and categories, but ERT identified the need for further improvements in the following areas:

(a) more comprehensive description of the national QA/QC plan should be included in the next NIR, including descriptions of the QA/QC and verification measures in specific sections in the sectoral chapters of NIR;

(b) higher tier methods should be used for key categories, where appropriate;

(c) the transparency of the inventory should be improved further by including additional information in NIR with regard to the assessment of inventory completeness, the identification of emission factors (EFs) used, improved descriptions of individual sectors, explanations as to the selection of methodologies, and information on the sources of activity data (AD);

(d) estimates for all the missing categories should be prepared and reported, and a discussion of these categories and of other potential sources or sinks not addressed in the current inventory submission should be provided in NIR, as well as of the possibility of including them in future submissions;

(e) the uncertainty analysis should be improved by addressing the LULUCF categories In addition, ERT recommended that the Czech Republic improve its archiving system.

However, the relevant ARR report was available to the Czech team rather late (25 March 2009), during finalisation of the 2009 submission and thus many findings of the ERT could be implemented only in this submission (2010 submission). As for the list of recommendation given above: the implementation of item (a) is discussed below, item (c) was partly implemented already in the 2009 submission and the implementation is continuing in 2010;items (d, e) will be resolved in the 2010 submission. In addition, a temporary archiving system has already been developed and is functional and its improvement is planned for next year. The resolution of item (b) needs some time and financial resources and thus implementation is proceeding gradually.

In October 2009, the Czech Republic was subjected to the In-country-review in Prague. From the draft of the review report (ARR 09), delivered to the Czech Republic on 22 January 2010, it is obvious that ERT reiterates some recommendations from the previous review, some of which were implanted in this submission as mentioned above.

ERT emphasized mainly the existing QA/QC plan, which was identified as a potential problem. The Czech inventory team accepted the recommendation of ERT to prepare a new QA/QC plan, which was submitted to UNFCCC in time (during a 6-week period). The main aspects of the newly developed QA/QC plan are presented the Chapter 1.x, in the section devoted to QA/QC procedures.

As mentioned above, draft inspection reports were submitted for comments only on January 22, 2010, where the official final version will be available sometime during April. It is mentioned in the draft ARR 09 that the draft new QA/QC plan, drawn up according to the ERT recommendations, has been accepted. However, it is obvious from the late date of the draft submitted to ARR that it was not possible to employ the new QA/QC plan to the full extent for the 2010 submission. In addition, the Czech team anticipates that it will be possible to identify and eliminate minor inadequacies during the process of implementation of the new QA/QC plan, so that a perfected version can be prepared for the 2011 submission. As the version of the QA/QC plan for 2011 is expected to be ready by the middle of 2010, sufficient time will remain for its implementation to the full extent.

Another important recommendation formulated in the ARR 09 draft consists in the need for an improvement plan, concerned mainly with:

- Inclusion of data on individual operations, especially those that participate in the emission trading system (ETS). For this purpose, it is necessary to prepare a database of all the so-far verified reports on greenhouse gas emissions in relation to supplementation of the prescribed categorization of sources, so that it will be possible to directly employ this data for the national greenhouse gas inventory. Simultaneously, it is necessary to ensure temporal consistency of the data taken to date from the national statistics.

- Determination of country-specific emission factors and other parameters required to determine emissions, which would permit use of higher level methods than those used to date. For this purpose, it is necessary to collect (in some cases also experimentally) and mathematically process a large amount of rather inaccessible data.

Work is currently being carried out on specification of the improvement plan, including the timetable, so that it can be included in the middle of the year as a basis for planning work for the next period. A description will be presented in the next submission.

Sector Chapters 3 to 8 contain current suggestions for improvements in the individual sectors as well as detailed explanations of how the ERT recommendations are specifically taken into account.

Part II: Supplementary Information Required under Article 7, paragraph 1

11. KP LULUCF

Emission and removal estimates from land use, land-use change and forestry (LULUCF) activities under Article 3.3 and 3.4 of the Kyoto Protocol

11.1 General Information

The information provided in this chapter follows the requirements set in “Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol” (Annex to decision 15/CMP.1, FCCC/KP/CMP/2005/8/Add.2).

11.1.1 *Definition of forest and any other criteria*

For reporting LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol, forest land is defined as land with tree crown cover over at least 30 % (or equivalent stocking density) and an area of more than 0.05 hectares. Trees should reach a minimum height of 2 meters at maturity. Tree rows less than 20 meters wide are not considered to form a forest.

11.1.2 *Elected activities under Article 3, paragraph 4, of the Kyoto Protocol*

In addition to the mandatory activities of Afforestation/Reforestation (further denoted as *AR*) and Deforestation (*D*) under Article 3, paragraph 3, of the Kyoto Protocol, the Czech Republic elected the optional activity of Forest Management (*FM*) under Article 3.4 of the Kyoto Protocol to be included in the accounting for the first commitment period. The accounting for KP LULUCF activities will be performed for the entire commitment period

11.1.3 *Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time*

Due to the tight links imposed between the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the emission estimates of KP LULUCF activities and those reported for the LULUCF sector under the Convention. Hence, reference is frequently made to the corresponding methodologies described in Chapter 7 of the NIR 2010 text, while additional and specific information related to the KP LULUCF activities is highlighted here.

The conceptual linkage between the *AR*, *D* and *FM* activities and the reporting based on land use categories under the Convention is as follows:

- *AR* activity may represent the following types of land-use conversions:
    - *5.A.2.1. Cropland converted to Forest Land*
    - *5.A.2.2. Grassland converted to Forest Land*
    - *5.A.2.3. Wetlands converted to Forest Land*
    - *5.A.2.4. Settlements converted to Forest Land*
- *D* activity may represent the following situations:
    - *5.B.2.1. Forest land converted to Cropland*
    - *5.C.2.1. Forest land converted to Grassland*
    - *5.D.2.1. Forest land converted to Wetlands*
    - *5.E.2.1. Forest land converted to Settlements*

- *FM* activities relate to emissions and removals correspondingly as described in category *5A1 Forest land remaining Forest land*

In this way, *AR* activities generally always represent a land-use conversion from a land-use category other than forest land to the land use category of forest land. Similarly, *D* is an activity when forest land is converted to other types of land-use, as shown above. These links are retained consistently for the entire reporting period, similarly as for the adopted methodology. This ensures consistent treatment of the activity data and methodologies across the Kyoto Protocol 1st Commitment Period, as well as for the reporting period under the Convention, i.e., since 1990, and in some applicable instances since 1969. Other details can be found below.

11.1.4 *Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified.*

Since only one activity of the listed Article 3.4 activities was elected by the Czech Republic, no precedence conditions and/or hierarchy among Article 3.4 activities are applicable.

11.2 Land-related information

11.2.1 *Spatial assessment unit used for determining the area of the units of land under Article 3.3*

