NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC

SUBMISSION UNDER THE UNFCCC

REPORTED INVENTORIES 1990-2013

This submission contains aspects only under the Convention (not Kyoto Protocol)

Prague

November 2015

According to Decision 13/CP.20 of the Conference of the Parties to the UNFCCC, CRF Reporter version 5.0.0 was not functioning in order to enable Annex I Parties to submit their CRF tables for the year 2015. In the same Decision, the Conference of the Parties reiterated that Annex I Parties in 2015 may submit their CRF tables after 15/April, but no longer than the corresponding delay in the CRF Reporter availability. "Functioning" software means that the data on the greenhouse emissions/removals are reported accurately both in terms of reporting format tables and XML format.

CRF reporter version 5.10 still contains issues in the reporting format tables and XML format in relation to Kyoto Protocol requirements, and it is therefore not yet functioning to allow submission of all the information required under Kyoto Protocol.

Recalling the Conference of Parties invitation to submit as soon as practically possible, and considering that CRF reporter 5.10 allows sufficiently accurate reporting under the UNFCCC (even if minor inconsistencies may still exist in the reporting tables, as per the Release Note accompanying CRF Reporter 5.10), the present report is the official submission for the year 2015 under the UNFCCC. The present report is not an official submission under the Kyoto Protocol, even though some of the information included may relate to the requirements under the Kyoto Protocol.

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Ministry of the Environment of the Czech Republic

Elaborated by institutions involved in National Inventory System:

KONEKO, CDV, CHMI, IFER, CUEC
with contribution of MoE and OTE

Compiled by editors at CHMI

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Contents

Executive Summary

ES 1 Background information on greenhouse gas (GHG) inventories and climate change

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 the Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 may 2013. This edition of National Inventory Report (NIR) deals with national greenhouse gas inventories for the period 1990 to 2013 with specific accent on the latest year 2013 while keeping track of already performed/planned changes according to the previous versions.

Inventories of emissions and removals of greenhouse gases were prepared in accord with the IPCC methodology: IPCC 2006 Guidelines, IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003). Application of this general methodology on country specific circumstances is 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 UNFCCC reporting guidelines (UNFCCC, 2013). 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. However, this inventory doesn't include submission under KP. Therefore no information about KP LULUCF is provided. The information related to KP LULUCF will be provided in next submission.

The both parts of the National Inventory Report, together with the data output - Common Reporting Format (CRF) Tables, are submitted annually by 15th April, however in 2015 they were submitted by 15th November.

The structure of this report follows new methodical handbook published by the Secretariat "Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention" (UNFCCC, 2013).

ES 2 Summary of national emission and removal related trends

ES 2.1 GHG inventory

In 2013, the most important GHG in the Czech Republic was CO_2 contributing 83.42% to total national GHG emissions and removals expressed in CO_2 eq., followed by CH_4 9.77% and N_2O 4.68%. PFCs, HFCs, SF_6 and NF_3 contributed for 2.25% to the overall GHG emissions in the country.

Tab. ES 1 provides data on GHG emissions in comparison of overall trend from 1990 to 2013. For overview of GHG emissions and removals by categories please see chapter ES 3.

Tab. ES 1 GHG emission/removal overall trends

	Base year	2013	Base year	2013	trend
	[Gg CO_2 eq.]		%		
CO_2 emissions without net CO_2 from LULUCF	161 700.15	106 067.07	83.63	83.42	-34.41
CO_2 emissions with net CO_2 from LULUCF	155 238.81	99 245.50	83.00	82.43	-36.07
CH_4 emissions without CH_4 from LULUCF	21 066.33	12 426.51	10.90	9.77	-41.01
CH_4 emissions with CH_4 from LULUCF	21 181.49	12 491.29	11.32	10.37	-41.03
N_2O emissions without N_2O from LULUCF	10 573.92	5 944.93	5.47	4.68	-43.78
N_2O emissions with N_2O from LULUCF	10 600.22	5 959.94	5.67	4.95	-43.78
F-gases	15.68	2705.42	0.01	2.25	
Total (without LULUCF)	**193 356.07**	**127 143.93**			**-34.24**
Total (with LULUCF)	**187 036.19**	**120 402.15**			**-35.63**
Total (without LULUCF, with indirect)	**196 994.19**	**129 392.92**			**-34.32**
Total (with LULUCF, with indirect)	**190 674.31**	**122 651.14**			**-35.68**

Over the period 1990 - 2013 CO_2 emissions and removals decreased by 34.41%, CH_4 emissions decreased by 41.01% during the same period mainly due to lower emissions from 1 Energy, 3 Agriculture and 5 Waste; N_2O emissions decreased by 43.78% over the same period due to emission reduction in 3 Agriculture and despite increase from the 1.A.3 Transport category. Emissions of HFCs and PFCs increased by orders of magnitude, whereas SF_6 emissions kept steady trend over the whole period.

ES 3 Overview of source and sink category emission estimates and trends, including KP-LULUCF activities

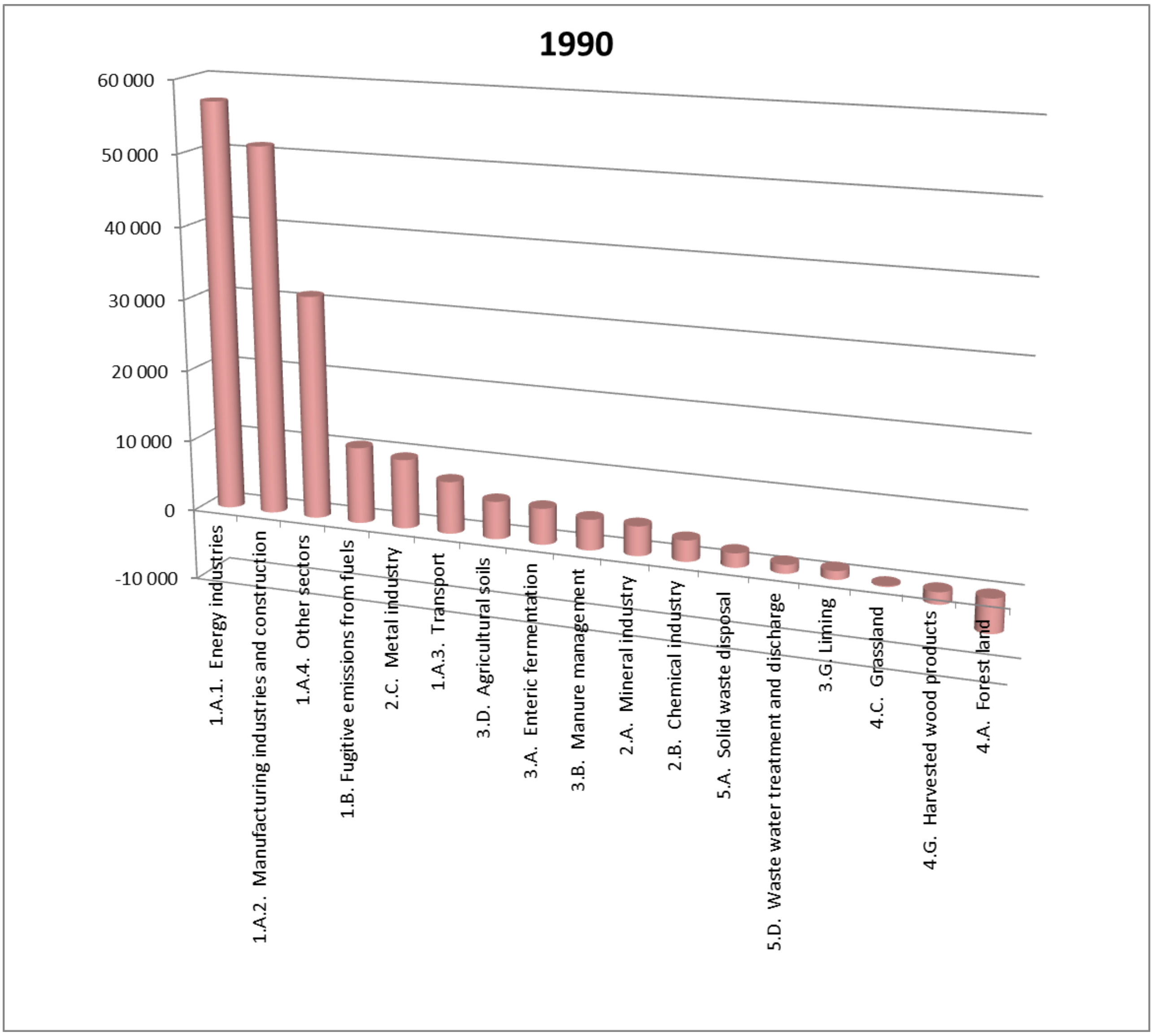


Fig. ES 1 Sources and sinks of greenhouse gases in 1990 (Gg CO_2 eq.)

ES 3.1 GHG inventory

Tab. ES 2 Overview of GHG emission/removal trends by CRF categories

	Base year	2013	2013	2013	Trend
	Gg CO_2 eq.	Gg CO_2 eq.	Total share [%]	Sectoral share [%]	%
1. Energy	157 253.80	100 876.57	83.78	100.00	-35.85
A. Fuel combustion (sectoral approach)	146 595.57	96 887.22	80.47	96.05	-33.91
1. Energy industries	56 900.29	55 919.61	46.44	55.43	-1.72
2. Manufacturing industries and construction	51 223.91	11 017.60	9.15	10.92	-78.49
3. Transport	7 284.03	16 649.55	13.83	16.50	128.58
4. Other sectors	31 187.34	12 991.03	10.79	12.88	-58.35
5. Other	NO	309.43	0.26	0.31	
B. Fugitive emissions from fuels	10 658.22	3 989.34	3.31	3.95	-62.57
1. Solid fuels	9 576.11	3 354.91	2.79	3.33	-64.97
2. Oil and natural gas and other emissions from energy production	1 082.12	634.43	0.53	0.63	-41.37
C. CO_2 transport and storage	NO	NO	NO	NO	
2. Industrial Processes	17 062.33	14 122.69	11.73	100.00	-17.23
A. Mineral industry	4 102.86	2 156.01	1.79	15.27	-47.45
B. Chemical industry	2 944.23	1 878.80	1.56	13.30	-36.19
C. Metal industry	9 667.79	7 058.16	5.86	49.98	-26.99
D. Non-energy products from fuels and solvent use	125.56	100.80	0.08	0.71	-19.72
E. Electronic industry	NO	16.39	0.01	0.12	
F. Product uses as ODS substitutes	NO,IE	2 672.61	2.22	18.92	
G. Other product manufacture and use	221.89	239.92	0.20	1.70	8.13
H. Other	NO	NO	NO	NO	
3. Agriculture	15 820.23	7 263.34	6.03	100.00	-54.09
A. Enteric fermentation	5 023.10	2 412.48	2.00	33.21	-51.97
B. Manure management	4 260.93	1 758.86	1.46	24.22	-58.72
C. Rice cultivation	NO	NO	NO	NO	
D. Agricultural soils	5 249.85	2 955.69	2.45	40.69	-43.70
E. Prescribed burning of savannas	NO	NO	NO	NO	
F. Field burning of agricultural residues	NO	NO	NO	NO	
G. Liming	1 177.82	135.50	0.11	1.87	-88.50
H. Urea application	108.53	0.81	0.00	0.01	-99.26
I. Other carbon-containing fertilizers	NO	NO	NO	NO	
J. Other	NO	NO	NO	NO	
4. Land use, land-use change and forestry	-6 319.88	-6 741.78	-5.60	100.00	6.68
A. Forest land	-4 731.34	-7 403.47	-6.15	109.81	56.48
B. Cropland	98.41	74.50	0.06	-1.11	-24.30
C. Grassland	-134.84	-322.01	-0.27	4.78	138.82
D. Wetlands	22.44	29.38	0.02	-0.44	30.96
E. Settlements	84.38	83.16	0.07	-1.23	-1.45
F. Other land	NO	NO	NO	NO	
G. Harvested wood products	-1 667.36	791.82	0.66	-11.74	-147.49
H. Other	NO	NO	NO	NO	
5. Waste	3 219.71	4 881.34	4.05	100.00	51.61
A. Solid waste disposal	1 979.27	3 324.45	2.76	68.11	67.96
B. Biological treatment of solid waste	IE,NO	585.17	0.49	11.99	
C. Incineration and open burning of waste	23.57	178.86	0.15	3.66	658.87
D. Waste water treatment and discharge	1 216.87	792.86	0.66	16.24	-34.84
E. Other	NO	NO	NO		
Total CO_2 equivalent emissions without land use, land-use change and forestry	193 356.07	127 143.93	-	-	-34.24
Total CO_2 equivalent emissions with land use, land-use change and forestry	187 036.19	120 402.15	100	-	-35.63
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	196 994.19	129 392.92	-	-	-34.32
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	190 674.31	122 651.14	-	-	-35.68

In 2013, 100 876.57 Gg CO_2 eq., that are 83.78% of national total emissions (including 4 Land Use, Land-Use Change and Forestry) arose from 1 Energy; 96.05% of these emissions arise from fuel combustion activities. The most important sub-category of 1 Energy with 55.43% of total sectoral emissions in 2013 is 1.A.1 Energy Industries, 1.A.2 Manufacturing Industries and Construction responses for 10.92% and 1.A.3 Transport for 16.5% of total sectoral emissions. From 1990 to 2013 emissions from 1 Energy decreased by 35.85%.

2 Industrial Processes is the second largest category with 11.73% of total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2013 (14 122.69 Gg CO_2 eq.); the largest sub-category is 2.C Metal Production with 49.98% of sectoral share. From 1990 to 2013 emissions from 2 Industrial Processes decreased by 17.23%.

3 Agriculture is the third largest category in the Czech Republic with 6.03% share of total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2013 (7 263.34 Gg CO_2 eq.); 40.69% of these emissions arose from 3.D Agricultural Soils. From 1990 to 2013 emissions from 3 Agriculture decreased by 54.09%.

4 Land Use, Land-Use Change and Forestry is the only category where removals exceed emissions. Net removals from this category increased from 1990 to 2013 by 6.68% to 6 741.78 Gg CO_2 eq.

4.05% of the national total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2013 arose from 5 Waste. 68.11% share of GHG emissions arose from 5.A Solid waste disposal. Emissions from 5 Waste increased from 1990 to 2013 by 51.61% to 4 881.34 Gg CO_2 eq.

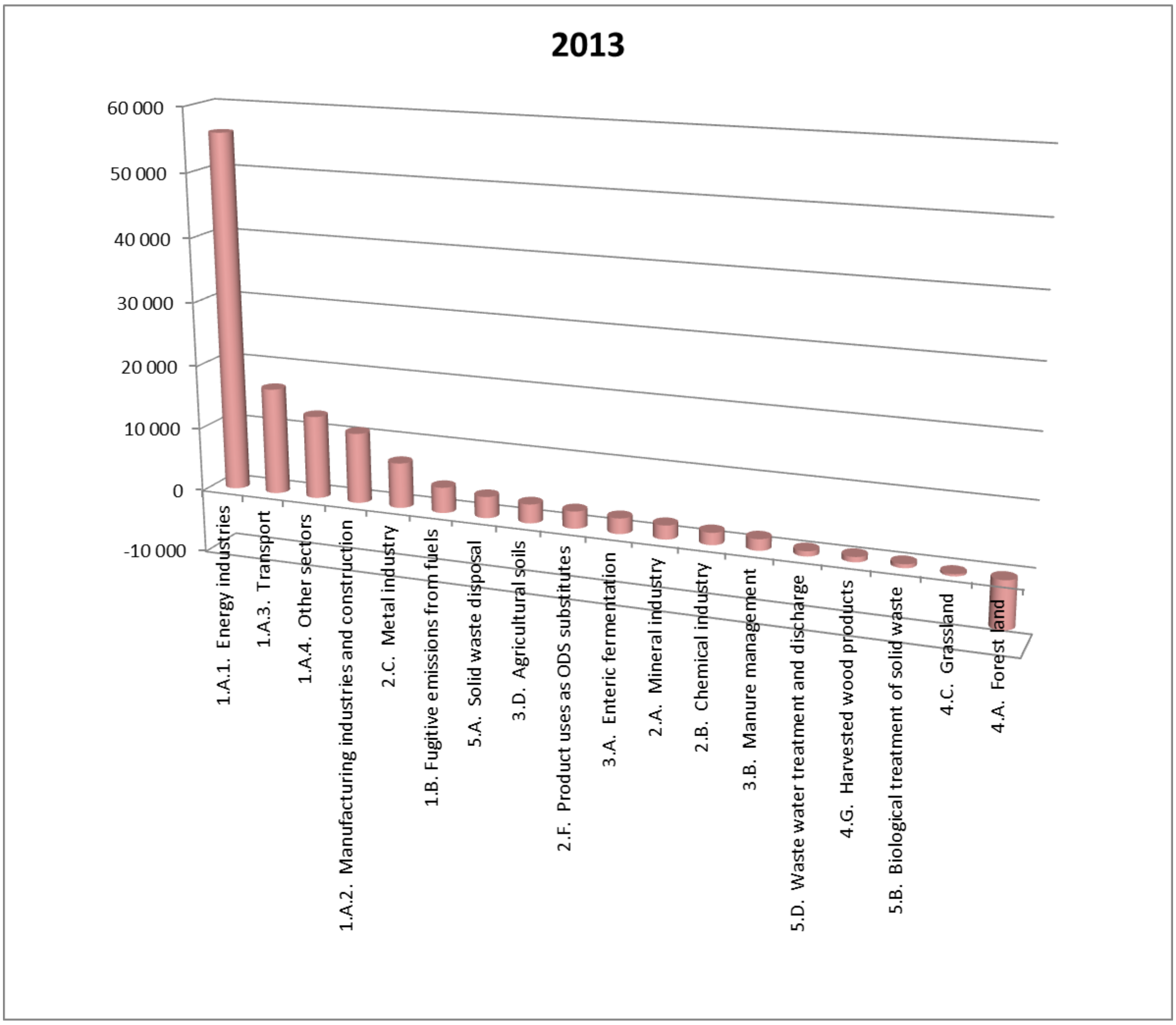


Fig. ES 2 Sources and sinks of greenhouse gases in 1990 (Gg CO_2 eq.)

ES 3.2 KP-LULUCF activities

This inventory doesn't include submission under KP. Therefore no information about KP LULUCF is provided. The description of emission trends for KP LULUCF will be provided in next submission.

ES 4 Other information

ES 4.1 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 2013 are presented in Tab. ES 3.

Tab. ES 3 Indirect GHGs and SO_2 for 1990 to 2013 [Gg]

	NO_X	CO	NMVOC	SO_X (as SO_2)
1990	738.50	1067.88	300.70	1870.91
1991	723.46	1152.49	263.24	1767.49
1992	699.42	1157.76	248.04	1554.42
1993	684.05	1189.26	224.28	1466.04
1994	441.27	1070.24	247.01	1284.80
1995	418.83	926.88	207.24	1090.23
1996	437.63	959.56	257.10	931.11
1997	461.63	975.41	263.80	977.45
1998	408.19	801.39	258.61	438.27
1999	375.12	720.24	239.94	264.35
2000	383.51	677.59	237.01	257.26
2001	330.75	686.17	219.52	250.20
2002	316.90	586.21	202.33	233.47
2003	323.29	629.79	202.62	229.51
2004	332.51	622.40	197.70	225.97
2005	278.42	553.13	181.38	217.60
2006	281.25	539.18	176.71	209.61
2007	283.24	577.95	173.47	213.57
2008	261.70	495.70	164.78	173.74
2009	251.62	452.16	149.34	172.91
2010	237.83	452.41	148.50	168.92
2011	224.68	404.49	138.07	167.95
2012	209.58	366.16	126.90	156.75
2013	222.16	612.82	149.38	138.04
Trend [%]	-69.92	-42.61	-50.32	-92.62
NEC	286	-	220	265

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

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2013: for NO_X by 69.92%, for CO by 42.61%, for NMVOC by 50.32% and for SO_2 by 92.62%. The most important emission source for indirect greenhouse gases and SO_2 are fuel combustion activities, for details see chapter 9 in Part1: Annual inventory report.

Part 1: Annual inventory submission

1 Introduction

1.1 Background information on GHG inventories and climate change

1.1.1 Climate change

Greenhouse gases (i.e. gases that contribute to the greenhouse effect) have always been present in the atmosphere, but in recent history 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 Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), the atmospheric concentrations of CO_2 have increased by 40%, primarily from fossil fuels emissions and secondarily from net land use change emissions. CH_4 concentrations increased by 150% and N_2O concentrations have risen by 20%, 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 emissions are on rapid 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 globally averaged land and ocean surface temperature has risen by about 0.85 °C in the period 1880 to 2012 according to the IPCC 5AR. 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, it concluded that anthropogenic climate change is a global threat and asked for an international agreement to deal with the problem. The *United Nations* started negotiations to create a *UN 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* established 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). During the second commitment period (CP2) of Kyoto Protocol, the EU, its member states and Iceland should reduce average annual emissions during 2013 - 2020 by 20% compared to base year.

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 fulfil its reporting requirements concerning GHG emissions and removals following from Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision 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* (MoE), 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 MoE 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, NF_3 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, SF_6 and NF_3 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 2013. Full time series of emissions and removals from 1990 to 2013 are included in the submission.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: *2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006)*; application of this general methodology under country-specific circumstances will be described in the sector-specific chapters. Since this submission the inventory was prepared using new updated methodology. Ale changes were conducted in the whole time-series. Details of specific changes are provided in specific chapters in this report. 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.

The 19. Conference of Parties agreed on Decision 24/CP.19 “Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention”, which establishing reporting requirements. This report attempts to follow this methodical handbook.

The current data submission (2015) for UNFCCC and for the EU contains all the data sets for 1990 - 2013 in the form of the official UNFCCC software called CRF Reporter. Since submission reported in 2015 the CRF Reporter was updated based on the new methodology in scope of different categorization and QWPs. The current version of CRF Reporter is web-based software, which is not considered fully reliable, especially concerning KP LULUCF tables. Therefore this submission does not report any information about KP LULUCF. Additionally, current version of CRF Reporter is adding digits after decimal point during importing of tables, as well as it doesn’t show appropriate notation keys in sum categories. The Party would like to note, that all subcategories are filled up with data, or appropriate notation keys.

1.2 A description of the national inventory arrangements

1.2.1 Institutional, legal and procedural arrangements

The National Inventory System (NIS), as required by the *Kyoto Protocol* (Article 5.1) and by Regulation No. 525/2013/EC, has been in place since 2005. As approved by the *Ministry of Environment* (MoE), which is the single national entity with overall responsibility, the founder of CHMI and its superior institution.

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 UNFCCC and EU bodies, etc. Mrs. Eva Krtková is the responsible person at CHMI.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and controlled by CHMI:

- 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 sector 2. Industrial Processes and Product Use
- Institute of Forest Ecosystem Research Ltd. (IFER), Jilove u Prahy, is responsible for compilation of the inventory in sectors 3. Agriculture and 4. Land Use, Land Use Change and Forestry
- Charles University Environment Centre (CUEC), Prague, is responsible for compilation of the inventory in sector 5. Waste.

Official submission of the national GHG Inventory is prepared by CHMI and approved by the *Ministry of Environment*. Moreover, the MoE 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 MoE provides financial resources for the NIS performance to the CHMI, which annually concludes contracts with sector-solving institutions.

More detailed information about NIS is given in the *Initial Report* (MoE, 2006) and in the 6th *National Communication* (MoE, 2014).

1.2.2 Overview of inventory planning, preparation and management

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 the 2015 submission contains estimates for the calendar year of 2013. 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 (1.2.1).

The preparation of the inventory includes the following three stages:

- inventory planning
- inventory preparation
- 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 1.2.3). 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 sectoral 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 1.2.3).

1.2.3 Quality assurance, quality control and verification plan

In the “in-country review” in October of 2009, the original QA/QC plan was considered inadequate and thus it was necessary to immediately establish a new conception of the QA/QC plan, an outline of which is presented in this chapter.

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 (Regulation No 525/2013/ of the European Parliament and of the Council).

Annex A5. 4 provides general form for QC procedures which is used in CR by each sectoral expert. Possible findings are examined and if possible corrected or included in Improvement plan for future submissions.

This year the meeting with Slovak National Inventory team in order to discuss difficulties in processing GHG inventories in both teams was held. Several general issues were discussed, for instance improving the cooperation in the field of QA/QC. Further information and potential problems concerning Agriculture and LULUCF sectors were conferred. Similar bilateral meeting will be held next year (2016) in May.

1.2.3.1 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* (MoE) during supervisory days. At these times, the NIS coordinator provides MoE with information about all QA/QC activities and discusses the potential for any further improvements. MoE 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 server of 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.

QA/QC plan is regularly updated. This years' amendment was focused mainly on documentation of performed QA/QC procedures and improvement of the archiving system.

1.2.3.2 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 specific 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 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.

1.2.3.3 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 2006 Guidelines. General inventory QC checks (Annex A5.4), 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, Mrs. Eva Krtková), their QA/QC guarantors, responsible for the compliance of all the QA/QC procedures in the given sector with the IPCC 2006 Guidelines and also with the QA/QC plan.

At the basic level of control, individual steps should be controlled according to the Table presented in Annex A5. 4. 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.

1.2.3.4 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.

An example of QA activities performed in the past was the QA audit focused on General and cross-cutting issues and on Transport, which was performed by Slovak GHG inventory experts in November 2009. The objectives of this QA review were

- Judgement of 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
- Recommendation of improvements in both cases.

Another QA procedure is held for Energy sector – stationary combustion and for Industrial Processes sector. External specialist for these sectors is participating on this issues.

Similar bilateral QA reviews concentrated more on individual sectors are planned for the future. Example of functional peer review can be deemed annual QA/QC assessment performed by EEA for each EU member state. Findings of the assessment and remedies/explanations are discussed and stored in a web based application specifically designed for this purpose. Most recent selective QA activity is the participation in "Project on assistance to MS with KP reporting" launched by European Commission.

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 analyses the comments and recommendations of the international Expert Review Team and strives to implement them as far as possible.

1.2.3.5 Implementation of QA/QC procedures in cases of recalculations

The QA/QC procedures described up to date are related particularly to standard situations, where the emission data from previous years remain unchanged and only emissions for the currently processed year are determined. The IPCC methodology requires that, in some cases, the emissions for previous years also be recalculated. These recalculations should be performed when an attempt is made to increase the accuracy by introducing a new methodology for the given category of sources or sinks, when more exact input data has been obtained or when consistent application of control procedures has revealed inadequacies in earlier emission determinations. In addition, recalculation should be performed in response to recommendations of the international inspection teams organized by the bodies of either the UN Framework Convention or the European Commission.

While new data are available roughly ten or eleven months after the end of the monitored year for standard emission determinations for the previous year, reasons for recalculation mostly arise well beforehand. If the methodology is changed during recalculation, the task becomes far more difficult than in standard determination of the previous year, as the new method must be thoroughly studied and tested. In addition, in order to maintain consistency of the time series, the recalculation is generally introduced for the entire time period, i.e. beginning with the reference year 1990. It is thus obvious that the danger of potential errors or omissions is greater in recalculation than in standard determination of the previous year using a well-tried methodology.

For these reasons, in recalculation, greater attention must be paid to QA/QC control mechanisms where, in addition to technical QC control (first step), it is necessary to employ more demanding control procedures (second step) and, where possible, also independent QA control by an expert not participating in the emission inventory in the given sector. While, for standardly performed QA/QC procedures, longer time validity is assumed, planning control procedures for recalculation must be tailored for the specific recalculation by the sector manager in cooperation with the NIS coordinator and QA/QC NIS guarantor.

Specific examples of recalculation are given in the sector-oriented chapters and in Chapter 10.

1.2.4 Changes in the national inventory arrangements since previous annual GHG inventory submission

There Czech national inventory system has undergone major staffing changes.

- The role of coordinator of national inventory process was transferred to Ing. Eva Krtková, who has been part of the national inventory team for 6 years already

- Ing. Ondřej Miňovský is no longer part of the team of the Czech national inventory system

- Ing. Martin Beck has been hired as new sectoral expert to support inventory in Industrial Processes and Product Use sector

- Denitsa Troeva Grozeva, MSc. has been hired to support national inventory team in scope of QA/QC process and Waste sector

No other significant changes were made and the main pillars of the national inventory system declared in the Czech Republic’s Initial Report under the Kyoto Protocol are operational and running.

1.3 Inventory preparation, and data collection, processing and storage

1.3.1 Activity data collection

Collection of activity data is based mainly on the official documents of the *Czech Statistical Office* (CzSO), 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 1.A 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).

Recently data from EU ETS system are used as well. For the purposes of Energy sector are these data used more for control purposes, more detailed information is given in relevant chapter for Energy sector. Furthermore, for the emission estimates in IPPU sectors are EU ETS data used in much higher extend. For some subcategories, e.g. Cement Production or Lime Production is these data used for the complete inventory; in the subcategories is EU ETS data used for improving emission factors and data. These improvements are listed in the Improvement Plan.

Furthermore across different sectors are used specific sectoral associations. In each chapter for subsectors are listed data providers for the specific subsectors.

1.3.2 Data processing and storage

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

Originally, the calculation spreadsheets related to the individual sectors were stored only in the relevant sector-solving institutions. On the basis of recommendations from the “in-country review” in 2007, a simple system was developed for central archiving, based on storage of documents from institutions participating in the national system in electronic form in a central folder-structured FTP data box located at CHMI. During the subsequent “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 arrangements.

Archiving process scheme

The NIS coordinator is responsible for the administration and functioning of the archive. The archiving system is administered in accordance with the provisions of the Kyoto Protocol and the IPPC methodical recommendations.

Material archived by the sector-solving organizations

- Input data in unmodified form
- Files for transformation of original data to calculation sheets (if used)
- Calculation sheets
- Outputs from CRF
- Outputs from QA/QC
- Other relevant documents

Material archived by the coordinator

- All administrative agenda with text outputs (contracts, orders, invoices)
- Important correspondence related to the operation and functioning of NIS
- Outputs from QA/QC
- Other relevant documents

Structural arrangements of the NIS Archive

The archiving system contains and connects 4 individual units.

8) The archive of the sector-solving organization
   - Functionality and administration are based on contracts with the sector-solving organizations
   - Administration is provided by the sectoral organizations
9) Central storage site for sharing material in the context of NIS
   - Storage site accessible at private ftp
   - Administered by the NIS coordinator
   - Contains working materials for current submissions intended for archiving
10) Central closed archive of the NIS Coordinator
   - Internal central archive, administered by the NIS coordinator
   - Contains all the officially archived materials
   - The content of the archive is stored in duplicate on special media designed for data archiving
   - The archive is located in the seat of the coordinator (CHMI – Prague Komořany)
   - Entries in the archive are always performed as of 30 June of the relevant year of submission and a detailed records of them is also archived.
   - Entries in the archive are also performed after the end of re-submissions or during any other unplanned intervention into the database or text part of already archived submissions.
   - Prior to archiving, data for archiving must be checked and authorized by the QA/QC guarantor of the relevant sectoral organization.
11) Central accessible archive
   - Mirror image of the central closed archive, available on the internet
   - Does not contain sensitive documents, but does contain a complete list of archived files
   - Available at http://portal.chmi.cz
   - Administered by the NIS coordinator
   - Updating corresponds to the entries in the Central closed archive, available a maximum of 3 working days after completion of archiving.

1.4 Brief general description of methodologies (including tiers used) and data sources used

The methods used in the Czech greenhouse gas 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 updated 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) are used for the inventory since this submission. For LULUCF sector IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003) was used as well.

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/Hard Coal, Brown Coal + Lignite, Bituminous Coal, Coking Coal, Gas Works Gas, Refinery Gas, LPG and Natural Gas, while the default emission factors are employed for the rest of the other fuels. For Bituminous Coal, Brown Coal + Lignite and Brown Coal Briquettes are used country specific oxidation factors as well. 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, 25 for CH_4 and 298 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, NMVOC 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. Thus 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), Submission under the UNECE/CLRTAP Convention* (submitted annually by 15th February) and shortly in chapter 9 of the NIR.

In September of 2014, the Czech national greenhouse gas inventory was subject to "*centralised review*". The Czech national inventory team received annual inventory report in April 2015. Since the delay caused by not-fully functioning reporting software occurred in this submission, the recommendations were implemented in the submission to as high extend as possible. Other recommendations are part of the Improvement plan for the future improvement of specific categories.

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

1.5 Brief description of key categories

The IPCC 2006 Guidelines (IPCC, 2006) provides two approaches of determining the key categories (key sources). Key categories by definition contribute to 90% percent of the overall uncertainty in a level (in emissions per year) or in a trend. Approach 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.

Tab. 1-1 Identification of key categories by level assessment (LA) and trend assessment (TA) for 2013 evaluated with and without LULUCF (Approach 1)

IPCC Source Categories	GHG	LA,%	TA,%	Cumulative Total (LA,%)	Cumulative Total (TA,%)	KC type
1.A Stationary Combustion - Solid Fuels	CO_2	39.53	28.40	39.53	28.40	LA,TA
1.A Stationary Combustion - Liquid Fuels	CO_2	12.02	4.28	51.56	73.03	LA,TA
1.A Stationary Combustion - Gaseous Fuels	CO_2	10.30	12.47	61.85	58.82	LA,TA
1.A.3.b Transport - Road Transportation	CO_2	10.23	17.95	72.08	46.35	LA,TA
4.A.1 Forest Land remaining Forest Land	CO_2	4.66	1.78	76.74	83.84	LA,TA
2.C.1 Iron and Steel Production	CO_2	4.28	0.41	81.03	94.88	LA,TA
5.A Solid Waste Disposal on Land	CH_4	2.18	3.07	83.20	80.25	LA,TA
1.B.1.a Coal Mining and Handling	CH_4	2.07	5.23	85.27	64.04	LA,TA
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	1.71	4.15	86.98	77.18	LA,TA
3.A Enteric Fermentation	CH_4	1.58	1.80	88.56	82.06	LA,TA
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	1.45	0.79	90.01	90.66	LA,TA
2.A.1 Cement Production	CO_2	0.87	0.68	90.88	92.10	LA,TA
3.B Manure Management	N_2O	0.78	1.45	91.66	85.29	LA,TA
2.B.8 Petrochemical and carbon black production	CO_2	0.62	0.62	92.28	93.39	LA,TA
4.G Harvested wood products	CO_2	0.52	4.70	92.80	68.75	LA,TA
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	0.48	0.40	93.28	95.68	LA
1.A Stationary Combustion - Liquid Fuels	N_2O	0.43	0.76	93.72	91.42	LA,TA
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	0.41	0.21	94.13	97.68	LA
2.A.2 Lime Production	CO_2	0.40	0.54	94.52	94.47	LA,TA
2.B.1 Ammonia Production	CO_2	0.39	0.16	94.92	98.20	LA
1.A.3.b Transport - Road Transportation	N_2O	0.39	0.80	95.31	89.87	LA,TA
5.D Wastewater treatment and discharge	CH_4	0.39	0.17	95.70	98.05	LA
1.A Stationary Combustion - Solid Fuels	CH_4	0.17	0.96	97.89	87.36	TA
5.B Biological treatment of solid waste	CH_4	0.36	0.87	96.36	88.23	TA
2.B.2 Nitric Acid Production	N_2O	0.14	0.84	98.49	89.07	TA
2.C.2 Ferroalloys Production	CH_4	0.28	0.67	96.64	92.77	TA
3.B Manure Management	CH_4	0.38	0.54	96.00	93.93	TA
1.A Stationary Combustion - Biomass	CH_4	0.28	0.41	96.92	95.27	TA

The procedure of the Approach 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.

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, 29 key categories were identified either by level assessment or by trend assessment. A summary of the assessed numbers concerning key categories is given in Tab. 1-2.

Tab. 1-2 Figures for key categories assessed

Key categories (KC) with LULUCF	29
KC identified by LA	20
KC identified by TA	24
KC identified by LA + TA concurrently	17
KC identified by only LA	4
KC identified by only TA	8
Key Categories (KC) without LULUCF:	24
KC identified by LA	17
KC identified by TA	21
KC identified by LA + TA concurrently	13
KC identified by only LA	4
KC identified by only TA	7

Of the overall number of 29 key categories, some of them are right on the 95% borderline and thus appear only occasionally.

1.6 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

Uncertainty analysis characterizes the extent (i.e. possible interval) of results for the entire national inventory and for its individual components. Knowledge of the individual and overall uncertainties enables compilers of emission inventories better understanding of the inventory process, which encompasses collection of suitable input data and their evaluation. Uncertainty analysis also help in identifying those categories of emission sources and sinks that contribute most to the overall uncertainty and thus establish priorities for further improvement of the quality of the data.

A method of uncertainty determination based on the error propagation method (Tier 1), using calculation sheets obtained according to the prescribed methodology (IPCC, 2006), has been used in the Czech national inventory for a number of years. The accuracy of the calculation algorithm has been sufficiently verified but problems have been caused to date by the only roughly estimated input parameters (i.e. uncertainty in the activity data and emission factors for the individual categories).

Consequently, the existing procedure was recently reviewed and these input parameters were refined both on the basis of data published in the literature (IPCC methodical manuals, national inventory report, scientific literature) and also on the basis of qualified expert estimates. Experts from CHMI and all the contributing sectoral organizations participated in this work. The individual experts investigated the uncertainty parameters coming under their field of work and proposed new ones or defended the original ones in discussions. Details are described in the study (CHMI, 2012b).

However, refinement of the input parameters did not substantially affect the resultant uncertainty values. For example, the resultant uncertainty in greenhouse gas emissions (including LULUCF) in the data for 2010 (reported in 2012) corresponded to a reduction of the value 3.79% to 3.43% and the resultant uncertainty in the trend decreased from 2.40% to 2.34%.

Uncertainty analysis of Tier 1, which is presented in this volume of NIR, employs the same source categorization as used in key categories assessment. Actual results of the uncertainty analysis for 2012 after above mentioned revision of the input parameters are given in Annex 2.

Results of uncertainty assessment were obtained (i) for all sectors including LULUCF and (ii) for comparison also for all sectors without LULUCF. The estimated overall uncertainty in level assessment (case with LULUCF) reached 3.31%. The corresponding uncertainty in trend is 2.41%.

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. The uncertainty analysis is provided in Annex 2 tables.

1.7 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.

Additionally this year was used the ‘completeness’ function of new CRF Reporter. However, it was discovered, that this functionality doesn’t always give proper results, so additional form created by CHMI was used for the completeness checks. Example of this form is given in Annex 5.5 (for Waste sector).

Specifically, there are some empty tables reported in this submission, since the CRF Reporter wasn't able to import specific tables or display information filled in subcategories. This issue is occurring only for categories, which are not occurring in the Czech Republic.

1.7.1 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 Documentation box in CRF Reporter and in relevant chapter of NIR. 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.

2 Trends in greenhouse gas emissions

According to the Kyoto Protocol, Czech national GHG emissions have to decrease by 8% of base year emissions during the five-year commitment period from 2008 to 2012. The Czech Republic has already met its goal, however it is very difficult to separate influences of general decrease in industrial and agricultural production and increase in overall energy-emission efficiency.

For 2013 – 2020 is existing joint commitment of the EU, its MS and Iceland to reduce average annual emissions by 20% compared to base year.

2.1 Description and interpretation of emission trends for aggregated GHG emissions

Tab. 2-1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2013. 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 1990-2013 excl. bunkers [Gg CO_2 eq.]