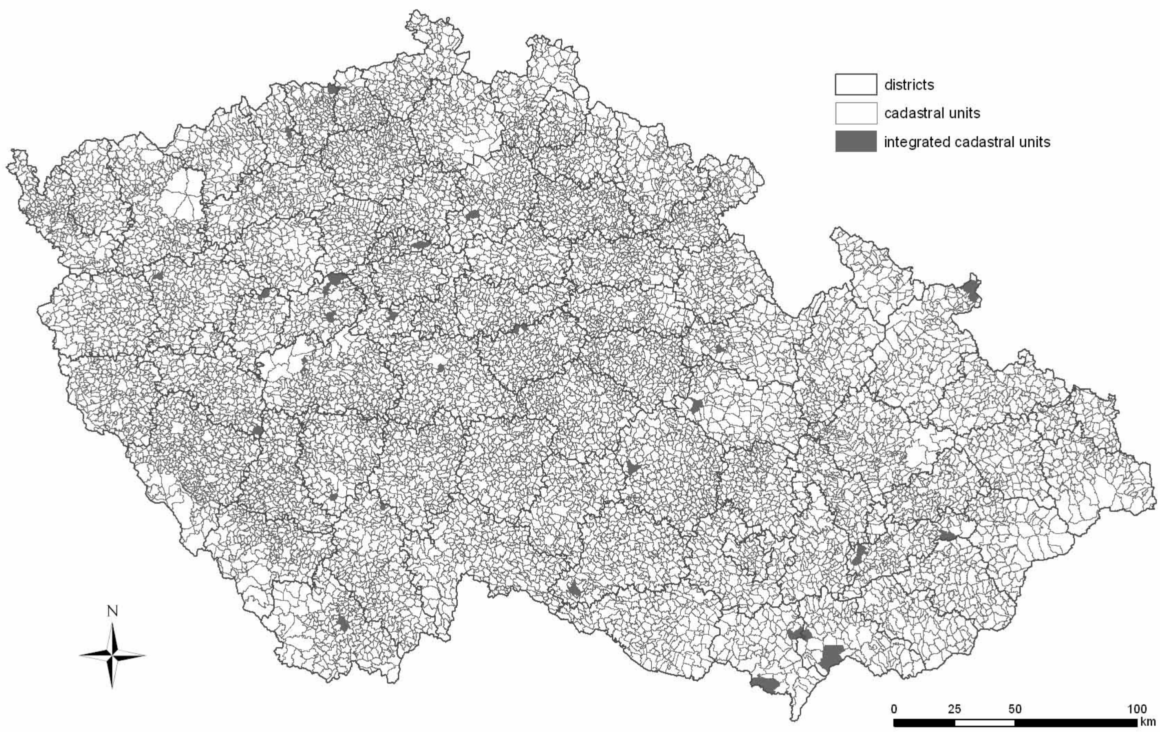


Fig. 11-1: The spatial detail of the land use representation and land-use change identification system used for detecting land use change associated with ARD activities. In 2008, the areas of ARD were estimated at the level of 12 966 individual cadastral units and 28 integrated cadastral units.

Land areas associated with the LULUCF activities are identified within a geographic boundary encompassing units of land or land subject to multiple activities under article 3.3 and 3.4 activities (i.e. reporting method 1, GPG for LULUCF, IPCC 2003[19]). Considering the small area of the country and its specific conditions, there is no applicable stratification that would justify reporting on smaller than a country-level unit. This is also supported by the attributes of the available activity data. However, the land-use representation and land-use change identification system developed for the KP and UNFCCC reporting purposes permit a truly detailed spatial assessment and identification of *AR* and *D* activities at the level of the individual cadastral units. The system is exclusively based on the annually updated data from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of about 13 thousands individual cadastral units (Fig. 11-1). In 2008, the areas of *AR* and *D* were estimated on the level of 12 994 individual cadastral units (including 28 integrated cadastral units) in the country. The mean area of these 12 994 units that enter analysis of land-use change was 6.07 km^2.

11.2.2 *Methodology used to develop the land transition matrix*

The land use representation and land-use change identification system was created in several steps, namely 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time-series. These steps are described in detailed in Section 7.2.1 of the Czech NIR 2010 submission. The result is a system of consistent representation of land areas, ranking as Reporting Method 1 of the GPG for LULUCF (IPCC 2003), having the attributes of both Approach 2 and Approach 3 and permitting accounting for all mandatory land-use transitions in annual time steps.

Tab. 11-1: The identified land-use change from Cropland (C), Grassland (G), Wetlands (W) and Settlements (S) to Forest Land (F), categorized as *AR* (kha/year) and land use change from F to land use categories C, G, W and S, which represent *D* (kha/year).

	Afforestation/Reforestation (*AR*, kha/year)					Deforestation (*D*, kha/year)				
Year	**C to F**	**G to F**	**W to F**	**S to F**	**Total**	**F to C**	**F to G**	**F to W**	**F to S**	**Total**
1990	0.71	0.52	0.01	0.00	**1.24**	0.10	0.09	0.02	0.28	**0.49**
1991	0.40	0.12	0.00	0.02	**0.54**	0.28	0.35	0.07	0.17	**0.87**
1992	0.21	0.12	0.01	0.00	**0.34**	0.14	0.25	0.04	0.31	**0.74**
1993	0.09	0.12	0.01	0.18	**0.39**	0.19	0.07	0.02	0.55	**0.82**
1994	0.20	0.21	0.12	0.90	**1.43**	0.11	0.08	0.02	0.38	**0.59**
1995	0.31	0.36	0.02	0.47	**1.16**	0.15	0.08	0.02	0.27	**0.52**
1996	0.86	0.40	0.03	0.50	**1.79**	0.18	0.35	0.02	0.36	**0.90**
1997	0.31	0.43	0.04	0.90	**1.69**	0.23	0.17	0.04	0.37	**0.80**
1998	0.48	0.68	0.10	2.25	**3.51**	0.39	0.39	0.05	0.53	**1.37**
1999	0.33	0.45	0.04	0.72	**1.54**	0.12	0.08	0.05	0.60	**0.84**
2000	0.47	0.54	0.08	2.36	**3.46**	0.10	0.14	0.06	0.37	**0.67**
2001	0.44	0.49	0.04	1.15	**2.12**	0.07	0.08	0.02	0.33	**0.49**
2002	1.13	0.94	0.03	2.54	**4.64**	0.04	0.06	0.08	0.32	**0.50**
2003	0.70	0.57	0.03	0.72	**2.02**	0.08	0.14	0.05	0.52	**0.78**
2004	0.75	0.84	0.02	0.64	**2.26**	0.10	0.07	0.03	0.50	**0.69**
2005	0.86	0.90	0.01	0.58	**2.35**	0.10	0.09	0.03	0.43	**0.66**
2006	1.05	0.65	0.03	0.45	**2.18**	0.05	0.06	0.03	0.32	**0.47**
2007	0.92	0.58	0.02	0.92	**2.45**	0.02	0.07	0.02	0.26	**0.38**
2008	0.80	0.47	0.09	0.91	**2.27**	0.10	0.05	0.03	0.26	**0.44**

The identified annual land use changes among the major land use categories as defined in the Czech emission inventory are shown Tab. 11-1. The mean area of *AR* activities reached 1.97 kha per year during the 1990 to 2008 period, which yields a cumulative area of 37.4 kha. For the same period, the

[19] All references used in this chapter can be found in Chapter 10 of the NIR text.

mean area of *D* reached 0.68 kha per year, which amounts to 13.0 kha for the entire period. The difference between *AR* and *D* basically corresponds to the net increment of cadastral forest land as shown in Fig. 7.3 of NIR 2010.

Although the system of land-use representation and land-use identification is basically identical for both KP-reporting and Convention reporting, there are some notable differences that have implications for the reported areas of KP activities (Tab. 11-2). These differences are imposed by the specific requirements for the reporting of LULUCF activities under the Kyoto protocol, namely:

i) *AR* activities that qualify under KP accounting are only those commenced since 1990

ii) *AR* land must be traced under KP reporting, i.e., it never enters the land registered under *FM* activity.

To handle this issue in the KP LULUCF reporting, two additional technical sub-categories were introduced for FM reporting in the UNFCCC CRF Reporter. One is "*Forest land remaining Forest land in KP reporting*", while the second is "*Residual afforested land from before 1990 (in conversion status)*". The entire land qualified as the area under *FM* activity represents the sum of these two categories.

Tab. 11-2: The forest areas of subcategories by four major tree species (Beech, Oak, Pine, Spruce) and the temporary unstocked areas (clearcut, CA), which altogether form the category 5A1 of the Convention reporting. Although not explicitly labeled, 5A1 is identical with the category of *Forest Land remaining Forest Land* (FLRFL) used in the KP reporting of FM. 5A2 represents Land converted to Forest land, remaining in conversion status for the period of 20 years. 5A1 and 5A2 form the entire category *5A Forest Land* used in the Convention reporting. Residual afforestation (AF) represents the fraction of *AR* areas afforested prior 1990, which form a part of *FM* area (*FM* = FLRFL+RA), while the *AR* since 1990 (Art. 3.3) is treated separately and shown in Tab. 11-1 above.