	CO_2 [1]	CH_4 [3]	N_2O [3]	HFCs	PFCs	NF_3	SF_6	Total emissions excl. LULUCF	Total emissions incl. LULUCF
1990	161 700.15	21 181.49	10 600.22				15.68	193 356.07	187 036.19
1991	146 084.41	19 519.16	9 162.02				15.60	174 671.89	165 639.37
1992	141 597.75	18 326.59	8 364.57		NE		15.78	168 191.44	158 569.04
1993	135 616.44	17 470.23	7 444.25				15.95	160 419.50	151 274.45
1994	129 208.13	16 593.02	7 240.57				16.11	152 928.42	146 423.65
1995	129 784.76	16 304.41	7 422.64	0.23	0.01	NO	16.28	153 407.26	146 700.29
1996	132 189.65	16 113.61	7 273.10	34.68	0.48	NO	25.19	155 483.37	148 365.22
1997	128 537.94	15 728.14	7 951.03	99.06	1.58	NO	22.79	152 177.67	146 085.83
1998	123 307.54	15 192.66	7 122.63	134.36	1.54	NO	21.37	145 634.04	139 266.93
1999	114 947.67	14 575.85	6 978.86	148.10	0.83	NO	23.75	136 539.91	130 075.57
2000	125 307.13	13 634.70	7 020.54	204.66	3.97	NO	37.93	146 084.02	138 968.89
2001	124 967.12	13 325.83	7 092.23	309.36	7.79	NO	28.76	145 602.09	138 166.81
2002	122 033.47	12 955.24	6 865.58	402.50	14.06	NO	49.88	142 182.99	134 850.49
2003	125 590.29	12 950.73	6 593.61	511.65	6.99	NO	73.22	145 556.45	139 836.50
2004	126 331.76	12 590.27	6 941.10	606.87	10.30	NO	50.53	146 374.47	140 258.24
2005	124 040.97	12 989.43	6 773.64	706.22	11.83	NO	47.16	144 419.67	137 987.47
2006	125 340.30	13 272.52	6 633.54	945.84	27.03	NO	30.83	146 066.99	142 124.52
2007	126 337.27	12 862.67	6 622.75	1292.53	24.92	NO	24.37	146 929.37	145 724.80
2008	121 212.68	12 965.64	6 648.23	1524.96	33.85	NO	25.06	142 222.65	137 456.38
2009	113 369.49	12 557.92	6 196.98	1654.24	39.15	NO	28.97	133 686.63	127 650.88
2010	115 033.97	12 761.89	5 986.84	1962.06	42.59	NO	15.00	135 633.72	130 330.63
2011	113 284.33	13 055.92	6 090.35	2240.49	10.24	NO	21.11	134 622.33	127 625.63
2012	109 011.19	13 180.88	6 028.60	2427.74	8.19	1.80	25.09	130 597.99	123 560.41
2013	106 067.07	12 491.29	5 959.94	2666.73	5.88	3.82	28.98	127 143.93	120 402.15
%	-34.41	-41.03	-43.78	100	100		84.91	-34.24	-35.63

Note: Global warming potentials (GWPs) used (100 years time horizon): CO_2 = 1; CH_4 = 25; N_2O = 298; SF_6 = 22 800; NF_3 = 17 200; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

[1] *GHG emissions excluding emissions/removals from LULUCF*

[2] *relative to base year*

[3] *incl. LULUCF*

GHG emissions and removals have significantly decreased in the period 1990 – 1994, mainly driven by the economy transition and pursuing major dropdown in heavy industry activities in the country. The fast decrease has stopped around 145 000 Gg CO_2 eq. and continues fluctuating ever since (see Fig. 2-1). From 2010 to 2013 the total GHG emissions (incl. LULUCF) decreased by 7.62% or 9 928.47 Gg CO_2 eq. resulting in total emissions of 120 402.15 Gg CO_2 eq. The decrease was caused by CO_2, CH_4, PFCs emissions (decreased by 2.6%; 5.2%; 28.25%) despite increase in HFC and SF_6 emissions (raised by 9.8% and 15.5% respectively) compared to previous year. The total GHG emissions and removals in 2013 were -35.63% below the base year level including LULUCF and -34.24%, when excluding LULUCF.

The decrease in CO_2, CH_4 and N_2O between 2012 and 2013 was 2.6%, 5.2% and 1.13% resp. Although F-gases show an increase of 9.85% the total emissions decreased between 2012 and 2013 by 2.56% (including LULUCF) and 2.64% (excluding LULUCF).

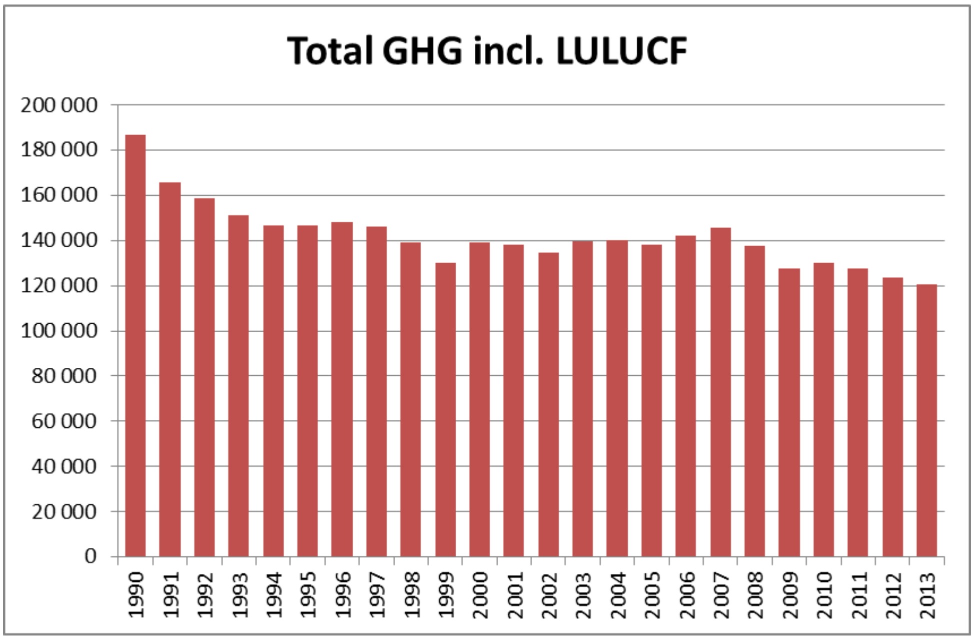


Fig. 2-1 Total trend of GHG emissions, [Gg CO_2 eq.]

In 1989 then Czechoslovak economy was one of the centrally planned economies with high level of monopolization. All economic processes were controlled through central planning. For all practical purposes, there was no real market and this situation resulted in an ever deepening economic and technological lag which resulted in high energy and material inefficiency. Since 1989 to the present the economy transformed successfully to a developed market-driven economy. The transformation led to a decline in production, investment in environmental protection, energy efficiency, fuel switch and increasing use of renewable energy.

Greenhouse gases emission trend between 2007 and 2009 and supposedly up to present days passed through significant change driven mainly by economic recession. It is noteworthy that in 2013 some of the industrial and energy subsectors reached its lowest amounts of emitted GHGs according to the whole reported time-series.

2.2 Description and interpretation of emission trends by sector

2.2.1 Description and interpretation of emission trends by gas

The major greenhouse gas in the Czech Republic is CO_2, which represents 83.42% of total GHG emissions and removals in 2013, compared to 83.63% in the base year. It is followed by CH_4 (10.37% in 2013, 11.32% in the base year), N_2O (4.95% in 2013, 5.67% in the base year) and F-gases (2.25% in 2013, 0.01% in the base year). The trend of individual GHG emissions relative to emissions in the respective base years is presented in Fig. 2-2.

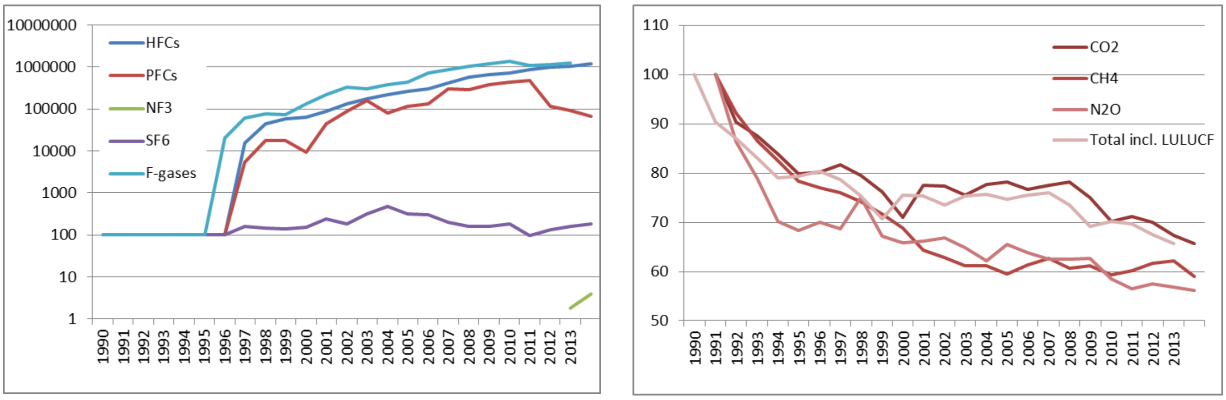


Fig. 2-2 Trend in CO_2, CH_4 and N_2O emissions 1990 - 2013 in index form (base year = 100%) and Trend in HFCs, PFCs (1995 – 2013) and SF_6 (1990 – 2013) actual emissions in index form (base year = 100%)

CO₂

CO_2 emissions have been rapidly decreasing in early 90's, after 1994 the emissions have kept at average of 68% of the amount produced in 1990. Inter-annual decrease in CO_2 emissions (excl. LULUCF) from 2010 to 2013 by 7.80% results the total decrease of 34.41% from 1990 to 2013 (36.07% decrease incl. LULUCF). Quoting in absolute figures, CO_2 emissions and removals decreased from 161 700.15 to 106 067.07 Gg CO_2 in the period from 1990 to 2013, mainly due to lower emissions from the 1 Energy category (mainly 1.A.2 Manufacturing Industries & Construction, 1.A.4.a Commercial/Institutional and 1.A.4.b Residential).

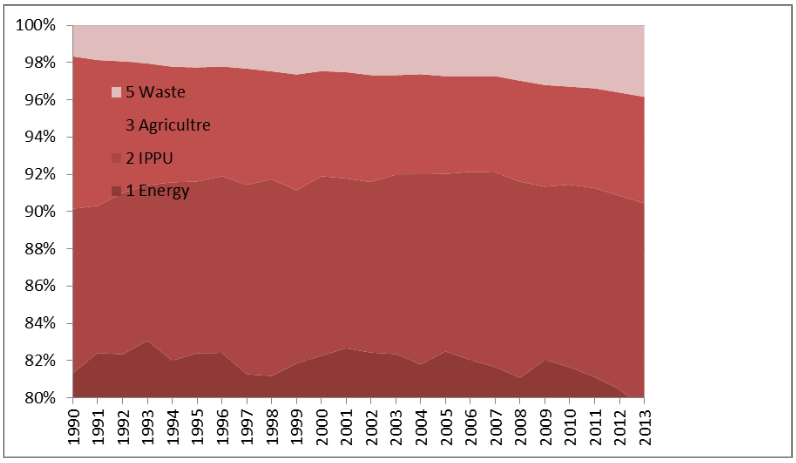


Fig. 2-3 Percentual share of GHGs (Y-axis begins at 80% - part of CO_2 share is hidden)

The main source of CO_2 emissions is fossil fuel combustion; within the 1.A Fuel Combustion category, 1.A.1 Energy Industry and 1.A.2 Manufacturing Industries & Construction sub-categories are the most important. CO_2 emissions increased remarkably between 1990 and 2013 from the 1.A.3 Transport category from 7 284 to 16 649 Gg CO_2.

CH_4

CH_4 emissions share decreased almost steadily during the period from 1990 to 2004, from 2004 methane fluctuated around 60% of its base year emissions. In 2013 CH_4 emissions were 41.03% below the base year level, mainly due to lower contribution of 1.B Fugitive Emissions from Fuels and emissions from 3 Agriculture and despite increase from the 5 Waste category. The main sources of CH_4 emissions are 1.B Fugitive Emissions from Fuels (solid fuel), 3 Agriculture (3.A Enteric Fermentation and 3.B Manure Management) and 5 Waste (5.A Solid Waste Disposal on Land and 5.B Wastewater Treatment and Discharge).

N_2O

N_2O emissions strongly decreased from 1990 to 1994 by 31.69% over this period and then shows slow decreasing trend with inter-annual fluctuation. N_2O emissions decreased between 1990 and 2013 from 10 600.22 to 5 959.94 Gg CO_2 eq. In 2013 N_2O emissions were 43.78% below the base year level, mainly due to lower emissions from 3 Agriculture and 2.B Chemical Industry and despite increase from the 1.A.3 Transport category.

The main source of N_2O emission is category 3.D Agricultural Soils (others less important sources are 1.A Fossil Fuel Combustion and 2 Industrial Processes – 2.B Chemical Industry).

HFCs

HFCs actual emissions increased remarkably between 1995 and 2013 from 0.23 to 2 666.73 Gg CO_2 eq. Emissions of HFCs have been rapidly increasing since the base year 1995. In 2013, HFCs emissions were more than 2000-times higher than in the base year 1995.

The main sources of HFCs emissions are 2.F Product Uses as ODS substitutes (Refrigeration and Air Conditioning).

PFCs

PFCs actual emissions show very similar trend as HFCs emissions but on much lower scale. They increased between 1995 and 2013 from 0.01 to 5.88 Gg CO_2 eq. In 2013, PFCs emissions are over 200 times higher than in the base year 1995. HFCs and PFCs have not 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 accounted for 15.68 Gg CO_2 eq. Between 1995 and 2013 they inter-annually fluctuated with maximum of 73.22 Gg CO_2 eq. in 2003 and minimum of 15.00 Gg CO_2 eq. in 2010. In 2013 SF_6 reached amount of 28.98 Gg, the level was 84.91% higher the base year.

The main sources of SF_6 emissions is 2.G Other product manufacture and use.

NF_3

With the technological progress a new gas was included in this year submission. NF_3 is a gas, used mainly for manufacturing of LCD displays, solar panels and etching semiconductors. Base year for this gas is 1995. In 2013 the emissions of NF_3 equalled to 3.82 Gg CO_2 eq., which is 53% increase, compared to year 2012.

2.2.2 Description and interpretation of emission trends by category

Fig. 2-4 presents a summary of GHG emissions by categories for the period from 1990 to 2013:

- Category 1 Energy
- Category 2 Industrial Processes and Product Use
- Category 3 Agriculture
- Category 4 LULUCF
- Category 5 Waste

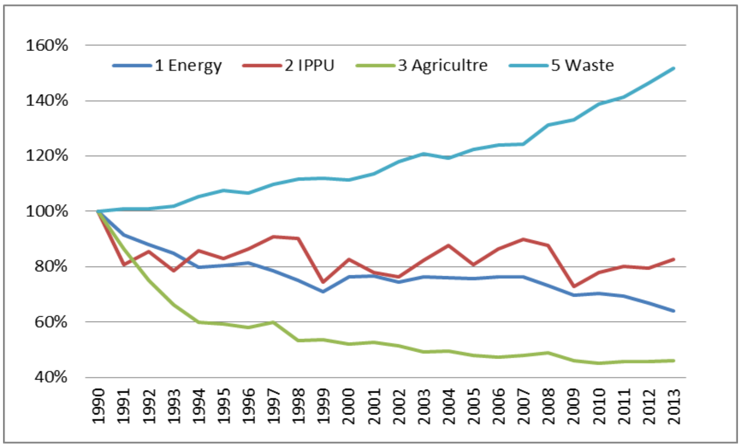


Fig. 2-4 Emission trends in 1990-2013 by categories in index form (base year = 100)

The dominant category is the 1 Energy category, which caused for 79.34% of total GHG emissions in 2013 (81.33% in 1990) excluding LULUCF, followed by the categories 2 Industrial Processes and Product Use and 3 Agriculture, which caused for 11.11% and 5.71% of total GHG emissions in 2013 (8.82% and 8.18% in 1990, resp.), 5 Waste category covered 3.84% and 4 LULUCF category removed 6 741.78 Gg CO_2 eq. which represents share of 5.3% of all GHG emissions.

The trend of GHG emissions by categories is presented in Fig. 2-4 (indexed relative to the base year), see also the percentual share of individual sectors (Fig. 2-4).

Tab. 2-2 Summary of GHG emissions by category 1990-2013 [Gg CO_2 eq.]

	1 Energy	2 IPPU	3 Agriculture	4 LULUCF	5 Waste
1990	157 253.80	17 062.33	15 820.23	-6 319.88	3 219.71
1991	143 943.16	13 803.05	13 676.07	-9 032.52	3 249.61
1992	138 488.70	14 566.60	11 887.20	-9 622.40	3 248.93
1993	133 253.99	13 410.41	10 476.81	-9 145.05	3 278.29
1994	125 394.25	14 648.84	9 490.24	-6 504.77	3 395.10
1995	126 404.83	14 137.56	9 403.36	-6 706.97	3 461.51
1996	128 143.87	14 744.45	9 158.28	-7 118.14	3 436.77
1997	123 670.88	15 471.44	9 503.11	-6 091.84	3 532.24
1998	118 215.63	15 380.73	8 444.79	-6 367.11	3 592.88
1999	111 752.79	12 691.88	8 494.12	-6 464.34	3 601.12
2000	120 169.81	14 079.47	8 248.24	-7 115.13	3 586.50
2001	120 354.31	13 280.52	8 312.59	-7 435.27	3 654.66
2002	117 199.66	13 022.75	8 159.39	-7 332.50	3 801.20
2003	119 863.72	14 031.87	7 769.86	-5 719.95	3 891.00
2004	119 716.75	14 961.43	7 857.43	-6 116.23	3 838.86
2005	119 132.44	13 769.33	7 573.95	-6 432.21	3 943.95
2006	119 818.79	14 763.45	7 496.10	-3 942.48	3 988.65
2007	119 972.53	15 353.71	7 604.54	-1 204.58	3 998.59
2008	115 308.90	14 975.06	7 712.44	-4 766.27	4 226.26
2009	109 681.39	12 430.82	7 293.19	-6 035.75	4 281.23
2010	110 727.68	13 305.09	7 137.90	-5 303.09	4 463.06
2011	109 201.85	13 650.36	7 218.74	-6 996.69	4 551.38
2012	105 069.02	13 579.87	7 237.88	-7 037.58	4 711.23
2013	100 876.57	14 122.69	7 263.34	-6 741.78	4 881.34
[1]%	-3.99%	4.00%	0.35%	-4.20%	3.61%
[2]%	-35.85%	-17.23%	-54.09%	6.68%	51.61%

[1] *Difference relative to previous year*
[2] *Difference relative to base year*

Tab. 2-3 Overview of trends in categories and subcategories (Gg CO_2 eq.)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2012	2013
Total (net emissions)	187036.19	146700.29	138968.89	137987.47	130330.63	123560.41	120402.15
1. Energy	157253.80	126404.83	120169.81	119132.44	110727.68	105069.02	100876.57
A. Fuel combustion (sectoral approach)	146595.57	117967.21	113746.41	113370.33	105568.97	100158.11	96887.22
1. Energy industries	56900.29	61827.25	62045.25	63149.21	61917.16	59236.49	55919.61
2. Manufacturing industries and construction	51223.91	26173.59	23421.48	18836.11	12466.20	11375.64	11017.60
3. Transport	7284.03	9354.55	12141.77	17459.48	17323.07	16801.33	16649.55
4. Other sectors	31187.34	20611.81	15957.95	13652.06	13533.39	12428.76	12991.03
5. Other	NO	NO	179.95	273.47	329.14	315.89	309.43
B. Fugitive emissions from fuels	10658.22	8437.62	6423.40	5762.11	5158.70	4910.91	3989.34
1. Solid fuels	9576.11	7600.67	5547.00	4866.40	4261.55	4226.50	3354.91
2. Oil and natural gas and other emissions from energy production	1082.12	836.95	876.40	895.71	897.15	684.41	634.43
2. Industrial Processes	17062.33	14137.56	14079.47	13769.33	13305.09	13579.87	14122.69
A. Mineral industry	4102.86	3050.14	3110.59	2734.22	2370.30	2330.33	2156.01
B. Chemical industry	2944.23	2808.20	2937.08	2837.88	2168.30	2132.46	1878.80
C. Metal industry	9667.79	7952.73	7438.74	7104.96	6421.36	6336.44	7058.16
D. Non-energy products from fuels and solvent use	125.56	103.75	140.30	120.85	101.98	94.32	100.80
E. Electronic industry	NO	NO	11.17	5.72	33.45	2.84	16.39
F. Product uses as ODS substitutes	NOIE	0.24	206.03	713.46	1971.20	2434.88	2672.61
G. Other product manufacture and use	221.89	222.50	235.56	252.25	238.50	248.59	239.92
3. Agriculture	15820.23	9403.36	8248.24	7573.95	7137.90	7237.88	7263.34
A. Enteric fermentation	5023.10	3133.04	2667.92	2493.25	2379.48	2413.04	2412.48
B. Manure management	4260.93	2767.49	2459.10	2149.83	1837.88	1745.81	1758.86
D. Agricultural soils	5249.85	3283.22	2941.47	2758.36	2722.68	2835.85	2955.69
G. Liming	1177.82	110.34	112.28	63.98	61.46	115.57	135.50
H. Urea application	108.53	109.27	67.47	108.53	136.40	127.60	0.81
4. Land use, land-use change and forestry[(2)]	-6319.88	-6706.97	-7115.13	-6432.21	-5303.09	-7037.58	-6741.78
A. Forest land	-4731.34	-6996.55	-7239.65	-6371.16	-5140.11	-7445.73	-7403.47
B. Cropland	98.41	109.44	89.05	78.02	77.88	69.66	74.50
C. Grassland	-134.84	-299.39	-395.33	-371.18	-368.59	-307.46	-322.01
D. Wetlands	22.44	9.84	27.28	20.22	33.81	24.55	29.38
E. Settlements	84.38	86.27	124.27	151.68	115.18	99.26	83.16
G. Harvested wood products	-1667.36	377.33	274.10	55.60	-26.00	517.22	791.82
5. Waste	3219.71	3461.51	3586.50	3943.95	4463.06	4711.23	4881.34
A. Solid waste disposal	1979.27	2404.98	2681.79	2867.18	3224.08	3297.57	3324.45
B. Biological treatment of solid waste	IENO	IENO	IENO	73.17	234.45	417.09	585.17
C. Incineration and open burning of waste	23.57	71.99	64.18	178.40	182.94	185.54	178.86
D. Waste water treatment and discharge	1216.87	984.55	840.54	825.20	821.59	811.02	792.86
Memo items:							
International bunkers	528.22	562.83	593.83	978.94	965.41	891.82	860.43
Aviation	528.22	562.83	593.83	978.94	965.41	891.82	860.43
CO_2 emissions from biomass	5400.43	4703.85	5370.93	7241.63	10701.85	11716.51	12716.68
Long-term storage of C in waste disposal sites	4243.13	5350.91	6613.29	8037.83	9621.38	10180.15	10416.85
Indirect N_2O	3300.97	2002.71	1818.27	1519.23	1377.08	1329.36	2417.75
Indirect CO_2 [(3)]	3638.12	3047.48	2451.83	2355.56	2070.68	1962.21	2248.99
Total CO_2 equivalent emissions without land use, land-use change and forestry	193356.07	153407.26	146084.02	144419.67	135633.72	130597.99	127143.93
Total CO_2 equivalent emissions with land use, land-use change and forestry	187036.19	146700.29	138968.89	137987.47	130330.63	123560.41	120402.15
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	196994.19	156454.74	148535.86	146775.23	137704.40	132560.19	129392.92
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	190674.31	149747.77	141420.73	140343.02	132401.31	125522.61	122651.14

Energy (IPCC Category 1)

The trend for GHG emissions from 1 Energy category shows decreasing trend of emissions. They strongly decreased from 1990 to 1994 and then fluctuated by 2002. After 2002 they stayed relatively stable by 2007. In the period 2002 – 2007 emissions kept around 120 000 Gg CO_2 eq. Total decrease between 1990 and 2013 is 35.85%. Between 2012 to 2013 emissions from category 1 Energy slightly decreased by 3.99%.

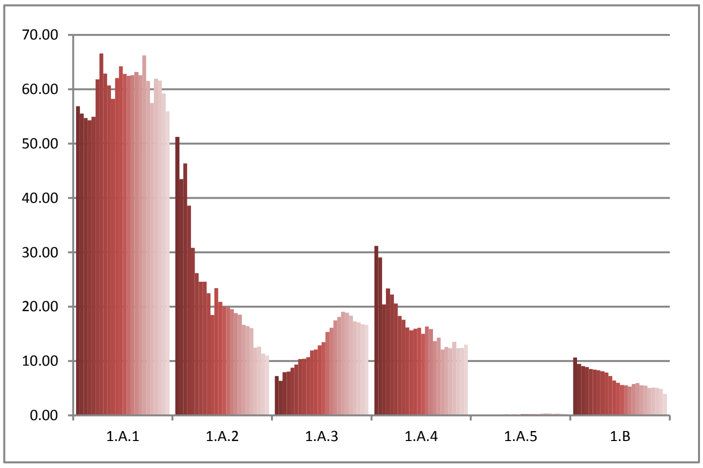


Fig. 2-5 Trends in Energy by categories 1990-2013 (Tg CO_2 eq.)

From the total 100 876.57 Gg CO_2 eq. in 2013 96.05% comes from 1.A Fuel Combustion, the rest are 1.B Fugitive Emissions from Fuels (mainly Solid Fuels). 1.B Fugitive Emissions from Fuels is the largest source for CH_4, which represented 30.32% of all CH_4 emissions in 2013. 30.12% of all CH_4 emissions in 2013 originated from Energy category.

CO_2 emissions from fossil fuels combustion (category 1 Energy) are the main source in Czech Republic's inventory with a share of 89.87% in national CO_2 emissions (excl. LULUCF). CO_2 from category 1 Energy contributes for 77.59% to total GHG emissions, CH_4 for 3.67% and N_2O for 0.84% in 2013.

Industrial Processes (IPCC Category 2)

In 2015 submission the IPPU category undergo significant change, due to the application of 2006 Guidelines. Category Solvents and Other Product Use was combined with category 2 IPPU. Further two new categories were developed (2.E Electronic Industry and 2.G Other Product Manufacture and Use).

GHG emissions from the 2 Industrial Processes and Product Use category fluctuated with decreasing trend during the whole period 1990 to 2013. In early 90's emissions decreased rather rapidly, then reached decade minimum in 1999 and subsequently decreased with total minimum in 2009 (global economic recession). Between 1990 and 2013 emissions from this category decreased by 17.23%. In 2013 emissions amounted for 14 122.69 Gg CO_2 eq.

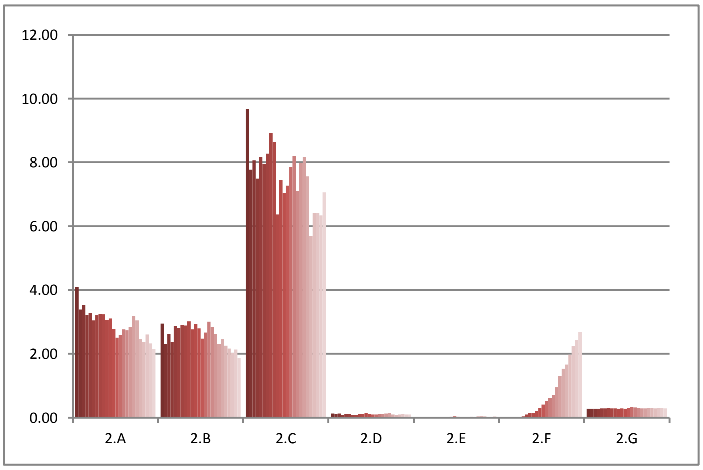


Fig. 2-6 Trends in IPPU by categories 1990-2013 (Tg CO_2 eq.)

The main categories in the 2 Industrial Processes and Product Use category are 2.C Metal Industry (49.97%), 2.A Mineral Industry (15.27%), 2.B Chemical Industry (13.3%) and 2.F Product Uses as ODS substitutes (18.92%) of the sectoral emissions in 2013 (Fig. 2-6).

The most important GHG of the 2 Industrial Processes and Product Use category was CO_2 with 73.46% of sectoral emissions, followed by F-gases (18.79%).

Agriculture (IPCC Category 3)

GHG emissions from the category 3 Agriculture decreased relatively steadily over the period from 1990 to 2003 and then fluctuated. In 2010 emissions reached minimum level which is 54.88% below the base year level.

Agriculture amounted 7 263.34 Gg CO_2 eq. in 2013 which corresponds to 5.71% of national total emissions (excluding LULUCF). The most important sub-category 3.D Agricultural Soils (N_2O emissions) contributed by 40.69% to sectoral total in 2013, followed by the 3.A Enteric Fermentation (CH_4 emissions, 33.21%).

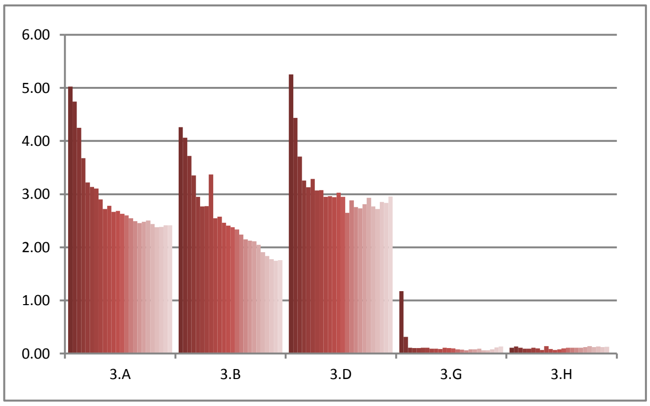


Fig. 2-7 Trends in Agriculture by categories 1990-2013 (Tg CO_2 eq.)

3 Agriculture is the largest source for N_2O and second largest source for CH_4 emissions (69.03% of total emissions of N_2O and 23.83% of total emissions of CH_4, excluding LULUCF). However it's emission trend steadily decreases over the whole observed period.

Land Use, Land-Use Change and Forestry (IPCC Category 4)

GHG removals from the 5 Land Use, Land-Use Change and Forestry category vary through the whole time series with minimum of – 9 622.4 Gg CO_2 eq. in 1992 and maximum -1 204.58 CO_2 eq. in 2007. In 2013 removals were by 6.68% above the base year level.

Emissions and removals amounted to -6 741.78 Gg CO_2 eq. in 2013, which corresponds to 5.3% of total national emissions. Emissions and removals are calculated from all categories and in line with GPG for LULUCF; IPCC 2003.

LULUCF category is the largest sink for CO_2. Net CO_2 removals from this category amounted to -6 741.78 Gg CO_2 in 2013. CH_4 emissions amounted to 64.78 Gg CO_2 eq., N_2O to 15 Gg CO_2 eq. Trends of the sub-categories in LULUCF sector are presented in Fig. 2-8.

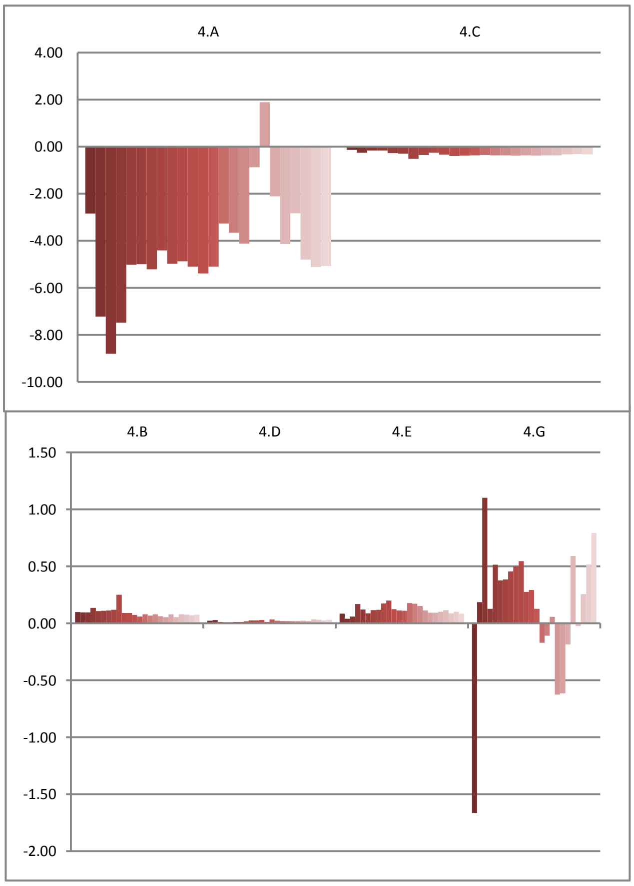


Fig. 2-8 Trends in LULUCF by separate source and sink categories 1990-2013 (Tg CO_2 eq.)

Waste (IPCC Category 5)

GHG emissions from category 5 Waste substantially increased during the whole period. In 2013 emissions amounted for 4 881.34 Gg CO_2 eq., which is 51.61% above the base year level. The increase of emissions is mainly due to higher emissions of CH_4 from 5.A Solid Waste Disposal (and partly due to increase of N_2O emissions from 5.B Wastewater Treatment and Discharge), which are the most important categories. As a result of CH_4 recovery systems installed in 5.B Wastewater Treatment and Discharge total emissions from this category decreased by approx. 34% compared to the base year. The share of category 5 Waste in total emissions was 3.84% in 2013.

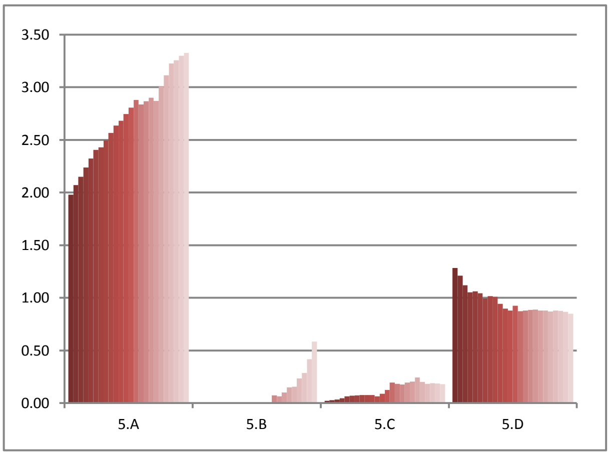


Fig. 2-9 Trends in Waste by categories 1990-2013 (Tg CO_2 eq.)

The main source is solid 5.A Solid Waste Disposal, which accounted for 68.10% of sectoral CH_4 emissions in 2013, followed by 5.D Wastewater Treatment and Discharge (16.24%) and 5.B Biological treatment of solid waste (11.98%). Trends of the separate sub-categories in Waste sector can be observed on Fig. 2-9.

91.34% of all emissions from Waste category are CH_4 emissions; CO_2 contributes by 3.59% and N_2O by 5.06%.

2.2.3 Description and interpretation of emission trends of indirect greenhouse gases and SO_2

Description of trends of emissions of indirect greenhouse gases is provided in Chapter 9.

2.2.4 Description and interpretation of emission trends for KP-LULUCF inventory

This inventory doesn't include submission under KP. Therefore no information about KP LULUCF are provided. The description of emission trends for KP LULUCF will be provided in next submission.

3 Energy (CRF Sector 1)

3.1 Overview of sector

The energy sector in the Czech Republic is driven by the combustion of fossil fuels in stationary and mobile sources; however fugitive emissions are also important source of emissions. The two main categories are 1.A Fuel Combustion and 1.B Fugitive Emissions from Fuels.

Activity data are based on the energy balance of the Czech Republic prepared by the Czech Statistical Office (CzSO). 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.

Processing of the activity data is based on the total energy balance of the Czech Republic. The energy balance is prepared by CzSO, and is divided into issues 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 Sectoral Approaches. The Reference Approach is based on data from the source part of the energy balance; the Sectoral Approach involves processing of data on fuel consumption in a structure corresponding to the requirements of the IPCC categorization.

Default emission factors from the IPCC methodology have been for key categories gradually substituted by country specific emission factors. Moreover, in case of CO_2 emission factors from lignite (brown coal) and bituminous coal the previous country-specific emission factors were in this submission refined by using recent national data.

In connection with implementation of new methodology (IPCC, 2006), there were in this submission newly applied relevant default emission factors from this methodology. As a consequence of these innovations, considerably increasing amount of recalculations appeared in this submission compared to previous years.

Inventories of CO_2, CH_4 and N_2O emissions from subsector 1.A.3 Transport are performed using the CDV model for mobile sources. This model is fully harmonised with activity data from the official CzSO Energy balance mentioned above.

Fugitive emissions in sector 1.B are determined by calculation from activity data and country-specific or default emission factors. The activity data are obtained first of all from the official CzSO energy balance. The sector statistics and annual targeted surveys are used in special cases, when data missing or are insufficient.

3.1.1 Key categories in sector 1 Energy

Combustion processes included in category 1.A make a decisive contribution to total emissions of greenhouse gases. All CO_2, CH_4 and N_2O emissions are derived from the combustion of fossil respectively biofuels and other fuels in stationary and mobile sources.

On the whole, 11 key sources have been identified in sector 1, the most important of which are the first 3 given Tab 3-1. This group of sources contributes 82.17% to total greenhouse gas emissions (without LULUCF).

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 1.A were appropriately completed for the entire required time interval of 1990 to 2013.

In 1.B Fugitive Emissions from Fuels category, especially 1.B.1.a Coal Mining and Handling was evaluated as a key category (Tab. 3-1.) Category 1.B.2 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*.

Tab. 3-1 Overview of key categories in 1 Energy (2013)

Category	Gas	Character of category	% of total GHG*
1.A Stationary Combustion - Solid Fuels	CO_2	LA,TA	39.53
1.A Stationary Combustion - Liquid Fuels	CO_2	LA,TA	12.02
1.A Stationary Combustion - Gaseous Fuels	CO_2	LA,TA	10.30
1.A.3.b Transport - Road Transportation	CO_2	LA,TA	10.23
1.B.1.a Coal Mining and Handling	CH_4	LA,TA	2.07
1.A Stationary Combustion - Liquid Fuels	N_2O	LA,TA	0.43
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	LA	0.41
1.A.3.b Transport - Road Transportation	N_2O	LA,TA	0.39
1.A Stationary Combustion - Solid Fuels	CH_4	TA	0.17
1.A Stationary Combustion - Biomass	CH_4	TA	0.28

** 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.*

3.1.2 Emissions Trends

CO_2 emissions from the 1.A sector decreased by 34.1% from 144 Tg CO_2 in 1990 to 95 Tg CO_2 in 2013. Furthermore CO_2 emissions from the 1.B sector decreased by 62.9% from 458 Gg in 1990 to 201 Gg in 2013, as well as CH_4 emissions from 1.B sectors decreased by 56.1% from 408 Gg in 1990 to 152 Gg in 2013. Fig. 3-1 indicates overall trend in CO_2 and CH_4 emissions in the whole time series for both sectors. Furthermore Tab. 3-2 provides data for trends in 1 Energy for each gas reported in sector.

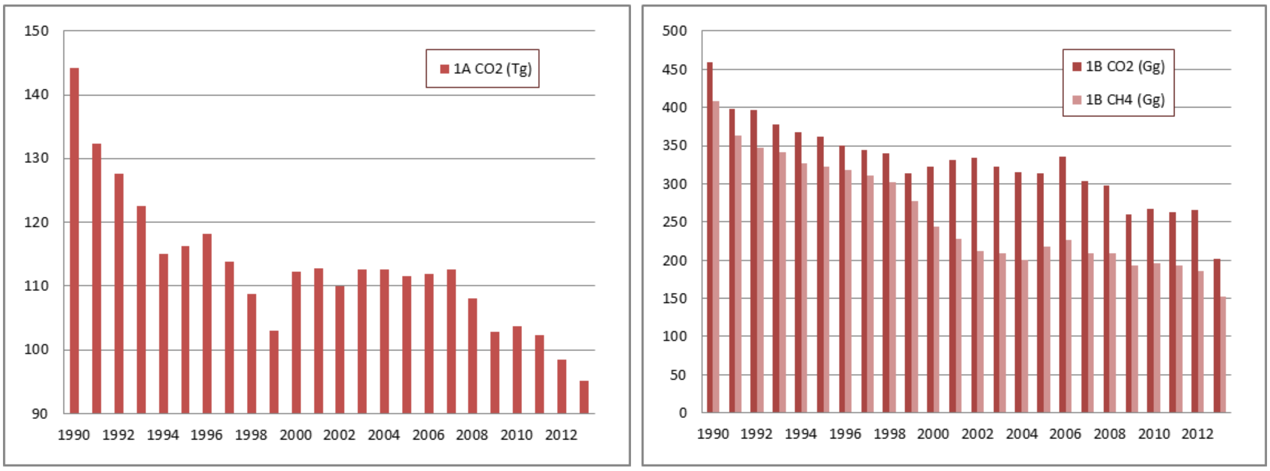


Fig. 3-1 Trend total CO_2 (Sectoral Approach) in 1.A and trend of CO_2 and CH_4 from 1.B sector in period 1990 – 2013

Tab. 3-2 Emissions of greenhouse gases and their trend from 1990 – 2013 from IPCC Category 1 Energy

	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]
1990	144 726	470	2.609
1991	132 820	417	2.373
1992	127 970	392	2.373
1993	122 945	385	2.332
1994	115 484	368	2.362
1995	116 674	360	2.428
1996	118 482	356	2.594
1997	114 248	346	2.592
1998	109 145	331	2.633
1999	103 357	303	2.718
2000	112 532	271	2.908
2001	113 051	256	3.063
2002	110 313	238	3.184
2003	112 924	236	3.486
2004	112 959	227	3.635
2005	111 920	244	3.765
2006	112 335	254	3.808
2007	112 903	235	3.990
2008	108 307	234	3.868
2009	103 083	219	3.786
2010	104 054	223	3.678
2011	102 629	219	3.658
2012	98 689	213	3.556
2013	95 327	180	3.482
Trend 1990/2013	**-34%**	**-62%**	**33%**

3.1.2.1 Emission trends by subcategories

The individual subsectors have different contributions to trends in emissions. Fig. 3-2 illustrates the trends in emissions on the example of CO_2 emissions and the share of CO_2 emissions in different subsectors in 2013.

The greatest increase in emissions was recorded in subsector 1.A.3 Transport between 1990 and 2007, when emissions increased by 160%. In absolute values, this corresponded to an increase from 7 Tg CO_2 in 1990 to 18.3 Tg in 2007. A slight decrease has been apparent since 2008, by 1.6 Tg in 2013. Emissions from subsector 1.A.1 Energy Industries are almost constant with slight fluctuations over the entire period; the greatest reduction occurred in subsectors 1.A.2 and 1.A.4 from 50.9 and 29.7 Tg CO_2 in 1990 to 10.9 and 12.3 Tg CO_2 in 2013, respectively.

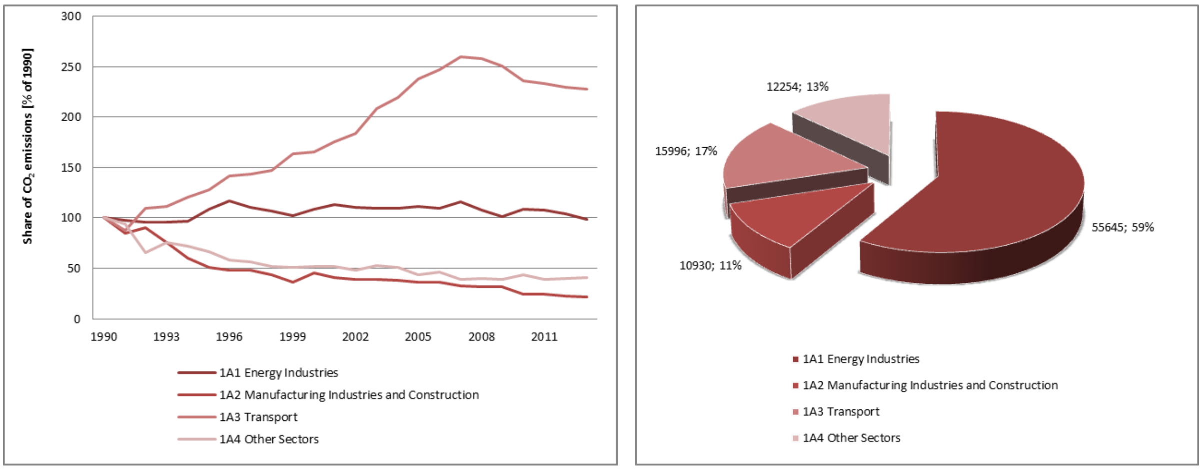


Fig. 3-2 Share and development of CO_2 emissions from 1990 - 2013 in individual sub-sectors; share of CO_2 emissions in individual subsectors in 2013 [Gg]

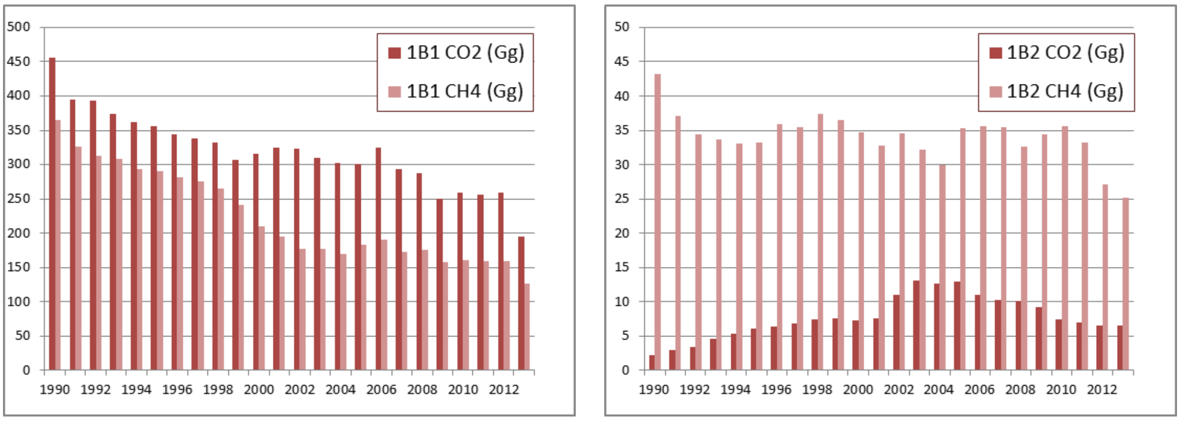


Fig. 3-3 CO_2 and CH_4 trend from the sector Fugitive Emissions from Solid Fuels and from from the sector Fugitive Emissions from Oil and Natural Gas

The fugitive emissions from Solid fuels also indicate substantial decrease in the whole time-series, i.e. 57.3% for CO_2 emission and 65.4% for CH_4 emissions. Fugitive CH_4 emissions from Oil and Natural Gas also indicate decrease for 41.9% in the time series. Fugitive CO_2 emissions from Oil and Natural Gas indicates increase, however these emissions are of minor importance in the whole submission.

The trends for different subcategories are also presented in Tab. 3-3.

Tab. 3-3 Total GHG emissions in [Gg CO_2 equivalent] from 1990 – 2013 by sub categories of Energy

	1	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5	1.B	1.B.1	1.B.2
1990	157 254	146 596	56 900	51 224	7 284	31 187	NO	10 658	9 576	1 082
1991	143 943	134 477	55 525	43 474	6 390	29 088	NO	9 466	8 535	931
1992	138 489	129 415	54 690	46 345	7 973	20 406	NO	9 074	8 211	863
1993	133 254	124 337	54 301	38 577	8 076	23 383	NO	8 917	8 072	845
1994	125 394	116 850	54 950	30 854	8 812	22 234	NO	8 544	7 712	832
1995	126 405	117 967	61 827	26 174	9 355	20 612	NO	8 438	7 601	837
1996	128 144	119 857	66 560	24 621	10 366	18 310	NO	8 287	7 382	905
1997	123 671	115 542	62 850	24 604	10 460	17 629	NO	8 128	7 236	892
1998	118 216	110 317	60 710	22 506	10 747	16 181	173	7 898	6 958	940
1999	111 753	104 500	58 210	18 504	11 986	15 634	167	7 253	6 331	922
2000	120 170	113 746	62 045	23 421	12 142	15 958	180	6 423	5 547	876
2001	120 354	114 321	64 228	20 876	12 904	16 152	161	6 034	5 206	828
2002	117 200	111 562	62 783	19 996	13 515	15 026	242	5 638	4 765	873
2003	119 864	114 319	62 433	19 928	15 339	16 374	245	5 544	4 728	816
2004	119 717	114 415	62 552	19 560	16 112	15 917	273	5 302	4 540	762
2005	119 132	113 370	63 149	18 836	17 459	13 652	273	5 762	4 866	896
2006	119 819	113 834	62 599	18 534	18 113	14 329	259	5 984	5 084	900
2007	119 973	114 450	66 247	16 651	19 056	12 149	347	5 522	4 626	897
2008	115 309	109 800	61 517	16 410	18 902	12 594	377	5 508	4 684	825
2009	109 681	104 609	57 444	16 076	18 379	12 345	364	5 073	4 205	868
2010	110 728	105 569	61 917	12 466	17 323	13 533	329	5 159	4 262	897
2011	109 202	104 119	61 582	12 676	17 123	12 351	387	5 083	4 244	839
2012	105 069	100 158	59 236	11 376	16 801	12 429	316	4 911	4 227	684
2013	100 877	96 887	55 920	11 018	16 650	12 991	309	3 989	3 355	634
Total Trend 1990 - 2013	**-36%**	**-34%**	**-1.7%**	**-78%**	**129%**	**-58%**	**79%[1)]**	**-54%**	**-56%**	**-39%**

[1)] *Trend 1998-2013*

3.2 Fuel combustion activities (CRF 1.A)

3.2.1 Comparison of the sectoral approach with the reference approach

In addition to the Sectoral approach (SA), used commonly for determination of greenhouse gas emissions from sector 1.A, the IPCC methodology requires also to perform a Reference Approach (RA), whose main objective is to control the estimation of the CO_2 emissions in the Sectoral approach. The calculation does not require a lot of input activity data, since the reference approach requires only the basic values included in the source section of the national energy balance (primary sources) and some additional information. It provides information only on total CO_2 emissions without any further division into consumer sectors.

From 2015 submission onward, it is required to use the Reference Approach in line with 2006 Guidelines (IPCC 2006). Main difference between the new reference approach in contrast with the old one, used until now (IPCC 1997), is that instead of the concept of "long-term stored carbon" (stored carbon), used for some non-energy fuels, now a new, broader concept is used - "excluded carbon", which includes not only the stored carbon, but also carbon used and emitted as CO_2 in other sectors, not only in 1.A (most often in sector 2 IPPU). This means that from the total carbon, calculated on the base of apparent domestic consumption (Apparent consumption, AC) is deducted the "excluded carbon". It is mainly the case of carbon contained in fossil fuels used: (i) as raw materials for further treatment in the industry (feedstocks), (ii) as reductants and (iii) as non-energy products.

Overview of materials, containing "excluded carbon" is given in Tab. 3-4.

Tab. 3-4 Products used as feedstocks, reductants, and for non-energy products (IPCC 2006)

Feedstocks	Naphtha
	LPG (propane - butane)
	Oils used as feedstocks
	Refinery gas
	Natural gas
	Ethane
Reductants	Metallurgical coke and petroleum coke
	Coal and coal tar/pitch
	Natural gas
Non-energy products	Bitumen
	Lubricants
	Paraffin waxes
	White spirit

For fuels, which are used in other sectors, than Energy sector – 1.A (i.e. non-energy fuels: for example coke or naphtha), it is necessary to know, what quantity of certain material is used outside 1.A (e.g. like feedstock or reductant).

In the Czech national inventory above mentioned "excluded carbon" is considered for counting in case of the following substances:

- Naphtha
- Bitumen
- Paraffin waxes
- Oils, used for production of hydrogen by partial oxidation (further for ammonia)
- White spirit

In Tab. 3-5 and 3-6 are reported values, set by the reference approach for the years 1990, 1995, 2000, 2005, 2010, 2011, 2012 and 2013 and a comparison between the reference and sectoral approach for the same years. In Tab. 3-7 is summarized comparison for all time period. In majority of cases relative differences are less than 2%.

Tab. 3-5 Activity data in energy units (TJ), used in reference and sectoral approach for basic groups of fossil fuels

Year	Type of fossil fuels	Apparent Consumption (PJ)	Carbon excluded (PJ)	Reference approach (PJ)	Sectoral approach (PJ)	(RA-SA)/SA (%)
1990	Liquid Fuels	358.56	71.77	286.79	300.00	-4.4
	Solid Fuels	1 315.08	86.73	1 228.36	1 149.99	6.8
	Gaseous Fuels	219.91	0.00	219.91	205.43	7.0
	Other Fuels				0.26	
	Total	1 893.55	158.49	1 735.06	1 655.68	4.8
1995	Liquid Fuels	321.28	96.96	224.31	240.00	-6.5
	Solid Fuels	937.64	71.03	866.61	878.67	-1.4
	Gaseous Fuels	274.74	0.00	274.74	260.80	5.3
	Other Fuels				0.65	
	Total	1 533.66	167.99	1 365.66	1 380.12	-1.0
2000	Liquid Fuels	310.58	87.58	222.99	238.56	-6.5
	Solid Fuels	901.78	66.29	835.48	810.11	3.1
	Gaseous Fuels	314.52	0.00	314.52	305.05	3.1
	Other Fuels				1.28	
	Total	1 526.87	153.87	1 373.00	1 355.00	1.3
2005	Liquid Fuels	387.68	111.37	276.31	292.06	-5.4
	Solid Fuels	847.04	75.47	771.57	754.69	2.2
	Gaseous Fuels	323.04	0.00	323.04	318.87	1.3
	Other Fuels				5.69	
	Total	1 557.77	186.84	1 370.93	1 371.31	0.0
2010	Liquid Fuels	368.81	100.02	268.80	276.22	-2.7
	Solid Fuels	769.39	68.25	701.14	685.66	2.3
	Gaseous Fuels	338.55	0.00	338.55	313.58	8.0
	Other Fuels				5.89	
	Total	1 476.75	168.27	1 308.49	1 281.35	2.1
2011	Liquid Fuels	355.60	93.77	261.82	270.67	-3.3
	Solid Fuels	754.36	64.52	689.84	686.06	0.6
	Gaseous Fuels	285.66	0.00	285.66	286.47	-0.3
	Other Fuels				6.78	
	Total	1 395.61	158.29	1 237.32	1 249.98	-1.0
2012	Liquid Fuels	349.11	96.60	252.51	264.45	-4.5
	Solid Fuels	696.15	63.33	632.82	654.47	-3.3
	Gaseous Fuels	287.60	0.00	287.60	281.95	2.0
	Other Fuels				5.78	
	Total	1 332.86	159.92	1 172.93	1 206.65	-2.8
2013	Liquid Fuels	337.83	91.09	246.74	255.75	-3.5
	Solid Fuels	681.94	67.53	614.41	627.50	-2.1
	Gaseous Fuels	291.43	0.00	291.43	286.71	1.6
	Other Fuels				4.65	
	Total	1311.21	158.62	1152.59	1174.61	-1.9

Tab. 3-6 Results for CO_2 emissions (kt) according to reference approach and comparison with sectoral approach

Year	Type of fossil fuels	Apparent Consumption (kt CO_2)	Carbon excluded (kt CO_2)	Reference approach (kt CO_2)	Sectoral approach (kt CO_2)	(RA-SA)/SA (%)
1990	Liquid Fuels	26 370	5 411	20 959	22 220	-5.7
	Solid Fuels	126 470	9 325	117 146	110 823	5.7
	Gaseous Fuels	11 990	0	11 990	11 201	7.0
	Other Fuels				24	
	Total	164 831	14 736	150 095	144 268	4.0
1995	Liquid Fuels	23 448	7 214	16 234	17 530	-7.4
	Solid Fuels	90 160	7 597	82 562	84 379	-2.2
	Gaseous Fuels	15 110	0	15 110	14 343	5.3
	Other Fuels				60	
	Total	128 718	14 811	113 907	116 311	-2.1
2000	Liquid Fuels	22 620	6 363	16 257	17 296	-6.0
	Solid Fuels	86 849	7 092	79 757	78 020	2.2
	Gaseous Fuels	17 297	0	17 297	16 777	3.1
	Other Fuels				117	
	Total	126 767	13 455	113 312	112 210	1.0
2005	Liquid Fuels	28 359	8 270	20 089	21 108	-4.8
	Solid Fuels	81 336	7 749	73 587	72 462	1.6
	Gaseous Fuels	17 765	0	17 765	17 535	1.3
	Other Fuels				501	
	Total	127 460	16 019	111 441	111 606	-0.1
2010	Liquid Fuels	27 021	7 400	19 620	19 945	-1.6
	Solid Fuels	74 103	6 977	67 126	65 994	1.7
	Gaseous Fuels	18 717	0	18 717	17 337	8.0
	Other Fuels				512	
	Total	119 841	14 378	105 464	103 788	1.6
2011	Liquid Fuels	26 031	6 911	19 120	19 564	-2.3
	Solid Fuels	73 042	6 602	66 440	66 383	0.1
	Gaseous Fuels	15 786	0	15 786	15 830	-0.3
	Other Fuels				589	
	Total	114 858	13 512	101 346	102 367	-1.0
2012	Liquid Fuels	25 611	7 102	18 492	19 110	-3.2
	Solid Fuels	67 468	5 912	61 005	63 210	-3.5
	Gaseous Fuels	15 876	0	15 876	15 564	2.0
	Other Fuels				539	
	Total	108 954	13 014	95 373	98 423	-3.1
2013	Liquid Fuels	24 753	6 733	18 019	18 490	-2.5
	Solid Fuels	65 794	6 873	58 921	60 368	-2.4
	Gaseous Fuels	16 117	0	16 117	15 856	1.6
	Other Fuels				412	
	Total	106 664	13 607	93 057	95 126	-2.2

Tab. 3-7 Activity data in energy units (PJ) used in reference and sectoral approach for all fossil fuels and corresponding results for CO_2 emissions (kt)

Year	Activity data (PJ)	Carbon excluded (PJ)	Reference approach (PJ)	Sectoral approach (PJ)	(RA-SA)/SA (%)	Activity data (kt CO_2)	Carbon excluded (kt CO_2)	Reference approach (kt CO_2)	Sectoral approach (kt CO_2)	(RA-SA)/SA (%)
1990	1893.5	158.5	1735.1	1655.7	4.8	164831	14736	150095	144268	4.0
1991	1702.4	114.0	1588.4	1522.0	4.4	148137	10766	137371	132421	3.7
1992	1639.7	120.2	1519.5	1486.4	2.2	140364	11327	129037	127574	1.1
1993	1578.8	108.3	1470.5	1431.1	2.8	134758	10250	124508	122567	1.6
1994	1510.4	130.6	1379.8	1353.9	1.9	128032	12125	115907	115116	0.7
1995	1533.7	168.0	1365.7	1380.1	-1.0	128718	14811	113907	116311	-2.1
1996	1575.8	174.0	1401.8	1418.8	-1.2	130704	15311	115392	118132	-2.3
1997	1589.7	171.2	1418.5	1375.0	3.2	132145	15109	117036	113904	2.7
1998	1538.5	167.2	1371.3	1326.7	3.4	126758	14808	111949	108805	2.9
1999	1421.3	149.1	1272.3	1267.7	0.4	115412	12784	102627	103043	-0.4
2000	1526.9	153.9	1373.0	1355.0	1.3	126767	13455	113312	112210	1.0
2001	1552.4	151.2	1401.2	1373.8	2.0	127730	13158	114572	112719	1.6
2002	1534.7	158.9	1375.9	1343.8	2.4	126102	13980	112122	109979	1.9
2003	1556.5	167.5	1389.0	1377.0	0.9	128023	14833	113191	112601	0.5
2004	1524.0	195.7	1328.3	1382.7	-3.9	124450	17036	107413	112644	-4.6
2005	1557.8	186.8	1370.9	1371.3	0.0	127460	16019	111441	111606	-0.1
2006	1585.3	196.8	1388.5	1373.5	1.1	130307	17059	113248	111999	1.1
2007	1585.1	187.4	1397.7	1374.3	1.7	130952	16394	114558	112599	1.7
2008	1522.5	188.3	1334.2	1327.6	0.5	124769	16263	108506	108009	0.5
2009	1400.1	154.7	1245.4	1259.5	-1.1	114595	13163	101432	102824	-1.4
2010	1476.8	168.3	1308.5	1281.3	2.1	119841	14378	105464	103788	1.6
2011	1395.6	158.3	1237.3	1250.0	-1.0	114858	13512	101346	102367	-1.0
2012	1332.9	159.9	1172.9	1206.6	-2.8	108954	13014	95373	98423	-3.1
2013	1311.2	158.6	1152.6	1174.6	-1.9	106664	13607	93057	95126	-2.2

3.2.2 International bunker fuels

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

Basic activity data are available in the CzSO energy balance (CzSO, 2014). Tab. 3-8 gives the amount of stored Kerosene Jet Fuel.

Tab. 3-8 Kerosene Jet Fuel in international bunkers

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
[TJ/year]	7325	6020	6967	5792	7208	7805	5866	6759	7991	7520	8234	8750
Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
[TJ/year]	7556	10163	13062	13573	14070	14763	15644	14287	13387	13272	12367	11931

3.2.3 Feedstocks and non-energy use of fuels

New and since this year valid methodology (IPCC, 2006) clearly sets the borders between the sectors Energy and Industrial Processes and Product Use (IPPU). Compared to the previous methodology version (IPCC, 1997), emissions from non-energy use of fuels is reported mainly in sector 2 – IPPU. To prevent double counting or omission of resources it is necessary to carefully carry out a completeness check of CO_2 emissions in the sectors 1.A (Energy – combustion) and 2 – IPPU, for those kinds of fuels that are used for both energy and non-energy purposes.

Non-energy fuels are divided into three categories:

12) **Raw materials for the chemical industry (Feedstocks)**. These fossil fuels are used in particular in the production of organic compounds and to a lesser extent in the production of inorganic chemicals (e.g. ammonia) and their derivatives. For organic substances normally part of the carbon contained in the feedstock remains largely stored in these products. Typical examples of raw materials are the feedstocks for petrochemical industry (naphtha), natural gas, or different types of oils (e.g. the production of hydrogen for the subsequent production of ammonia by partial oxidation).
13) **Reductants**. Carbon is used as a reductant in metallurgy and inorganic technologies. Unlike the previous case, here when using fossil fuel as reductant only a very small amount of carbon remains long fixed in the products and the larger part of the carbon is being oxidized during the reduction process. Typical example of reductant is metallurgical coke.
14) **Non-energy products**. Non-energy products are materials, derived from fuels in refineries or coke plants, which unlike the previous two cases, are used directly for its conventional physical properties, specifically it is about lubricants (lubricating oils and petrolatum), diluents and solvents, bitumen (for covering roads and roofs) and paraffin. In category IPPU emissions of CO_2 and other GHG occur only to a limited extent (e.g. during the oxidation of lubricants and paraffin). Substantial emissions occur during their recovery and during disposal by incineration (in the sector and in Waste).

Emissions from feedstocks in chemical industry are reported in subsector 2.B, from reductants primarily in subsector 2.C and from non-energy products, used mainly for other purposes, than incineration (e.g. lubricating oils) in subsector 2.D.

The energy balance of the Czech Republic in accordance with the Regulation No 1099/2008 of the European Parliament and of the Council on energy statistics distinguishes various types of fuels in their use for energy and non-energy purposes. Below are listed the different kinds of fuels with a high proportion of non-energy use in the Czech Republic.

Some types of liquid fuels are designed mainly for non-energy use. This is primarily naphtha, for which CzSO indicates, since 2001, that virtually the entire amount is consumed for non-energy purposes by the chemical industry, mainly as petrochemicals (2.B). For example, in 2013 the consumption was 38.1 PJ. Less significant is the non-energy use of LPG.

Another important type of liquid fuels consumed for non-energy purposes of fuels is a group marked as Other Oils. Their most significant share is Other Petroleum Products, which finds application in the production of hydrogen by partial oxidation with steam for subsequent production of ammonia and further part of it is also used as a Solvent Use. In 2013, the consumption of Other Petroleum Products for non-energy purposes (particularly in sub-sectors 2.B, 2.D) was 22.7 PJ, compared to 7.1 PJ utilized for combustion in sector 1.A. Less important categories are White Spirit and Paraffin Wax, which are indeed only used for non-energy purposes in 2.D and naturally their consumption is small compared to Other Petroleum Products (total of 0.9 PJ in 2013).

The liquid fuels, used specially for non-energy purposes, include also bitumen, whose consumption in 2013 was 16.2 TJ and lubricants with consumption in 2013 of 6.5 PJ. While in the case of using bitumen practically there are no emissions of CO_2 (Stored carbon), in the case of lubricants use, annually a part is oxidized to CO_2 (Reported in 2.D).

Solid fuels for non-energy purposes are mainly used as reductants. These include coke (Coke Oven Coke), from which in 2013 were used 54.1 PJ in the production of iron and steel (2.C) compared to 13 PJ utilized in sector 1.A. In the case of tar (Coal Tar) in 2013 were used 13.5 PJ in industry while 6 PJ in sector 1.A.

Natural gas (NG) is in many countries also used as a feedstock. In the Czech Republic it was not until recently, and since 2008 the CzSO indicates that approximately 1% of annual consumption of natural gas in the Czech Republic is used for non-energy purposes in the chemical industry. Since the NIS team could not still clearly identify the specific process, which is with a high probability associated with a practical complete conversion of carbon to CO_2, these emissions were set for the moment under 1.A.2.c.

Fuels for non-energy use are not accounted for into the Sectoral approach in category 1.A. In the Reference approach NEU are deducted from the apparent consumption as excluded carbon (see. Sub-chapter "CO_2 reference approach and comparison with sectoral approach").

In Tab. 3-9 are listed calorific values of the energy balance calculation of CzSO and default emission factors, which were used in the reference approach.

Tab. 3-9 Net calorific values and emission factors of feedstocks

Non-energy Fuels	NCV	EF
	[GJ/Gg]	[t CO_2/TJ]
LPG	45 945	65.86 [1)]
Naphtha	43 600	73.30
White Spirit	40 193	73.30
Lubricants	40 193	73.30
Bitumen	40 193	80.70
Paraffin Wax	40 193	73.30
Petroleum Coke	38 500	97.50
Other Petroleum Products	40 179	73.30
Refinery Gas	46 023	55.08 [1)]
Coke Oven Coke	28 465 [2)]	107.0

1) *country-specific value*
2) *used in blast furnaces*

3.2.4 Methodological issues

The chapter describes procedures, which are applied for emission estimates from combustion sources in general. Each chapter for specific subcategories then contains (if applicable) any specific procedures used for these specific sources.

The data for the whole time series was constructed on the basis of data from the CzSO Questionnaire (CzSO, 2014), where the data on fuel consumption are provided 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. The Energy balance in mass units (kt p.a.) for last reported year (2013) is given in Annex 4, Tables A4-1 – A4-7.

Since 2012 submission net calorific values for Liquid Fuels for the whole time series are available. These are now assumed to be right (agreed by CzSO) and therefore used for conversion of activity data from natural units to energy units. Except of the official NCV provided by CzSO are use country specific NCVs, for Refinery Gas and LPG.

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 data storage.

3.2.4.1 Collection of activity data

In collection of activity data, all the background data are stored at the workplace of the sector compiler, where possible in electronic form. These consist primarily in datasets obtained from CzSO as officially submitted data for drawing up the activity data. The dataset for the last reported year is given in Annex 4, Tables A4-1 – A4-7; similar datasets for the whole time series are stored in the archive of the sectoral expert.

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 compiler 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 compiler; 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.

In case EU ETS data are used, the original forms are stored in archive of national inventory system coordinator, as well as officially at Ministry of Environment.

3.2.4.2 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 sheet. Using interconnected system of excel files was created computational model for emission estimates from the stationary sources in Energy sector.

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.

Separate computational files for each kind of fuels are used, which are then interconnected with the final computational files, where are data transferred in the specific subcategories and the computation of emission estimates is carried out. The operational part of the files contains whole computational approach for estimation of CO_2, CH_4 and N_2O emissions, which includes following steps:

- complete division of data about consumption of each kind of fuels from Energy balance provided by CzSO into the structure compatible with CRF Reporter (for purposes of Sectoral and Reference Approaches)
- complete set of NCV for specific kinds of fuels and emission and oxidation factors (if applicable)
- computation of emission estimates

- summation of activity data and emissions for each group of fuels (solid, liquid, gaseous etc.) into specific subcategories

Outputs form the computational model are datasets, which are possible to import into CRF Reporter. All computational sheets are managed in whole time-series and units of input and output values are recorded as well.

For current submission is added additional part of computational model, which enables comparison of data from previous submission with the data from current submission. This step is important especially because this year's submission was compiled using new updated methodology IPCC 2006 Guidelines (IPCC, 2006).

3.2.4.3 Calculations of emissions

Original activity data are provided in kilotons. It means that it is necessary to convert these values to energy units – terajoules. For this conversion are used calorific values listed in Annex 5.

Coke Oven Gas, Gas Works Gas and biofuels are given directly in terajoules in the CzSO Questionnaires (CzSO, 2014), however the data were calculated using the gross calorific values, so it is necessary to recalculate these values to net calorific values.

Natural Gas is provided in the statistic reporting in the CzSO Questionnaire (CzSO, 2014) in thousand m^3 and in TJ; however, the data in TJ is determined using the gross caloric value. Volume reported by CzSO in thousand m^3 is related to the „trade conditions", i.e. temperature 15°C and pressure 101.3 kPa.

CzSO uses for the conversion between gross and net calorific value coefficient NCV/GCV = 0.9. In 2014 was carried out research in order to develop methodology for determination of precise values of this coefficient. Details concerning the research and methodology of determination of the coefficient NCV/GCV is provided in Annex 5.

It was found (see Annex 5), that the ratio NCV/GCV for natural gas can be very preciously described by linear dependence

$$NCV/GCV = (0.001011 * GCV + 0.863274)$$

where NCV and GCV are expressed in MJ/m^3 in the reference temperatures of 15 ˚C (i.e. trade conditions). However, improved values of the ratio NCV/GCV is not far from the IPCC default value 0.9. For example, to the NCV = 34.424 MJ/m^3 given in the Tab. 3-10 it corresponds the ratio NVC/GCV=0.9019 calculated from the equation above. This equation was used for calculation of NCV from GCV for all time period.

For calculation of CO_2 emissions are used emission factors, which are either provided in the IPCC 2006 Guidelines (IPCC, 2006), or which were determined as country-specific emission factors. Since CO_2 emission factors depend on quality of specific of fuel, the values of emission factors are listed in the specific chapters bellow. Default emission factors from the IPCC methodology have been for key categories gradually substituted by country specific emission factors. Moreover, in case of CO_2 emission factors from lignite (brown coal) and bituminous coal, the previous country-specific emission factors were in this submission refined by using up-to-date national data. Description of used country-specific emission factors including ways of their evaluations is provided in Annex 3.

CH_4 and N_2O emissions from fuel combustion from stationary sources are not among the key categories. Thus contrary to CO_2 emission factors, for CH_4 and N_2O emission factors are used always default values from IPCC 2006 Guidelines (IPCC, 2006). CH_4 and N_2O emission factors are listed in the specific subchapters for specific subcategories.

General CO_2 emission factors and NCV are provided in Tab. 3- 10.

Tab. 3-10 Net calorific values (NCV), CO_2 emission factors and oxidation factors used in the Czech GHG inventory – 2013

Fuel (IPCC 2006 Guidelines definitions)	NCV [TJ/kt]	CO_2 EF [a] [t CO_2/TJ]	Oxidation factor	CO_2 EF [b] [t CO_2/TJ]
Crude Oil	42.400	73.30	1	73.30
Gas/Diesel Oil	42.600	74.10	1	74.10
Residual Fuel Oil	39.475	77.40	1	77.40
LPG [d]	45.945	65.86	1	65.86
Naphtha	43.600	73.30	1	73.30
Bitumen	40.193	80.70	1	80.70
Lubricants	40.193	73.30	1	73.30
Petroleum Coke	38.500	97.50	1	97.50
Other Oil	40.179	73.30	1	73.30
Coking Coal [d]	28.709	93.68	1	93.68
Other Bituminous Coal [d]	25.502	94.32	0.9707	91.55
Lignite (Brown Coal) [d]	13.409	99.49	0.9846	97.96
Brown Coal Briquettes	20.809	97.50	0.9846[d]	96.00
Coke Oven Coke	28.465	107.00	1	107.00
Coke Oven Gas (TJ/mill. m^3)	16.064 [c]	44.40	1	44.40
Natural Gas (TJ/Gg) [d]	48.845	55.30	1	55.30
Natural Gas (TJ/mill. m^3) [d]	34.424 [c]	55.30	1	55.30

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

3.2.5 Uncertainties and time-series consistency

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

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

Extensive research was carried out in 2012 to obtain new, more accurate values for the uncertainties (CHMI, 2012b). The results are given in chapter 1.6 and Annex 2 furthermore lists source of expert judgement provided for uncertainty analysis for each category.

Activity data

Information on fuel consumption is taken from CzSO (CzSO, 2014).

Uncertainties:

1) on the part of CzSO in collecting and processing the primary data

CzSO 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. Overall the uncertainty in Natural Gas activity data should be lower than uncertainty of Solid Fuels activity data since the Natural Gas is measured more accurately in comparison to for instance coal.

Uncertainties also arise during data processing. CzSO 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.

2) on the part of the sector compiler in interpretation of CzSO data

The sector compiler 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

1) Default emission factors

The research carried out in 2012 focused also on the determining of uncertainties of emission factors (CHMI, 2012b). Results are provided in the Tab. 3-11. The uncertainty values for the default emission factors are based on the 2006 Guidelines (IPCC, 2006).

2) Country specific emission factors

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

Tab. 3-11 Uncertainty data from Energy sector (stationary combustion) for uncertainty analysis

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.A Stationary combustion – Solid Fuels	4	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion – Gaseous Fuels	3	2.5	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion– Liquid Fuels	5	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion – Other Fuels – 1.A.2	10	15	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.e Other Transportation	4	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.5.b Mobile sources in agriculture and forestry	7	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Solid Fuels	5	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Gaseous Fuels	4	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Liquid Fuels	5	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Biomass	8	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.5.b Mobile sources in agriculture and forestry	7	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.e Other Transportation	4	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Solid Fuels	5	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion –	4	60	E. Krtkova, V. Neuzil, AD and EF unc. in line

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
	Gaseous Fuels			with 2006 Guidelines
N_2O	1.A Stationary combustion – Liquid Fuels	5	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Biomass	8	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Other Fuels – 1.A.2	10	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.e Other Transportation	4	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.5.b Mobile sources in agriculture and forestry	7	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines

Time - series consistency

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external CzSO 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, CzSO is informed about 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 CzSO 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 1.A.2.c 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 1.A.2.c to 1.A.1.a.

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 compiler.

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.

Other Fuels (CRF 1.A.1.a) - Uncertainties and time-series consistency

The time series comes from two data sources – time-series was reproduced by MIT and data about current incineration comes from ISOH (Information system of waste management). There are no country-specific uncertainties yet, as all the factors but activity data used in the equations are default IPCC factors.

3.2.6 QA/QC and verification

The general QA/QC plan was formulated since the last submission and is presented in the Chapter 1.2.3. The QA/QC procedures applied in the company KONEKO Ltd. are based on the QA/QC plan for GHG inventory in the Czech Republic and are harmonized with the QA/QC system of the Transport Research Centre (CDV). As the basic data sources for the processing of activity data are based on the energy balance of the Czech Republic the main emphasis is given to close cooperation with the Czech statistical office (CzSO). This cooperation is based on the contract between CHMI, as the NIS coordination workplace, and CzSO. CzSO is a state institution established for statistical data processing in the Czech Republic, which has its own control and verification mechanisms and procedures to ensure data quality.

Sectoral guarantor and administrator of QA/QC procedures, Vladimir Neuzil (KONEKO manager):

- processes and updates the sectoral QA/QC plan
- organizes QC procedure
- ensures verification procedures and is responsible for its realization
- is responsible for the submission of all documents and data files for the storing in the coordinating institution suggests external experts for QA procedure
- ensures data input in the CRF Reporter
- carries out auto-control – control of input data and primary computations
- ensures and is responsible for the storing of documents

The QC procedures are related to the processing, manipulation, documentation, storing and transmission of information. The first step of the control is carried out by the expert responsible for the Sectoral Approach (Vladimir Neuzil), followed up by the control carried out by the QA/QC expert familiar with the topic (Pavel Fott, former NIS coordinator). At this control level individual steps are controlled according official QA/QC methodology (IPCC, 2006).

Data transmission to the CRF Reporter is accomplished by the data administrator. After data transmission to the CRF Reporter the control of correct data transmission based on the summary values of activity data and emission data is carried out. If there are any discrepancies, the erroneous data are detected and corrected.

Verification procedures are included upon the suggestion of the QA/QC sectoral guarantor after the consultation with the NIS coordinator. They are aimed mainly at the comparison with independent data sources that are not based on data processing from the CzSO energy balance. The relevant independent sources in the Czech Republic are represented by data published and verified within the EU Emission Trading Scheme (ETS), from the national system REZZO, used for the registration of ambient air pollutants, and based mainly on data collection from individual plants. In addition to emission data the REZZO database includes also activity data, independent of CzSO data. The way how to optimally use the above data sources has to be determined on the basis of systematic research and will be covered in the national inventory improvement plan.

External employees of KONEKO (Pavel Fott) familiar with the assessed topic participate in the QC procedures. The cooperation is based on ad hoc contracts ensured by the QA/QC sectoral guarantor. As already mentioned above, also experts from CzSO, closely cooperating with CHMI and KONEKO, take part in the control procedures.

The QA procedures are planned in a way described in the general part of the QA/QC plan, i.e. approximately once in three years. This year the QA was held by external expert of NIS team. Since this submission was processed using new updated methodology, the QA/QC procedures were applied on very detail this year.

Other QC procedures were performed using data indicators which should have the same course as the reported value. Where these data are available, details of this QC are given in the following figures.

3.2.7 Public electricity and heat production (CRF 1.A.1.a)

This category is divided into 3 sub categories:

- Electricity Generation (CRF 1.A.1.a.i)
- Combined Heat and Power Generation (1.A.1.a.ii)
- Heat Plants (1.A.1.a.iii)

Even though this division is used in the new methodology (IPCC, 2006), since so far no reliable data is available for this detailed classification, in this submission, the reported data is summarized in category CRF 1.A.1.a.i.

3.2.7.1 Category description (CRF 1.A.1.a.i)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.1.a.i, 2013								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**	**[-]**	**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
Heating and Other Gasoil	127.8	74.1	1	9.5	3	0.00038	0.6	0.00008
Fuel Oil - Low Sulphur	552.1	77.4	1	42.7	3	0.00166	0.6	0.00033
Fuel Oil - High Sulphur	118.5	77.4	1	9.2	3	0.00036	0.6	0.00007
Other Bituminous Coal	71 770.5	95.00*)	0.971*)	6 618.1	1	0.07177	1.4	0.10048
Brown Coal + Lignite	401 605.7	100.31*)	0.985*)	39 663.8	1	0.40161	1.4	0.56225
Coal Tars	151.0	80.7	1	12.2	1	0.00015	1.4	0.00021
Coke Oven Gas	5 665.5	44.4	1	251.5	1	0.00567	0.1	0.00057
Natural Gas	34 604.5	55.30*)	1	1 913.7	1	0.03460	0.1	0.00346
Waste - fossil fraction	2 336.0	91.7	1	214.2	30	0.07008	4	0.00934
Waste - biomass fraction	3 504.0	100	1	350.4	30	0.10512	4	0.01402
Wood/Wood Waste	14 952.0	112	1	1 674.6	30	0.44856	4	0.05981
Gaseous Biomass	975.0	54.6	1	53.2	1	0.00098	0.1	0.00010
Total year 2013	**536 362.6**			**50 813.2**		**1.14093**		**0.75071**
Total year 2012	563 982.2			53 564.5		1.17038		0.78797
Index 2013/2012	0.95			0.95		0.97		0.95
Total year 1990	569 994.5			54 685.8		0.62125		0.75898
Index 2013/1990	0.94			0.93		1.84		0.99

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are presented in detail in the following outline.

2013							
Structure of Fuels	**Source of Activity data**	**Emission factors**			**Method used**		
		CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Waste - fossil fraction	ISOH, MTI	D	D	D	Tier 1	Tier 1	Tier 1
Waste - biomass fraction	ISOH, MTI	D	D	D	Tier 1	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The fraction of CO_2 emissions from sector 1.A.1 equalled 47.1% in 2013 in the whole Energy sector (1.A) – combustion of fuels and consumption of fuels present 41.1%.

Under source category 1.A.1.a the energy balance includes district heating stations and electricity and heat production of public power stations.

This category encompasses all facilities that produce electric 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 Inc. company, DALKIA Inc. power plants and heating plants, Energy United Inc. and a number of others in the individual regions and larger cities in the Czech Republic.

The fraction of CO_2 emissions in subsector 1.A.1.a in CO_2 emissions in sector 1.A.1 equalled 88.0% in 2013; consumption of fuels present 87.1%.

From the total installed capacity of electricity generation 19.2 GWe in 2013, 10.5 GWe are accounted for thermal power plants:

Nuclear	4 290	MWe
Hydro	2 064	MWe
Solar photovoltaic	2 064	MWe
Wind	262	MWe
Combustible fuels	10 498	MWe
Total capacity	**19 178**	**MWe**

In the final energy balance of CzSO (CzSO, 2014), 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

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)

The volume of production of electricity and heat and the structure of the sources are shown in the following overview.

Electricity production (GWh)	**50 167**
Main activity producer electricity plants	28 902
Main activity producer CHP plants	13 668
Autoproducer electricity plants	615
Autoproducer CHP plants	6 982
Heat production (TJ)	**118 338**
Main activity producer CHP plants	85 271
Main activity producer heat plants	19 638
Autoproducer CHP plants	10 668
Autoproducer heat plants	2 761

Fig. 3-4 presents an overview of development of CO_2 emissions in source category 1.A.1.a.

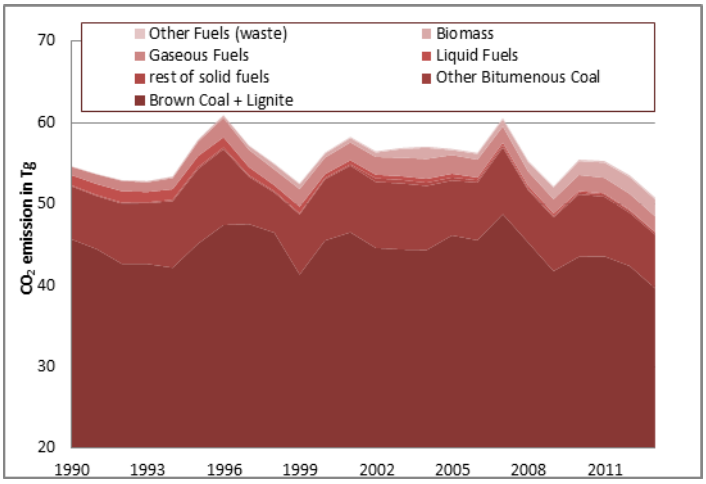


Fig. 3-4 Development of CO_2 emissions in 1.A.1.a category

CO_2 emissions indicate stable trend with only a few oscillations in the whole time series.

The trend in emissions is mainly shaped by the development and structures of the electricity generation installations involved, since these installations account for the majority of the pertinent emissions. As is clear from the figure, Solid Fuels are the main driving force for emissions in this source category. Brown Coal and Lignite is the most important, with average consumption of 452 PJ, corresponding to 44 512 kt CO_2/year on an average for the whole 1990 – 2013 period. The second largest consumption is indicated for Other Bituminous Coal with an average consumption value of 79 PJ, corresponding to 7 326 kt CO_2/year on an average for the whole 1990 – 2013 period. The remaining Solid Fuels do not correspond to any significant consumption in this category.