	Convention and KP LULUCF reporting categories and their areas (kha) since 1990									
Year	**Beech**	**Oak**	**Pine**	**Spruce**	**CA**	**5A2**	**5A**	**FLRFL**	**RA**	**FM**
1990	372.1	152.4	455.4	1 503.8	40.6	52.6	**2 576.9**	2 524.3	51.4	**2 575.7**
1991	375.3	153.0	455.5	1 500.2	40.7	51.9	**2 576.7**	2 524.8	50.1	**2 574.9**
1992	378.7	154.2	454.3	1 500.3	41.9	47.1	**2 576.5**	2 529.4	45.0	**2 574.4**
1993	381.3	154.9	452.6	1 499.7	41.4	46.1	**2 576.1**	2 530.0	43.6	**2 573.5**
1994	384.9	155.0	450.9	1 502.1	39.8	44.2	**2 576.9**	2 532.8	40.2	**2 573.0**
1995	388.3	155.6	451.2	1 503.0	38.9	40.6	**2 577.5**	2 537.0	35.5	**2 572.4**
1996	391.0	157.3	450.5	1 502.0	38.1	39.5	**2 578.4**	2 538.9	32.6	**2 571.5**
1997	394.4	157.4	450.1	1 503.2	36.0	38.1	**2 579.2**	2 541.1	29.5	**2 570.6**
1998	400.9	157.8	452.8	1 499.1	33.7	36.8	**2 581.1**	2 544.3	24.7	**2 569.1**
1999	403.7	159.7	448.9	1 504.1	32.2	33.1	**2 581.8**	2 548.7	19.5	**2 568.1**
2000	408.1	161.8	447.7	1 503.6	31.0	32.4	**2 584.5**	2 552.1	15.3	**2 567.5**
2001	413.2	163.0	446.5	1 503.0	29.8	30.7	**2 586.1**	2 555.5	11.5	**2 566.9**
2002	419.0	164.5	444.5	1 499.2	28.3	34.6	**2 590.2**	2 555.6	10.7	**2 566.3**
2003	426.3	166.1	443.3	1 493.2	27.0	35.4	**2 591.3**	2 555.9	9.5	**2 565.4**
2004	431.9	166.9	440.9	1 489.8	26.8	36.6	**2 592.8**	2 556.3	8.4	**2 564.7**
2005	438.0	167.5	439.4	1 486.0	26.3	37.3	**2 594.5**	2 557.2	6.8	**2 564.0**
2006	442.4	169.4	437.6	1 482.9	25.9	37.9	**2 596.2**	2 558.2	5.3	**2 563.5**
2007	448.2	170.7	435.7	1 479.1	26.1	38.5	**2 598.2**	2 559.7	3.4	**2 563.1**
2008	455.2	173.0	433.9	1 471.9	27.1	38.9	**2 600.0**	2 561.1	1.5	**2 562.6**

Since the Czech inventory system adopts the 20-year default period for preserving lands under conversion status as recommended by GPG for LULUCF (IPCC 2003), currently the areas of the sub-category *Forest land remaining Forest land in KP reporting* are equal to the areas in the category 5A1 under Convention reporting. In KP reporting, the entire area of *FM* must additionally include the fraction of land afforested prior 1990, which is represented by the second introduced sub-category, i.e., "*Residual afforested land from before 1990 (in conversion status)*". Since the reported year 2010, the area of that subcategory will become zero as all land converted to Forest land prior 1990 becomes

a part of *FM*. At the same time, the *FM* area will likely become smaller than that reported under 5A1 under the Convention reporting. This is due to the expected *D* activities that will not be compensated by any areas of afforested land, because these are registered exclusively under *AR* activities.

11.2.3 *Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations*

The KP LULUCF reporting of the Czech Republic is based on the annually updated data from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of about 13 thousands individual cadastral units (Fig. 11-1), which represent the Czech cadastral system. At that level, land use change is identifiable, using the standard identification codes and names of the Czech cadastral system, while additional codes for the small fraction of aggregated cadastral units were prepared by the LULUCF emission inventory team.

The spatial resolution of the adopted land-use representation and land-use change identification system is depicted in Figs. 2 and 3, which show the identified units with *AR* and *D* activities, respectively, in 2008.

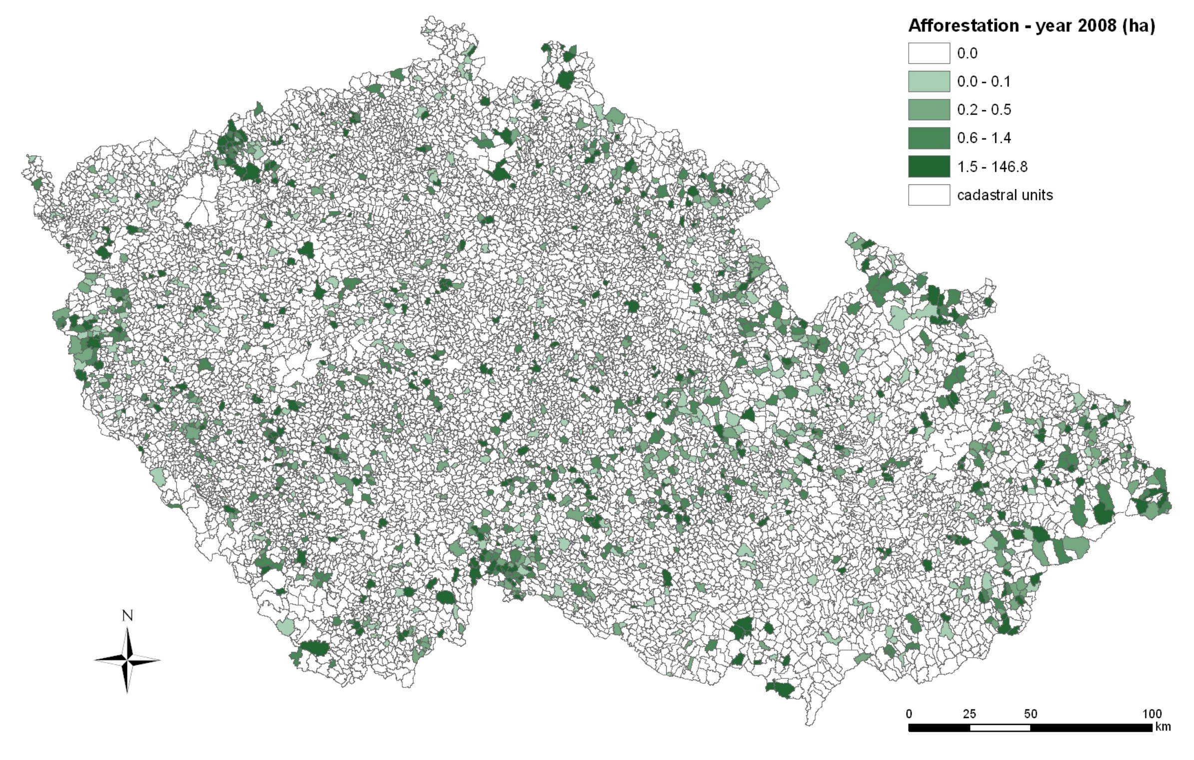


Fig. 2: The cadastral units with identified afforestation (*AR*) activities in 2008.