Since 2007, the country-specific emission factor for Brown Coal + Lignite has been equal to 27.27 t C/TJ; a country-specific emission factor equal to 25.43 t C/TJ for Other Bituminous Coal and Coking Coal has been used to calculate CO_2 emissions. In 2014 was conducted research in order to update these emission factors. The detailed description of the research is provided in Annex 3. As mentioned above, this means that approximately 95% of the emissions from fuels in this category were determined using country-specific emission factors, i.e. at the level of Tier 2.

Since this submission country specific oxidation factors for Other Bitumenous Coal, Brown Coal and Lignite and Brown Coal Briquettes were applied. The detailed description of the research is given in Annex 3.

Liquid Fuels play a minor role in the electricity supply of the Czech Republic. They are used for auxiliary and supplementary firing in power stations – for instance stabilization of burners. Use of Liquid Fuels has decreased by more than half since 1990.

Natural Gas also plays a role in this source category. Use of NG does not exhibit a substantially oscillating trend. At the beginning of the period, it shows increasing trend, but later only minor changes were observed, which can be considered insignificant.

The item Other Fuels in Fig. 3-4 represents waste consumption for waste incineration.

3.2.7.2 Methodological issues (CRF 1.A.1.a.i)

The basic methodological approaches were presented in section 3.2.4. In the following text, only specific problems, which are characteristic for the described subsector, will be addressed. This is essentially a waste combustion in the municipal waste incinerators, which simultaneously produce electricity and supply heat - see chapter 3.2.7.2.1.

3.2.7.2.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

This category consists of emissions caused by incineration of municipal solid waste for energy purposes. Originally this chapter was part of 5 C Waste Incineration but, based on the suggestion of ICR (in-country review), this chapter was shifted under the energy sector. This chapter is still prepared by CUEC (Charles University Environment Center) – the organization responsible for the Waste sector.

This category consists of emissions of CO_2 from incinerated fossil carbon in MSW and emissions of methane and N_2O from incineration of MSW.

There are three municipal solid waste (MSW) incineration plants in the Czech Republic. One is located in Prague (ZEVO Malesice), one in Brno (SAKO) and the newest one in Liberec (Termizo). The amount of incinerated waste increased in previous year and this inventory year significantly. It is due to the fact that incinerator in Brno was recently reconstructed and its former annual capacity of 240 Gg of MSW was decreased to 224 Gg of MSW. In reality the new technology actually allowed the facility to be used to the full potential (the old stokers were regularly out of order and the real former capacity of the plant was about one third of the maximum value) and since then there is constant increase of incinerated waste in this category.

Tab. 3-12 Capacity of municipal waste incineration plants in the Czech Republic, 2013

Incinerator (city)	**Capacity (Gg) 2013**
TERMIZO (Liberec)	96
Pražské služby a.s. (Praha)	310
SAKO a.s. (Brno)	224

There are also 76 other facilities incinerating or co-incinerating industrial and hazardous waste, with a total capacity 600 Gg of waste. This waste is reported under 5C.

All the parameters and calculations are shown in the following Tab. 3-13.

Tab. 3-13 Parameters and emissions from waste incineration 1990-2013

	Used factors
Amount of carbon fraction	0.4
Fosil carbon fraction	0.4
Combust efficiency fraction	0.95
C-CO_2 ratio	3.7
Avrg. Emission factor Gg CH_4/Gg	2E-07
Avrg. Emission factor Gg N_2O/Gg	5E-05

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
MSW incinerated (Gg MSW)	66	58	82	102	156	163	171	174	245	285	334	382
MSW incinerated (TJ NCV)	656	577	822	1018	1564	1631	1710	1741	2332	2686	3190	3701
Waste heating value (GJ/t)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.5	9.4	9.6	9.7
Biogenic (TJ)	393	346	493	611	939	979	1026	1045	1399	1612	1914	2221
Fossil (TJ)	262	231	329	407	626	652	684	697	933	1074	1276	1480
Total CO_2 emissions (Gg CO_2) Fossil	36.5	32.2	45.8	56.7	87.2	90.9	95.3	97.0	136.3	158.6	185.9	212.9
Total CO_2 emissions (Gg CO_2) Biogenic	54.8	48.2	68.7	85.1	130.8	136.4	143.0	145.6	204.4	238.0	278.9	319.4
Total CH_4 emissions (Gg CO_2 eq)	3.3E-04	2.9E-04	4.1E-04	5.1E-04	7.8E-04	8.2E-04	8.6E-04	8.7E-04	1.2E-03	1.4E-03	1.7E-03	1.9E-03
Total N_2O emissions (Gg CO_2 eq)	1.0	0.9	1.2	1.5	2.3	2.4	2.5	2.6	3.6	4.2	5.0	5.7

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
MSW incinerated (Gg MSW)	411	408	409	388	392	392	376	360	467	586	610	615
MSW incinerated (TJ NCV)	3987	3749	4231	3957	3779	4157	4052	3744	4900	5574	5840	5887
Waste heating value (GJ/t)	9.7	9.2	10.3	10.2	9.6	10.6	10.8	10.4	10.5	9.5	9.6	9.6
Biogenic (TJ)	2392	2250	2539	2374	2268	2494	2431	2247	2940	3345	3504	3532
Fossil (TJ)	1595	1500	1692	1583	1512	1663	1621	1498	1960	2230	2336	2355
Total CO_2 emissions (Gg CO_2) Fossil	228.8	227.3	228.1	216.4	218.4	218.3	209.8	200.9	260.3	326.5	339.9	342.5
Total CO_2 emissions (Gg CO_2) Biogenic	343.2	340.9	342.2	324.6	327.7	327.4	314.7	301.3	390.4	489.7	509.9	513.7
Total CH_4 emissions (Gg CO_2 eq)	2.1E-03	2.0E-03	2.0E-03	1.9E-03	2.0E-03	2.0E-03	1.9E-03	1.8E-03	2.3E-03	2.9E-03	3.0E-03	3.1E-03
Total N_2O emissions (Gg CO_2 eq)	6.1	6.1	6.1	5.8	5.8	5.8	5.6	5.4	7.0	8.7	9.1	9.2

3.2.7.3 Uncertainties and time-series consistency (CRF 1.A.1.a.i)

See chapter 3.2.5.

3.2.7.4 Category-specific QA/QC and verification (CRF 1.A.1.a.i)

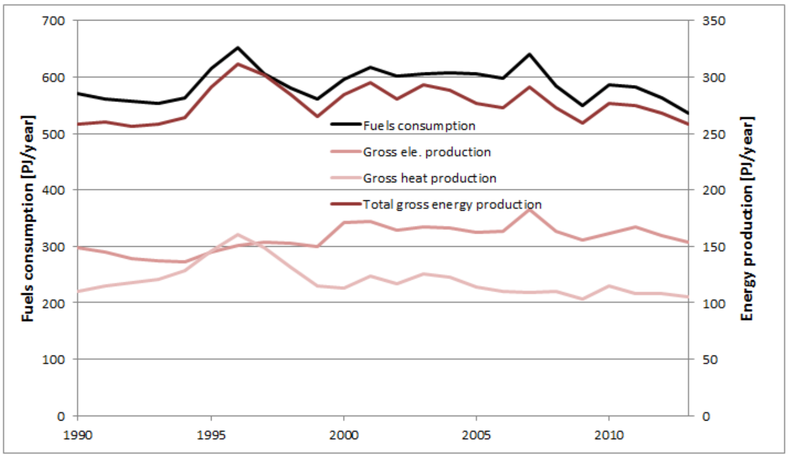


Fig. 3-5 The ratio between the total consumption of fuels from the heat sources in the category 1.A1.a and overall energy production

Fig. 3-5 shows the correlation of fuel consumption in category 1.A.1.a and total gross electricity and heat production. Total energy production should have a similar trend to total fuels consumption in category 1.A.1.a.

Throughout the whole time period it is possible to see a good correlation between the total fuel consumption and gross energy production. There are minor fluctuations, caused by variation of the ratio between the electricity and the amount of heat produced.

For additional information please see chapter 3.2.6.

3.2.7.4.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

Waste incineration is reported in the energy but in NIS it is still managed under waste sector and for this particular chapter all relevant QA/QC procedures are described in waste chapter.

3.2.7.5 Category-specific recalculations (CRF 1.A.1.a.i)

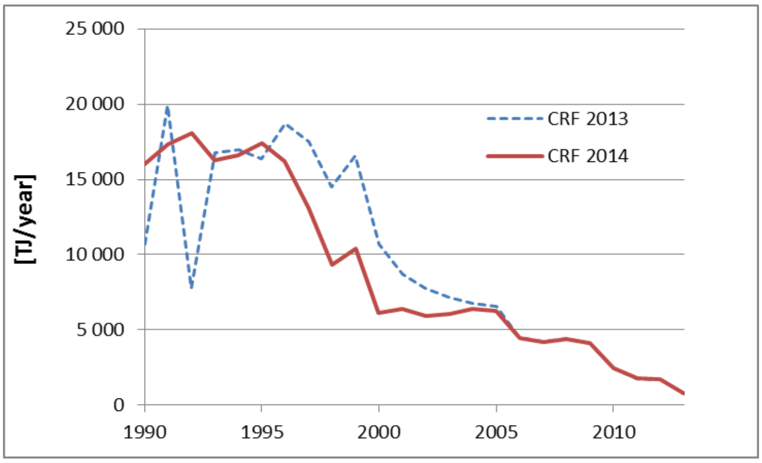


Fig. 3-6 Recalculation of the consumption of liquid fuels (CRF 1.A.1.a.i)

There was a fundamental recalculation in the consumption of liquid fuels. This recalculation was caused by the choice of new methodological approach to the distribution of liquid fuels for their energy and non-energy use. At the same time, new data calculations from CzSO were used for the whole time period 1990-2013, while in the previous submission, in the balance of liquid fuels was still used data for 1990 to 1995, from the original energy balance, prepared according to national methodology of the Czech Republic. This recalculation has changed the structure of liquid fuels consumption. Comparison of the data from the previous submission, and data that are used in the current submission, is shown on Fig. 3-6.

The figure shows that the changes in the recalculation took effect primarily from 1990 to 2006. Additional minor recalculation also occurred in the consumption of fossil fuels and natural gas in the period 1990 to 1995 and for the same reason as for liquid fuels (transition from national methodology for energy balance to the IEA methodology). Given that liquid fuels are in this subcategory minority and that no other changes to the data in the report are substantial, total fuel consumption did not change significantly. As seen in Fig. 3-7 the recalculation in fuel consumption was reflected significantly only in the years 1993 to 1995.

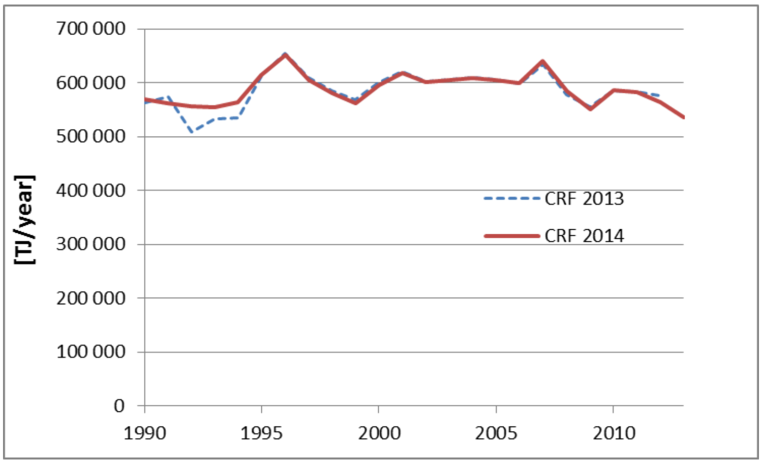


Fig. 3-7 Recalculation of total fuel consumption (CRF 1.A.1.a)

The recalculation addresses, among other things, the incompatibility between data, available for the Czech Republic in international statements for the periods 1990 to 1995, and the data, that was so far used in the CRF.

Given that the transition to the new methodology led to changes in emission factors (CO_2, CH_4, N_2O) and oxidation factors and further, new country-specific emission factors (Bituminous Coal, Lignite - CO_2) were also used, all resulted in changes in the emission calculations (Fig. 3-8).

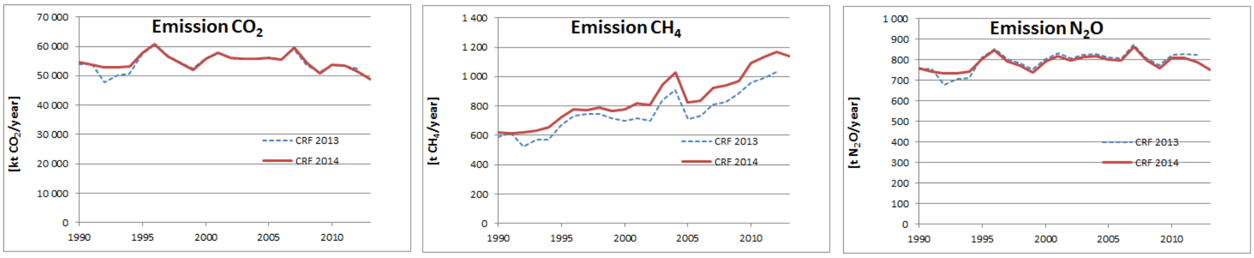


Fig. 3-8 Recalculation of CO_2, CH_4 and N_2O emissions from combustion in category 1.A.1.a

In conclusion, on Fig. 3-9 is presented a comparison of the amount of greenhouse gases, expressed as CO_2 equivalent

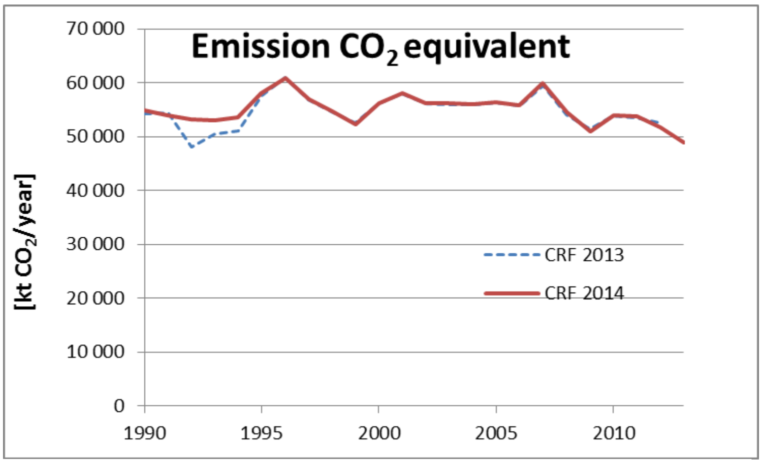


Fig. 3-9 Sum of the GHG CO_2, CH_4 and N_2O, as CO_2 equivalent from combustion in category 1.A.1.a – comparison between the state before and after recalculation

3.2.7.5.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

No recalculations were performed this year.

3.2.7.6 Category-specific planned improvements (CRF 1.A.1.a.i)

The new methodology includes further subdivision of category 1.A1.a into:

- 1.A.1.a.i - Electricity Generation
- 1.A.1.a.ii - Combined Heat and Power Generation
- 1.A.1.a.iii - Heat Plants

In the current submission, this detailed division was not applied and all activity data and GHG emissions are included in the category 1.A.1.a.i. Although the materials from CzSO contain information for the distribution of fuel consumption in each subsector, it will be required to verify their credibility and reliability from the point of the trends during the entire time series.

Therefore, for the next submission attention will be paid on the distribution of fuels in the specified subsectors in the detailed division.

Furthermore, attention will be focused on determining the country specific emission factors for other fuels, while considering the significance of the individual types of fuel.

3.2.8 Petroleum Refining (CRF 1.A.1.b)

3.2.8.1 Category description (CRF 1.A.1.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.1.b, 2013								
Structure of Fuels	**Activity data [TJ]**	**CO_2 EF [t CO_2/TJ]**	**OxF**	**Emission [kt]**	**CH_4 EF [kg CH_4/TJ]**	**Emission [kt]**	**N_2O EF [kg N_2O /TJ]**	**Emission [kt]**
Refinery Gas	5 430.7	55.076	1	299.1	1	0.00543	0.6	0.00326
Other Oil	2 611.6	73.3	1	191.4	3	0.00783	0.6	0.00157
Natural Gas	3 820.3	55.3018	1	211.3	1	0.00382	0.1	0.00038
Total year 2013	**11 862.6**			**701.8**		**0.0171**		**0.00521**
Total year 2012	13 676.7			826.4		0.0209		0.00629
Index 2013/2012	0.87			0.85		0.82		0.83
Total year 1990	8 705.4			492.6		0.0102		0.00232
Index 2013/1990	1.36			1.42		1.68		2.25

The origin of the data, emission factors used and the method for calculating the emissions for each gas is shown in details in the following outline.

2013							
Structure of Fuels	**Source of Activity data**	**Emission factors**			**Method used**		
		CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Refinery Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1

This category includes all facilities that process raw petroleum imported into this country as their primary raw material. Domestic petroleum constitutes approximately 2.3% of the total amount in 2013. 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 Inc. company in the Czech Republic. Fugitive CH_4 emissions are included in category 1.B.2.a Fugitive Emissions from Fuels - Oil.

The fraction of CO_2 emissions in subsector 1.A.1.b in CO_2 emissions in sector 1.A.1 equalled 1.2% in 2013. It contributed 0.7% to CO_2 emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2014), 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

Since this submission the greenhouse gas emissions from combustion of refinery gas are estimated using country specific emission factor. Detailed description of the research carried out in 2013 is provided in Annex 3 of this NIR. For the rest of liquid fuels the default emission factors were used. Country specific emission factor is used also for Natural Gas – see outlines at the beginning of each subchapter.

Fig. 3-10 shows an overview of emissions trends in source category 1.A.1.b:

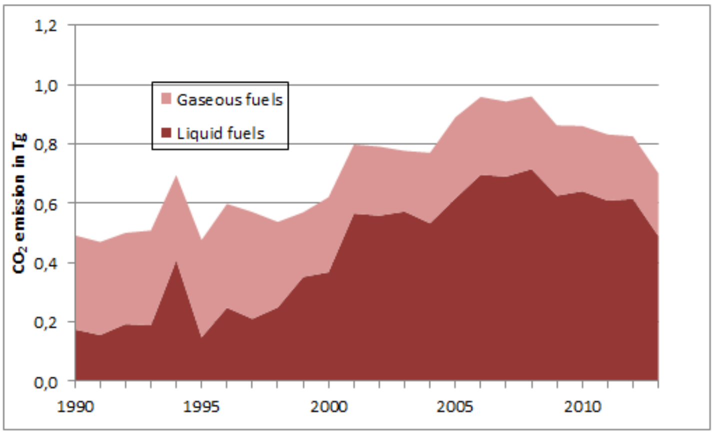


Fig. 3-10 Development of CO2 emissions in 1.A.1.b category

No consumption of Solid Fuels occurred in this category.

Liquid Fuels are of the greatest importance and exhibit an increasing trend in the whole period. The fluctuations that have occurred over the years can be explained as resulting from differences in production quantities (see also Fig. 3-11). The maximum production equal to 961 kt CO_2 occurred in 2008, followed by a value of 959 kt CO_2 in 2006. Thereafter, production decreased to the resulting level of 702 kt CO_2 in 2013.

The second greatest role is played by Natural Gas, with emissions in the range between 205 kt CO_2 in 2003 and 360 kt CO_2 in 1997 and resulting with 211 kt CO_2 in 2013.

3.2.8.2 Methodological issues (CRF 1.A.1.b)

Basic methodological approaches were presented in the section 3.2.4. In Chapter 3.2.8. no specific approaches were used for performing QA/QC in category 1.A.1.b.

3.2.8.3 Uncertainties and time-series consistency (CRF 1.A.1.b)

See chapter 3.2.5.

3.2.8.4 Category-specific QA/QC and verification (CRF 1.A.1.b)

Fig. 3-11 contains a comparison of fuel consumption in the sector 1.A.1.b with the total amount of crude oil processed in the Czech Republic in the separate years.

From the figure is apparent that since 2000 the relation between the amount of crude oil processed and the amount of fuel used are in line. In the period from 1990 to 2000, it is clear that the specific energy consumption for processing crude oil was lower than at present, and went through certain fluctuations. They were driven by the fact that, in this period the production capacity of both refineries were expanded (Litvinov and Kralupy nad Vltavou) towards deeper crude oil processing (especially using of cracking units since the end of the 90s).

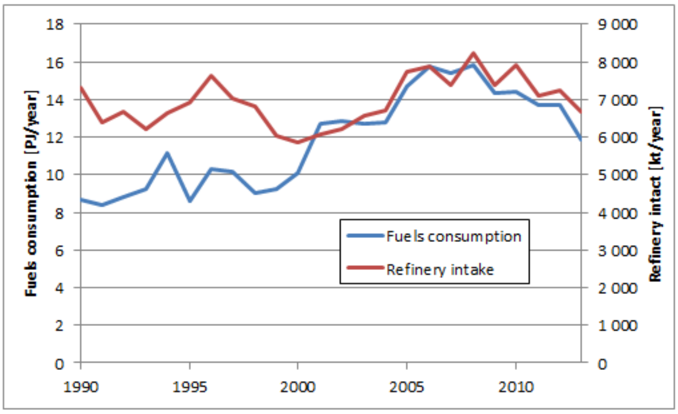


Fig. 3-11 Comparison of fuel consumption in the sector 1.A.1.b and amount of crude oil processed

The other QA/QC procedures were performed as described in chapter 3.2.6.

3.2.8.5 Category-specific recalculations (CRF 1.A.1.b)

Recalculation was performed in the consumption of liquid fuels. This recalculation was caused by the implementation of the new methodological approach to the distribution of liquid fuels for their energy and non-energy use. At the same time, new data calculations from CzSO were used for the whole time series 1990-2013, while in the previous submission, in the balance of liquid fuels was still used data for 1990 to 1995, from the original energy balance, prepared according to national methodology of the Czech Republic. This recalculation has changed the structure of consumption of liquid fuels. Comparison of the data from the previous submission, and data that are used in the current submission, is shown on Fig. 3-12.

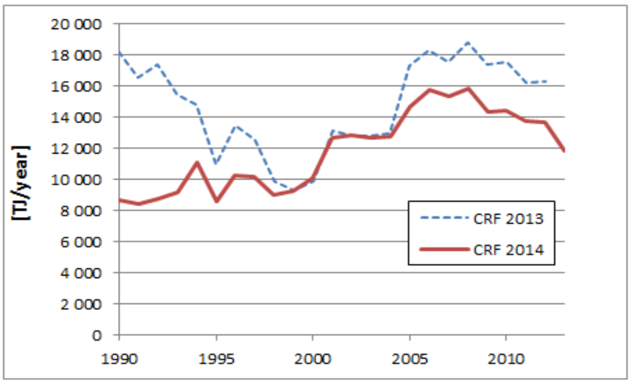


Fig. 3-13 Recalculation of total fuel consumption (CRF 1.A.1.b)

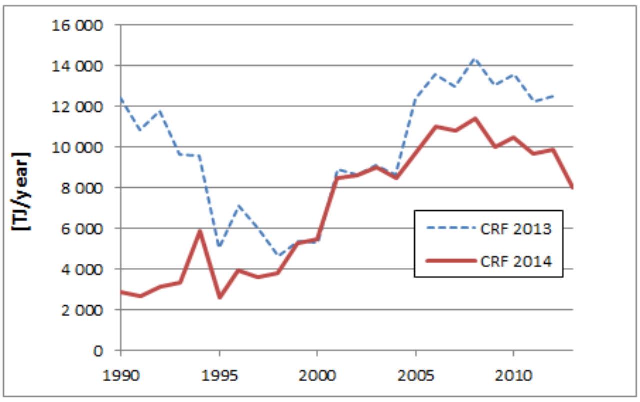


Fig. 3-12 Recalculation of consumption of liquid fuels (CRF 1.A.1.b)

The figure shows that changes in the recalculation appeared mainly from 1990 to 1998, the period for which it was partly used data from the original energy balance, which was processed according to national methodology of the Czech Republic. Since 2005, a further distinct decline in consumption of liquid fuels compared to the previous submission is observed. The decline in this period was mainly due to the reallocation of consumption of other petrochemical products in IPPU. Whereas liquid fuels are dominant for this subcategory, significant recalculation of total fuel consumption was conducted, since the consumption of natural gas has not changed. Comparison of total fuel consumption before and after recalculation is shown on Fig. 3-13.

Recalculation in fuel consumption also influenced the CO_2 emissions. Fig. 3-14 illustrates the change that occurred due to this recalculation of CO_2 emissions. Similarly, the change in fuel consumption is reflected in the N_2O emissions. CH_4 emissions have changed due to two factors. The first factor has been described as a change in fuel consumption. The second factor is change in the emission factor for refinery gas, which was used in the last submission and according to the methodology IPCC, 1996 equalled to 3 kg CH_4/TJ. According to the IPCC methodology 2006, this emission factor is reduced to 1 kg CH_4/TJ, which resulted in a significant decrease in methane emissions. The resulting methane emissions are compared in Fig. 3-14.

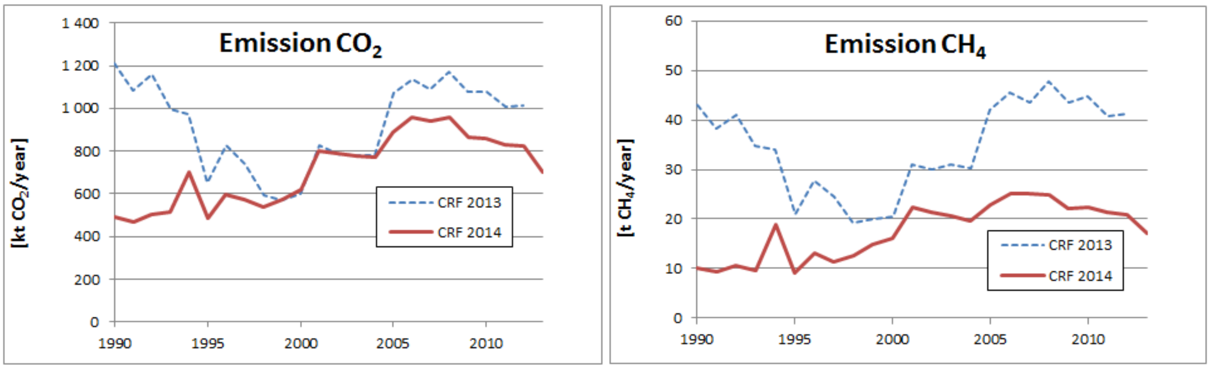


Fig. 3-14 Recalculation of CO_2 and CH_4 emissions from fuel combustion in the category 1.A.1.b

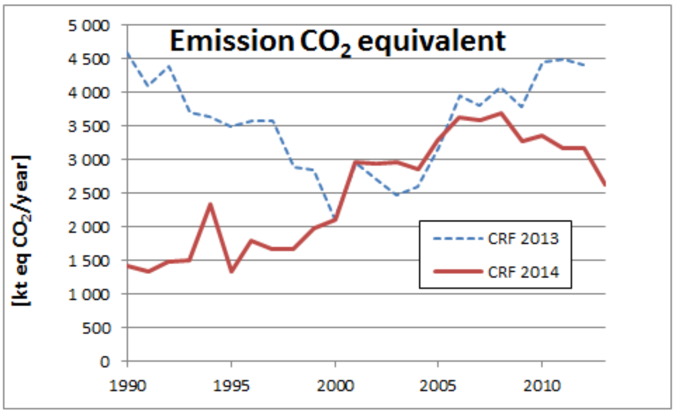


Fig. 3-15 Sum of the GHG CO_2, CH_4 and N_2O, as CO_2 equivalent from fuel combustion in category 1.A.1.b – comparison between the state before and after recalculation

In conclusion, on Fig. 3-15 is presented a comparison of the amount of greenhouse gases, expressed as CO_2 equivalent

The figure shows that the change in fuel consumption and in the emission factor for CH_4 is partly compensated in the middle period.

3.2.8.6 Category-specific planned improvements (CRF 1.A.1.b)

Since the consumption of liquid fuels in 1994 shows a large difference (outlier) compared to 1993 and 1995 in further submissions, this data will be subjected to inspection. Specifically it is about the consumption of Other Oil as refinery fuel.

No further improvement in this subcategory are currently planned.

3.2.9 Manufacture of solid fuels and other energy industries (1.A.1.c)

This category is divided into two subcategories:

- Manufacture of Solid Fuels (1.A.1.c.i)
- Other Energy Industries (1.A.1.c.ii)

Given that this division is used in the new methodology (IPCC, 2006) and the fact that there are no precise data for more detailed classification, in this submission, the data is reported as a summary in category CRF 1.A.1.c.ii. Production of briquettes, which would fall under 1.A.1.c.i in the Czech Republic has been terminated and in terms of the share of the emissions, this production had, it was negligible and further accurate data on fuel consumption in this category are now hardly accessible.

3.2.9.1 Category description (CRF 1.A.1.c.ii)

The structure of fuels, their consumption, the emission factors and emissions of various greenhouse gases are shown in the following outline.

1.A.1.c, 2013								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
Heating and Other Gasoil	724.2	74.1	1	53.7	3	0.00217	0.6	0.00043
Brown Coal + Lignite	38 782.5	100.31*)	0.985*)	3 830.3	1	0.03878	1.4	0.05430
Coal Tars	3 361.5	80.7	1	271.3	1	0.00336	1.4	0.00471
Gas Works Gas	16 888.4	100.38*)	1	1 695.2	1	0.01689	0.1	0.00169
Coke Oven Gas	7 880.6	44.40	1	349.9	1	0.00788	0.1	0.00079
Natural Gas	146.5	55.30*)	1	8.1	1	0.00015	0.1	0.00001
Total year 2013	**67 783.8**			**6 208.4**		**0.06923**		**0.06193**
Total year 2012	71 242.8			6 627.6		0.07252		0.06467
Index 2013/2012	0.95			0.94		0.95		0.96
Total year 1990	28 984.6			1 516.4		0.03348		0.00794
Index 2013/1990	2.34			4.09		2.07		7.80

*) *Country specific data*

The table shows that while the index for 2013/1990 of fuel consumption is 2.3, the same index for CO_2 emissions is significantly higher. It is caused by the high proportion of coke oven gas in the fuel structure in 1990, which has a relatively low emission factor. Later, part of coke oven gas was reallocated to other subsectors (1.A.1.a and 1.A.2.a). Even more markedly the high proportion of coke oven gas, combined with relatively low emission factor, compared to other fuels, occurred in N_2O emissions.

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is presented in details in the following outline.

2013							
Structure of Fuels	**Source of Activity data**	**Emission factors**			**Method used**		
		CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gas Works Gas	CzSO, CHMI	CS	D	D	Tier 2	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1

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 to 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 importance in the Czech Republic.

The fraction of CO_2 emissions in subsector 1.A.1.c in CO_2 emissions in sector 1.A.1 equalled 11% in 2013. It contributed only 7% to CO_2 emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in capture Energy Sector under the items:

- 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)

Fig. 3-16 provides an overview of emission trends in source category 1.A.1.c. The figure clearly shows the increase in emissions in 1995 – 2012 period. The use of Coal predominated in the whole period followed by the consumption of Gas Works Gas and Coke Oven Gas. There is very low use of Liquid Fuels and Natural Gas in this category.

Sokolovská Uhelná Inc. makes the greatest contribution to the consumption of Solid fuels . The section for processing Brown Coal was established in 1950 and also produced Gas Works Gas and other chemical products. Formally, the existence of this combine ended in 1974 when this facility was moved under the Hnědouhelné doly a briketárny company. Together with this step was established Fuel combine Vřesová. The new combined-cycle power station started to operate in 1996 (http://www.suas.cz).

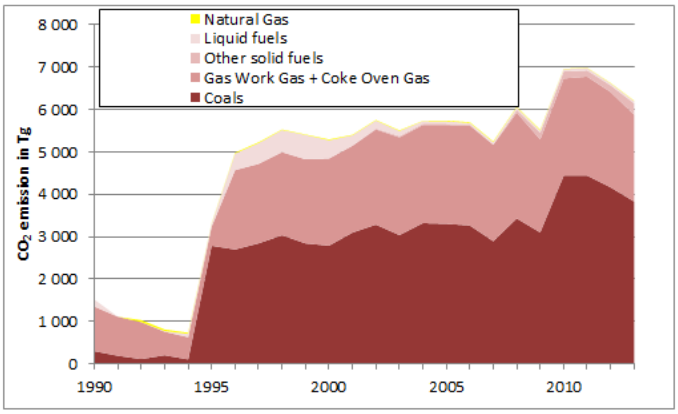


Fig. 3-16 Development of CO_2 emissions in 1.A.1.c.ii category

Between 1990 and 1995, production of Town Gas, which was distributed in the Czech Republic by Gas Work Vřesová, has been gradually phased out. On Fig. 3-16 can be seen a decline in production of Town Gas and the starting up of production of Gas Work Gas for the production of electricity and the supply heat. Pipelines used to distribute Town Gas at that time were converted for Natural Gas and took over the role for its long-distance transport and local distribution. Coke Oven Gas is produced in the Ostrava area where the Coke Plants operating.

3.2.9.2 Methodological issues (CRF 1.A.1.c.ii)

Dominant role in fuel consumption in this category plays the fuel consumption in Fuel combine Vřesová. This fuel is used for its own gasification process, as well as for production of technological steam, which enters into the process as a process raw material. The produced high-pressure synthesis gas is then purified by acidic components (CO_2 and H_2S) and is used for power generation and supplied heat. From a methodological point of view, the whole combined production is divided into two parts – consumption of produced Gas Work Gas (and associated GHG emissions) for the production of electricity and heat and fuel consumption for technological purposes (input coal to produce technological steam). Not to be neglected CO_2 emissions and other greenhouse gases, which are produced from the gasification of pressure gas, it was necessary to replace in the model the consumption of Gas Work Gas with the coal, which enters into the process. For the calculation of CO_2 was used an emission factor for lignite and as an activity data was used the value of total coal consumption in the technological part of the process.

The amount of coal that was used for the production of technological steam is not directly accessible from the CzSO energy balance. To determine the amount of coal, data from CHMI REZZO national emission database was used. The quantity of coal for production of technological steam is given in Tab. 3-14.

Tab. 3-14 Consumption of Lignite for production of technological steam in Fuel combine Vřesová 1995 – 2013

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Lignite [kt/year]	1 439	1 596	1 536	1 571	1 588	1 651	1 715	1 746	1 856	1 931
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Lignite [kt/year]	2 064	2 003	2 088	2 107	1 938	2 044	2 094	2 117	2 117	

This amount of coal is in the data calculation of CzSO included in the total fuel consumption in the sector "Transformation - autoproducer heat plants". To avoid double counting of the quantity of coal, the amount was deducted from the other calculations in the model for fuels used in autoproducers.

No other specific approaches were used in this category.

3.2.9.3 Uncertainties and time-series consistency (CRF 1.A.1.c.ii)

See chapter 3.2.5.

3.2.9.4 Category-specific QA/QC and verification (CRF 1.A.1.c.ii)

Fig. 3-17 contains a comparison between consumption of lignite in sector 1.A.1.c (data from the REZZO national emission database) and the total amount of lignite, entering the transformation process (gasified coal) in the Czech Republic (data CzSO) in the period 1995-2013.

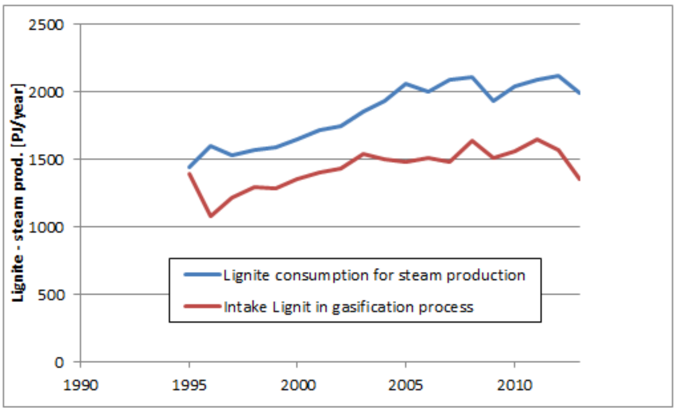


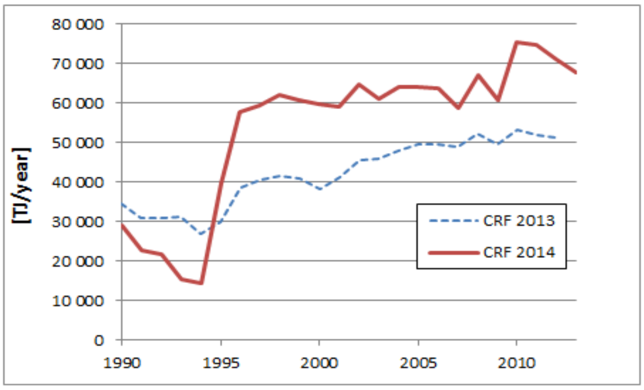
Fig. 3-17 Comparison of lignite consumption for steam production and gasification

The Fig. 3-18 shows that, apart from the early years, when combined cycle was starting to reach his full power (1995 to 1998), the trends of the two curves are very similar. The minor fluctuations are caused by annual climatic influences, the technological steam is also used as a heating medium in the entire company and its consumption also depends on the average annual temperatures.

As a QA/QC procedure for this part of the calculations was utilized internal expertise of experts from the Department of emissions and sources at CHMI. Other procedures were performed as described in chapter 3.2.6.

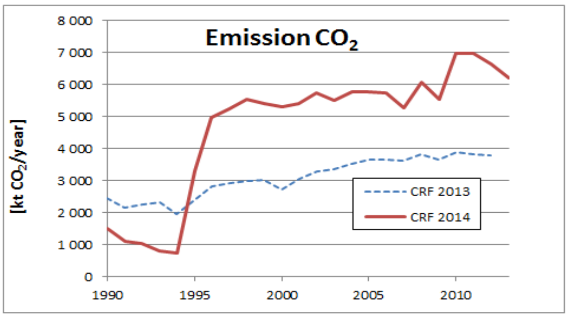
3.2.9.5 Category-specific recalculations (CRF 1.A.1.c.ii)

Recalculation was performed mainly in the consumption of fossil fuels, which is dominant in this category. The recalculation mainly consisted in replacing the consumption of Gas Work Gas with Lignite, which is used in the manufacture of Gas Work Gas. As described in section 3.2.9.2. this recalculation was performed to avoid the omission of the proportion of CO_2 emissions, which are removed from Gas Work Gas during washing out of the acidic gases. The increase in the consumption of fossil fuels since 1995 is determined by changing of the consumption of pure Gas Work Gas for overall consumption of lignite, entering the gasification process. Data prior to 1995 was in the last submission still taken from the original energy balance prepared according to national methodology and in this submission is replaced by the data from CzSO provided in the questionnaires for IEA/EUROSTAT. The results from the recalculation are shown in Fig. 3-18.



Total fuel consumption has a direct impact on CO_2 emissions. Given the dominance of fossil fuels in this subcategory is the time course of CO_2 practically identical to the course of fuel consumption - see Fig. 3-19 in comparison with Fig 3-18.

Fig. 3-18 Total consumption of fuels – comparison between data in previous and current submission



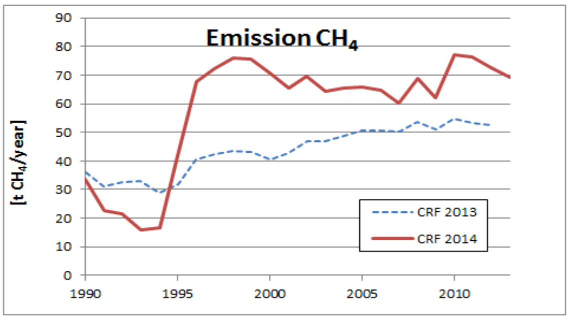


Fig. 3-19 CO_2 and CH_4 emissions – comparison between data in previous and current submission

A similar course have the curve for methane emissions. The higher emissions in the period 1996 to 2000 are due to insignificant share of liquid fuels, which are reported in the balance. Due to their significantly higher emission factors, their attribution is apparent from the curve. In the evaluation of total emissions are however insignificant - see Fig 3-19.

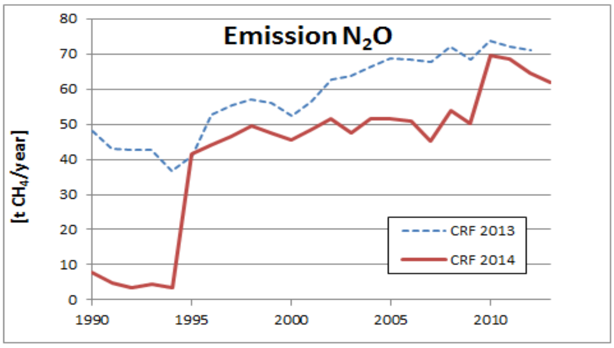


Fig. 3-20 Emissions N_2O - comparison between data in previous and current submission

N_2O emissions were in the previous submission, reported at a higher level than at present. This is caused primarily by the change of the default emission factors in the new methodology (IPCC, 2006) for energy gases produced from fossil fuels (derivated gases) from the value of 1.4 to 0.1 kg/TJ - see Fig. 3-20.

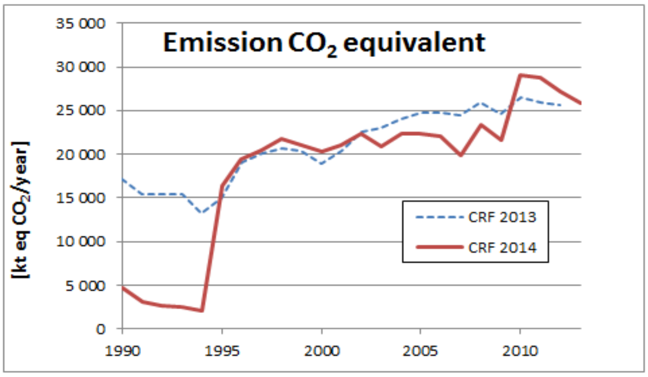


Fig. 3-21 Total GHG emissions in CO_2 equivalent - comparison between data in previous and current submission

The change of the emission factors for N_2O and partly for CH_4 is so important that it is reflected in the evaluation of the recalculations in terms of the total GWP of greenhouse gases expressed as CO_2 equivalent - see Fig. 3-21.

3.2.9.6 Category-specific planned improvements (CRF 1.A.1.c.ii)

Currently there are no planned improvements in this category..

3.2.10 Manufacturing industries and construction – Iron and Steel (1.A.2.a)

3.2.10.1 Category description (CRF 1.A.2.a)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.a, 2013								
Structure of Fuels	**Activity data [TJ]**	**CO_2 EF [t CO_2/TJ]**	**OxF**	**Emission [kt]**	**CH_4 EF [kg CH_4/TJ]**	**Emission [kt]**	**N_2O EF [kg N_2O /TJ]**	**Emission [kt]**
Fuel Oil - Low Sulphur	142.7	77.4	1	11.0	3	0.00043	0.6	0.00009
Fuel Oil - High Sulphur	108.6	77.4	1	8.4	3	0.00033	0.6	0.00007
Anthracite	4 370.5	98.3	1	429.6	10	0.04371	1.4	0.00612
Other Bituminous Coal	4 454.2	94.03*)	0.971*)	406.6	10	0.04454	1.4	0.00624
Brown Coal + Lignite	306.4	100.38*)	0.985*)	30.3	10	0.00306	1.4	0.00043
Coke	10 930.6	107	1	1 169.6	10	0.10931	1.4	0.01530
Coal Tars	264.4	80.7	0.985	21.3	10	0.00264	1.4	0.00037
Coke Oven Gas	4 353.8	44.4	1	193.3	1	0.00435	0.1	0.00044
Natural Gas	9 801.8	55.30*)	1	542.1	1	0.00980	0.1	0.00098
Wood/Wood Waste	30.4	112	1	3.4	30	0.00091	4	0.00012
Total year 2013	**34 763.4**			**2 815.6**		**0.2191**		**0.0301**
Total year 2012	33 014.9			2 649.7		0.2014		0.0277
Index 2013/2012	1.05			1.06		1.09		1.09
Total year 1990	155 319.2			54 685.8		1.3950		0.1958
Index 2013/1990	0.22			0.05		0.16		0.15

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is sown in details in the following outline.

2013							
Structure of Fuels	**Source of Activity data**	**Emission factors CO_2**	**CH_4**	**N_2O**	**Method used CO_2**	**CH_4**	**N_2O**
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Anthracite	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

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 CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in section 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 Divisions 24.1 – 24.3 and 24.51, 24.52.

The fraction of CO_2 emissions in subsector 1.A.2.a in CO_2 emissions in sector 1.A.2 equalled 19% in 2013. It contributed only less 3% to CO_2 emissions in the whole Energy sector.

Important facility belongs to this category is ArcelorMittal Ostrava, a.s. and Třinecké železárny a.s. Both metallurgical plants include iron ore sinter production, blast furnaces, coke production, iron processing in oxygen converters for steel and casting of steel in electric furnaces and in tandem furnaces. Production of steel using Siemens-Martin process was stopped before 1990.

The following figure provides an overview of CO_2 emissions in the various sub-source categories in 1.A.2.a.

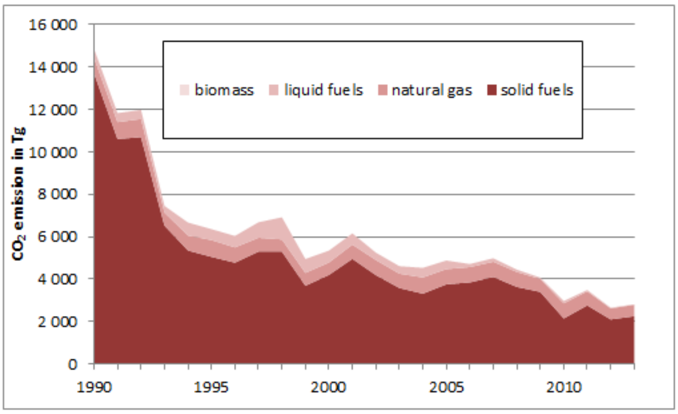


Fig. 3-22 Development of CO_2 emissions in source category 1.A.2.a

The graph in Fig. 3-22 shows apparent sharp decline in emissions in the early 90s, which was mainly due to the loss of markets, following the sharp political changes in the country. At the same time, an impact on the emissions was caused by the new legislation on air pollution and other environmental components. Gradual implementation and introduction of new, more stringent requirements for the protection of the environment is reflected in the decrease of emissions since about 1998. On the course of emissions after 2000 the competition of metallurgical plants in countries outside of Europe caused an impact. Minor fluctuations are caused by market demand and to a lesser extent, the necessary restructuring undertaken in individual companies.

Further, from Fig. 3-22 is clear that the main proportion of the CO_2 emissions is due to the use of fossil fuels, which are in this sector completely dominant.

3.2.10.2 Methodological issues (CRF 1.A.2.a)

All CO_2 emissions from metallurgical coke used in blast furnaces are reported under the Industrial processes sector (2.C.1) and estimated from the amount of carbon in the coke (see Chapter 4.4). Most of the blast furnace and converter gas is combusted in the two metallurgical plants (complexes) and only partly is used elsewhere. At present we are not able to identify exactly amount of these gases combusted outside metallurgical complexes. In order to prevent double-counting, we report all CO_2 emissions coming from metallurgical coke under 2.C.1. As a consequence of such approach we do not calculate any CO_2 emissions from blast furnace and converter gas.

3.2.10.3 Uncertainties and time-series consistency (CRF 1.A.2.a)

See chapter 3.2.5.

3.2.10.4 Category-specific QA/QC and verification (CRF 1.A.2.a)

As a basic indicators for verification of fuel consumption in the sector of production of pig iron and steel, it is necessary to be considered the indicators of the overall production of agglomerates of iron ore and pig iron. This is due to their high energy intensity. Fig. 3-23 shows the relationship between fuel consumption and total production of sinter and iron in mill. tons.

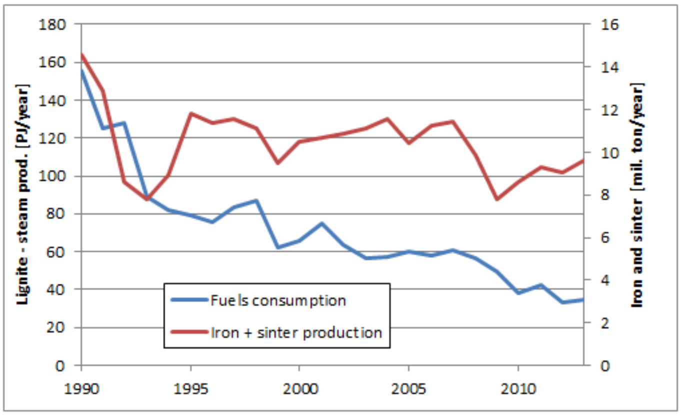
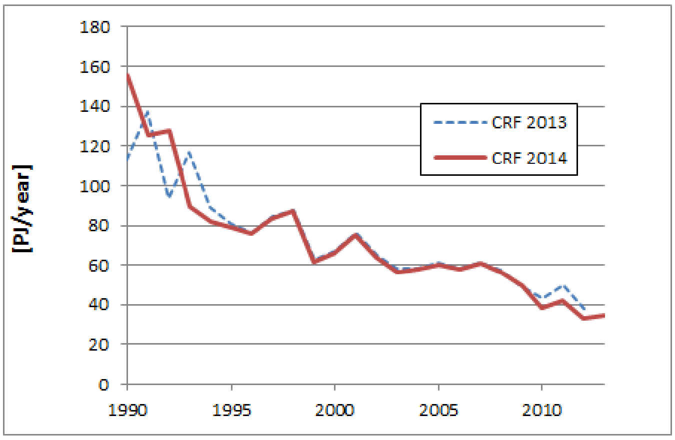


Fig. 3-23 The trend in the manufacture of agglomerates of iron ore and iron, in comparison with the development of fuel consumption in the sector 1.A.2.a

From the graph in Fig. 3-23 is clear that the fuel consumption decreases faster than the actual production. This is due to the gradual reduction of overall energy intensity throughout the metallurgical industry. This trend is particularly evident in the early 90s, when there was a major restructuring of production. This restructuring enabled, after the decline in 1990 and 1993, to return the volume of production almost to the level of 1990, but the decrease in total fuel consumption went further. Additional reductions in energy intensity are evident then until the end of the period.

Generally accepted methods of QA/QC are described in section 3.2.6.

3.2.10.5 Category-specific recalculations (CRF 1.A.2.a)



Substantial recalculations were performed at the beginning of the period. In the previous submission, data from the energy balance was used, which was conducted according to national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are reported in the international statements for IEA/EUROSTAT. Other less significant changes in fuel consumption were carried out in the years 2010 to 2012 on the basis of the updated data on the consumption of fossil fuels, which was performed in hindsight by CzSO on the basis of their actual findings - see Fig. 3-24.

Fig. 3-24 Recalculation in liquid fuels consumption (CRF 1.A.2.a)

On the total greenhouse gas emissions in this category had greater influence the change of emission factors for CH_4 and N_2O, which occurred due to the transition to the new methodology (IPCC, 2006) - Fig. 3-24. This is essentially a change in the emission factor from 10 kg CH_4/TJ to 1 kg of CH_4/TJ for combustion of coke oven gas, which is in the category of particular importance. Minor change was brought by the implementation of the new emission factor for the combustion of liquid fuels (amendment of 3 kg CH_4/TJ to 2 kg CH_4/TJ). The effect of the recalculations of emission is shown in Fig. 3-25.

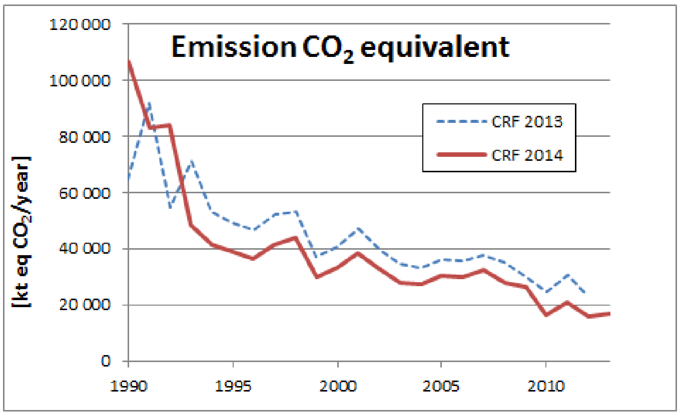


Fig. 3-25 Sum of the GHG CO_2, CH_4 and N_2O, as CO_2 equivalent from fuel combustion in category 1.A.2.a – comparison between the state before and after recalculations

3.2.10.6 Category-specific planned improvements (CRF 1.A.2.a)

We are planning to find data making possible to identify portions of both blast furnace and converter gases, which are combusted outside metallurgical complexes (see 3.2.10.2.).

3.2.11 Manufacturing industries and construction – Non-Ferrous Metals (1.A.2.b)

3.2.11.1 Category description (CRF 1.A.2.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.b, 2013								
Structure of Fuels	**Activity data [TJ]**	**CO_2 EF [t CO_2/TJ]**	**OxF**	**Emission [kt]**	**CH_4 EF [kg CH_4/TJ]**	**Emission [kt]**	**N_2O EF [kg N_2O /TJ]**	**Emission [kt]**
Fuel Oil - Low Sulphur	8.1	77.4	1	0.6	3	0.00002	0.6	0.000005
Coke	142.3	107	1	15.2	10	0.00142	1.4	0.00020
Natural Gas	1 792.5	55.30*)	1	99.1	1	0.00179	0.1	0.00018
Wood/Wood Waste	2.6	112.00	1	0.3	30	0.00008	4	0.00001
Total year 2013	**1 945.6**			**115.3**		**0.0033**		**0.0004**
Total year 2012	1 478.4			91.3		0.0031		0.0004
Index 2013/2012	1.32			1.26		1.08		1.00
Total year 1990	1 476.3			102.0		0.0057		0.0008
Index 2013/1990	1.32			1.13		0.58		0.51

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	**Source of Activity data**	**Emission factors CO_2**	**CH_4**	**N_2O**	**Method used CO_2**	**CH_4**	**N_2O**
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This category encompasses combustion processes in various areas of production of non-ferrous 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 CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section 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 Divisions 24.4, 24.53, 24.54

Important facility belongs to this category is Kovohutě Příbram. The fraction of CO_2 emissions in subsector 1.A.2.b in CO_2 emissions in sector 1.A.2 equalled 0.8% in 2013. It contributed only 0.1% to CO_2 emissions in the whole Energy sector.

It can be said that this is one of the sectors that rank according to its emissions of greenhouse gases among the least important in the entire sector Fuel combustion.

The following figure (Fig. 3-26) provides an overview of CO_2 emissions in the various sub-source categories in 1.A.2.b.

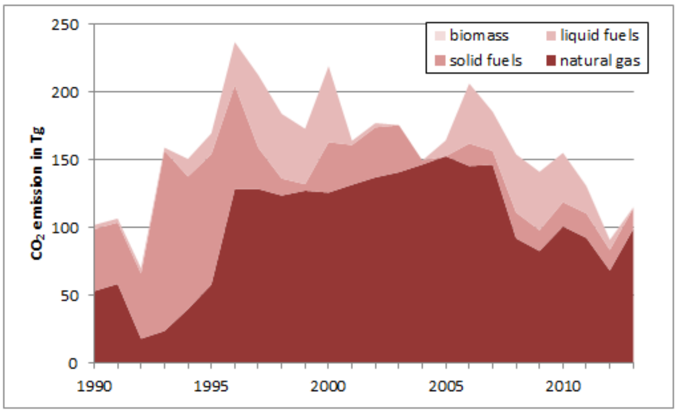


Fig. 3-26 Development of CO_2 emissions in source category 1.A.2.b

The trend of CO_2 emissions corresponds to the trend of consumption of individual types of fuels. After a decline in the early 90s, it is apparent a sharp increase in emissions, which was caused by the recovery in the industry. The recovery of the industry has happened in this sector, especially due to the increase in demand for parts, made of ferrous metals in the emerging automotive industry. Decrease in emissions at the end of the period was caused by the crisis between 2008 and 2012, as well as the reduction of the energy intensity of production. With this is also related a shift from fossil fuels in favour of natural gas. Furthermore, electrical energy is increasingly used for heating the melting furnaces, which has a positive impact on greenhouse gas emissions.

3.2.11.2 Methodological issues (CRF 1.A.2.b)

In this subcategory, specific methodologies are not used - a description of the general procedures - see Section 3.2.4.

3.2.11.3 Uncertainties and time-series consistency (CRF 1.A.2.b)

See chapter 3.2.5.

3.2.11.4 Category-specific QA/QC and verification (CRF 1.A.2.b)

In this subcategory, specific methodologies are not used - a description of the general procedures - see Section 3.2.6.

3.2.11.5 Category-specific recalculations (CRF 1.A.2.b)

In the category 1.A.2.b have not been conducted significant recalculations. Only at the beginning of the period (1990 to 1995), the original data from the energy balance on fuel consumption, according to national methodology was replaced by the official data from CzSO, reported on an international level. The minor differences in further years are primarily due to the application of the new default emission factors from the IPCC 2006. Comparison between the situation before and after recalculations is visible on Fig. 3-27.

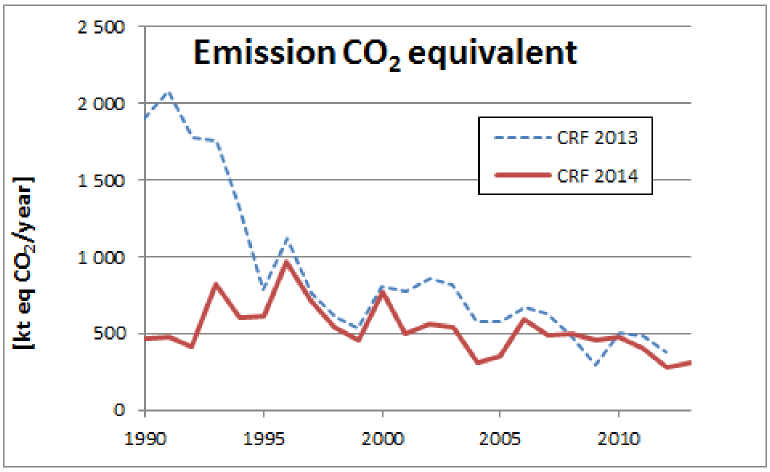


Fig. 3-27 Sum of the GHG CO_2, CH_4 and N_2O, as CO_2 equivalent from fuel combustion in category 1.A.2.b – comparison between the state before and after recalculations

3.2.11.6 Category-specific planned improvements (CRF 1.A.2.b)

Currently there are no planned improvements in this category.

3.2.12 Manufacturing industries and construction – Chemicals (1.A.2.c)

3.2.12.1 Category description (CRF 1.A.2.c)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.c, 2013								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
Fuel Oil - Low Sulphur	8.1	77.4	1	0.6	3	0.00002	0.6	0.000005
Coke	142.3	107	1	15.2	10	0.00142	1.4	0.00020
Natural Gas	1 792.5	55.30*)	1	99.1	1	0.00179	0.1	0.00018
Wood/Wood Waste	2.6	112.00	1	0.3	30	0.00008	4	0.00001
Total year 2013	**1 945.6**			**115.3**		**0.0033**		**0.0004**
Total year 2012	1 478.4			91.3		0.0031		0.0004
Index 2013/2012	1.32			1.26		1.08		1.00
Total year 1990	1 476.3			102.0		0.0057		0.0008
Index 2013/1990	1.32			1.13		0.58		0.51

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	Source for	Emission factors			Method used		
	Activity data	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes all the processes in the organic and inorganic chemical industry and all related processes, incl. petrochemistry. The petrochemical plants are linked to two major refinery enterprises in Litvinov (Unipetrol RPA, sro) and in Kralupy (Synthos Kralupy as). Due to the historical linkage between the two units, it is very difficult to determine the fuel combusted in the refinery and petrochemical parts of both plants separately. Furthermore, in the Czech Republic there are in operation other major plants for processing products of organic chemistry (DEZA as Meziříčí - the processing of coal tar, SYNTHESIA as Pardubice - basic organic chemistry) and a number of factories for the manufacture of inorganic products (SPOLANA as Neratovice, SPOLCHEMIE as Ústí nad Labem, PRECHEZA as Přerov and others). The largest plants are also equipped with energy resources, with a significant share of electricity and heat (autoproducers); this is the reason for the relatively high consumption of fossil fuels (see Fig 3-28. For the generating process of heat is used abundant natural gas and to a lesser extent, liquid fuels or eventually electrical energy. In total, the national emission database recorded 1,000 production units that fall within the sector 1.A.2.c

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

Chemical (including Petrochemical)

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

Chemicals: NACE Division 20

The fraction of CO_2 emissions in subsector 1.A.2.c in CO_2 emissions in sector 1.A.2 equalled 13.3% in 2013. It contributed 1.8% to CO_2 emissions in the whole Energy sector.

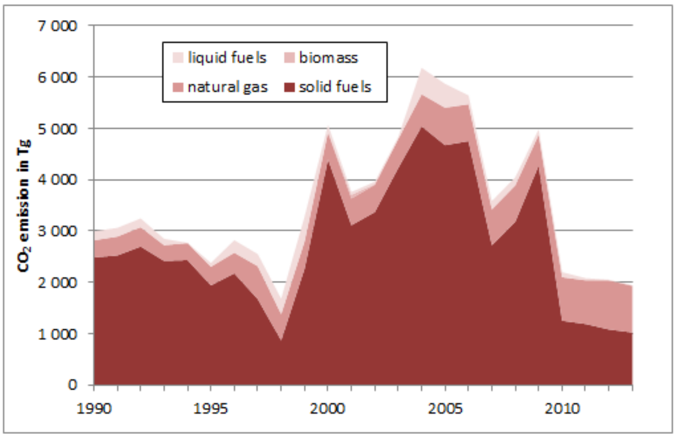


Fig. 3-28 Development of CO_2 emissions in source category 1.A.2.c

The following figure (Fig. 3-28) provides an overview of CO_2 emissions in the sub-category in 1.A.2.c.

The course of CO_2 emissions is not directly related to the volume of chemical production, since it is primarily emissions from burning fossil fuels to produce electricity and heat (autoproducers). For this reason, the development of emissions in time cannot be commented.

3.2.12.2 Methodological issues (CRF 1.A.2.c)

Given that in the IPCC 2006 is used a new approach to the allocation of feedstocks and non-energy use of fuels into IPPU, a recalculation was performed on the consumption of liquid fuels in this subsector (see section 3.2.12.5.). The new distribution of liquid fuels is to be considered as category specific methodological issue. This methodological approach is in the same time based on the new reallocation of fuel consumption for energy and non-energy use in the questionnaire from CzSO (2014). The reallocation of feedstocks and non-energy use of fuels in IPPU is in details described in chapter 3.2.3.

Other methodological approaches were applied as in the other subcategories, and their description is provided in chapter 3.2.4.

3.2.12.3 Uncertainties and time-series consistency (CRF 1.A.2.c)

See chapter 3.2.5.

3.2.12.4 Category-specific QA/QC and verification (CRF 1.A.2.c)

In this category, no specific QA/QC procedures were used. Given that the fuel consumption in this sector, reported directly, is not related to the production volume of chemicals, there cannot be used the relevant comparison with specific commodities.

Description of the QA/QC procedures is given in chapter 3.2.6.

3.2.12.5 Category-specific recalculations (CRF 1.A.2.c)

As mentioned in previous chapters, in the subsector 1.A.2.c was mainly done recalculation in consumption of liquid fuels. In the previous submission, the consumption of

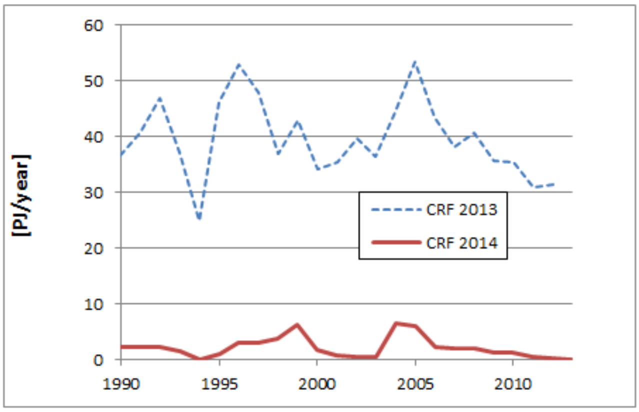


Fig. 3-29 Recalculation of liquid fuels consumption (CRF 1.A.2.c)

certain types of liquid fuels was counted in the consumption to a certain proportion (as recommended in IPCC, 1996). It concerned the combustion of feedstock such as naphtha, lubricants, other oils. These fuels were in this submission, virtually all reallocated to IPPU. Hence, the decline in consumption of liquid fuels in this subsector is quite noticeable - see Fig. 3-29.

The performed recalculation has also a significant impact on the overall CO_2 emissions.

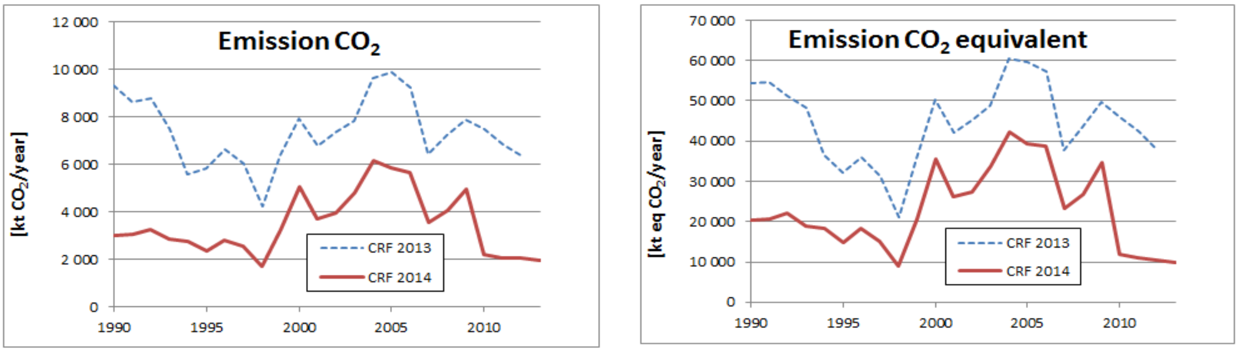


Fig. 3-30 CO_2 emissions from fuel combustion in chapter 1.A.2.c - comparison between the state before and after recalculations; Sum of the GHG CO_2, CH_4 and N_2O, as CO_2 equivalent from fuel combustion in category 1.A.2.c – comparison between the state before and after recalculations

The influence on the emissions of methane and N_2O that this recalculation has, is virtually the same as on CO_2 emissions. Therefore, the progress of the resulting curve is very similar to the progress of greenhouse gas emissions, expressed as CO_2 equivalent - see Fig. 3-30.

3.2.12.6 Category-specific planned improvements (CRF 1.A.2.c)

Currently there are no planned improvements in this category.

3.2.13 Manufacturing industries and construction – Pulp, Paper and Print (1.A.2.d)

3.2.13.1 Category description (CRF 1.A.2.d)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.d, 2013								
Structure of Fuels	**Activity**		**CO_2**		**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
Fuel Oil - Low Sulphur	174.0	77.4	1	13.5	3	0.00052	0.6	0.00010
Fuel Oil - High Sulphur	74.1	77.4	1	5.7	3	0.00022	0.6	0.00004
Other Bituminous Coal	416.3	94.03 *)	0.971 *)	38.0	10	0.00416	1.4	0.00058
Brown Coal + Lignite	1 345.5	100.38 *)	0.985 *)	133.0	10	0.01345	1.4	0.00188
Natural Gas	4 627.7	55.30 *)	1	255.9	1	0.00463	0.1	0.00046
Wood/Wood Waste	15 800.7	112	1	1 769.7	30	0.47402	4	0.06320
Gaseous Biomass	1 935.2	54.6	1	105.7	1	0.00194	0.1	0.00019
Total year 2013	**24 373.5**			**2 321.4**		**0.4989**		**0.0665**
Total year 2012	23 754.6			2 241.9		0.4677		0.0624
Index 2013/2012	1.03			1.04		1.07		1.07
Total year 1990	25 900.8			2 285.3		0.1878		0.0272
Index 2013/1990	0.94			1.02		2.66		2.44

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

		2013					
Structure of Fuels	**Source of**	**Emission factors**			**Method used**		
	Activity data	**CO_2**	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes all manufacturing processes related to the production of paper, cardboard and print in printing plants. There are two primary paper production factories in the Czech Republic (JIP - Papírny Větřní, a. s., Mondi Štětí a.s.) 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.

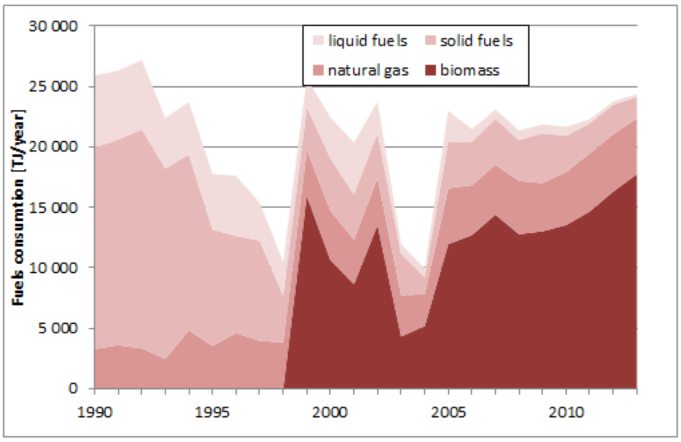


Fig. 3-31 Development of fuels consumption in source category 1.A.2.d

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section 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 17 and 18

The fraction of CO_2 emissions in subsector 1.A.2.d in CO_2 emissions in sector 1.A.2 equalled 16% in 2013. It contributed 2.2% to CO_2 emissions in the whole Energy sector.

Fig. 3-31 provides an overview of fuels consumption in the sub-category in 1.A.2.d.

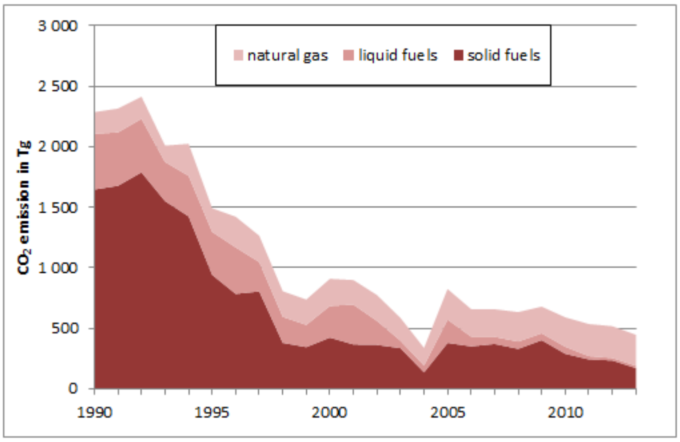


Fig. 3-32 Development of CO_2 emissions in source category 1.A.2.d

From the graph on Fig. 3-32 is clear that at the end of the 90s there was significant substitution, heretofore used fossil fuels (primarily lignite) with wood and later biogas. Both biofuels represent waste products from the production of paper and pulp from the two largest plants in the Czech Republic. In addition to the decline in 2003 and 2004, the consumption of fuels after 2000 were relatively stable, while the share of biofuels further increased.

Biofuel consumption has a beneficial effect on the production of CO_2, which is included in the balance of greenhouse gases. In Fig. 3-32 is shown the development of CO_2 emissions from fossil fuels only in sector 1.A.2.d.

3.2.13.2 Methodological issues (CRF 1.A.2.d)

No specific methodological approaches were applied in this subcategory, otherwise see chapter 3.2.6.

3.2.13.3 Uncertainties and time-series consistency (CRF 1.A.2.d)

See chapter 3.2.5.

3.2.13.4 Category-specific QA/QC and verification (CRF 1.A.2.d)

No specific methods for QA/QC in this category were used - otherwise see chapter 3.2.7.4.

3.2.13.5 Category-specific recalculations (CRF 1.A.2.d)

Recalculations were performed only at the beginning of the period. In the previous submission was used data from the energy balance, which was conducted according to national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are included in international statements for IEA/EUROSTAT. The other, already less significant changes in fuel consumption, were carried out based on updated data on consumption of liquid fuels, which were obtained by performing calculations in hindsight by CzSO on the basis of their actual findings - see Fig. 3-33.

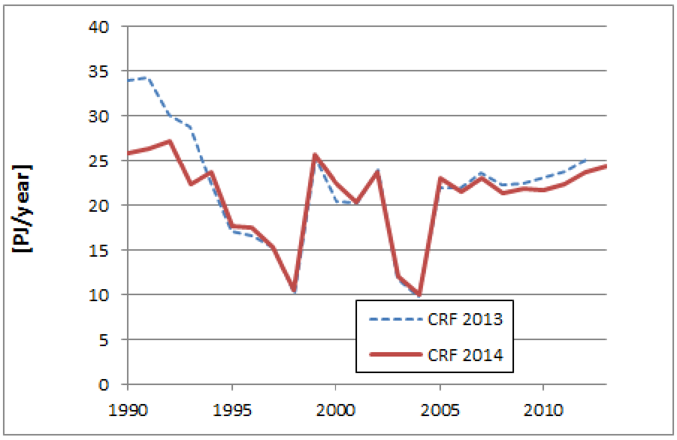


Fig. 3-33 Recalculations in fuel consumption (CRF 1.A.2.d)

As the dominant fuel in this subcategory is waste wood mass and at the end of the period also biogas produced from the biomass, the critical greenhouse gases are methane and N_2O. For this reason, the course of overall greenhouse gas emissions was expressed as CO_2 equivalent emission, controlled by methane and N_2O. As shown in the graph on Fig. 3-34, the recalculations are visible in the early period, due to the change of quantity of the liquid fuel and at the end period, it is shown the onset of the use of biogas, which has significantly lower emission factors for CH_4 and N_2O than in the previous submission. (change IPCC methodology from 1996 to 2006).

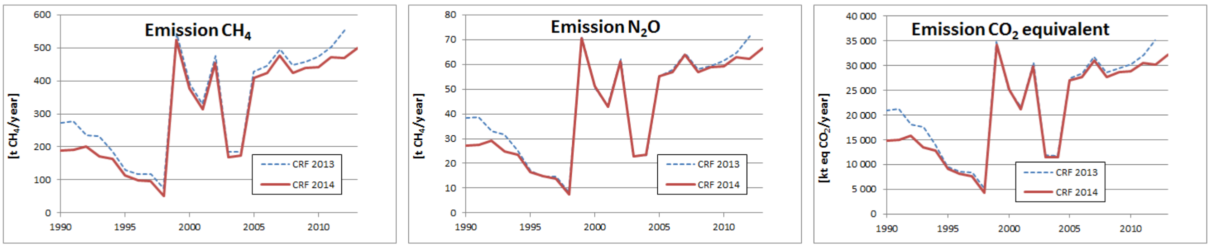


Fig. 3-34 Recalculation of CH_4 and N_2O emissions and their influence on the total emissions, expressed in CO_2 equivalent

3.2.13.6 Category-specific planned improvements (CRF 1.A.2.d)

Currently there are no planned improvements in this category.

3.2.14 Manufacturing industries and construction – Food Processing, Beverages and Tobacco (1.A.2.e)

3.2.14.1 Category description (CRF 1.A.2.e)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.e, 2013								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
LPG	45.9	65.86 *)	1	3.0	1	0.00005	0.1	0.000005
Heating and Other Gasoil	42.6	74.1	1	3.2	3	0.00013	0.6	0.00003
Fuel Oil - Low Sulphur	39.4	77.4	1	3.1	3	0.00012	0.6	0.00002
Other Oil	40.2	73.3	1	2.9	3	0.00012	0.6	0.00002
Other Bituminous Coal	582.8	94.03 *)	0.971 *)	53.2	10	0.00583	1.4	0.00082
Brown Coal + Lignite	1 238.9	100.38 *)	0.985 *)	122.4	10	0.01239	1.4	0.00173
Coke	199.3	107	1	21.3	10	0.00199	1.4	0.00028
Natural Gas	13 342.4	55.30 *)	1	737.9	1	0.01334	0.1	0.00133
Wood/Wood Waste	120.2	112.0	1	13.5	30	0.00361	4	0.00048
Gaseous Biomass	9 837.4	54.6	1	537.1	1	0.00984	0.1	0.00098
Total year 2013	**25 489.1**			**1 497.6**		**0.0474**		**0.00571**
Total year 2012	22 160.2			1 320.0		0.0448		0.0055
Index 2013/2012	1.15			1.13		1.06		1.04
Total year 1990	37 616.5			2 988.2		0.2134		0.0304
Index 2013/1990	0.68			0.50		0.22		0.19

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

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 biofuels, especially towards the end of the period.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section 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 10, 11 and 12

The fraction of CO_2 emissions in subsector 1.A.2.e in CO_2 emissions in sector 1.A.2 equalled 10.2% in 2013. It contributed 1.4% to CO_2 emissions in the whole Energy sector.

The following figure provides an overview of fuels consumption in the sub-category in 1.A.2.e.

From the graph on Fig. 3-35 is obvious that for the entire time series natural gas is the dominant fuel by having a quite balanced consumption. The high share of fossil fuels at the beginning of the period reduces continuously and at the end of the period results in substitution of the fossil fuels with solid and gaseous biofuels. The overall development of fuel consumption has reduced up to 2008. Since 2008

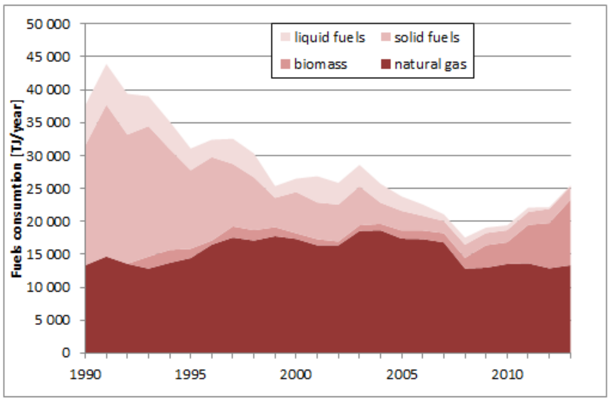


Fig. 3-36 Development of fuels consumption in source category 1.A.2.e

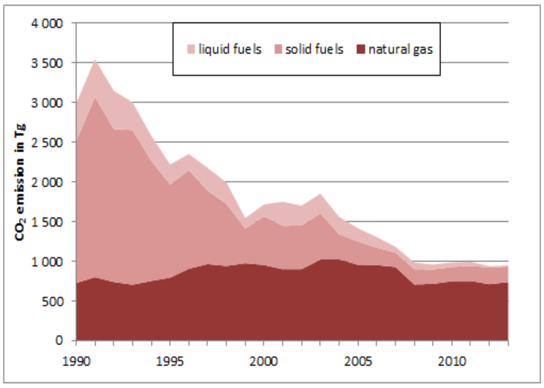


Fig. 3-36 Development of CO_2 emissions from fossil fuels combustion in source category 1.A.2.e

there is an increase in fuel consumption, which is covered by increasing consumption of biofuels, in response to the crisis development in the period at the end of the first decade of the 21st century.

Biofuel consumption has a beneficial effect on the production of CO_2, which is included in the balance of greenhouse gases. On Fig. 3-36 is shown the development of CO_2 emissions from fossil fuels only from sector 1.A.2.e.

3.2.14.2 Methodological issues (CRF 1.A.2.e)

No specific methodological approaches were applied in this subcategory, otherwise see chapter 3.2.6.

3.2.14.3 Uncertainties and time-series consistency (CRF 1.A.2.e)

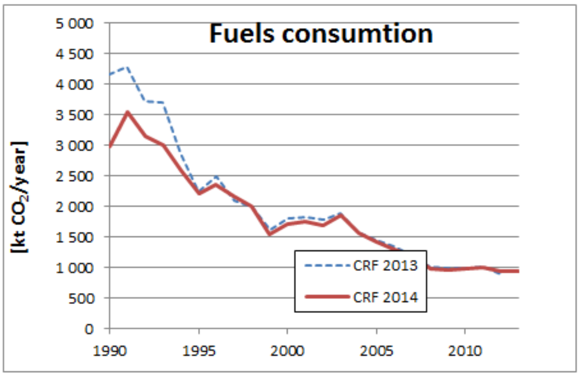
See chapter 3.2.5.

3.2.14.4 Category-specific QA/QC and verification (CRF 1.A.2.e)

No specific methods for QA/QC in this category were used - otherwise see chapter 3.2.7.4.

3.2.14.5 Category-specific recalculations (CRF 1.A.2.e)

Recalculations were performed only at the beginning of the period. In the previous submission, it was used data from the energy balance, which was conducted according to national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are included in the international statements for IEA/EUROSTAT. The other, less significant changes in fuel consumption, were carried out based on updated data on consumption of liquid fuels, which performs CzSO in hindsight on the basis of their actual findings. The recalculation of CO_2 emissions corresponds to the course of fuel consumption till 2008. After 2008 is apparent increase of biofuels usage (no changes in reported CO_2 emissions) - see Fig. 3-37.



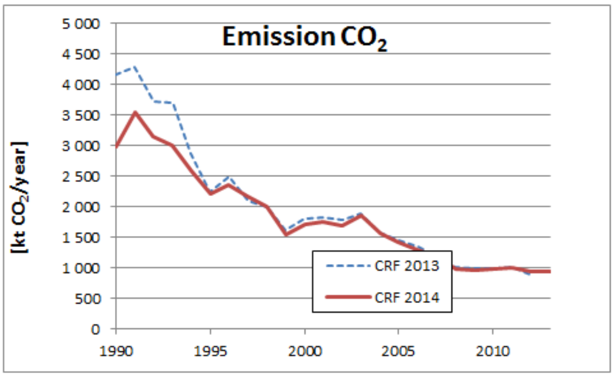


Fig. 3-37 Recalculation of fuel consumption and corresponding CO_2 emissions (CRF 1.A.2.e)

The recalculations of CH_4 and N_2O emissions are projected to reduce total greenhouse gas emissions expressed as CO_2 equivalent, due to the application of new emission factors, which are lower for the energy gases, therefore a significant reduction in their emissions was observed. In this case in particular, impact of emission reduction of CH_4 and N_2O during the combustion of natural gas is obvious, but significant influence has also the use of biogas, in particular at the end of the period - see Fig. 3-38.