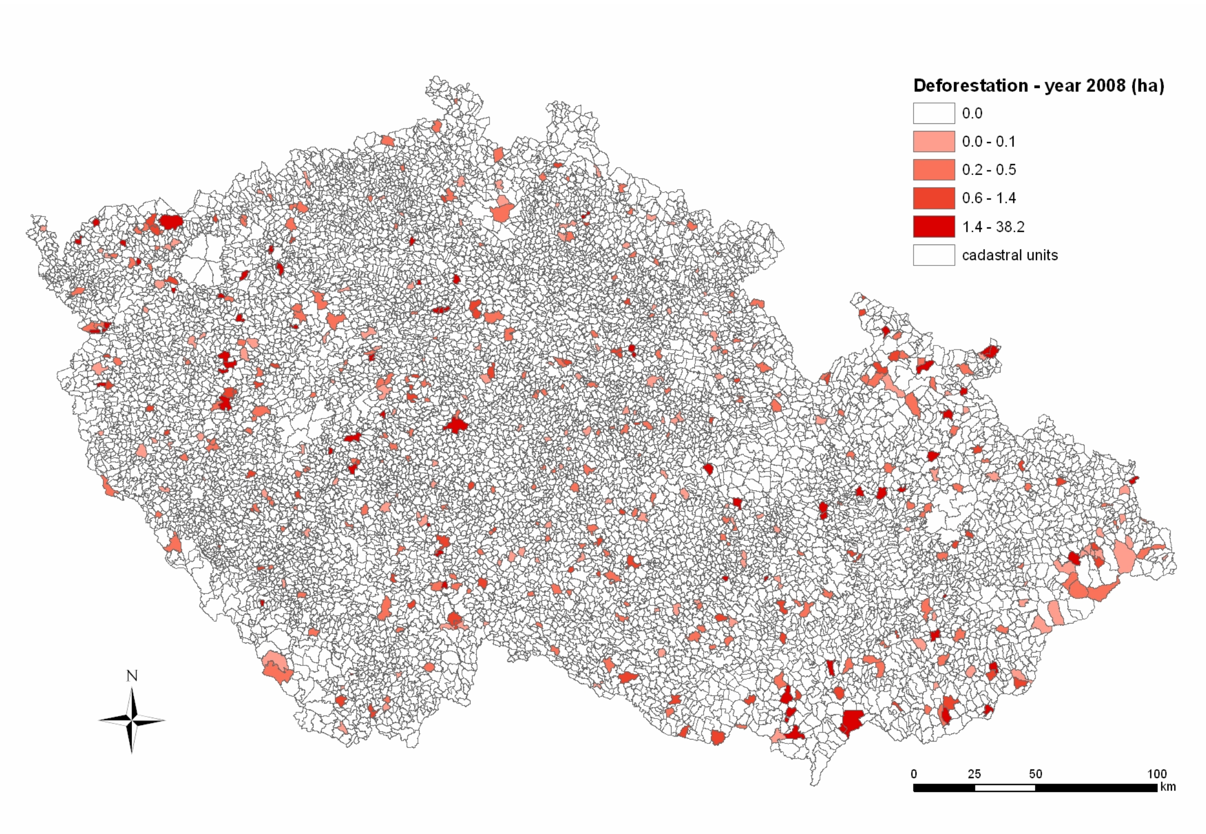


Fig. 3: The cadastral units with identified deforestation (*D*) activities in 2008.

11.3 Activity-specific information

11.3.1 *Methods for carbon stock change and GHG emission and removal estimates*

11.3.1.1 Description of the methodologies and the underlying assumptions used

Due to efforts to link the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the KP LULUCF activities and the relevant LULUCF categories under the Convention reporting. These are described in detail in Chapter 7 (LULUCF) of the 2010 NIR submission. Hence, reference is often made to these methodologies, while additional and specific information related to Kyoto Protocol LULUCF activities is highlighted here.

For *AR* activities, the applicable methodology of GPG for LULUCF (IPCC 2003) for estimating emissions and removals is given in Chapter 3.2.2. Correspondingly, the emissions due to *D* were estimated based on the guidance given in Chapters 3.3.2, 3.4.2, 3.5.2 and 3.6.2. For specific details on the approaches employed, country-specific activity data and factors, Chapter 7 of the NIR 2010 submission should be consulted.

In the KP LULUCF reporting., the emissions and/or removals of CO_2 are quantified for changes in five ecosystem carbon pools, namely above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter. Hence, some methodological differences result from the fact that the Convention reporting uses only three pools, aggregating above-ground and below-ground biomass into living biomass, and dead wood and litter into dead organic matter (see Table 3.1.2 in GPG for LULUCF, IPCC 2003).

Changes in above-ground biomass carbon pool were estimated primarily on the basis of forest taxation data in Forest Management Plans (further denoted as FMP), disaggregated in line with the country-

specific approaches at the level of the four major tree species, namely beech, oak, pine and spruce (Chapter 7.3.1 of NIR 2010).

Since the estimates of biomass carbon stock change on Forest Land under the Convention involve one default coefficient for the root/shoot ratio (*R*; 0.20) and the equations of the default method involving multiplicative members, the attributing of carbon stock change to the below- and above-ground components, required for the reporting under Kyoto Protocol, was determined solely by *R*.

Carbon stock change in litter for *AR* and *D* activities was estimated jointly with the component of soil. This follows the methodology of soil carbon stock change estimation resulting from land use change among the land use categories Forest Land, Cropland and Grassland, based on interpreted soil carbon stock maps (Section 7.3.2.2, NIR 2010). Therefore, the notation key “IE” (included elsewhere) was used in the CRF tables to indicate that the litter carbon stock change is estimated inherently with changes in the soil carbon pool.

The carbon stock change in deadwood was estimated for all types of *D* events. It was based on the information on standing and lying deadwood that was obtained from the recently (2008 to 2009) conducted field campaign of the landscape inventory project CzechTerra (ME 2007). This provides data on mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood (7.5 m^3/ha) classified in four categories according to degree of decomposition. These categories are defined as follows: i) basically solid wood; ii) peripheral layers soft, central hard; iii) peripheral layers hard, central soft; iv) totally rotten wood. The amount of carbon held in lying deadwood was estimated as the product of the wood volume, density weighted by the mean growing stock volume of major tree species (0.433 t/m3), reduction coefficients of 0.8, 0.5, 0.5, 0.2 (Cerny *et al*. 2002; Carmona *et al*. 2002) applicable to the above described decomposition categories, respectively, and the carbon fraction in the wood (0.5 t C/t biomass). A default, conservative assumption that no deadwood is present following a land use change was adopted in this calculation.

For the *FM* activity, which resembles the category *5A1 Forest land remaining Forest land*, the Tier 1 assumption of GPG for LULUCF (IPCC 2003), resp. IPCC Guidelines (IPCC 2006) of no significant change was adopted. However, under the real circumstances of the Kyoto Protocol commitment period, the carbon stock change of deadwood for FM will most likely be revised using independent Tier 2 or Tier 3 estimation based on the results of the recently implemented statistical landscape inventory in the Czech Republic.

In contrast, carbon stock change of litter and soil carbon pools under *FM* is not estimated and no net CO_2 emissions are assumed. The argumentation for this aspect is given in Section 11.3.1.2 below.

Additional emissions of CO_2 may arise from liming on forest soil. Note that liming on forest soil is not included in the Convention reporting, where the emission reporting concerning liming is restricted to the agricultural land-use categories of Cropland and Grassland. Since some liming on Forest Land occurs in the Czech Republic, it is reported in this submission in the corresponding CRF KP LULUCF table for FM. For these emissions, the methodology described in Section 3.3.1.2.1 of GPG for LULUCF (IPCC 2003) was used. The activity data in terms of forest area and amount of limestone applied were taken from the national report on Czech forestry (Green report, MA 2009). In 2008, the amount of lime applied to forest soils equaled 12.3 kton and concerned an area of 3 973 ha.

Additional greenhouse gases (CO_2, CH_4 and N_2O) are reported from biomass burning. Burning is confined to the activity of FM and thus matches the corresponding estimates under the Convention for the land-use category *5A1 Forest Land remaining Forest Land*. The emissions are estimated identically as described in Section 7.3.2.1 of the NIR 2010 text.

There are no N_2O emissions from N-fertilization and soil drainage, which are therefore not applicable for the reporting period. On the contrary, N_2O emissions are reported for deforestation of Forest land that is converted to Cropland. This estimation is identical to that reported under the Convention and described in NIR 2010, Section 7.4.2.2 for land use category *5.B.2.1*.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Carbon stock change of litter and soil carbon pools under *FM* are not estimated as no net CO_2 emissions are assumed. For this purpose, the reasoning based on the targeted peer-reviewed modeling analysis performed for the actual circumstances of *FM* in the country is used (Cienciala et al. 2008a).