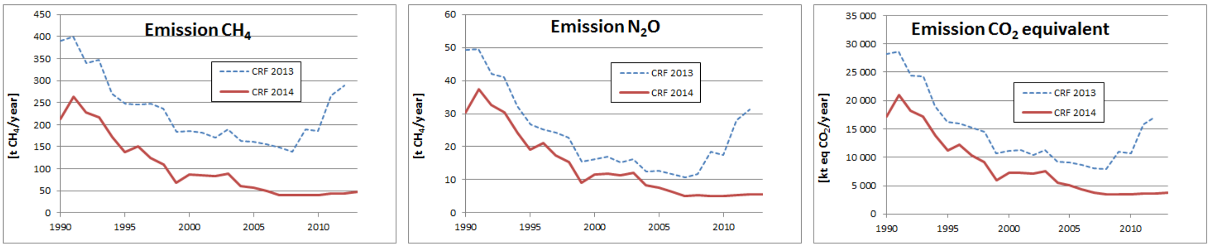


Fig. 3-38 Recalculation of CH_4 and N_2O emissions and their influence on the total emissions expressed in CO_2 equivalent

3.2.14.6 Category-specific planned improvements (CRF 1.A.2.e)

Currently there are no planned improvements in this category.

3.2.15 Manufacturing industries and construction – Non-metallic Minerals (1.A.2.f)

3.2.15.1 Category description (CRF 1.A.2.f)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline

1.A.2.f, 2013								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	45.9	65.86*)	1	3.0	1	0.00005	0.1	0.000005
Fuel Oil - Low Sulphur	95.1	77.4	1	7.4	3	0.00029	0.6	0.00006
Fuel Oil - High Sulphur	197.5	77.4	1	15.3	3	0.00059	0.6	0.00012
Other Oil	200.9	73.3	1	14.7	3	0.00060	0.6	0.00012
Other Bituminous Coal	6 993.6	94.03*)	0.971*)	638.3	10	0.06994	1.4	0.00979
Brown Coal + Lignite	439.6	100.38*)	0.984*)	43.4	10	0.00440	1.4	0.00062
Coke	597.8	107	1	64.0	10	0.00598	1.4	0.00084
Coal Tars	755.4	80.7	1	61.0	10	0.00755	1.4	0.00106
Coke Oven Gas	44.5	44.4	1	2.0	1	0.00004	0.1	0.000004
Natural Gas	21 093.4	55.30	1	1 166.5	1	0.02109	0.1	0.00211
Other fuels - liquid	1 181.0	77.8*)	1	91.9	3	0.00354	0.6	0.00071
Other fuels - solid	1 136.7	92.8*)	1	105.5	10	0.01137	1.4	0.00159
Wood/Wood Waste	72.7	112	1	8.1	30	0.00218	4	0.00029
Total year 2013	**32 854.0**			**2 221.1**		**0.1276**		**0.0173**
Total year 2012	35 687.3			2 502.3		0.1587		0.0215
Index 2013/2012	0.92			0.89		0.80		0.80
Total year 1990	59 962.4			4 527.1		0.2937		0.0426
Index 2013/1990	0.55			0.49		0.43		0.41

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Natural Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other fuels - liquid	ETS, REZZO[**)]	CS	D	D	Tier 2	Tier 1	Tier 1
Other fuels - solid	ETS, REZZO[**)]	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

[**)] *REZZO - national emissions database; Data was verified by the Czech Union of manufacturers of cement and lime*

Category 1.A.2.f now newly (unlike previous submission) comprises all industrial processes for the treatment of non-minerals raw materials and products such as cement, lime, burnt building materials and refractory materials, ceramics, glass etc. Category 1.A.2.f was established by dividing the original category into 2 groups, i.e. in 1.A.2.g are included remained sources of greenhouse gases from the category "Manufacturing industries and construction."

The category is characterized by high energy intensity, and for it is also typical consumption "Other fuels", that are burned at the cement works furnaces. The cement kilns in the Czech Republic are the only one facilities (except the industrial waste incinerators reported in sector 5 Waste), in which it is allowed incinerating waste, respectively an alternative fuels made from waste.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:
Non-Metallic Minerals

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

NACE Divisions 23

23 Manufacture of other non-metallic mineral products
- 23.1 Manufacture of glass and glass products
- 23.2 Manufacture of refractory products
- 23.4 Manufacture of other porcelain and ceramic products
- 23.5 Manufacture of cement, lime and plaster

The fraction of CO_2 emissions in subsector 1.A.2.f in CO_2 emissions in sector 1.A.2 equalled 15.2% in 2013. It contributed 2.1% to CO_2 emissions in the whole Energy sector.

Between the most important businesses are included mainly cement (a total of 5 facilities), which are operated in the northern, central and eastern Bohemia and Central Moravia and lime (a total of 3 facilities) in southern and eastern Bohemia and North Moravia.

Total production of the most important mineral products is shown in the graph on Fig. 3-39.

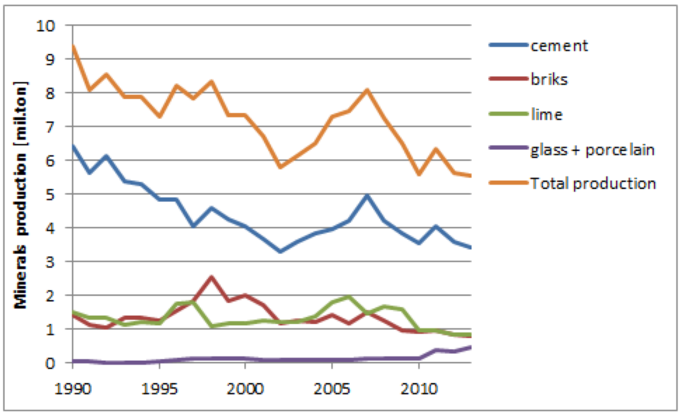


Fig. 3-39 Production of the most important mineral products

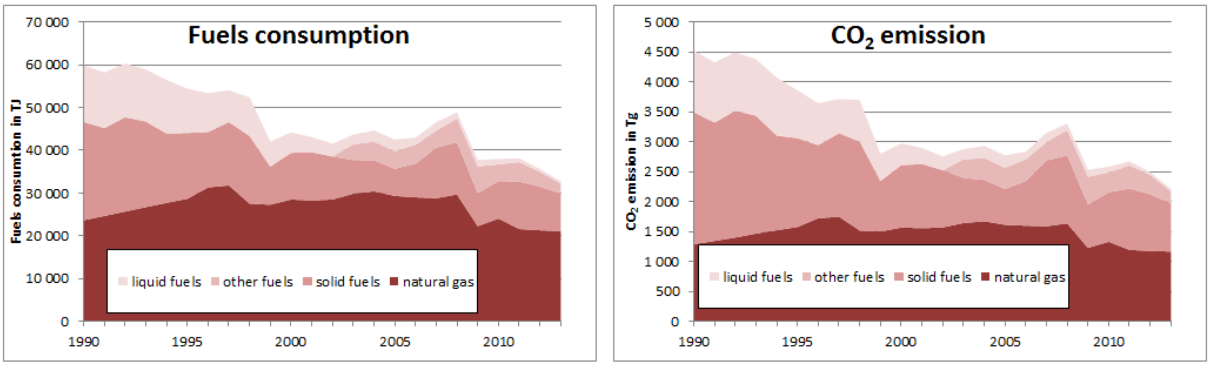


Fig. 3-40 Development of fuels consumption and CO_2 emissions in source category 1.A.2.f

The following figure (Fig. 3-40) provides an overview of fuels consumption and CO_2 emissions in the sub-category in 1.A.2.f.

The graph shows the evolution of CO_2 emissions, that has the same pattern as the fuel consumption. The high consumption of fossil fuel at the beginning of the period decreased gradually, and it is evident that the most important fuel in this sector is natural gas. The high consumption of fossil fuels gradually was declining and liquid fuels, from 2002 gradually were replaced by alternative fuels (Other fuels). The increase in fuel consumption between 2005 and 2008, was interrupted by the crisis development of the economy and after some recovery in 2010-2011, followed by another decline.

3.2.15.2 Methodological issues (CRF 1.A.2.f)

In the category of Non-Metallic Minerals is reported consumption of alternative fuels (Other fuels). The compilation consumption balance and the determination of the emission factors are different from the procedures used for other fuels, as described in section 3.2.4. The basic source of information is the ETS database, where the emission factors for different types of alternative fuels are available. At the same time data from the REZZO national emission database are used, where data are available on the consumption of alternative fuels in the whole time series since 2003. The resulting processed data on consumption of alternative fuels is further corrected according to the data on the server of the Union of cement and lime manufacturers (www.svcement.cz). Alternative fuel consumption is shown on Tab. 3-15.

Tab. 3-15 Consumption of alternative fuels in sector 1.A.2.f

[TJ/year]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Solid fuels	2 423.7	3 199.9	3 516.7	3 397.8	3 726.2	5 037.0	5 537.0	3 224.5	3 884.9	3 054.6	1 136.7
Liquid fuels	1 266.0	1 156.2	588.6	1 013.8	240.1	557.0	681.7	707.6	661.3	394.1	1 181.0
Total	3 689.7	4 356.1	4 105.3	4 411.6	3 966.3	5 594.0	6 218.7	3 932.0	4 546.2	3 448.7	2 317.7

Emission factors for calculating CO_2 emissions vary according to composition of the individual types of fuel (solid, liquid fuels). As a solid alternative fuels are used variety of sorted waste, used tires, animal meal, etc. Among the alternative liquid fuels are included mainly used oils, waste petroleum products, or even rendered fats. The resulting emission factor corresponds to the relative representation of individual types of fuels. In Tab. 3-16 is shown an overview of emission factors used for solid and liquid alternative fuels in different years.

Tab. 3-16 CO_2 emission factors used in the consumption of alternative fuels in sector 1.A.2.f

[t CO_2/TJ]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Solid fuels	87.5	87.5	88.5	84.5	78.3	75.7	75.7	85.2	85.8	96.2	92.8
Liquid fuels	75.4	75.8	75.1	76.2	73.0	71.9	64.6	81.2	77.4	77.4	77.8

For the calculation of CH_4 and N_2O emissions were used default emission factors in line with the IPCC methodology 2006, for the entire time series 2003-2013 (Tab. 3-17).

Tab. 3-17 Emission factors for CH_4 and N_2O emissions used in the consumption of alternative fuels sector 1.A.2.f

EF [kg/TJ]	CH_4	N_2O
Solid fuels	10	1.4
Liquid fuels	2	0.6

3.2.15.3 Uncertainties and time-series consistency (CRF 1.A.2.f)

See chapter 3.2.5.

3.2.15.4 Category-specific QA/QC and verification (CRF 1.A.2.f)

As a basic indicator for verification of fuel consumption in the sector of production of pig iron and steel, should be regarded indicators of the overall production of basic goods such as cement, lime, clay tiles and roof tiling or glass and fine ceramics. This is a relatively large mass flows, which also exhibit high energy demands - see Fig. 3-39. Comparison of total production and total fuel

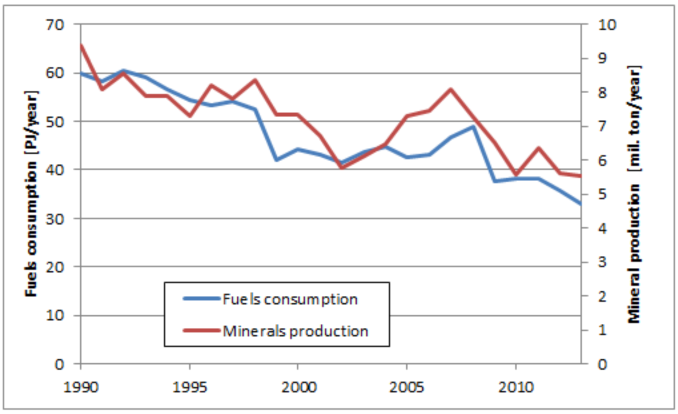


Fig. 3-41 Trends in production of mineral products compared with the development of fuel consumption in the sector 1.A.2.f

consumption in the sub sector 1.A.2.f is shown in Fig. 3-41.

The basic trend flow of production of mineral products in total corresponds well with the total fuel consumption. Given that this is a rough comparison, it might be that the minor variations are caused by different specific energy intensities of the individual kinds of mineral products.

Other QA/QC procedures are set out in section 3.2.6.

3.2.15.5 Category-specific recalculations (CRF 1.A.2.f)

Original category 1.A.2.f in the last submission was used for a sum of other processes, that were not disclosed in the subsectors 1.A.2.a to 1.A.2.e. In this submission, 1.A.2.f category is reserved for the production of Non-Metallic Minerals and from this perspective, it is a new category that has not been reported separately. For this reason, the first processing cannot be considered as a recalculation. Comments on the recalculation of subsector 1.A.2.f from the last submission is given in chapter 3.2.16. Manufacturing industries and construction - Other (1.A.2.g).

3.2.15.6 Category-specific planned improvements (CRF 1.A.2.f)

Currently there are no planned improvements in this category.

3.2.16 Manufacturing industries and construction – Other (1.A.2.g)

3.2.16.1 Category description (CRF 1.A.2.g)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.g, 2013								
Structure of Fuels	**Activity**		**CO_2**			**CH_4**		**N_2O**
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
LPG	1 470.3	65.86*)	1	96.8	1	0.00147	0.1	0.00015
Heating and Other Gasoil	340.8	74.1	1	25.3	3	0.00102	0.6	0.00020
Fuel Oil - Low Sulphur	1 118.2	77.4	1	86.5	3	0.00335	0.6	0.00067
Fuel Oil - High Sulphur	54.3	77.4	1	4.2	3	0.00016	0.6	0.00003
Other Oil	4 218.8	73.3	1	309.2	3	0.01266	0.6	0.00253
Other Bituminous Coal	124.9	94.03*)	0.971*)	11.4	10	0.00125	1.4	0.00017
Brown Coal + Lignite	1 172.3	100.38*)	0.985*)	115.9	10	0.01172	1.4	0.00164
Coke	256.2	107	1	27.4	10	0.00256	1.4	0.00036
Coke Oven Gas	93.4	44.4	1	4.1	1	0.00009	0.1	0.00001
Natural Gas	32 197.1	55.30*)	1	1 780.6	1	0.03220	0.1	0.00322
Wood/Wood Waste	8 347.5	112	1	934.9	30	0.25043	4.0	0.03339
Gaseous Biomass	5 644.4	54.6	1	308.2	1	0.00564	0.1	0.00056
Total year 2013	**55 038.2**			**3 704.6**		**0.3226**		**0.0429**
Total year 2012	51 789.8			3 545.3		0.3091		0.0421
Index 2013/2012	1.06			1.04		1.04		1.02
Total year 1990	301 656.3			24 730.8		1.9732		0.2874
Index 2013/1990	0.18			0.15		0.16		0.15

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The issue is that, this is a new subcategory that in this submission already does not include the sources from the subsector of Non-Metallic Minerals.

This subcategory includes the remaining enterprises in the processing industry not included in subcategories 1.A.2.a to 1.A.2.f. This is an energy-demanding branch with fuel consumption, such as 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.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

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

There are embodied the fuels of economic part according to NACE Rev. 2 Other: NACE Divisions 05 – 09, 13 – 16, 21 – 22, 25 – 33 and 41 – 43.

The fraction of CO_2 emissions in subsector 1.A.2.f in CO_2 emissions in sector 1.A.2 equalled 25.3% in 2012. It contributed 3.4% to CO_2 emissions in the whole ENERGY sector. Overall emissions indicate decrease since 1990. Solid Fuels had at the beginning of the period major importance, which constantly decrease until 2013. Liquid fuels also constantly decrease since 1990. Natural Gas has also apparent

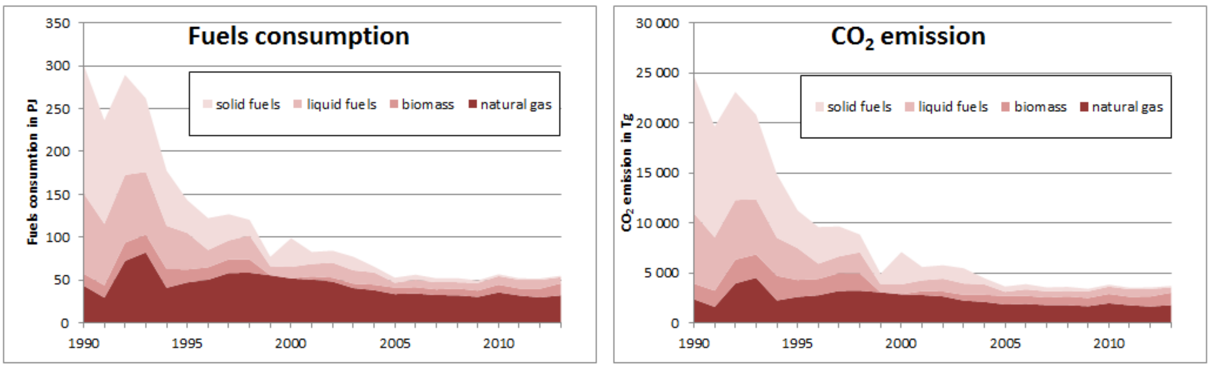


Fig. 3-42 Development of fuels consumption and CO_2 emissions in source category 1.A.2.g

importance in this category.

The graph on Fig. 3-42 shows that at the beginning of the period existed in this category highly energy intensive types of industrial processes. Social changes undergone in the Czech Republic in the early 90s resulted in energy saving behaviour of newly privatized enterprises. Ensemble of these influences led to the cessation of inefficient production and to suppression of consumption particularly of fossil fuels, which were at the beginning of the period, the dominant and virtually disappeared by 2005, when they were taken over by biomass. At the same time decreased the importance of liquid fuels. All this was reflected very significantly by the decline in CO_2 emissions (and other greenhouse gases). This is the category with the largest relative decrease in CO_2 emissions from 1990 to 2013 (85% decrease).

3.2.16.2 Methodological issues (CRF 1.A.2.g)

Sector specific methodological approaches were not used, the general approaches are given in chapter 3.2.4.

3.2.16.3 Uncertainties and time-series consistency (CRF 1.A.2.g)

See chapter 3.2.5.

3.2.16.4 Category-specific QA/QC and verification (CRF 1.A.2.g)

See chapter 3.2.6.

3.2.16.5 Category-specific recalculations (CRF 1.A.2.g)

Original category for the entire sum of other processes, that were not disclosed in the subsectors from 1.A.2.a to 1.A.2.e in the last submission, was identified as 1.A.2.f. It is now reserved for the production of Non-Metallic Minerals.

In this context, the recalculation carried out, consisted in the distribution of fuel consumption between the subsectors 1.A.2.f and 1.A.2.g. Comparing the situation before and after the recalculation is possible only with the current subsectors 1.A.2.g and 1.A.2.f (sum) with the subsector of the previous submission, marked earlier as 1.A.2.f.

In addition to the distribution of fuels, in this recalculation is also apparent the transition to official data from CzSO, at the beginning of the period and the change of some CO_2 emission factors (country specific LPG, bituminous coal, lignite, natural gas) and the implication of new recommended (default) emission factors according to the IPCC 2006 in some liquid and gaseous fuels for CH_4 and N_2O emissions.

The results of the recalculations of fuel consumption can be seen on Fig. 3-43.

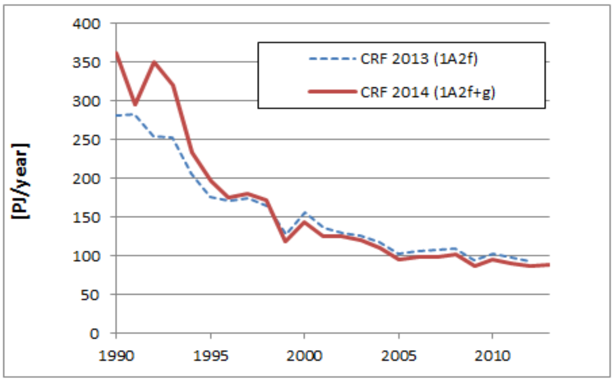


Fig. 3-43 Recalculations in fuel consumption – CRF 2013 (1.A.2.f) and CRF 2014 (1.A2.f+g)

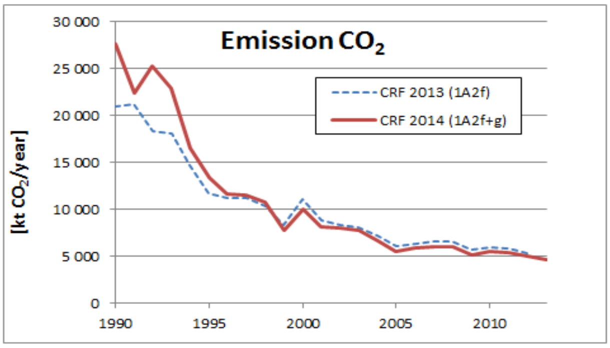


Fig. 3-44 Recalculation of CO_2 emissions – CRF 2013 (1.A.2.f) and CRF 2014 (1.A.2.f + g)

Development of CO_2 emissions basically follows the development of fuel consumption and the results of the recalculation for CO_2 emissions are virtually identical (see Fig. 3-44).

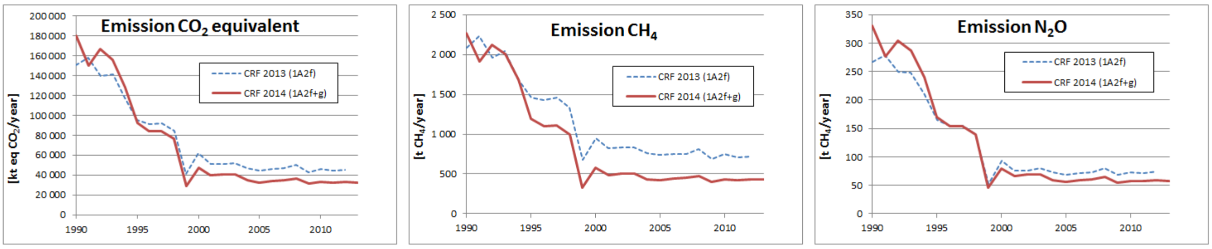


Fig. 3-45 Sum of greenhouse gases CO_2, CH_4, and N_2O as CO_2 equivalent from fuel combustion in the category 1.A.2.g - comparing the situation before and after recalculation

The influence of the use of new emission factors, during recalculation, resulted in reduction of emissions of CH_4, N_2O and total greenhouse gas emissions, expressed as CO_2 equivalent - see Fig 3-45.

3.2.16.6 Category-specific planned improvements (CRF 1.A.2.g)

Currently there are no planned improvements in this category.

3.2.17 Transport (1.A.3)

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:

Domestic Aviation (CRF 1.A.3.a)

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

Road Transportation (CRF 1.A.3.b)

- motorcycles,
- passenger and light duty gasoline vehicles conventional,
- passenger and light duty gasoline vehicles with EURO 1-5 limits,
- passenger and light duty diesel vehicles conventional,
- passenger and light duty diesel vehicles with EURO 1-5 limits,
- passenger cars and light duty vehicles using LPG, CNG and biofuels (separately),
- heavy duty diesel vehicles and buses, conventional,
- heavy duty diesel vehicles and buses with EURO I-VI limits,
- heavy duty vehicles and buses using CNG and biofuels (separately).

Railways(CRF 1.A.3.c)

- diesel locomotives

Domestic Navigation (CRF 1.A.3.d)

- ships with diesel engines

Other Transportation(CRF 1.A.3.e)

The consumption of Natural Gas for powering compressors for the transit gas pipeline is included in this subcategory under mobile combustion sources, but in fact it is stationary combustion. This consumption is reported in the IEA – CzSO (CzSO, 2014) Questionnaire in the section Transport Sector under the item:

- Pipeline Transport

There are embodied the fuels of economic part according to NACE Rev. 2 Pipeline Transport: NACE Divisions 35.22, 49.50.

3.2.17.1 Methodological issues

The methodology in Czech Republic operates with emission factors in unit g/kg fuel (not g/TJ energy), because the country-specific measured data of every greenhouse gas or pollutant in the internal database are in this unit. The main reason that emission factors are in g/kg fuel is fact that consumption of every fuel is in unit of weight. The emission data calculated for the CRF Reporter are not affected by the calorific value (variable in years) of individual fuel but the fuel consumption for the CRF Reporter must be converted from weight to energy (using the calorific value). So the trend of IEF depends partially on the trend of calorific value and in this case mostly on emission factor of different vehicle technology (due EURO emission standard). Emission factors of individual transport categories are always given for current submission year. All calorific values used for calculation in transport sector are presented within Energy chapter.

Activity data

Activity data for mobile sources are based on official energy balance of the Czech Republic prepared by the Czech Statistical Office (CzSO). The most important feature is annually amount of fuel sold in units of weight since emission factor values are expressed in $g.kg^{-1}$ in CDV database. The parameters necessary for distribution of sold fuels are transport mode, fuel type, weight of vehicle and equipment with more or less effective catalytic system. The appropriate distribution is necessary for assigning of the relevant emission factor. Sector 1.A.3.b Road Transportation is based on the IPCC 2006 Gl. split into five subsectors:

- 1.A.3.b.i Cars
- 1.A.3.b.ii Light Duty Trucks
- 1.A.3.b.iii Heavy Duty Trucks and Buses
- 1.A.3.b.iv Motorcycles
- 1.A.3.b.v Other

Activity data and greenhouse gas emission estimates of subsector 1.A.3.b.ii Light Duty Trucks were in this submission included in the subsector 1.A.3.b.i Cars, because the differentiation between these two subsectors was not available, when the emission model was created. In some years a lot of passenger cars are registered in Central Vehicle Register as light duty vehicles, because of fixed separation between passenger cabin and trunk space according to Czech legislation. The distribution of the data into these two subsectors is included in the current Improvement plan.

The data, which are necessary for fuel distribution are provided by the Ministry of Transport (transport yearbooks), Czech Hydrometeorological Institute (research), Air Navigation Services of the Czech Republic (yearbooks), and last but not least, traffic surveys (Traffic census) and CDV research activities. Some sources for categories of road transport are monitored separately. Primarily data about CNG vehicles, which have been experiencing a boom in recent years, are collected from two public website sources. The first source of information is Czech source administrated by Czech Gas Association and the second one is Natural & bio Gas Vehicle Association Europe. The most important source of information to distribute a dynamic structure (emission standards) of vehicle fleet on roads in Czech Republic is particularly CDV research, a lot of traffic surveys, every five years traffic census and also aggregate outcomes of the studies prepared in 2001 (Pisa et al., 2001), 2005 (Pisa et al., 2006) and 2010 (Pisa et al., 2010) for Road and Motorway Directorate of the Czech Republic.

The total consumption of Kerosene in the Czech Republic is divided into five categories (Domestic Aviation, International Bunkers, Army, Industry and Commercial and Public Services). The Kerosene consumption as well as relevant emissions from categories Army, Industry, Commercial and Public Services is not reported in CRF Reporter in Transport sector 1.A.3 (or International Bunkers 1.D.1), but in sectors 1.A.5.b.i, 1.A.2.f and 1.A.4.a respectively. Other two categories (Domestic Aviation 1.A.3.a and Aviation Bunkers 1.D.1.a) were divided on the basis of expert judgment in the whole time period if the main criteria were passengers transport (now only one regular domestic line between Prague and Ostrava airports) and transport of goods (MoT, 2000; MoT, 2006; MoT, 2011; MoT, 2014). The regular domestic flights (22 TJ) using Kerosene in comparison with international flights (12 368 TJ) are represented in the Czech Republic by a very small percentage. In IEA data (823 TJ) is included in the category Domestic Aviation also Kerosene consumption from categories Army (15 tons of Jet Kerosene frontloading is included in 2011), Industry, Commercial and Public Services and that is not used for aviation or transport at all. The following table (on the ERT recommendation) shows the distribution of Kerosene consumption in CRF Reporter in comparison with IEA data. It is obvious from the table that the total sum of Kerosene is same in both cases.

Tab. 3-18 Distribution of Jet Kerosene consumption in CRF Reporter and IEA data in 1990-2013 [TJ]

Year	CRF Reporter						IEA data		
	Domestic Aviation (1.A.3.a)	Internat. Aviation (1.D.1.a)	Army (1.A.5.b.i)	Industry (1.A.2.f)	Commercial and Public Services (1.A.4.a)	Total CRF	Internat. Aviation	Domestic Aviation	Total IEA
1990	19	7 325	0	0	0	7 344	7 344	0	7 344
1991	20	6 020	0	0	0	6 040	6 040	0	6 040
1992	29	6 967	0	0	0	6 996	6 996	0	6 996
1993	31	5 792	0	0	0	5 823	5 823	0	5 823
1994	49	7 208	0	0	0	7 257	7 257	0	7 257
1995	15	7 805	0	0	0	7 820	7 820	0	7 820
1996	41	5 866	0	0	0	5 907	5 603	304	5 907
1997	54	6 759	0	0	0	6 812	5 217	1 595	6 812
1998	50	7 991	0	0	0	8 041	4 902	3 139	8 041
1999	48	7 520	0	0	0	7 568	5 633	1 935	7 568
2000	22	8 234	0	0	0	8 256	6 665	1 591	8 256
2001	24	8 750	0	0	0	8 774	6 762	2 012	8 774
2002	19	7 556	770	0	0	8 346	6 976	1 370	8 346
2003	24	10 163	556	0	0	10 743	8 432	2 311	10 743
2004	35	13 062	685	0	0	13 782	12 070	1 712	13 782
2005	37	13 573	728	0	0	14 338	13 182	1 156	14 338
2006	46	14 070	563	0	0	14 679	14 073	606	14 679
2007	46	14 763	823	87	217	15 934	14 462	1 472	15 934
2008	31	15 644	823	87	173	16 757	14 895	1 862	16 757
2009	45	14 287	909	87	173	15 501	14 246	1 256	15 501
2010	36	13 387	650	87	130	14 289	13 120	1 169	14 289
2011	22	13 272	1 256	87	173	14 809	12 990	1 819	14 809
2012	17	12 367	520	87	130	13 120	12 297	823	13 120
2013	19	11 931	563	43	43	12 600	11 864	736	12 600

Emission factors

Based on the ERT recommendation, tables of emission factors for all the greenhouse gases were added. The first table is for road transportation and is divided in detail by vehicle category, fuel type and EURO standard. The second table contains information about the emission factors of non-road transportation, particularly railways, navigation and aviation. Aviation is divided into two modes (LTO and CRUISE). The emission factors were derived from the internal database of the Transport Research Centre, which contains the default emission factors taken from the IPCC and EIG databases (CO_2 and N_2O), and also those that have country-specific character (CH_4). The calculated emission factor for biomass was taken as the weighted average for gasoline and diesel oil, taking into account the real vehicle fleet on roads (recommended by ERT). Calculation of the emission factors for biomass for other greenhouse gases also takes into account the amount of renewable components in the fuel. The CDV methodology employs emission factors in unit g/kg fuel but not g/TJ energy, because the country-specific measured data in this unit are in the internal database.

Tab. 3-19 Emission factors of CO_2, N_2O and CH_4 from road transport in 2013 [g/kg fuel]

Vehicle type	Fuel type	European emission standard	EF CO_2	EF N_2O	EF CH_4
			g/kg fuel	g/kg fuel	g/kg fuel
Motorcycles	Gasoline	PRE-EURO and higher	3 071	0.06	4.10
Motorcycles	Bioethanol	PRE-EURO and higher	1 912	0.02	0.08
PC+LDT	Gasoline	PRE-EURO	3 071	0.31	0.90
PC+LDT	Gasoline	EURO I and EURO II	3 071	0.70	0.40
PC+LDT	Gasoline	EURO III and higher	3 071	0.90	0.10
PC+LDT	Diesel Oil	PRE-EURO	3 183	0.10	0.08
PC+LDT	Diesel Oil	EURO I and EURO II	3 183	0.20	0.08
PC+LDT	Diesel Oil	EURO III and higher	3 183	0.25	0.08
PC+LDT	LPG	PRE-EURO and higher	3 028	0.01	1.02
PC+LDT	CNG	PRE-EURO and higher	2 697	0.15	4.52
PC+LDT	Bioethanol	PRE-EURO and higher	1 912	0.02	0.08
PC+LDT	FAME	PRE-EURO and higher	2 620	0.02	0.06
HDT	Diesel Oil	PRE-EURO	3 183	0.10	0.60
HDT	Diesel Oil	EURO I and EURO II	3 183	0.20	0.20
HDT	Diesel Oil	EURO III and higher	3 183	0.25	0.15
HDT	CNG	PRE-EURO and higher	2 697	0.15	4.52
HDT	FAME	PRE-EURO and higher	2 620	0.02	0.06
Bus	Diesel Oil	EURO II and older	3 183	0.18	0.60
Bus	Diesel Oil	EURO III and higher	3 183	0.10	0.15
Bus	CNG	PRE-EURO and higher	2 697	0.15	4.52
Bus	FAME	PRE-EURO and higher	2 620	0.02	0.06

Tab. 3-20 Emission factors of CO_2, N_2O and CH_4 from non-road transport in 2013 [g/kg fuel]

Transport type	Fuel type	EF CO_2	EF N_2O	EF CH_4
		g/kg fuel	g/kg fuel	g/kg fuel
Railways	Diesel Oil	3 183	1.23	0.18
Water-borne navigation	Diesel Oil	3 183	0.09	0.30
Civil Aviation - LTO	Aviation Gasoline	3 065	0.09	0.02
Civil Aviation - Cruise	Aviation Gasoline	3 065	0.09	0.02
Civil Aviation - LTO	Kerosene	3 096	0.09	0.02
Civil Aviation - Cruise	Kerosene	3 096	0.09	0.02

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 CzSO. 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 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.

In 2008, for the first time, in emissions of carbon dioxide from transport is recorded a decrease, which has started a downward trend continuing until 2013 (Jedlicka et al, 2014). The reduction in carbon dioxide emissions is a result primary of a reduction in the consumption of gasoline and diesel oil, which is interpreted as being a consequence of the global economic crisis. The downward trend of fuel consumption is evaluated very favourably from viewpoint of greenhouse gases.

There has been appeared a continuing downward trend of gasoline consumption since 2007. However, the persistent downward trend may no longer be a consequence of the economic crisis. A slight decrease is recorded in diesel oil trend in 2013 as well. This phenomenon indicates a return to the theoretical expectations of development in the consumption of conventional fuels. The fuel consumption in 2013 may be affected by a cross boarder purchase of gasoline and especially diesel oil. The price of diesel oil has been in the Czech Republic still higher than in some neighbouring countries. Higher fuel price is related to the excise tax laid down by Czech legislation. The greenhouse gas emission balance reflects not only the scenario of consumption of alternative fuels, but also the scenario of trends in the transport infrastructure, further construction of the throughway network in different variants, urban bypasses, further construction of railway corridors, etc.

The consumption of gasoline fluctuated around 2 mil. tons from 2002 to 2009, but it has started to decline significantly since 2010. It reached even a value 1474 tons in 2013. This decline is caused especially by a downward trend of average fuel consumption of recent passenger cars. Since 2008 the consumption of gasoline also has included the consumption of bioethanol, which has been added to all gasoline in an amount of 2% since January 1, 2008. The fraction of bioethanol as a renewable resource in gasoline reached a value 4.1% in 2010 and the fraction of fatty acid methyl esters (FAME) as renewable resource in diesel oil reached a value 6% in 2010 and both values will be unchanged in the coming years. These facts (reduction in consumption and increasing the share of bio-components) have a favourable impact on CO_2 emissions.

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.

Tab. 3-21 CO_2 emissions calculation from mobile sources in 1990 – 2013 [Gg CO_2]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	139.4	6 177	654	56.6	5.4	1 655	8 687
1991	38.2	5 478	582	56.2	9.2	1 439	7 602
1992	38.9	7 108	494	54.8	13.1	1 335	9 044
1993	23.7	7 299	415	54.3	17.0	1 290	9 099
1994	21.9	8 079	335	53.5	20.8	1 299	9 809
1995	13.4	8 584	334	55.2	36.0	1 191	10 210
1996	15.2	9 504	329	45.9	87.6	1 139	11 121
1997	10.0	9 654	283	38.5	75.2	1 188	11 249
1998	9.7	9 862	356	37.8	58.2	1 401	11 725
1999	12.6	11 083	332	22.1	62.2	1 377	12 889
2000	10.8	11 237	329	15.8	58.0	1 380	13 031
2001	7.8	11 975	301	24.9	59.3	1 319	13 687
2002	10.6	12 561	292	12.4	61.5	1 290	14 228
2003	10.9	14 309	286	12.4	58.1	1 237	15 914
2004	11.7	15 047	282	18.6	56.0	1 301	16 716
2005	8.8	16 344	285	15.5	68.5	1 284	18 006
2006	9.4	16 964	304	19.0	73.4	1 259	18 628
2007	9.4	17 831	301	15.8	119.0	1 336	19 612
2008	8.3	17 641	334	12.7	146.1	1 406	19 548
2009	9.3	17 155	303	15.9	151.6	1 381	19 016
2010	8.7	16 156	293	12.8	151.6	1 336	17 958
2011	4.6	15 985	287	9.6	145.5	1 400	17 832
2012	7.4	15 742	277	15.9	89.3	1 340	17 472
2013	7.5	15 619	271	6.4	92.3	1 334	17 330

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 at the beginning of this chapter.

The total consumption of gasoline, diesel oil, LPG, CNG and biofuels has been determined from the statistical surveys of the CzSO. 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 2010. 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 UNECE regulations. New vehicles must fulfill substantially higher EURO standards for hydrocarbons than older vehicles (currently the EURO 5 standard for passenger cars and EURO VI for heavy duty vehicles and buses). The greatest problems are associated with the slow renewal of the freight transport fleet.

There has been mild 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).

Tab. 3-22 CH_4 emissions calculation from mobile sources in 1990 – 2013 [Mg CH_4]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	0.996	1 500	37	5.35	0.10	0.13	1 544
1991	0.273	1 354	33	5.31	0.17	0.12	1 393
1992	0.278	1 757	28	5.18	0.24	0.11	1 791
1993	0.169	1 683	23	5.13	0.31	0.10	1 712
1994	0.156	1 814	19	5.05	0.38	0.10	1 839
1995	0.095	1 826	19	5.22	0.66	0.09	1 851
1996	0.108	1 924	18	4.34	1.59	0.08	1 948
1997	0.071	1 851	16	3.64	1.37	0.09	1 872
1998	0.069	1 771	20	3.57	1.06	0.10	1 796
1999	0.090	1 834	19	2.09	1.13	0.10	1 857
2000	0.077	1 703	18	1.49	1.05	0.13	1 724
2001	0.056	1 701	17	2.35	1.08	0.13	1 722
2002	0.075	1 647	16	1.17	1.12	0.13	1 665
2003	0.077	1 703	16	1.17	1.06	0.11	1 722
2004	0.083	1 612	16	1.76	1.02	0.11	1 631
2005	0.062	1 556	16	1.46	1.25	0.11	1 575
2006	0.067	1 473	17	1.80	1.33	0.10	1 493
2007	0.067	1 448	17	1.50	2.16	0.11	1 469
2008	0.059	1 336	19	1.20	2.65	0.11	1 359
2009	0.066	1 215	17	1.50	2.75	0.11	1 236
2010	0.062	1 060	16	1.21	2.74	0.11	1 080
2011	0.033	991	16	0.90	2.63	0.12	1 019
2012	0.052	929	16	1.50	1.62	0.11	948
2013	0.054	904	15	0.60	1.67	0.10	921

N_2O emissions

Nitrous oxide emissions decreased in 2008 similar to carbon dioxide emissions as a consequence of reduced consumption of gasoline and diesel oil. Newer vehicles exhibit higher emissions compared to older models, because they are equipped with 3-way catalytic converters, which reduce only NO_X emissions but not N_2O emissions. However, this effect is suppressed in new vehicles as a consequence of lower fuel consumption. Between 2008 and 2013, N_2O emissions still continued to decrease, similar to carbon dioxide emissions.

Road transport was identified as a key source of N_2O emissions over the past 5 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, 2006) 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, 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 Tab. 3-23.

Tab. 3-23 N_2O emissions calculation from mobile sources in 1990 – 2013 [Mg N_2O]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	3.98	459	252	1.53	0.010	0.059	716.6
1991	1.09	418	225	1.52	0.017	0.053	646.5
1992	1.11	543	191	1.48	0.024	0.050	736.7
1993	0.68	589	160	1.47	0.031	0.050	751.2

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
1994	0.63	728	129	1.44	0.038	0.053	859.2
1995	0.38	828	129	1.49	0.066	0.047	959.0
1996	0.43	996	127	1.24	0.159	0.047	1 124.9
1997	0.28	1070	109	1.04	0.137	0.051	1 180.9
1998	0.28	1132	138	1.02	0.106	0.064	1 271.6
1999	0.36	1305	128	0.60	0.113	0.065	1 434.1
2000	0.31	1376	127	0.43	0.105	0.070	1 503.9
2001	0.22	1537	116	0.67	0.108	0.073	1 654.1
2002	0.30	1683	113	0.34	0.112	0.080	1 796.8
2003	0.31	1970	110	0.34	0.106	0.079	2 080.8
2004	0.33	2090	109	0.50	0.102	0.089	2 200.0
2005	0.25	2233	110	0.42	0.125	0.094	2 343.9
2006	0.27	2251	117	0.51	0.133	0.091	2 369.0
2007	0.27	2378	116	0.43	0.216	0.100	2 495.0
2008	0.24	2308	129	0.34	0.265	0.106	2 438.0
2009	0.27	2279	117	0.43	0.275	0.105	2 397.1
2010	0.25	2146	113	0.34	0.274	0.100	2 260.0
2011	0.13	2125	111	0.26	0.263	0.109	2 236.8
2012	0.21	2061	107	0.43	0.162	0.102	2 168.9
2013	0.21	2012	104	0.17	0.167	0.101	2 116.6

Other Transportation (CRF1.A.3.e)

Country specific CO_2 emission factor is used since this submission. For detailed information please see Annex 3.