This analytical study confirms that, for the range of scenarios with *FM* obeying sustainability principles as adopted in the country, no loss of carbon in soils is projected, including the likely effect of changing climatic conditions on soil decomposition. Therefore, the notation key "NR" is used for both litter and soil under *FM* activity.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

The indirect and natural GHG emissions and removals were not factored out.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Although the Czech Republic previously reported emissions and removals in its voluntary 2009 submission, the recalculations are not applicable. This submission of 2010 represents the first estimates of the KP LULUCF activities for 2008 and any recalculations may be relevant for the following submissions.

11.3.1.5 Uncertainty estimates

The uncertainty estimates were prepared following the methodological guidance of GPG for LULUCF (IPCC 2003). The details are described in Section 7.3.3 of NIR 2010. It should be noted that the adopted method of combining uncertainties (Eq. 5 in NIR 2010 following GPG for LULUCF) is not considered suitable for the LULUCF activities. It is specifically questionable when uncertainties associated with removals and emissions are to be combined, which may result in a denominator close to or equal to zero (which is not admissible).

The estimated overall uncertainty for *AR* activities reached 55 %. The overall uncertainty for *D* reached 82 %. As for *FM*, the overall uncertainty reached 271 %. This is mainly due to the described effect of the recommended (IPCC 2003, IPCC 2006) combination of uncertainties adopted here (see more explanation in Section 7.3.3 of the NIR text). The uncertainty of the key components of the *FM* emission estimates that are combined, i.e., biomass growth and biomass loss, reached 38 and 56 %, respectively.

11.3.1.6 Information on other methodological aspects

Despite efforts to make the reporting of KP LULUCF activities correspond to that under the Convention, there are some aspects that make the direct comparison difficult. Specifically for *FM*, a direct comparison with the emission estimates of the related category 5A1 under the Convention reporting will reveal some differences. There are two aspects to be considered when comparing the quantitative estimates of these categories.

First, the KP LULUCF reporting of *FM* additionally includes the contribution of forest areas afforested prior 1990. In this inventory, these are registered in the sub-category "Residual afforested land from before 1990 (in conversion status)". Second, the KP LULUCF reporting of *FM* also includes the emissions from lime application in forests, while the Convention reporting considers lime application only for the land use categories Cropland and Grassland. It was verified that, once the two aspects are properly sorted out, the *FM* reporting matches that of category 5A1 under the Convention.

11.3.1.7 The year of the onset of an activity, if after 2008

Not applicable.

11.4 Article 3.3

11.4.1 *Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are directly human-induced*

The annually updated cadastral information from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) refers exclusively to intentional, i.e., human-induced interventions

into land use. These interventions are thereby reflected in the corresponding records, including the time attribute, collected and summarized at the level of cadastral units and individual years.

11.4.2 *Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation*

Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on Forest land, while deforestation is a cadastral change of land use from Forest land to other categories of land use.

11.4.3 *Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested.*

Any deforestation in terms of land use change requires an official decision. Hence, no permanent loss of forest cover may occur prior this approval, which is reflected in cadastral land use. A temporary loss of forest cover up to an area of 1 ha may occur as part of forest management operations on Forest land (units of land subject to *FM*), which is not qualified as deforestation in terms of Art. 3.3. KP LULUCF activity.

11.4.4 *Information on estimated emissions and removals of activities under Art. 3.3*

In 2008, the estimated removals from *AR* activities reached -272.0 Gg CO_2. The estimated emissions from *D* reached 160.2 Gg CO_2 eq. The details can be found in the corresponding CRF tables of KP LULUCF.

11.5 Article 3.4

11.5.1 *Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced*

The Czech Republic adopted the broad definition (FCCC/CP/2001/13/Add.1; IPCC 2003) of FM. It reads "*Forest management" is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner*." This decision implies that entire forest area in the country is subject to *FM* interventions, as guided by the Forestry Act (No. 289/1995 Coll.).

11.5.2 *Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year*

Not applicable for the Czech Republic.

11.5.3 *Information relating to Forest Management*

As noted in Section 11.5.1 above, the practice of *FM* is generally guided by the Forestry Act (No. 289/1995 Coll.).

11.5.4 *Information on estimated emissions and removals of Forest Management activity under Art. 3.4*

In 2008, the estimated removals from *FM* reached -4 413.7 Gg CO_2. The details can be found in the corresponding CRF tables of KP LULUCF.

11.6 Other information

11.6.1 *Key category analysis for Article 3.3 activities and any elected activities under Article 3.4*

As stated in CRF KP-LULUCF table “NIR-3”, there was one key category identified among the KP LULUCF activities, namely *FM*. Similarly to its associated LULUCF category *5A1 Forest land remaining Forest land*, it was identified by level assessment. Emissions or removals through other activities are not expected to increase substantially. Hence, no other activity is identified as key (Chapter 5.4.4, IPCC 2003).

11.7 Information relating to Article 6

No LULUCF joint implementation project under Art. 6 concerns the Czech Republic.

11.8 References

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12. Information on Accounting of Kyoto Units

12.1 Background Information

The information from the national registry on the issue, acquisition, holding, transfer, cancellation, withdrawal and carryover of assigned amount units, removal units, emission reduction units and certified emission reductions in the period from 1st of January 2009 to 31st of December 2009 is provided in standard electronic format in Annex 8.

12.2 Summary of Information Reported in the SEF Tables

The total number of AAUs in the registry at the end of the year 2009 corresponded to 815,162,195 tonnes CO_{2eq}, of which 745,963,013 units were in the Party holding account and 69,199,182 units in the entity holding accounts.
The number of ERUs in registry corresponded to 98,637 tonnes CO_{2eq}, all of which were in the entity holding accounts.
The CER units in the registry corresponded to 5,928,890 tonnes CO_{2eq}, of which 1,845,344 were in the Party holding account and 4,083,546 units were in the entity holding accounts.
The were no RMUs, t-CERs or l-CERs and no units in the Article 3.3/3.4 net source cancellation accounts and the t-CER and l-CER replacement accounts.
The total amount of units in the registry correponded to 821,189,722 tonnes CO_{2eq}.
The Czech Republic's assigned amount equals 893,541,801 tonnes CO_{2eq}.

12.3 Discrepancies and Notifications

No discrepancies and notifications occurred in 2009. (to be confirmed)

12.4 Publicly Accessible Information

In accordance with Decision 13/CMP.1, the Czech Registry Administrator makes non-confidential information publicly available and provides publicly accessible user interface through the registry web pages. The information provided is in line with requirements set in the Annex to Decision 13/CMP.1. The Czech Registry Administrator is working on improving the information provided on Article 6 projects. The information according to paragraph 46 (a) – (c) is publicly accessible. However the project documentation according to paragraph 46 (d) does not fit current structure of the user interface and confidentiality issues may still exist.

12.5 Calculation of the Commitment Period Reserve (CPR)

Each Party included in Annex I shall maintain, in its national registry, a commitment period reserve which should not drop below 90 per cent of the Party's assigned amount calculated pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, or 100 percent of five times the most recently reviewed inventory, whichever is lowest.

In the case of the Czech Republic, the relevant size of the Commitment Period Reserve is five times the most recent inventory (2008), which is calculated below:

5 x 141,409,510= **707,047,550 t** CO_{2eq}

13. Information on Changes in National System

As reported in the Chapter 1.5, new QA/QC plan was developed and now is being implemented, which can be considered as an important change in the national system. Moreover, recommendations of expert review teams (annual UNFCCC reviews) are gradually implemented, mainly by recalculations aimed at the improvement of accuracy and by addressing the existing gaps regarding completeness.