Default emission factors are used for CH_4 and N_2O in the entire time series.

3.2.17.2 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.

Tab. 3-24 lists source of expert judgement provided for uncertainty analysis for each category in mobile combustion.

Tab. 3-24 Uncertainty data from Energy sector (mobile combustion) for uncertainty analysis

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.A.3.a Domestic Aviation	4	3.73	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.b Road Transportation	3	2.36	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.c Railways	5	1.48	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.d Domestic Navigation	5	1.5	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.a Domestic Aviation	4	21.5	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.b Road Transportation	3	100	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.c Railways	5	100	J. Tichy, J. Jedlicka, AD and EF unc. in line

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
				with 2006 Guidelines
CH_4	1.A.3.d Domestic Navigation	5	50	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.a Domestic Aviation	4	40	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.b Road Transportation	3	100	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.c Railways	5	100	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.d Domestic Navigation	5	90	J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines

3.2.17.3 Source-specific QA/QC and verification

Transport research centre (CDV) is a sector-solving institution responsible for this category. The plan of QA/QC procedures in CDV is based on the inner quality control procedure system, which is harmonised with the QA/QC system of KONEKO Ltd. company. Since the transport sector belongs to the energy sector, there is been a close co-operation of CDV and KONEKO in the field of energy and fuel consumption data as well as specific energy data used (in MJ/ kg fuel). The KONEKO Ltd. company in close co-operation with CzSO ensures that Transport research centre works with the most updated data about total energy and specific energy consumed.

The sectoral guarantor of QA/QC procedures for mobile sources, Jiri Jedlicka (Head of the Infrastructure and Environment Department in CDV):

- is responsible for the sectoral QA/QC plan and the compliance of all QA/QC procedures with 2006 IPCC Guidelines (IPCC, 2006),
- provides for the QC procedure (Tier 2) and is responsible for its implementation.

Sectoral administrator, Jakub Tichy:

- performs the emission calculations for the transport in emission model,
- provides for data import in the online CRF Reporter,
- provides for and is responsible for the storing of documents,
- carries out auto-control (1st step of QC procedure, Tier 1) and control of data consistency.

The inner quality assurance and quality control procedure consists of the designation of responsible persons for emission calculation – Researcher Mr. Jakub Tichy and Head of the Infrastructure and Environment Department, Mr. Jiri Jedlicka. Mr. Tichy implements the calculations and is responsible for all the work with the online Common Reporting Format (CRF). This work involves data input (emissions of greenhouse gases, energy consumption) from its own emission calculation model to CRF and year-to-year comparison of implied emission factors calculated in CRF. In addition, the QC Tier 2 is planned through checking of the official GHG emission data with the data calculated according to the CORINAIR methodology. Mr. Jedlicka is responsible for checking of the results and their consistency.

3.2.17.4 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

There is a recalculation in sector 1.A.3 Transport and 1.D.1 International Bunkers for the whole time period according to the 2006 IPCC Guidelines. The recalculation involves changes of the structure in the Sectoral approach, default values of emission factors and oxidation factors. On the basis of QA/QC and comparison with UNECE/IEA/OECD Questionnaires, the country specific coefficient for the ratio between GCV and NCV for gaseous fuels is changed and the fuel consumption of gasoline and diesel oil is reallocated (1990-1998) within sector Energy. It should be noted, that the total consumption of these fuel type in sector Energy remains unchanged.

3.2.17.5 Source-specific planned improvements, including tracking of those identified in the review process

The planned improvements are related mainly to performance of projects to measure country-specific emission factors in key categories of road transportation. The greatest emphasis will be placed on acquisition of sufficient data for CO_2 and N_2O emission calculation and refinement of methodologies for each category of transport.

3.2.18 Other Sectors – Commercial/Institutional (1.A.4.a)

3.2.18.1 Category description (CRF 1.A.4.a)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.a, 2013								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	137.8	65.86*)	1	9.1	5	0.00069	0.1	0.00001
Other kerosene	85.6	71.9	1	6.2	10	0.00086	0.6	0.00005
Heating and Other Gasoil	127.8	74.1	1	9.5	10	0.00128	0.6	0.00008
Fuel Oil - Low Sulphur	197.2	77.4	1	15.3	10	0.00197	0.6	0.00012
Other Bituminous Coal	134.3	94.03*)	0.971*)	12.3	10	0.00134	1.4	0.00019
Brown Coal + Lignite	1 164.2	98.11*)	0.985*)	112.5	10	0.01164	1.4	0.00163
Coke	284.7	107	1	30.5	10	0.00285	1.4	0.00040
Natural Gas	58 639.2	55.30*)	1	3 242.9	5	0.29320	0.1	0.00586
Wood/Wood Waste	530.0	112	1	59.4	300	0.15900	4	0.00212
Gaseous Biomass	956.0	54.6	1	52.2	5	0.00478	0.1	0.00010
Total year 2013	**62 256.7**			**3 549.5**		**0.4776**		**0.0106**
Total year 2012	60 027.2			3 406.9		0.4488		0.0098
Index 2013/2012	1.04			1.04		1.06		1.08
Total year 1990	121 435.7			10 023.6		1.0166		0.0966
Index 2013/1990	0.51			0.35		0.47		0.11

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other kerosene	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The whole category 1.A.4 includes emissions which are not included in the 1.A.1 and 1.A.2 categories. They can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in category 1.A.4 is energy consumption for purposes of space heating. The fluctuations in consumption then can be ascribed to differences in cold winter periods. The trend of decreasing CO_2 emissions is a result of higher standards for new buildings and of successful execution of energy-efficiency-oriented modernisations of existing buildings. The trend has also been supported by shifting to fuels with lower CO_2 emissions (emission factors). The importance of Solid Fuels at the beginning of the period constantly decreases in time. On the other hand, the consumption of Natural Gas increased during the period as well as Biomass consumption. Liquid Fuels play a minor role in this category.

CO_2 emissions produced in category 1.A.4 were in 2013 at 18.4 Tg, which represents 17% of CO_2 emissions from the Energy sector.

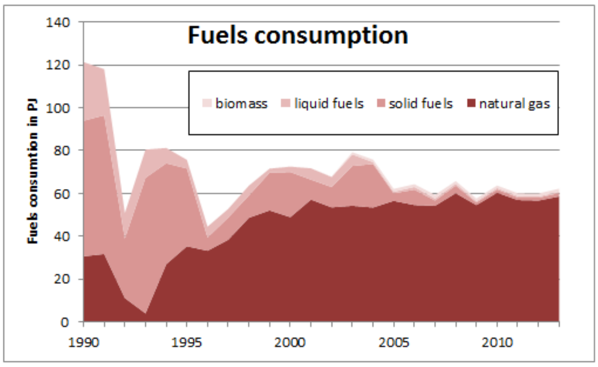
The 1.A.4.a subcategory includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in capture Other sectors under the item:

- Commercial and Public Services
- Non-specified (Other)

Last point is included under 1.A.4.a Commercial/Institutional on the basis of an agreement with CzSO. There are embodied the fuels of economic part according to NACE Rev. 2 Commercial/Institutional: NACE Divisions 35 excluding 1.A.1.a and 1.A.3.e, 36 – 39, 45 – 99 excluding 1.A.3.e and 1.A.5.a.

The fraction of CO_2 emissions in subsector 1.A.4.a in CO_2 emissions in sector 1.A.4 equalled 19.3% in



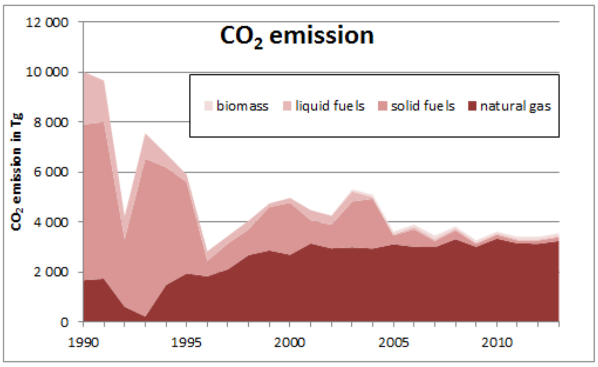


Fig. 3-46 Development of fuels consumption and CO_2 emissions in source category 1.A.4.a

2013. It contributed 3.3% to CO_2 emissions in the whole Energy sector.

The graph (Fig. 3-46) shows that at the beginning of the period in the subsector 1.A.4.a predominated the consumption of fossil fuels, which was coupled with liquid fuels, and gradually substituted primarily with natural gas. The share of biofuels in this subsector is a minority. The overall decrease in fuel consumption is about 50%, which resulted in a decrease in CO_2 emissions by about 65%. Higher decrease in emissions than the one in the fuel consumption is determined by the changes in the structure of fuels in favour of natural gas.

At the beginning of the time-series are apparent outlier values in the fuels consumption. This unusual trend will be subject of detailed revision of activity data. This issues is also included in the Improvement plan.

3.2.18.2 Methodological issues (CRF 1.A.4.a)

During processing data for the subsector 1.A.4.a among the used fuels are also included fuels, which are in the questionnaires of CzSO, listed in section "Transport sector". The amounts of these fossil fuels is given in Tab. 3-25 in TJ.

Tab. 3-25 Quantities of fuels used in the sector transport in stationary sources

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
TJ/year	27.9	28.1	0.0	13.7	38.0	34.3	36.9	13.9	13.8	12.5	13.0	15.4

According to the communication to CzSO, this is a fuel for heating the buildings of the state-owned company Czech Railways and that is why its combustion was situated in the subsector 1.A.4.a. This is the consumption of bituminous coal, lignite and coke oven coke worth 1-2 kt per year. The amount of these fuels in the total balance of 1.A.4.a virtually has no effect.

No other sector-specific methodological issues are applied, the general issues are given in chapter 3.2.4.

3.2.18.3 Uncertainties and time-series consistency (CRF 1.A.4.a)

See chapter 3.2.5.

3.2.18.4 Category-specific QA/QC and verification (CRF 1.A.4.a)

See chapter 3.2.6.

3.2.18.5 Category-specific recalculations (CRF 1.A.4.a)

The performed recalculation concerned only the beginning of the period from 1990 to 1995. In the previous submission, it was used data from the energy balance, which was conducted according to the national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are included in the international statements for IEA/EUROSTAT. This recalculation was performed for all fuels except biofuels, which in this period have not been yet implemented. The results of recalculation of fuel consumption are shown on Fig. 3-47 compared with the previous submission.

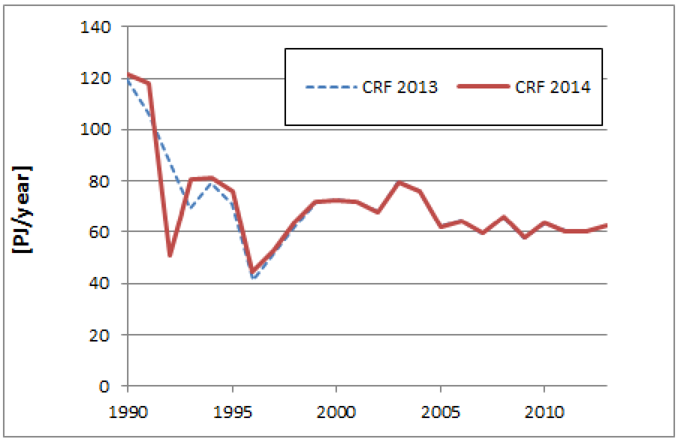


Fig. 3-47 Recalculation in fuel consumption (CRF 1.A.4.a)

The recalculation of fuel consumption influenced the CO_2 emissions in the same way.

Greater impact, however, had the recalculation of CH_4 emissions, eventually also of N_2O, as compared to the previous submission, new default emission factors for LPG and especially gaseous biomass (change of emission factor from 10 kg CH_4/TJ to 5 kg of CH_4/TJ) were used. This change in emission factors led to a significant decrease in emissions of CH_4, which then reflected in a decline in total greenhouse gas emissions, expressed as CO_2 equivalent - see Fig. 3-48.

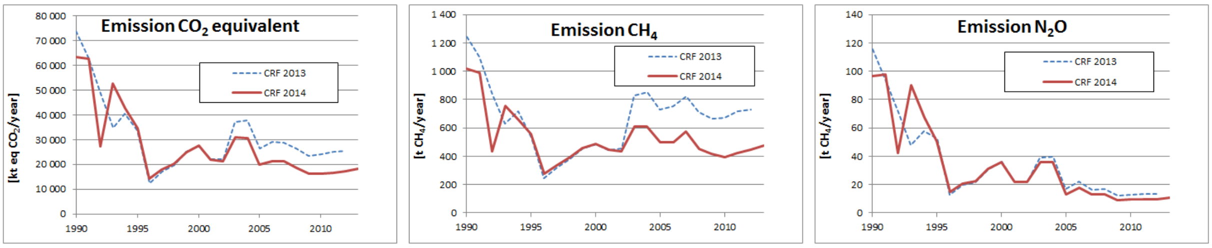


Fig. 3-48 The amount of greenhouse gases CO_2, CH_4 and N_2O as CO_2 equivalent from fuel combustion in the category 1.A.4.a - comparing the situation before and after recalculation

3.2.18.6 Category-specific planned improvements (CRF 1.A.4.a)

Detailed research of data at the beginning of 90s is planned for the future submissions.

3.2.19 Other Sectors – Residential (1.A.4.b)

3.2.19.1 Category description (CRF 1.A.4.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.b, 2013								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
LPG	183.8	65.86*)	1	12.1	5	0.00092	0.1	0.00002
Other Bituminous Coal	2 604.5	94.03*)	0.971*)	237.7	300	0.78134	1.4	0.00365
Brown Coal + Lignite	23 494.7	98.11*)	0.985*)	2 269.5	300	7.04840	1.4	0.03289
Coke	569.3	107	1	60.9	300	0.17079	1.4	0.00080
Brown Coal Briquets	2 934.1	97.5	0.985*)	281.7	300	0.88022	1.4	0.00411
Natural Gas	85 165.7	55.30*)	1	4 709.8	5	0.42583	0.1	0.00852
Wood/Wood Waste	50 663.0	112	1	5 674.3	300	15.19890	4	0.20265
Charcoal	431.0	112	1	48.3	200	0.08620	1	0.00043
Total year 2013	**166 046.0**			**13 294.2**		**24.593**		**0.2531**
Total year 2012	159 362.1			12 631.5		22.673		0.2365
Index 2013/2012	1.04			1.05		1.08		1.07
Total year 1990	213 400.7			19 637.1		49.052		0.3208
Index 2013/1990	0.78			0.68		0.50		0.79

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2013							
Structure of Fuels	**Source for**	**Emission factors**			**Method used**		
	Activity data	**CO_2**	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Brown Coal Briquets	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Charcoal	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

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 CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in capture Other Sector under the item:

Residential

The fraction of CO_2 emissions in subsector 1.A.4.b in CO_2 emissions in sector 1.A.4 equalled 72.3% in 2012. It contributed 12.3% to CO_2 emissions in the whole Energy sector.

At the beginning of the period, a majority of households in the Czech Republic used coal as a heating fuel (mainly brown coal + lignite). This habit has changed over time and Natural Gas began to be used more than Solid Fuels. The same trend appears in the institutional sphere. The number of households using biomass for heating (biomass boilers) in the Czech Republic has increased in the last few years. This trend is also apparent in the Fig. 3-49.

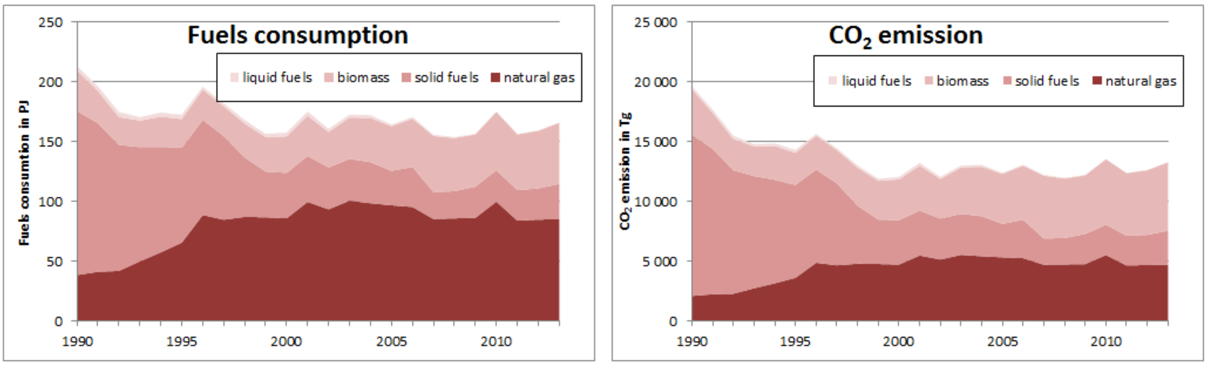


Fig. 3-49 Development of fuels consumption and CO_2 emissions in source category 1.A.4.b

The graph shows that at the beginning of the period in the subsector 1.A.4.b dominated consumption of fossil fuels, which have been gradually substituted primarily by natural gas, but also biofuels (in the case of households, it is mainly firewood). The share of liquid fuels (LPG) is negligible. Small annual fluctuations in fuel consumption are to be attributed to the average annual temperatures. Throughout the sector Residential, a slight decrease can be observed in fuel consumption, which was affected by the replacement of old boilers with more modern with higher efficiency and most importantly building insulations, which is controlled by the national programs "Green Savings". Increasing share of biomass has a positive effect on reducing CO_2 emissions, which are included in total greenhouse gas emissions. While the total fuel consumption declines in this subsector generally slightly (only about 20%), CO_2 emissions from the combustion of fossil fuels decreased by about 50%.

3.2.19.2 Methodological issues (CRF 1.A.4.b)

No specific methodological approaches were applied - general approaches are given in section 3.2.4.

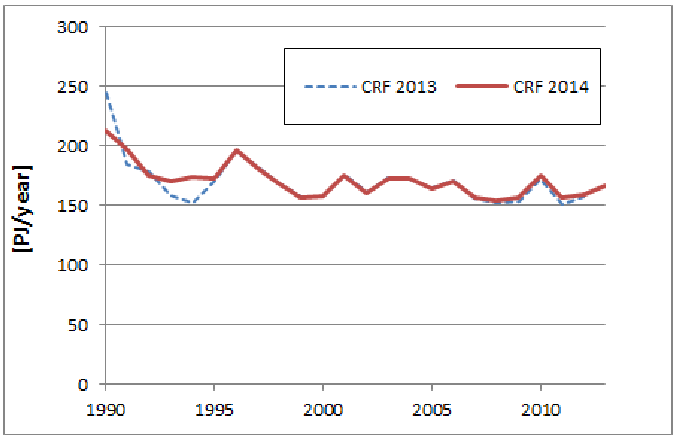
3.2.19.3 Uncertainties and time-series consistency (CRF 1.A.4.b)

See chapter 3.2.5.

3.2.19.4 Category-specific QA/QC and verification (CRF 1.A.4.b)

See chapter 3.2.6.

3.2.19.5 Category-specific recalculations (CRF 1.A.4.b)



The performed recalculation concerned only the beginning of the period from 1990 to 1995. In the previous submission, the data used was from the energy balance, which was conducted according to national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are included in the international statements for IEA/EUROSTAT. The recalculation was performed in all kinds of fuels and the results are shown on Fig. 3-50 in comparison with the previous submission.

Fig. 3-50 Recalculation in fuel consumption (CRF 1.A.4.b)

The graph on Fig. 3-50 shows the recalculation at the beginning of the period and other minor changes at the end of the period. These changes correspond to the updated data from CzSO in the last statement of the energy balance for the IEA/EUROSTAT. CzSO annually improves the accuracy of the data from previous submissions based on the current findings. The recalculation performed in this submission, reflects, therefore, inter alia, this more accurate data from CzSO.

The performed recalculation showed minimally in the emissions of CH_4, mainly for the reason that in this subsector does not occur fuels, in which there has been a change in methodology and change in the emission factors (e.g. gaseous biomass). The more significant increase in N_2O emissions from 1990 to 1995 is due to the lower share of biomass in the previous submission. Further, the effect of recalculation on the total emissions of greenhouse gases, expressed as CO_2 equivalent, was not significant - see Fig. 3-51.

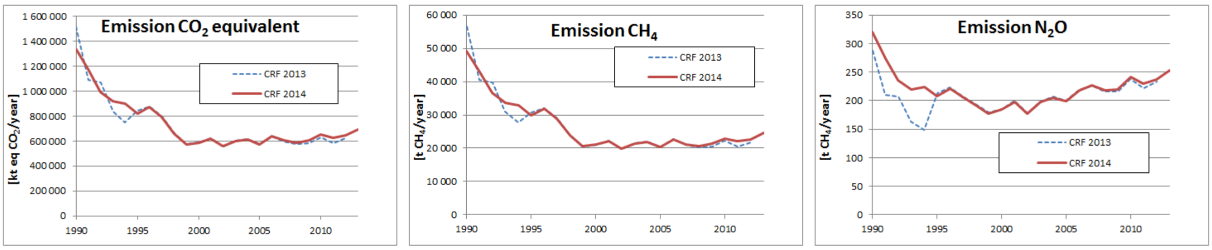


Fig. 3-51 Sum of greenhouse gases CO_2, CH_4 and N_2O as CO_2 equivalent from fuel combustion in the category 1.A.4.b - comparing the situation before and after recalculation

3.2.19.6 Category-specific planned improvements (CRF 1.A.4.b)

Currently there are no planned improvements in this category.

3.2.20 Other Sectors – Agriculture/Forestry/Fishing (1.A.4.c)

The subsector is further divided into:

- Stationary sources – 1.A.4.c.i
- Off-road Vehicles and Other Machinery – 1.A.4.c.ii

The structure of the fuels throughout the subsector 1.A.4.c, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.c, 2013								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	183.8	65.86*)	1	12.1	5	0.00092	0.1	0.00002
Gasoline	265.9	69.3	1	18.4	10	0.00183	0.6	0.00512
Diesel Oil	13 704.9	74.1	1	1 015.5	10	0.07447	0.6	0.06770
Fuel Oil - Low Sulphur	78.9	77.4	1	6.1	10	0.00079	0.6	0.00005
Other Bituminous Coal	53.7	94.03*)	0.971*)	4.9	300	0.01611	1.4	0.00008
Brown Coal + Lignite	368.5	98.11*)	0.985*)	35.6	300	0.11056	1.4	0.00052
Coke	28.5	107	1	3.0	300	0.00854	1.4	0.00004
Natural Gas	2 687.6	55.30*)	1	148.6	5	0.01344	0.1	0.00027
Wood/Wood Waste	383.0	112	1	42.9	300	0.11490	4	0.00153
Gaseous Biomass	4 562.0	55	1	249.1	5	0.02281	0.1	0.00046
Total year 2013	**22 316.7**			**1 536.3**		**0.364**		**0.0758**
Total year 2012	20 210.2			1 419.8		0.347		0.0755
Index 2013/2012	1.10			1.08		1.05		1.00
Total year 1990	47 622.9			3 790.2		5.414		0.0838
Index 2013/1990	0.47			0.41		0.07		0.90

*) *Country specific data*

The high emissions of CH_4 in 1990 is mainly due to the high consumption of other bituminous coal and lignite in the early periods, that have high emission factors (300 kg CH_4/TJ) compared to other fuels. At the end of the period there was a significant decrease in the consumption of solid fossil fuels.

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is detailed in the following outline.

2013							
Structure of Fuels	Source for	Emission factors			Method used		
	Activity data	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Gasoline	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Diesel Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes both combustion at stationary sources for heating buildings, breeding and cultivation halls and other operational facilities. These are areas from the agriculture (crop and livestock production), forest and fishing. In rural areas is also about the very energy-intensive operations, such as greenhouses, drying grain and hops.

Unlike previous submission, here are presented also the off-road means of transport and machinery. In accordance with the IPCC 2006, data on fuel consumption and emission data are divided into two subcategories, as mentioned above. In rural areas is mainly about fuel consumption for land cultivation and harvesting mechanisms, in forestry are mainly mining mechanisms. The fishing area has minor importance in the Czech Republic and is concentrated almost exclusively on fish farming.

In the CzSO Questionnaire (CzSO, 2014), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Agriculture/Forestry
- Fishing

The distribution of fuels is done according to their nature - motor fuels are allocated to the subcategory 1.A.4.c.ii, all other fuels -into subcategory 1.A.4.c.i. This division is subsequently agreed annually with the CzSO during mutual consultation.

There are embodied the fuels of economic part according to NACE Rev. 2 Agriculture/Forestry/Fisheries: NACE Divisions 01 – 03.

The fraction of CO_2 emissions in subsector 1.A.4.c in CO_2 emissions in sector 1.A.4 equalled 8.4% in 2013. It contributed 1.4% to CO_2 emissions in the whole Energy sector.

Development of fuel consumption and the corresponding CO_2 emissions throughout the subcategory 1.A.4.c are visible on Fig. 3-52.

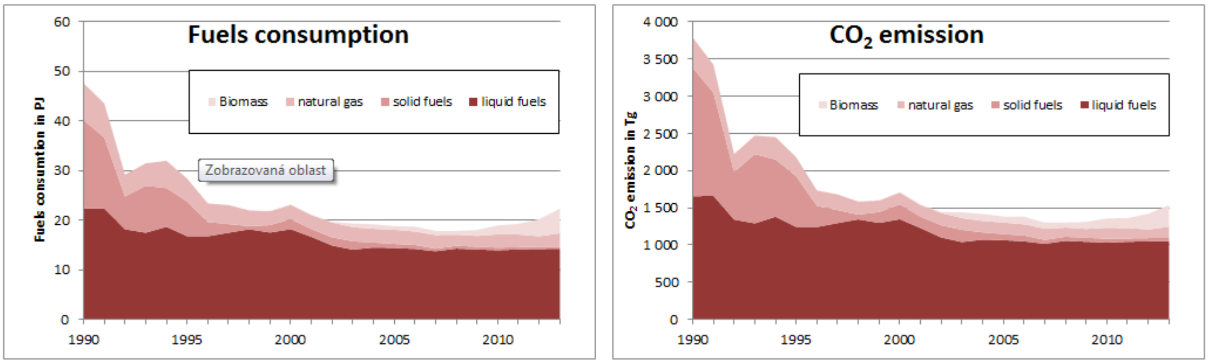


Fig. 3-52 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c

From the graph on Fig. 3-52 is evident, that the stake in the entire subsector and in the overall period is for the liquid fuel (as it will be shown later, it is mainly about propellant fuel). At the beginning of the period a significant share is for the fossil fuels, but their consumption during the entire period declines due to the cancelation of the inefficient ways of heating of buildings and process plants. Biofuels are increasingly used until the end of the period.

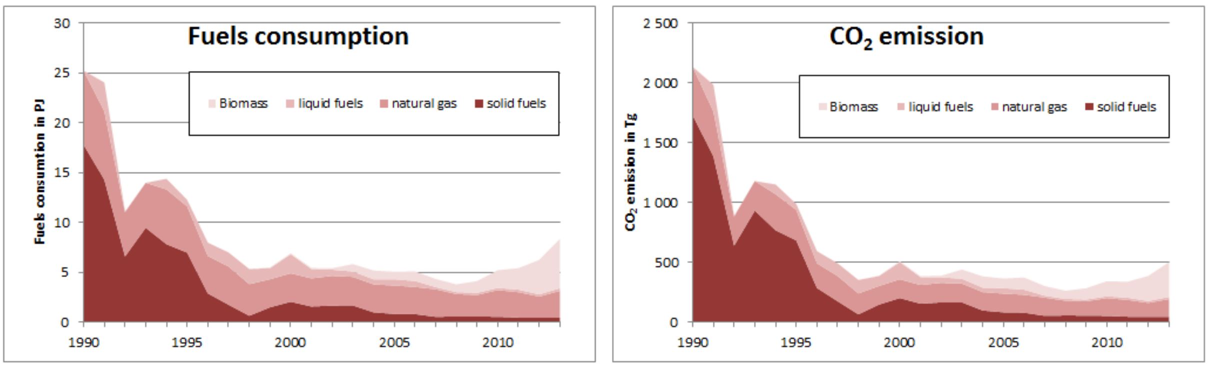


Fig. 3-53 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c.i

In the next chart is shown the fuel consumption and the corresponding CO_2 emissions of only stationary sources and in the following graphs (Fig. 3-53, Fig. 3-54) are represented the consumption of fuels in off-road transportation and other mechanisms in the agriculture, forestry and fisheries.

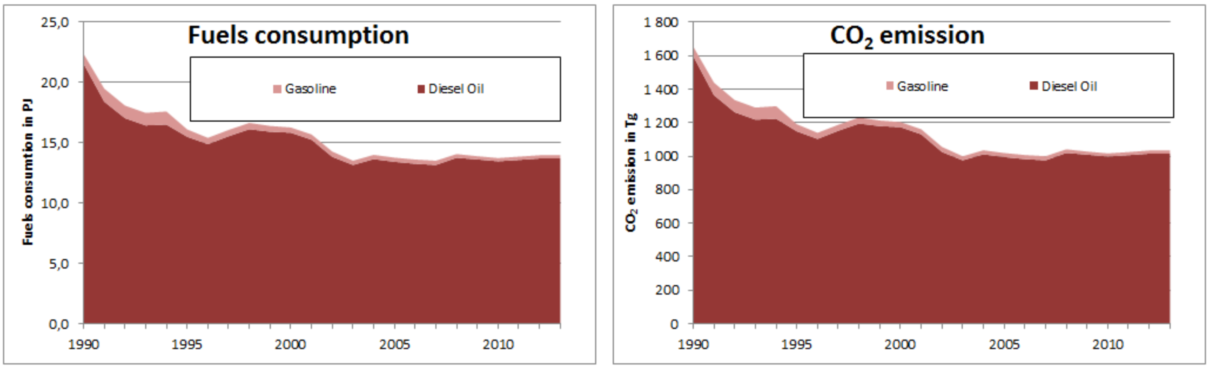


Fig. 3-54 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c.ii

In the stationary sources decreased decisively consumption of fossil solid and liquid fuels. The role of natural gas throughout the period was virtually stable and at the end of the period is evident an increased use of biofuels, especially biogas, produced in the biogas stations, built on individual agricultural farms.

To the mobile sources and other mechanisms are to a large extent attributed the consumption of diesel fuels, motor gasoline has minor importance, other fuels are virtually absent. During the period, a noticeable decrease in fuel consumption roughly in the first half of the period is observed, which was caused by higher technical level of engines and especially a decline in demand in all subsectors for agricultural products.

3.2.20.1 Methodological issues (CRF 1.A.4.c)

The basic requirement for processing fuel consumption from mobile sources is their division between subsectors 1.A.3 Transport, 1.A.4.c.ii Off-road vehicles and other machinery and 1.A.5 Other. This distribution is done in coordination with CDV. The aim is that no fuel is included in the balance twice, nor that any fuel is omitted. Therefore, the following distribution is performed:

Motor fuels, which are consumed in the subsector 1.A.4.c.ii are used only for off-road vehicles and other mechanisms.

Motor fuels, which are consumed in the subsector 1.A.5 are allocated to 1.A.3. This is the fuel consumption of the army (transport on and off road, kerosene jet fuel consumption for air transport), and consumption in the fields of construction, extraction of fuels and minerals, industry (only areal transport). Furthermore, the consumption of motor fuels for mobile sources in the public sector (ambulance, fire brigade, etc.), both on and off roads as well as the consumption of aviation fuel are included here.

3.2.20.2 Uncertainties and time-series consistency (CRF 1.A.4.c)

See chapter 3.2.5.

3.2.20.3 Category-specific QA/QC and verification (CRF 1.A.4.c)

QA/QC procedures in this subsector must be coordinated with CDV. KONEKO, as the company responsible for processing the entire sector 1.A, performs before each submission distribution of motor fuels between the various subsectors 1.A.3, 1.A.5 and 1.A.4.c.ii. Simultaneously, after processing the data part of the submission, checks whether the predetermined distribution of fuel was properly applied and if it is necessary proposes corrections in order to avoid double counting of fuels, or their omission.

Other QA/QC and verification - see section 3.2.6.

3.2.20.4 Category-specific recalculations (CRF 1.A.4.c)

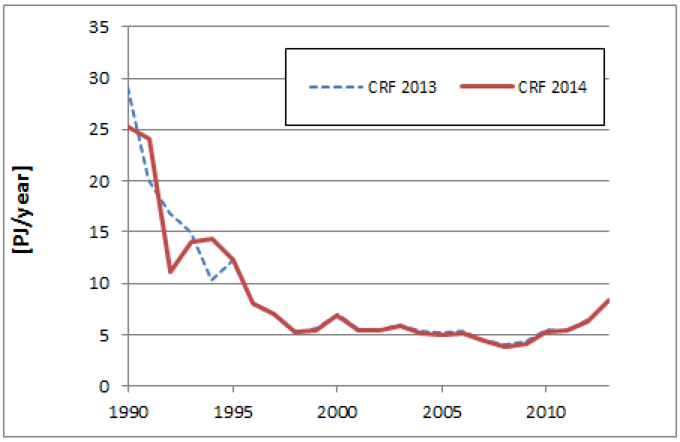


Fig. 3-55 Recalculation of fuel consumption (CRF 1.A.4.ci)

The performed recalculation concerns only fuel used in stationary sources, which were reported in the previous submission in 1.A.4.c. Mobile sources in agriculture, forestry and fisheries have been reported in previous submission, along with other sources in 1.A.5.

This recalculation is primarily related to the beginning of the period from 1990 to 1995. In the previous submission was used data from the energy balance, which was conducted according to the national methodology. This data for the period 1990 to 1995 has been replaced by the official data from CzSO, which are included in the international statements for IEA/EUROSTAT. This recalculation was performed for all fuels except biofuels, which in this period have not been yet used. The results of recalculation of fuel consumption on stationary sources are shown in Fig. 3-55 compared with the previous submission.

Greater impact, however, was made by the recalculation of CH_4 and N_2O emissions, as compared to the previous submission, new default emission factors for gaseous biomass (change of emission factor from 10 kg CH_4/TJ to 5 kg of CH_4/TJ) were used. This change in emission factors led to a significant decline in CH_4 and N_2O emissions, especially towards the end of the period, when the consumption of biogas increased. This change in the emission factor is then reflected in the decline in total greenhouse gas emissions, expressed as CO_2 equivalent - see Fig. 3-56.

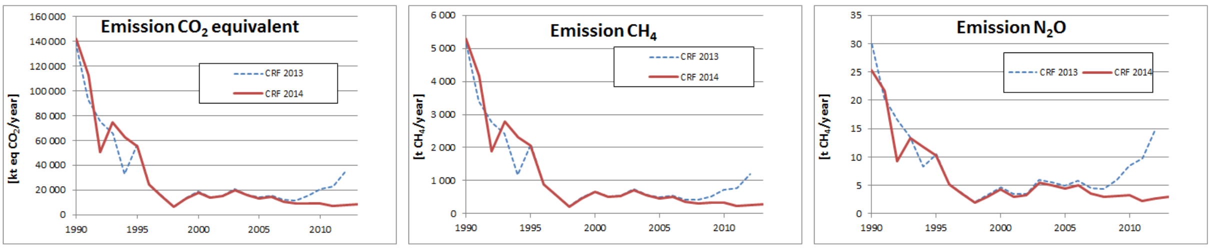


Fig. 3-56 Sum of greenhouse gases CO_2, CH_4 and N_2O as CO_2 equivalent from fuel combustion in category 1.A.4.c.i - compared to the situation before the recalculation (1.A.4.c) and after recalculation

3.2.20.5 Category-specific planned improvements (CRF 1.A.4.c)

Currently there are no planned improvements in this category.

3.2.21 Other (1.A.5)

The subsector is further divided into:

- Stationary sources – 1.A.5.a (Non specified stationary; Emissions from fuel combustion in stationary sources that are not specified elsewhere)
- Mobile sources – 1.A.5.b (Non specified mobile; Mobile Emissions from vehicles and other machinery, marine and aviation (not included in 1.A.4.c.ii or elsewhere). Includes emissions from fuel delivered for aviation and water-borne navigation to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in.)

The structure of fuels throughout the subsector 1.A.5. their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.5.b, 2013								
Structure of Fuels	Activity data [TJ]	CO_2 EF [t CO_2/TJ]	OxF	Emission [kt]	CH_4 EF [kg CH_4/TJ]	Emission [kt]	N_2O EF [kg N_2O TJ]	Emission [kt]
Gasoline	310.2	69.3	1	21.5	6.90*)	0.00214	19.27*)	0.00598
Kerosene Jet Fuel	649.5	71.5	1	46.4	14.38*)	0.00934	10.26*)	0.00666
Diesel Oil	3 136.2	74.1	1	232.4	5.43*)	0.01704	4.94*)	0.01549
Total year 2013	**4 095.9**			**300.3**		**0.0285**		**0.0281**
Total year 2012	4 182.1			306.5		0.0298		0.0290
Index 2013/2012	0.98			0.98		0.96		0.97
Total year 1990	n.a.			n.a.		n.a.		n.a.
Index 2013/1990	-			-		-		-

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is detailed in the following outline.

2013							
Structure of Fuels	Source of Activity data	Emission factors CO_2	Emission factors CH_4	Emission factors N_2O	Method used CO_2	Method used CH_4	Method used N_2O
Gasoline	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2
Kerosene Jet Fuel	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2
Diesel Oil	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2

Given that all stationary sources have been reported in subsectors 1.A.1., 1.A.2. and 1.A.4., in this subsector (starting with this submission) will be reported only mobile sources, which were not disclosed in the subsectors 1.A.3. and 1.A.4.c.

In accordance with the IPCC 2006, the subsector 1.A.5.b. is subdivided into:

- 1.A.5.b.i – Mobile (aviation component)
- 1.A.5.b.iii – Mobile (other)

In the subsector 1.A.5.bi is reported fuel consumption and corresponding emissions of greenhouse gases from aviation, besides the public air transport. This is primarily the consumption of aviation fuels in the army, in state institutions (aerial vehicles from Integrated Rescue System) or private air transport.

Subsector 1.A.5.b.ii is not exploited in the submission of the Czech Republic, especially as it relates to maritime transport which is not present in the Czech Republic.

Subsector 1.A.5.b.iii is used for the reporting of all remaining fuels (and greenhouse gases) that have not been reported elsewhere; it is mainly the consumption of motor fuels for ground vehicles in the military and in governmental institutions (Integrated Rescue System). Furthermore, it includes the consumption in the fields of construction, mining of fuels and minerals, industry (only areal transport).

The fraction of CO_2 emissions in subsector 1.A.5 in 2013 contributed 0.3% to CO_2 emissions in the whole Energy sector.

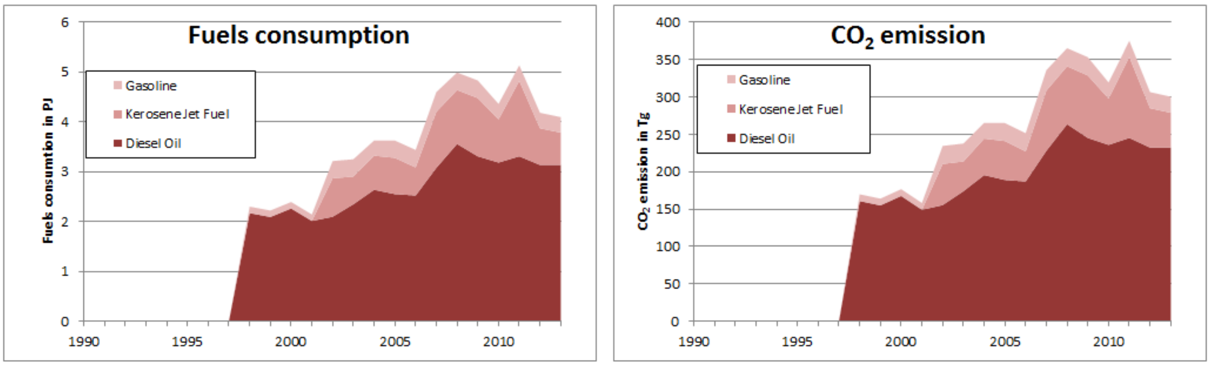


Fig. 3-57 Development of fuels consumption and CO_2 emissions in source category 1.A.5.b.

Development of fuel consumption and the corresponding CO_2 emissions throughout the subcategory 1.A.5.b. are seen in Fig. 3-57.

Data before 1998 are not available in sufficient details. Shares of fuels and corresponding emissions before 1998 are reported in the sector 1.A.3. Transport.

The graph on Fig. 3-57 shows that a decisive proportion has diesel oil, another significant share is appertain to kerosene jet fuel (mainly army), the proportion of gasoline is minor.