The national system is described in the “Czech Republic’s Initial Report under the Kyoto Protocol”(ME, 2006) and no significant changes were made with the exceptions described above. It means that (i) the institutional arrangements including staffing remains unchanged (as reported in the Chapter 1, and (ii) the main pillars of the national system declared in the “Czech Republic’s Initial Report under the Kyoto Protocol” are functional.

14. Information on Changes in National Registry

General description and background information on the National registry has been included in the Czech Republic's Initial Report, submitted to the UNFCCC. Czech national registry is fully compliant with registry requirements as defined by decisions 13/CMP.1 and 5/CMP.1 and also in IAR report. The Czech Republic has been completely eligible to connect ITL since 2007. On 16 October 2008, the Czech Registry Administrator and the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat completed the live connection between the UNFCCC International Transaction Log (ITL) and the Czech Registry. The whole process was synchronized between ITL, the European Union Community Independent Transaction Log (CITL) and 26 EU greenhouse gas emissions trading registries.

15. Information on Minimization of Adverse Impact in Accordance with Article 3, paragraph 14

The Czech Republic strives to implement its Kyoto commitments in a way, which minimizes adverse impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. The impact of mitigation actions on overall objectives of sustainable development is also given due consideration. As there is no common methodology for reporting of possible adverse impacts on developing country Parties, the information provided is based on the expert judgment of the Ministry of the Environment of the Czech Republic. The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Action	Implementation by the Party
(a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	The ongoing liberalization of energy market is in line with EU policies and directives. No significant market distortions have been identified. Consumption taxes for electricity and fossil fuels were harmonized recently. The main instrument addressing externalities is the emission trading under the EU ETS. Introduction of new instruments is subject to economic modelling and regulatory impact assessment.
(b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	No subsidies for environmentally unsound and unsafe technologies have been identified.
(c) Cooperating in the technological development of non-energy uses of fossil fuels and supporting developing country Parties to this end.	The Czech Republic does not take part in any such activity.
(d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.	Advanced low-carbon technologies are currently not a priority area in the Czech Republic's research, development and innovation system. Research and development is focused on improving efficiency of currently available technologies. Preliminary assessment of carbon storage potential was carried out. However, there is currently no significant CCS programme or demonstration project in the Czech Republic.
(e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.	The Czech Republic supports technology and capacity development through development assistance. Example of such activities is a project for modernization of powering and control of power plant block connected with establishment of a technical training centre at the University in Ulan Bator, Mongolia.

(f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	The Czech republic is cooperating in several bilateral development assistance projects focusing on reduction of fossil fuels dependence and development of renewable energy sources, inter alia: - Introduction of a system of utilization of renewable energy sources through construction of mini-hydropower plants in Phillipines - Solar energy for schools in Kenya - Renewable energy sources for a remote village community in Angola - Development of renewable sources of energy in poor rural areas of Vietnam (solar and small hydropower projects) - Development of small and medium size energy sources and interconnecting networks in Palestine

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Abbreviations

AACLC	Aggregate areas of cadastral land categories
APL	Association of Industrial Distilleries (Asociace průmyslových lihovarů)
AVNH	Association of Coatings Producers (Asociace výrobců nátěrových hmot)
CAPPO	Czech Association of the Petroleum Industry (Česká asociace petrolejářského průmyslu a obchodu)
CCA	Czech Cement Association
CDV	Transport Research Centre (Centrum dopravního výzkumu)
CGA ČPS	Czech Gas Association Český plynárenský svaz
CHMI ČHMÚ	Czech Hydrometeorological Institute Český hydrometeorologický ústav
CNG	compressed natural gas
COD	chemical oxygen demand
COSMC	Czech Office for Surveying, Mapping and Cadastre
CSO ČSÚ	Czech Statistical Office Český statistický úřad
CUEC COŽP UK	Charles University Environment Center Centrum pro otázky životního prostředí Univerzity Karlovy
BOD	biochemical oxygen demand
DOC	degradable organic carbon
EEA	European Environmental Agency
FAO	Food and Agriculture Organization
FMI ÚHÚL	Forest Management Institute, Brandýs nad Labem Ústav pro hospodářskou úpravu lesů
FMP	Forest Management Plans

FOD (model)	first order decay (model)
IEA	International Energy Agency
IFER	Institute of Forest Ecosystem Research (Ústav pro výzkum lesních ekosystémů)
IGU	International Gas Union
LPG	liquid petroleum gas
MA MZe	Ministry of Agriculture (CR) Ministerstvo zemědělství (ČR)
MCF	methane correction factor
ME (CR) MŽP (ČR)	Ministry of Environment (CR) Ministerstvo životního prostředí (ČR)
MIT MPO	Ministry of Industry and Trade (CR) Ministerstvo průmyslu a obchodu (ČR)
MSW	municipal solid waste
NACE	nomenclature classification of economic activities
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)
SWDS	Solid Waste Disposal Sites
VŠCHT	Institute of Chemical Technology (Vysoká škola chemicko technologická)
ÚVVP	Institute for Research and Use of Fuels (Ústav pro výzkum a využití paliv)

Annexes to the National Inventory Report

Annex 1 Key Categories

Annex 2 Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

Annex 3 Other detailed methodological description for individual source or sink categories, including for KP-LULUCF activities

Annex 4 CO2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

Annex 5 Assessment of completeness and potential sources and sinks of greenhouse gas emissions and removals excluded for the annual inventory submission and also for the KP-LULUCF inventory

Annex 6 Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

Annex 7 Table 6.1 and 6.2 of the IPCC good practice guidance

Annex 8 SEF Tables

Annexes 1 – 8 will be supplemented in the submission for UNFCCC

Annex 9 : National Energy Balance

The following tables present the data of the national energy balance by IEA categories. Calorific values for unit conversion are presented at Chapter 3.

SOLID FUELS	Coking Coal [kt/year]	Sub Bituminous Coal [kt/year]	Lignite/Brown Coal [kt/year]	Coke Oven Coke [kt/year]	Coal Tar [kt/year]
Indigenous Production	7512	5 151	47 537	3 399	246
Total Imports (Balance)	1103	1 138	35	519	285
Total Exports (Balance)	4138	1 944	1 537	830	17
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	-176	743	-654	-202	17
Inland Consumption (Calculated)	4301	5 088	45 381	2 886	531
Statistical Differences	0	322	-322	0	0
Transformation Sector	4301	3 540	42 176	2 484	67
Main Activity Producer Electricity Plants	0	1 042	25 897	0	0
Main Activity Producer CHP Plants	0	1 911	10 565	0	8
Main Activity Producer Heat Plants	0	4	177	0	0
Autoproducer Electricity Plants	0	0	513	0	0
Autoproducer CHP Plants	0	551	3 006	0	0
Autoproducer Heat Plants	0	32	50	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0
Coke Ovens (Transformation)	4301	0	0	118	0
BKB Plants (Transformation)	0	0	331	0	0
Gas Works (Transformation)	0	0	1 637	0	0
Blast Furnaces (Transformation)	0	0	0	2 366	59
Coal Liquefaction Plants (Transformation)	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0
Energy Sector	0	0	5	0	21
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	0	5	0	0
Patent Fuel Plants (Energy)	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0
BKB Plants (Energy)	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	21
Blast Furnaces (Energy)	0	0	0	0	0
Petroleum Refineries	0	0	0	0	0
Coal Liquefaction Plants (Energy)	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0
Distribution Losses	0	49	18	0	0
Total Final Consumption	0	1 177	3 504	402	443
Total Non-Energy Use	0	0	0	0	381
Final Energy Consumption	0	1 177	3 504	402	62
Industry Sector	0	1 102	2 158	362	62
Iron and Steel	0	629	59	313	30
Chemical (including Petrochemical)	0	172	1 578	0	15
Non-Ferrous Metals	0	0	1	6	0
Non-Metallic Minerals	0	260	76	31	17
Transport Equipment	0	0	31	0	0
Machinery	0	0	66	5	0
Mining and Quarrying	0	0	5	0	0
Food, Beverages and Tobacco	0	19	95	6	0
Paper, Pulp and Printing	0	10	182	0	0
Wood and Wood Products	0	0	2	0	0
Construction	0	1	8	0	0
Textiles and Leather	0	11	42	0	0
Non-specified (Industry)	0	0	13	1	0
Transport Sector	0	1	10	2	0
Other Sectors	0	74	1 336	38	0
Commercial and Public Services	0	5	198	11	0
Residential	0	67	1 104	25	0
Agriculture/Forestry	0	2	34	2	0
Fishing	0	0	0	0	0
Non-specified (Other)	0	0	0	0	0

	BKB-PB [kt/year]	Gas Works Gas [TJ/year]	Coke Oven Gas [TJ/year]	Blast Furnace Gas [TJ/year]	OxygenSteelFurnaceGas [TJ/year]
Indigenous Production	156	16 353	26 227	27 363	1 989
Total Imports (Balance)	13	0	0	0	0
Total Exports (Balance)	60	0	0	0	0
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	-2	0	0	0	0
Inland Consumption (Calculated)	107	16 353	26 227	27 363	1 989
Statistical Differences	0	0	0	0	0
Transformation Sector	4	15 963	5 665	9 197	530
Main Activity Producer Electricity Plants	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	4 341	4 640	530
Main Activity Producer Heat Plants	0	0	0	0	0
Autoproducer Electricity Plants	0	174	0	0	0
Autoproducer CHP Plants	4	15 789	1 324	4 557	0
Autoproducer Heat Plants	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0
BKB Plants (Transformation)	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0
Coal Liquefaction Plants (Transformation)	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0
Energy Sector	0	390	10 067	4 811	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	390	0	0	0
Patent Fuel Plants (Energy)	0	0	0	0	0
Coke Ovens (Energy)	0	0	10 067	3 188	0
BKB Plants (Energy)	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	1 623	0
Petroleum Refineries	0	0	0	0	0
Coal Liquefaction Plants (Energy)	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0
Distribution Losses	0	0	529	1 794	35
Total Final Consumption	103	0	9 966	11 561	1 424
Total Non-Energy Use	0	0	0	0	0
Final Energy Consumption	103	0	9 966	11 561	1 424
Industry Sector	0	0	9 966	11 561	1 424
Iron and Steel	0	0	8 754	11 260	1 424
Chemical (including Petrochemical)	0	0	0	0	0
Non-Ferrous Metals	0	0	0	0	0
Non-Metallic Minerals	0	0	183	0	0
Transport Equipment	0	0	0	0	0
Machinery	0	0	1 029	301	0
Mining and Quarrying	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0
Paper, Pulp and Printing	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0
Construction	0	0	0	0	0
Textiles and Leather	0	0	0	0	0
Non-specified (Industry)	0	0	0	0	0
Transport Sector	0	0	0	0	0
Other Sectors	103	0	0	0	0
Commercial and Public Services	0	0	0	0	0
Residential	103	0	0	0	0
Agriculture/Forestry	0	0	0	0	0
Fishing	0	0	0	0	0
Non-specified (Other)	0	0	0	0	0

LIQUID FUELS

Crude Oil [kt/year]	
Indigenous Production	242
Refinery Gross Output	0
Inputs of Recycled Products	0
Refinery Fuel	0
Total Imports (Balance)	8109
Total Exports (Balance)	20
International Marine Bunkers	0
Interproduct Transfers	0
Products Transferred	0
Stock Changes (National Territory)	-82

Natural Gas Liquids [kt/year]	
Indigenous Production	0
Refinery Gross Output	0
Inputs of Recycled Products	0
Refinery Fuel	0
Total Imports (Balance)	0
Total Exports (Balance)	0
International Marine Bunkers	0
Interproduct Transfers	0
Products Transferred	0
Stock Changes (National Territory)	0

Refinery Feedstocks [kt/year]	
Indigenous Production	0
Refinery Gross Output	0
Inputs of Recycled Products	0
Refinery Fuel	0
Total Imports (Balance)	0
Total Exports (Balance)	0
International Marine Bunkers	0
Interproduct Transfers	0
Products Transferred	145
Stock Changes (National Territory)	-11

	Refinery Gas [kt/year]	LPG [kt/year]	Naphtha [kt/year]	Motor Gasoline [kt/year]	Biogasoline [kt/year]	Aviation Gasoline [kt/year]
Refinery Gross Output	165	210	838	1 622	21	0
Refinery Fuel	150	0	0	0	0	0
Total Imports (Balance)	0	82	53	596	12	2
Total Exports (Balance)	0	114	11	239	5	0
International Marine Bunkers	0	0	0	0	0	0
Stock Changes (National Territory)	0	-3	-30	13	-1	0
Gross Inland Deliveries (Calculated)	15	219	850	2 019	54	2
Statistical Differences	0	0	0	0	0	0
Gross Inland Deliveries (Observed)	15	219	850	2 019	54	2
Refinery Intake (Observed)	0	0	0	0	0	0
Inland Demand (Total Consumption)	15	219	850	2 019	54	2
Transformation Sector	0	0	0	0	0	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0
Autoproducer CHP Plants	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0
Total Final Consumption	15	219	850	2 019	54	2
Transport Sector	0	78	0	2 019	54	2
International Aviation	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	2
Road	0	78	0	2 019	54	0
Rail	0	0	0	0	0	0
Domestic Navigation	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0
Industry Sector	15	120	850	0	0	0
Iron and Steel	0	0	0	0	0	0
Chemical (including Petrochemical)	15	110	850	0	0	0
Non-Ferrous Metals	0	0	0	0	0	0
Non-Metallic Minerals	0	2	0	0	0	0
Transport Equipment	0	0	0	0	0	0
Machinery	0	3	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0
Food, Beverages and Tobacco	0	2	0	0	0	0
Paper, Pulp and Printing	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0
Construction	0	2	0	0	0	0
Textiles and Leather	0	1	0	0	0	0
Non-specified (Industry)	0	0	0	0	0	0
Other Sectors	0	21	0	0	0	0
Commercial and Public Services	0	0	0	0	0	0
Residential	0	17	0	0	0	0
Agriculture/Forestry	0	2	0	0	0	0
Fishing	0	0	0	0	0	0
Non-specified (Other)	0	2	0	0	0	0
Total Non-Energy Use	15	110	850	0	0	0
Non-Energy Use in Transformation Sector	0	0	0	0	0	0
Non-Energy Use in Energy Sector	0	0	0	0	0	0
Non-Energy Use in Transport	0	0	0	0	0	0
Non-Energy Use in Industry	15	110	850	0	0	0
Of which: Non-Energy Use-Chemical/Petrochem	15	110	850	0	0	0
Non-Energy Use in Other Sectors	0	0	0	0	0	0

	Kerosene Type Jet Fuel [kt/year]	Other Kerosene [kt/year]	Transport Diesel [kt/year]	Biodiesel [kt/year]	Heating and Other Gasoil [kt/year]	White Spirit SBP [kt/year]
Refinery Gross Output	170	0	3 458	55	58	0
Refinery Fuel	0	0	0	0	0	0
Total Imports (Balance)	238	6	1 272	21	7	21
Total Exports (Balance)	0	1	668	18	2	0
International Marine Bunkers	0	0	0	0	0	0
Stock Changes (National Territory)	4	0	-40	0	2	0
Gross Inland Deliveries (Calculated)	387	5	4 039	85	85	21
Statistical Differences	0	0	0	0	0	0
Gross Inland Deliveries (Observed)	387	5	4 039	85	85	21
Refinery Intake (Observed)	0	0	0	0	0	0
Inland Demand (Total Consumption)	387	5	4 039	85	85	21
Transformation Sector	0	0	0	0	3	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	3	0
Autoproducer CHP Plants	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0
Energy Sector	0	0	14	0	4	0
Coal Mines	0	0	14	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	4	0
Distribution Losses	0	0	0	0	0	0
Total Final Consumption	387	5	4 025	85	78	21
Transport Sector	387	0	3 635	85	0	0
International Aviation	325	0	0	0	0	0
Domestic Aviation	62	0	0	0	0	0
Road	0	0	3 526	85	0	0
Rail	0	0	105	0	0	0
Domestic Navigation	0	0	4	0	0	0
Pipeline Transport	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0
Industry Sector	0	0	54	0	63	21
Iron and Steel	0	0	0	0	0	0
Chemical (including Petrochemical)	0	0	0	0	20	1
Non-Ferrous Metals	0	0	0	0	0	0
Non-Metallic Minerals	0	0	0	0	1	0
Transport Equipment	0	0	0	0	1	0
Machinery	0	0	0	0	2	0
Mining and Quarrying	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	2	0
Paper, Pulp and Printing	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	1	0
Construction	0	0	52	0	2	0
Textiles and Leather	0	0	0	0	0	2
Non-specified (Industry)	0	0	2	0	34	18
Other Sectors	0	5	336	0	15	0
Commercial and Public Services	0	0	6	0	5	0
Residential	0	0	0	0	0	0
Agriculture/Forestry	0	0	321	0	5	0
Fishing	0	0	0	0	0	0
Non-specified (Other)	0	5	9	0	5	0
Total Non-Energy Use	0	0	0	0	20	21
Non-Energy Use in Transformation Sector	0	0	0	0	0	0
Non-Energy Use in Energy Sector	0	0	0	0	0	0
Non-Energy Use in Transport	0	0	0	0	0	0
Non-Energy Use in Industry	0	0	0	0	20	21
Of which: Non-Energy Use-Chemical/Petrochem	0	0	0	0	20	0
Non-Energy Use in Other Sectors	0	0	0	0	0	0

	Fuel Oil - Low Sulphur [kt/year]	Fuel Oil - High Sulphur [kt/year]	Lubricants [kt/year]	Bitumen [kt/year]	Paraffin Wax [kt/year]	Petroleum Coke [kt/year]	Other Products [kt/year]
Refinery Gross Output	192	143	146	485	9	0	1 163
Refinery Fuel	25	0	0	0	0	0	88
Total Imports (Balance)	63	6	101	234	15	5	24
Total Exports (Balance)	4	72	42	166	7	1	8
International Marine Bunkers	0	0	0	0	0	0	0
Stock Changes (National Territory)	12	-9	5	4	-1	0	17
Gross Inland Deliveries (Calculated)	255	68	155	557	16	4	989
Statistical Differences	0	0	0	0	0	0	0
Gross Inland Deliveries (Observed)	255	68	155	557	16	4	989
Refinery Intake (Observed)	0	0	0	0	0	0	0
Inland Demand (Total Consumption)	255	68	155	557	16	4	989
Transformation Sector	137	4	0	0	0	0	75
Main Activity Producer Electricity Plants	8	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	36	2	0	0	0	0	0
Autoproducer CHP Plants	31	1	0	0	0	0	0
Main Activity Producer Heat Plants	61	1	0	0	0	0	0
Autoproducer Heat Plants	1	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	75
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	1	0
Coal Mines	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	1	0
Gas Works (Energy)	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0
Total Final Consumption	118	64	155	557	16	3	914
Transport Sector	0	0	133	0	0	0	0
International Aviation	0	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	0	0
Road	0	0	120	0	0	0	0
Rail	0	0	13	0	0	0	0
Domestic Navigation	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0
Industry Sector	110	34	22	552	16	3	914
Iron and Steel	1	5	0	0	0	0	0
Chemical (including Petrochemical)	48	1	0	0	0	0	770
Non-Ferrous Metals	0	0	0	0	0	0	0
Non-Metallic Minerals	5	20	0	0	0	0	7
Transport Equipment	0	0	0	0	0	0	0
Machinery	2	0	0	0	0	3	1
Mining and Quarrying	0	8	0	0	0	0	0
Food, Beverages and Tobacco	22	0	0	0	0	0	0
Paper, Pulp and Printing	18	0	0	0	0	0	0
Wood and Wood Products	6	0	0	0	0	0	0
Construction	4	0	0	552	0	0	2
Textiles and Leather	4	0	0	0	0	0	0
Non-specified (Industry)	0	0	22	0	16	0	134
Other Sectors	8	30	0	5	0	0	0
Commercial and Public Services	5	30	0	0	0	0	0
Residential	0	0	0	0	0	0	0
Agriculture/Forestry	3	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0
Non-specified (Other)	0	0	0	5	0	0	0
Total Non-Energy Use	0	0	155	552	16	0	845
Non-Energy Use in Transformation Sector	0	0	0	0	0	0	75
Non-Energy Use in Energy Sector	0	0	0	0	0	0	0
Non-Energy Use in Transport	0	0	133	0	0	0	0
Non-Energy Use in Industry	0	0	22	552	16	0	770
Of which: Non-Energy Use-Chemical/Petrochem	0	0	0	0	0	0	770
Non-Energy Use in Other Sectors	0	0	0	0	0	0	0

NATURAL GAS

Natural Gas [TJ]	
Indigenous Production	7 468
Associated Gas	4 707
Non-Associated Gas	2 761
Colliery Gas	0
From Other Sources	0
Total Imports (Balance)	363 565
Total Exports (Balance)	36 766
International Marine Bunkers	0
Stock Changes (National Territory)	-3 024
Inland Consumption (Calculated)	331 243
Statistical Differences	1 481
Inland Consumption (Observed)	329 762
Inland Demand (Total Consumption)	329 762
Transformation Sector	38 211
Main Activity Producer Electricity Plants	383
Autoproducer Electricity Plants	8
Main Activity Producer CHP Plants	8 138
Autoproducer CHP Plants	6 093
Main Activity Producer Heat Plants	20 385
Autoproducer Heat Plants	3 204
Gas Works (Transformation)	0
Coke Ovens (Transformation)	0
Blast Furnaces (Transformation)	0
Gas-to-Liquids (GTL) Plants (Transformation)	0
Non-specified (Transformation)	0
Energy Sector	5 218
Coal Mines	209
Oil and Gas Extraction	83
Petroleum Refineries	4 926
Coke Ovens (Energy)	0
Blast Furnaces (Energy)	0
Gas Works (Energy)	0
Own Use in Electricity, CHP and Heat Plants	0
Liquefaction (LNG) / Regasification Plants	0
Gas-to-Liquids (GTL) Plants (Energy)	0
Non-specified (Energy)	0
Distribution Losses	3 499
Total Final Consumption	282 834

Natural Gas [TJ]	
ENERGY USE	
Total Final Consumption	278 354
Transport Sector	3 195
Road	257
of which Biogas	0
Pipeline Transport	2 938
Non-specified (Transport)	0
Industry Sector	110 726
Iron and Steel	12 965
Chemical (including Petrochemical)	8 938
Non-Ferrous Metals	1 700
Non-Metallic Minerals	30 253
Transport Equipment	6 709
Machinery	12 726
Mining and Quarrying	1 344
Food, Beverages and Tobacco	13 072
Paper, Pulp and Printing	4 494
Wood and Wood Products	1 115
Construction	3 764
Textiles and Leather	2 697
Non-specified (Industry)	10 949
Other Sectors	164 433
Commercial and Public Services	61 822
Residential	95 246
Agriculture/Forestry	2 485
Fishing	0
Non-specified (Other)	4 880
NON- ENERGY USE	
Total Final Consumption	4 480
Transport Sector	0
Road	0
of which Biogas	0
Pipeline Transport	0
Non-specified (Transport)	0
Industry Sector	4 480
Iron and Steel	0
Chemical (including Petrochemical)	4 480
Non-Ferrous Metals	0
Non-Metallic Minerals	0
Transport Equipment	0
Machinery	0
Mining and Quarrying	0
Food, Beverages and Tobacco	0
Paper, Pulp and Printing	0
Wood and Wood Products	0
Construction	0
Textiles and Leather	0
Non-specified (Industry)	0
Other Sectors	0
Commercial and Public Services	0
Residential	0
Agriculture/Forestry	0
Fishing	0
Non-specified (Other)	0