3.2.21.1 Methodological issues (CRF 1.A.5.b)

The basic requirement for processing fuel consumption on mobile sources is their division between the subsectors 1.A.3 Transport and 1.A.4.c.ii and 1.A.5. This distribution is done in coordination with CDV. The aim is that no fuel was included in the balance twice, nor that any fuel is omitted. Therefore, the following distribution is performed:

Motor fuels, which are consumed in the subsector 1.A.4.c.ii are used only for off-road vehicles and other mechanisms in the agricultural sector, forestry and fisheries.

In the subsector 1.A.5.b.i are reported fuels from aviation, which have since 1998 been allocated from the consumption in 1.A.3. This is the consumption of kerosene jet fuel in the army and aviation of state organizations (aerial rescue equipment). In the subsector 1.A.5.b.iii are reported motor fuels for ground transport systems, which have since 1998 been allocated from consumption in 1.A.3. This is the consumption of motor fuels for mobile sources in the army and the public sector (ambulance, fire brigade, etc.), both on and off road.

3.2.21.2 Uncertainties and time-series consistency (CRF 1.A.5.b)

See chapter 3.2.5.

3.2.21.3 Category-specific QA/QC and verification (CRF 1.A.5.b)

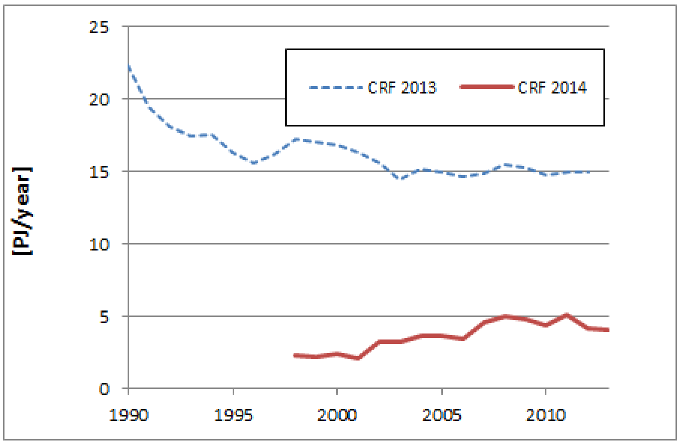
QA/QC procedures in this subsector must be coordinated with CDV. KONEKO, as the company responsible for processing the entire sector 1.A, performs before each submission the distribution of motor fuels between the various subsectors 1.A.3, 1.A.5 and 1.A.4.c.ii. Simultaneously, after processing the data portion of the submission, checks whether the predetermined distribution of fuels was properly used and if necessary proposes corrections in order to avoid double counting of fuels as well as their omission.

Other QA/QC and verification - see section 3.2.6.

3.2.21.4 Category-specific recalculations (CRF 1.A.5.b)

In the last submission, all of the diesel and aviation fuel (and corresponding GHG emissions), which was not reported in the sector 1.A.3 Transport, was reported in the subsector 1.A.5. Therefore in this category has been reported the sum of motor and aviation fuels from agriculture, forestry and fishing, along with other fuels, which has not been included in the sector 1.A.3.

The performed recalculation separated used motor and aviation fuels into sources from agriculture, forestry and fishing (which was reported in this submission in 1.A.4.c.ii) and other fuels, reported so far in 1.A.5.



The results of recalculation of the fuel consumption from mobile sources in 1.A.5 are shown on Fig. 3-58 , compared with the previous submission.

Fig. 3-58 Recalculation in fuel consumption (CRF 1.A.5)

In a similar manner resulted the recalculation in emissions of CO_2. Due to the low importance of CH_4 and N_2O emissions in this recalculation, the curve course of CO_2 and overall greenhouse gas emissions, expressed as CO_2 eq. (Fig. 3-59), are virtually the same.

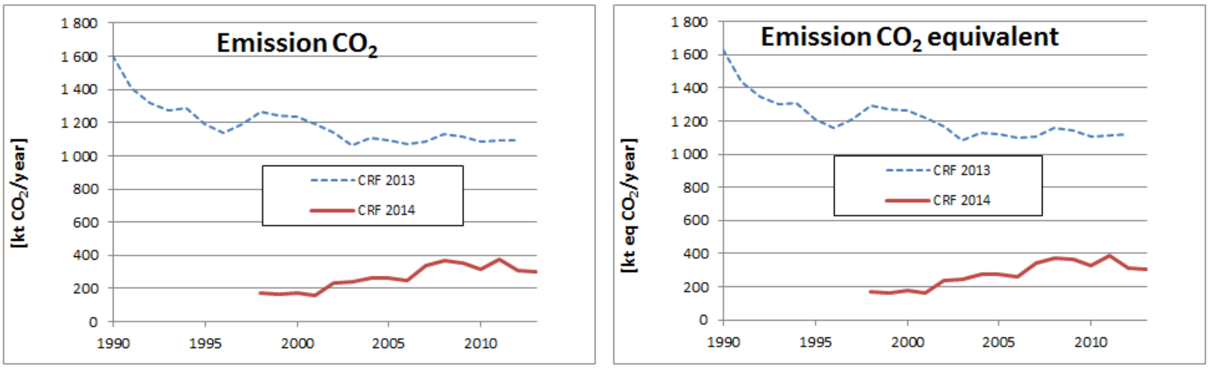


Fig. 3-59 Recalculation of CO_2 emission and emissions in CO_2 eq. (CRF 1.A.5)

3.2.21.5 Category-specific planned improvements (CRF 1.A.5.b)

Currently there are no planned improvements in this category.

3.3 Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (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, transmission, storage and distribution are less important.

The current inventory includes CH_4 emissions for the following categories:

- 1.B.1 Solid fuels
- 1.B.2 Oil and Natural Gas

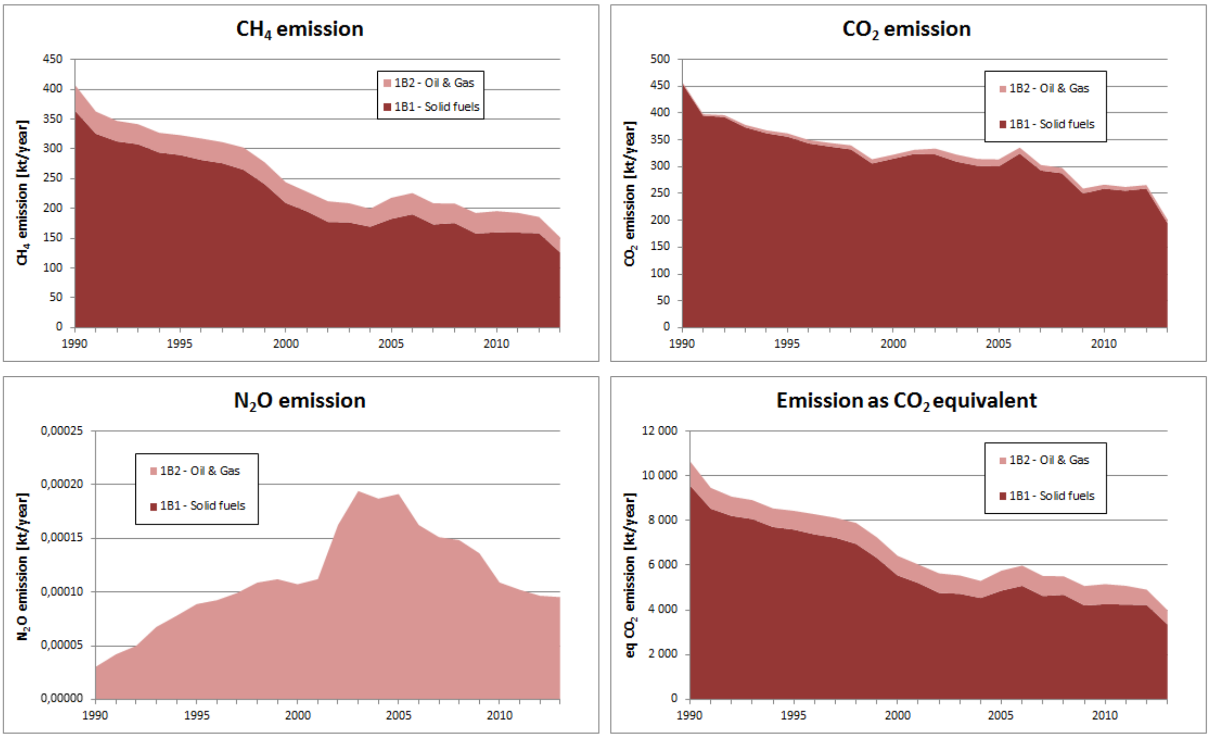


Fig. 3-60 GHG emissions trends from the sector Fugitive Emissions from Fuels [Gg/year]

In 1.B Fugitive Emissions from Fuels category, especially 1.B.1.a Coal Mining and Handling was evaluated as a key category (Tab. 3-1). Category 1.B.2 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.

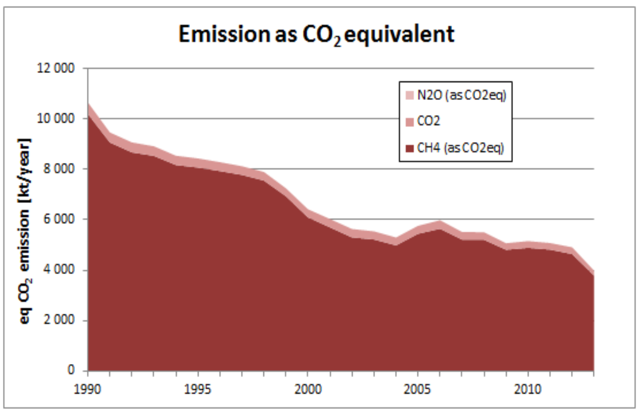


Fig. 3-61 The share of individual GHG emissions from the total emissions, expressed as CO_2 eq. (1.B.)

Development of individual emissions of greenhouse gases in sector 1.B is shown on the graphs in Fig. 3-60.

Sector 1.B is dominated by methane emissions from subcategory 1.B.1. - Solid fuels, while emissions from sector 1.B.2. - Oil and Natural gas represents on average 15% of the total emissions. CO_2

emissions arise primarily in subcategory 1.B.1 - Solid fuels (share of the subcategory 1.B.2 has low importance- about 2% of total CO_2 emissions). N_2O emissions originate only from the subsector 1.B.2.a - Oil and there are insignificant.

The importance of individual greenhouse gases from the total emissions, expressed as CO_2 equivalent, is visible from Fig. 3-61.

From the graphs on Fig. 3-60 and Fig. 3-61 is also clear that during the period occurred a significant decrease in GHG emissions across category 1.B. As it is shown below, the decrease was mainly due to a decrease in subcategory 1.B.1. - Solid fuels, in which vital source of emissions is underground mining of hard coal. For 2013, the decrease of total GHG emissions is 62.5% compared to the 1990 level.

3.3.1 Solid Fuels (CRF 1.B.1)

The category is further divided into the following subcategories according to IPCC 2006:

- 1.B.1.a Coal mining and handling
  - 1.B.1.a.1 Underground mines
    - 1.B.1.a1.i Mining
    - 1.B.1.a.1.ii Post-mining seam gas emissions
    - 1.B.1.a.1.iii Abandoned underground mines
  - 1.B.1.a.2 Surface mines
    - 1.B.1.a.2.i Mining
    - 1.B.1.a.2.ii Post-mining seam gas emissions
- 1.B.1.b Solid fuel transformation
- 1.B.1.c Other

3.3.1.1 Category description (CRF 1.B.1)

The structure of the sector, corresponding activity data, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.B.1, 2013								
Structure of sector		**Activity**	**CH_4**		**CO_2**		**N_2O**	
		data	**EF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
		[Gg]	**[kg CH_4/t]**	**[kt]**	**[t CO_2/t]**	**[kt]**	**[kg N_2O/t]**	**[kt]**
1.B.1.a	Coal mining/handl.	48 979		126.40		194.88		NA
1.B.1.a.1	Underground mines	8 594		92.39		194.88		NA
1.B.1.a.1.i	Mining		8.75*)	75.20*)	22.68	194.88	NA	NA
1.B.1.a.1.ii	Post-mining activ.		1.64	14.11	NA	NA	NA	NA
1.B.1.a.1.iii	Abandoned mines	+)		3.08	NA	NA	NA	NA
1.B.1.a.2	Surface mines	40 385		33.82		NA		NA
1.B.1.a.2.i	Mining		0.77	31.12	NA	NA	NA	NA
1.B.1.a.2.ii	Post-mining activ.		0.067	2.71	NA	NA	NA	NA
1.B.1.b	Solid fuel transformation	6.4	30	0.192	NA	NA	NA	NA
Total year 2013				**126.59**		**194.88**		**NA**
Total year 2012				158.68		259.41		NA
Index 2013/2012				0.80		0.75		NA
Total year 1990				364.79		456.24		NA
Index 2013/1990				0.35		0.43		NA

*) *Country specific data; +) Methodology and emission factors are explained in 3.3.1.2.*

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is shown in detail in the following outline.

2013								
Structure of sector		**Source of Activity data**	**Emission factors**			**Method used**		
			CH_4	**CO_2**	**N_2O**	**CH_4**	**CO_2**	**N_2O**
1.B.1.a	Coal mining/handl.	CzSO				Tier 1-2	Tier 1-2	-
1.B.1.a.1	Underground mines	CzSO				Tier 1-2	Tier 1-2	-
1.B.1.a.1.i	Mining	CzSO	CS	CS	NA	Tier 2	Tier 2	-
1.B.1.a.1.ii	Post-mining activ.	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.1.iii	Abandoned mines	various+)	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.2	Surface mines	CzSO				Tier 1	Tier 1	-
1.B.1.a.2.i	Mining	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.2.ii	Post-mining activ.	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.b	Solid fuel transformation	FAOSTAT	D	D	NA	Tier 1	Tier 1	-

+) Methodology and emission factors are explained in 3.3.1.2.

The source category 1.B.1 Solid Fuels consists of three sub – source categories: source category 1B.1.a Coal mining and Handling, source category 1.B.1.b Coal transformation and source category 1.B.1.c Other.

The main process that emits more than 80% of methane emissions from the category 1.B.1 Solid Fuels 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.

Besides methane, during mining of coal mass a certain amount of carbon dioxide is released, that accompanies methane in the firedamp. CO_2 is reported only for the underground mining of hard coal, for surface mining of lignite emission factor is not available.

The proportion of subcategory 1.B.2 - Solid fuel transformation in the total emissions of greenhouse gases is quite minor. Subcategory 1.B.1.c - Other is not used, because for reporting the previous subcategories are used.

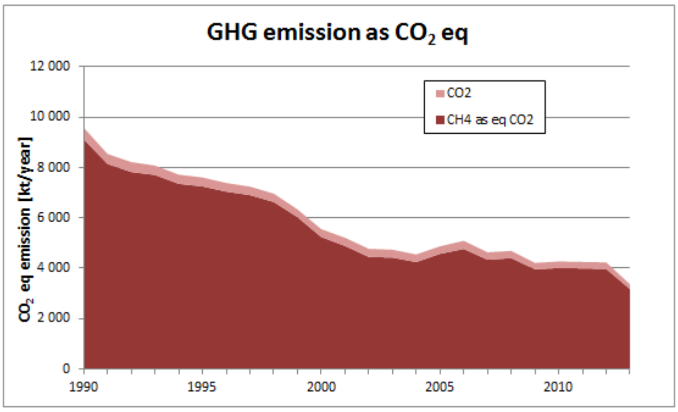


Fig. 3-62 The trend of GHG emissions and the relationship between emissions of CO_2 and CH_4 (1.B.1)

The graph on Fig. 3-62 shows the time trend of total emissions of greenhouse gases in the entire subsector 1.B.1. The chart also demonstrates the share of CO_2 emissions in the total GHG emissions, which on average makes about 6%.

The contribution of the individual subsectors to the total emissions of CH_4, depending on the volume of mining from undergroung mines (hard coal) and surface mines (lignite) in category 1.B.1 is shown on the graph in Fig. 3-63.

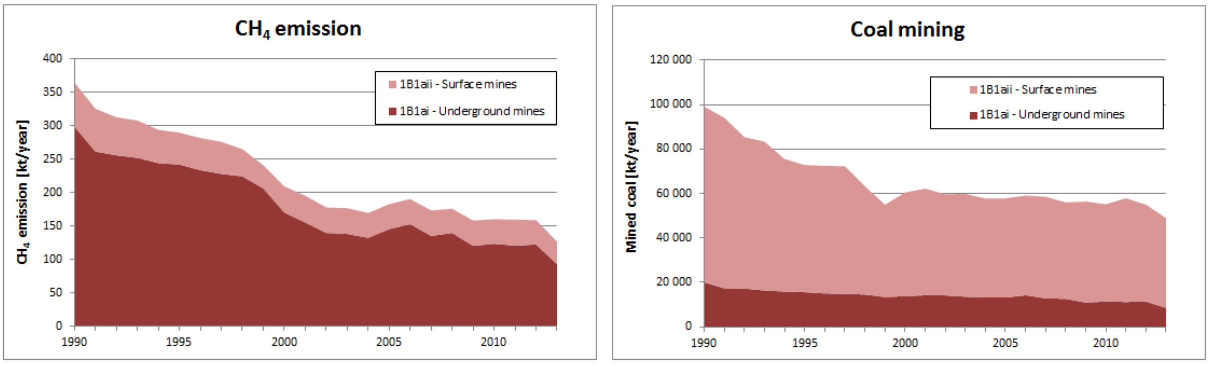


Fig. 3-63 The ratio of methane emissions from Underground mines and Surface mines and the corresponding development of mining of Hard Coal and Lignite (1.B.1)

The Czech Republic has historically mined and is still mining large volumes of lignite, primarily for energy purposes. Hard coal is used for energy purposes, as well as for the production of metallurgical coke. Hard coal mining, although its volume is about 20% of the total volume, is accompanied by considerably more significant CH_4 emissions than mining of lignite.

3.3.1.1.1 Coal Mining and Handling (CRF 1.B.1.a)

In the Czech Republic, mainly Hard Coal is mined in underground mines (i.e. Hard Coal: Coking Coal and Bituminous Coal). Currently, underground mines are in operation in the Ostrava-Karviná coalmining 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. Emissions from this mine are reported together with surface mining of Brown Coal – Lignite in subcategory 1.B.1.a.2 Surface Mines.

Data for mining of various types of coal are taken from the CzSO report for the IEA/EUROSTAT (the report CZECH_COAL.xls). For control purposes are used data from the miners yearbooks issued by the State Mining Administration and the Employers' Association of Mining and Oil Industries.

Underground Mines (CRF 1.B.1.a.1)

In underground 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.

Underground Mining Activities (1.B.1.a.1.i)

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.

Post-Mining Activities (1.B.1.a.1.ii)

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

Abandoned underground mines (1.B.1.a.1.iii)

Abandoned underground mines in the Czech Republic are located in Kladno Basin (near Kladno, 30 km northwest of Prague) and in the Ostrava-Karvina coalfield - OKR (North Moravia). In terms of methane emissions are relevant only abandoned mines in OKR. Coal mining in the Kladno Basin was terminated in 2002. In these mines methane was absent, so the methane emissions estimate is made only from OKR mines.

In the Ostrava-Karvina coalfield coal has been extracted for more than two hundred years. Crucial decline of mining in this area started in 1991, but the closure of mines occurred in the 20s of the 20th century.

Ostrava mines have always been a significant sources of coal seam gas and in terms of mine safety regulations they were categorized under the mines with greatest threat of occurrence of methane. Methane is observed more than 100 years and reached its peak in the sixties when was the maximum in mining in Ostrava. At that time, exceeded the daily amount of gas is 500 thousand. m^3 CH_4. The gas was discharged from the mines using ventilation with 17 air pits and mine degassing. Amount on the gas in abandoned mines today, after the destruction of almost all pits, is stabilized at around 40 thousand. m^3 CH_4 per day. Based on the amount of methane escaped in recent years and using the international experience, can be forecasted that the gas will continue to be released from the underground spaces in Ostrava for a number of years.

Parts of abandoned mines have CH_4 recovery systems. There is company, which has established mining areas for mining of fire-damp in Ostrava-Karviná area. In the abandoned mines there are automatic suction devices and firedamp stations. Firedamp arises from abandoned mining pits and surface boreholes into abandoned areas. Mined firedamp is used at the place of mining in autonomous cogeneration units (aggregate for electricity energy production with an ignition combustion engine)(http://www.dpb.cz/).

Surface Mines (CRF 1.B.1.a.2)

Surface Mining Activities (1.B.1.a.2.i)

Lignite (Brown Coal) is mined in surface mines in the Czech Republic. Lignite is mined primarily in the Northern Bohemia area. Small parts of very young Lignite mines are located in Southern Moravia.

Prior to the commencement of surface mining in northern Bohemia, where today a decisive amount of lignite in the Czech Republic is mined, there were underground mines. The abundance of methane in these mines has never been a problem. If there was an explosion in the mines, it was caused by swirling of coal dust. Surface mining began in the 50s of the 20th century and in the period after 1990 the underground mines were already not in use.

Post-Mining Activities (1.B.1.a.2.ii)

The activity data are the same as in category 1.B.1.a.2.i Mining Activities. It is assumed that the entire mined volume undergoes treatment during which residual methane is released.

3.3.1.1.2 Solid Fuel Transformation (CRF 1.B.1.b)

Production of Coke from Coking Coal

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

Production of briquettes from Brown Coal

Fugitive methane emissions from coal treatment prior to the actual briquetting process are listed under 1.B.1.a.1.ii Post-Mining Activities. CO_2 emissions from the actual production of briquettes are included in subcategory 1.A.2.g.

Production of charcoal

CH_4 emissions from charcoal production were estimated by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); the value of 1000 kg CH_4/TJ of charcoal produced was used. Since there are no available official activity data about charcoal production in the Czech Republic, the un-official data from FAOSTAT statistics were used. The missing data were extrapolated. The default net calorific value 30 MJ/kg (Table 1-13 in Revised 1996 Guidelines) was used to convert activity data to the energy units. Resulting CH_4 emissions please see in the Tab. 3-26.

Tab. 3-26 CH_4 emissions from charcoal production

1.B.1.b Solid Fuel Transformation			
	Production	Production	CH_4 emissions
	Gg/year	TJ/year	Gg/year
1990	1.00	30.00	0.03
1991	1.00	30.00	0.03
1992	1.00	30.00	0.03
1993	1.00	30.00	0.03
1994	1.00	30.00	0.03
1995	1.00	30.00	0.03
1996	1.00	30.00	0.03
1997	1.00	30.00	0.03
1998	1.80	54.00	0.05
1999	2.60	78.00	0.08
2000	3.40	102.00	0.10
2001	4.20	126.00	0.13
2002	5.00	150.00	0.15
2003	6.00	180.00	0.18
2004	6.00	180.00	0.18
2005	6.00	180.00	0.18
2006	6.00	180.00	0.18
2007	6.00	180.00	0.18
2008	6.00	180.00	0.18
2009	6.00	180.00	0.18
2010	6.60	198.00	0.20
2011	6.40	192.00	0.19
2012	6.40	192.00	0.19
2013	6.40	192.00	0.19

Fugitive CO_2 emissions are not estimated or are negligible and no known method is available for their determination in this category (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) and also IPCC 2006 Guidelines (IPCC, 2006) do not provide default emission factor.

3.3.1.1.3 Other (CRF 1.B.1.c)

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

3.3.1.2 Methodological issues

Underground Mines (CRF 1.B.1.a.1)

Underground Mining Activities (1.B.1.a.1.i)

Country specific 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 Tab. 3-27, see (Takla and Nováček, 1997).

Tab. 3-27 Coal mining and CH_4 emissions in the Ostrava - Karvina coal-mining area

	Coal mining [mil. t/year]	CH_4 emissions [mil. m^3/year]	Emission factors [m^3/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	20.60	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 coalmining area for years 1990 - 1999. The emission factor set by estimation at 50% of this value was used for the remaining Hard Coal from underground 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).

For the period after 2000 were determined new, revised emission factors CH_4/t mined coal.

The management of OKD, a.s. (Ostrava-Karviná mines, joint share company) was contacted since this company monitors in very detail the issues about methane production. In response to a request from the reporting team, the company provided a document in which the total amount of gas released by OKD mines was determined, together with the amount of methane withdrawn by degassing, the amounts of methane used for industrial purposes, venting of methane from degassing and the total amount of methane released into the atmosphere. A summary of the information provided is given in Tab. 3-28.

Tab. 3-28 Methane production from gas absorption of mines and its use

year	mil.m^3 CH_4 * year^{-1}				
	total amount of gas	pumped out by gas absorption	industrial use	venting from gas absorption into the atmosphere	released into the atmosphere - total
2000	236.7	84.1	77.9	6.2	158.8
2001	210.7	73.9	71.1	4.0	140.8
2002	210.0	81.0	70.3	1.3	130.3
2003	200.6	74.8	72.8	2.0	127.8
2004	194.6	77.1	73.4	3.2	120.7
2005	207.7	73.9	70.3	3.6	137.4
2006	221.1	76.9	75.9	0.8	145.0
2007	194.7	71.5	71.0	0.5	123.7
2008	199.5	68.8	68.5	0.3	131.0

This data was used to calculate the emission factors and to determine the average emission factor, which is used for the period after 2000-2008.

The emission factors given in Tab. 3-29 are used for 2000 – 2008. After 2008, the emission factor calculated as the average value from the values for 2000-2008, i.e. 8.12 t/kt, is used. Research with aim to develop this emission factor was performed in 2011.

Tab. 3-29 Calculation of emission factors from OKD mines for period 2000 onwards

year	OKD mining [kt/year]	CH_4 emissions [t/year]	EF [t CH_4/kt]
2000	11 514	106 396	9.24
2001	11 844	94 336	7.96
2002	12 049	87 301	7.25
2003	11 301	85 626	7.58
2004	10 901	80 869	7.42
2005	10 822	92 058	8.51
2006	11 656	97 150	8.33
2007	10 153	82 879	8.16
2008	10 030	87 770	8.75
2000 - 2008	100 270	814 385	8.12

For years 2000 – 2008 were used emission factors given in Tab. 3-29 for calculation of emission factors from OKD mines. For years onwards 2008 is used average emission factors from the period 2000-2008; 8.12 t/kt of mined hard coal, for period before 1999 the value is same as in previous submission 12.3 t/kt of mined coal (Takla and Nováček, 1997).

This emission factor can be considered as emissions factor on the level Tier II – it is country-specific emission factor, which is applicable for Ostrava-Karviná area.

For other mines in the Czech Republic where hard coal was also mined, the value of 6.7 t/kt was used – the same as in previous submissions. However it is necessary to remind that underground mining in the mines of other areas than OKD is really minor and at the end of the first decade of 21st century was completely stopped.

Country specific emission factors were determined for calculation of fugitive carbon dioxide emissions. An extra study was performed to determine the CO_2 emission factor for underground hard coal mining. Monthly data on the concentrations and amounts of CO_2 were processed for all the exhaust air shafts in the OKD area for 2009, 2010 and for part of 2011. These data yielded an average value of the emission factor, which is related to the volume of mining. The emission factor is equal to 22.75 t CO_2/kt of mined coal and this emission factor is country specific – Tier II level. This value is valid for the OKD area. The author of the study recommended that the determined emission factor for 1990 – 2009 be used. He determined an emission factor 22.68 t CO_2/kt of mined coal for 2010 and it was recommended that this value also be used for the subsequent years. These emission factors were used to extend the data for CO_2 emissions for underground hard coal mining; the values are given in the Tab. 3-30.

Tab. 3-30 Emission factors and emissions from underground mining of hard coal

year	production OKD	emission factor	emission of CO_2
	[kt/year]	[t CO_2/kt]	[kt CO_2/year]
1990	20 059	22.75	456.3
1991	17 371	22.75	395.1
1992	17 271	22.75	392.9
1993	16 419	22.75	373.5
1994	15 942	22.75	362.6
1995	15 661	22.75	356.2
1996	15 109	22.75	343.7
1997	14 851	22.75	337.8
1998	14 620	22.75	332.6
1999	13 468	22.75	306.4
2000	13 855	22.75	315.2
2001	14 246	22.75	324.1
2002	14 200	22.75	323.0
2003	13 614	22.75	309.7
2004	13 272	22.75	301.9
2005	13 227	22.75	300.9
2006	14 280	22.75	324.8
2007	12 886	22.75	293.1
2008	12 622	22.75	287.1
2009	11 001	22.75	250.2
2010	11 435	22.68	259.3
2011	11 265	22.68	255.4
2012	11 440	22.68	259.4
2013	8 594	22.68	194.9

Post-Mining Activities (CRF 1.B.1.a.1.ii)

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 1.B.1.a.1.i Mining Activities.

Tab. 3-31 contains of fugitive methane emissions from post-mining operations with Hard Coal from Underground mines.

Tab. 3-31 Used emissions factors and calculation of CH_4 emissions from underground coal mining – post mines operations in period 1990 - 2013

year	production OKD	emission factor	emission of CO_2
	[kt/year]	[t CO_2/kt]	[kt CO_2/year]
1990	20 059	1.64	34.3
1991	17 371	1.64	29.8
1992	17 271	1.64	29.1
1993	16 419	1.64	28.1
1994	15 942	1.64	27.0
1995	15 661	1.64	26.6
1996	15 109	1.64	25.7
1997	14 851	1.64	25.1
1998	14 620	1.64	24.7
1999	13 468	1.64	22.7
2000	13 855	1.64	23.3
2001	14 246	1.64	23.9
2002	14 200	1.64	23.5
2003	13 614	1.64	22.4
2004	13 272	1.64	21.8
2005	13 227	1.64	21.7
2006	14 280	1.64	23.4
2007	12 886	1.64	21.2
2008	12 622	1.64	20.8
2009	11 001	1.64	18.1
2010	11 435	1.64	18.8
2011	11 265	1.64	18.5
2012	11 440	1.64	18.8
2013	8 594	1.64	14.1

Abandoned underground mines (CRF 1.B.1.a.1.ii)

Calculation of methane emissions from abandoned mines has been carried out in accordance with the methodology IPCC 2006 at the level Tier 1. For the purposes of this calculation, the number of closed mines in the Ostrava-Karvina coalfield was determined in prescribed intervals (intervals years 1901-1925, 1926-1950, 1951-1975 , 1976 - 2000 2001 to the present). Given that in the Ostrava-Karvina coalfield occur only mines with high amount of the gas, were used values for the percentage of coal mines that are gassy from the column High (2006 IPCC Guidelines for National Greenhouse Gas Inventories: Tab. 4.1.5: TIER 1 – ABANDONED UNDERGROUND MINES, DEFAULT VALUES - PERCENTAGE OF COAL MINES THAT ARE GASSY, page 4.24.), the following:

1901 – 1925: 0%

1926 – 1950: 50%

1951 – 1975: 75%

1976 – 2013: 100%

For calculating the emissions were used emission factors from Table 4.1.6, p. 4.25 (TABLE 4.1.6: TIER 1 - Abandoned UNDERGROUND MINES - EMISSION FACTOR, MILLION M3 methane/MINE).

Total emissions of methane from abandoned mines have, since 2005 gradually reduced in the context of increasing degassing of abandoned mines by company Green Gas (electricity generation at cogeneration units, stationed on-site extraction of methane). The overall data and the calculation procedure is shown on Tab. 3-32.

Tab. 3-32 Emission of CH_4 on abandoned mines

year	CH_4 emission in period [kt/year]				Calculated emission	Use of CH_4 [%]	Total emission
	1926 - 1950	1951 - 1975	1976 - 2000	2001 - 2013			
1990	0.46	2.40	0.00		2.86		2.86
1991	0.46	2.36	1.79		4.60		4.60
1992	0.45	2.32	3.96		6.73		6.73
1993	0.45	2.28	7.18		9.90		9.90
1994	0.44	2.24	9.27		11.95		11.95
1995	0.44	2.21	10.49		13.13		13.13
1996	0.43	2.17	10.43		13.04		13.04
1997	0.43	2.14	9.87		12.43		12.43
1998	0.43	2.11	9.38		11.92		11.92
1999	0.42	2.08	9.46		11.96		11.96
2000	0.42	2.05	9.55		12.03		12.03
2001	0.42	2.02	9.19		11.63		11.63
2002	0.41	1.99	8.86		11.27		11.27
2003	0.41	1.97	8.56	1.18	12.12		12.12
2004	0.41	1.94	8.31	0.97	11.63		11.63
2005	0.40	1.92	8.05	0.85	11.22	5.0	10.66
2006	0.40	1.90	7.84	0.76	10.90	7.5	10.08
2007	0.40	1.87	7.62	0.69	10.59	20.0	8.47
2008	0.40	1.85	7.44	0.64	10.33	25.0	7.75
2009	0.39	1.83	7.26	1.80	11.29	50.0	5.65
2010	0.39	1.81	7.09	1.70	10.99	60.0	4.40
2011	0.39	1.79	6.94	1.61	10.73	70.0	3.22
2012	0.38	1.77	6.79	1.53	10.48	70.0	3.15
2013	0.38	1.76	6.65	1.47	10.25	70.0	3.08

Surface Mines (CRF 1.B.1.a.ii)

Total emissions, used activity data and emission factors for proper extraction of lignite (Brown Coal) from surface mines and post-mining related adjustments are presented in the Tab. 3-33.

Tab. 3-33 Used activity data, emissions factors and calculation of CH_4 emissions from surface coal mining and post mines operations in period 1990 - 2013

year	Brown Coal production [kt/year]	Emission factors for activities: mines [t CH_4/kt]	Emission factors for activities: post-mines [t CH_4/kt]	emission of CH_4 [kt CH_4/year]
1990	78 983	0.77	0.067	66.1
1991	76 680	0.77	0.067	64.2
1992	68 084	0.77	0.067	57.0
1993	66 884	0.77	0.067	56.0
1994	59 568	0.77	0.067	49.9
1995	57 163	0.77	0.067	47.9
1996	57 356	0.77	0.067	48.0
1997	57 446	0.77	0.067	48.1
1998	48 619	0.77	0.067	40.7
1999	41 524	0.77	0.067	34.8
2000	46 655	0.77	0.067	39.1
2001	47 960	0.77	0.067	40.2
2002	45 480	0.77	0.067	38.1
2003	46 240	0.77	0.067	38.7
2004	44 498	0.77	0.067	37.3
2005	44 619	0.77	0.067	37.4
2006	44 849	0.77	0.067	37.6
2007	45 664	0.77	0.067	38.2
2008	43 362	0.77	0.067	36.3
2009	45 416	0.77	0.067	38.0
2010	43 774	0.77	0.067	36.7
2011	46 639	0.77	0.067	39.1
2012	43 533	0.77	0.067	36.5
2013	40 385	0.77	0.067	33.8

Determination of activity data and emission factors for mining and post-mining treatment is given in the description of the individual activities on surface mines.

Surface Mining Activities (1.B.1.a.2)

Post-Mining Activities (1.B.1.a.2.ii)

Data from the source part of the questionnaire completed in the CzSO Questionnaire (CzSO, 2014), was employed to determine activity data on extraction of Brown Coal and Lignite. The mining yearbooks and other data sources continue to be used only 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).

3.3.1.2.1 Solid Fuel Transformation (CRF 1.B.1.b)

Emission calculation was performed for the production of wood charcoal at Tier I, using default emission factors - see chapter 3.3.1.1.2.

CH_4 emissions from charcoal production were estimated by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); the value of 1000 kg CH_4/TJ of charcoal produced was used. Since there are no available official activity data about charcoal production in the Czech Republic, the un-official data from FAOSTAT statistics were used. The missing data were extrapolated. The default net calorific value 30 MJ/kg (Table 1-13 in Revised 1996 Guidelines) was used to convert activity data to the energy units.

3.3.1.3 Uncertainties 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 2013. The uncertainties in the activity rate result primarily from inaccuracies in weighing of extracted coal. Extensive research concerning new evaluation of uncertainties was performed last year. Uncertainties in determining the activity data were estimated at 4%.

Uncertainties in calculating methane emissions further follow from the emission factors employed. The emission factors for determining emissions from underground mining of hard 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 uncertainty in the emission factors is considered to be at the level of 12.9%.

The uncertainty in the CO_2 emission factor is considered to be at the level of 25%.

Summary of uncertainty estimates provides Tab. 3-34.

Tab. 3-34 Uncertainty estimates for fugitive emissions from Solid Fuels

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.B.1.a Coal Mining and Handling	4	25	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement
CH_4	1.B.1.a Coal Mining and Handling	4	13	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement

3.3.1.4 Category-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 sector compiler. 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 CzSO 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.

Furthermore, the correct usage of the methodology at Tier I level for the calculation of CH_4 emissions from abandoned mines and the performance of own calculations were checked. The calculation procedure was consulted with an independent expert from the VSB-Technical University of Ostrava. It was concluded that the input data and the method of calculation are in line with the methodology.

Control that the transfer of numerical data from the working set to the CRF Reporter does not reveal any differences. The final working set in EXCEL format is locked to prevent intentional rewriting of values and archived at the coordination workplace. The protocols on the performed QA/QC procedures are stored too.

3.3.1.5 Category-specific recalculations

No recalculations were performed in this submission.

3.3.1.6 Category-specific planned improvements

Given that the issue of emissions from abandoned mines was included in the same time as the transition to new methodology IPCC 2006, Tier 1 approach was used. Planned improvements assume a change to a higher level, at least Tier II. In terms of the planned improvements, was ensured a cooperation with the specialist on the issue of leakage of methane from abandoned mines in the Ostrava-Karvina coalfield.

In the other sub-sectors no improvements are planned at the present.

3.3.2 Oil and Natural Gas (CRF 1.B.2)

The category is divided according to IPCC 2006 and CRF Reporter into subcategories:

- 1.B.2.a Oil
  - 1.B.2.a.1 Exploration
  - 1.B.2.a.2 Production
  - 1.B.2.a.3 Transport
  - 1.B.2.a.4 Refining/Storage
  - 1.B.2.a.5 Distribution of Oil Products
  - 1.B.2.a.6 Other
- 1.B.2.b Natural Gas
  - 1.B.2.b.1 Exploration
  - 1.B.2.b.2 Production
  - 1.B.2.b.3 Processing
  - 1.B.2.b.4 Transmission and Storage
  - 1.B.2.b.5 Distribution
  - 1.B.2.b.6 Other
- 1.B.2.c Venting and Flaring
  - 1.B.2.c.1 Venting
  - 1.B.2.c.2 Flaring

3.3.2.1 Category description (CRF 1.B.2)

The structure of the sector, the corresponding activity data, the used emission factors and emissions of individual greenhouse gases can be seen on the following outline.

1.B.2, 2013								
Structure of sector		**Activity**	**CH_4**		**CO_2**		**N_2O**	
		data	**EF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
		[PJ]	**[t CH_4/PJ]**	**[kt]**	**[t CO_2/PJ]**	**[kt]**	**[kg N_2O/PJ]**	**[kt]**
1.B.2.a.1	Exploration	NA						
1.B.2.a.2	Production and Upgr.	6.53	4.746*)	0.031	7.576	0.049	NA	-
1.B.2.a.3	Transport	282.6	0.146	0.041	0.013	0.004	NA	-
1.B.2.a.4	Refining	282.6	0.585	0.165	NA	-	NA	-
1.B.2.a.5	Distrib. of Oil Prod.	NA						
1.B.2.a.6	Other	NO						
1.B.2.b.1	Exploration	NO						
1.B.2.b.2	Production	8.581	38.65*)	0.332	+)	0.0001*)	NA	-
1.B.2.b.3	Processing	NO						
1.B.2.b.4	Transmission and	1 194.1	5.058*)	6.040	+)	0.024*)	NA	-
	Storage	160.3	4.515*)	0.724	+)	0.003*)	NA	-
1.B.2.b.5	Distribution	143.4	113.3*)	16.243	+)	0.065*)	NA	-
1.B.2.b.6	Other	NO						
Total year 2013				**25.12**		**6.47**		**0.0001**
Total year 2012				27.11		6.56		0.0001
Index 2013/2012				0.93		0.99		0.99
Total year 1990				43.20		2.20		0.00003
Index 2013/1990				0.58		2.94		3.14

**) Country specific data;*

+) As emission factor is used the average annual CO_2 content in natural gas

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is shown in details in the following outline.

2013								
Structure of sector		**Source of Activity data**	**Emission factors**			**Method used**		
			CH_4	**CO_2**	**N_2O**	**CH_4**	**CO_2**	**N_2O**
1.B.2.a.1	Exploration	NA						
1.B.2.a.2	Production and Upgrading	CzSO	CS	D	NA	Tier 2	Tier 1	-
1.B.2.a.3	Transport	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.2.a.4	Refining	CzSO	D	NA	NA	Tier 1	-	-
1.B.2.a.5	Distribution of Oil Products	NA						
1.B.2.a.6	Other	NO						
1.B.2.b.1	Exploration	NO						
1.B.2.b.2	Production	CzSO	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.3	Processing	NO						
1.B.2.b.4	Transmission and	CzSO	CS	CS	NA	Tier 2	Tier 2	-
	Storage	ERU	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.5	Distribution	ERU	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.6	Other	NO						

Approximately 93% 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 very 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 2006 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.

The graph in Fig. 3-65 gives an overview of the trend in emissions in this category in the time series since 1990.

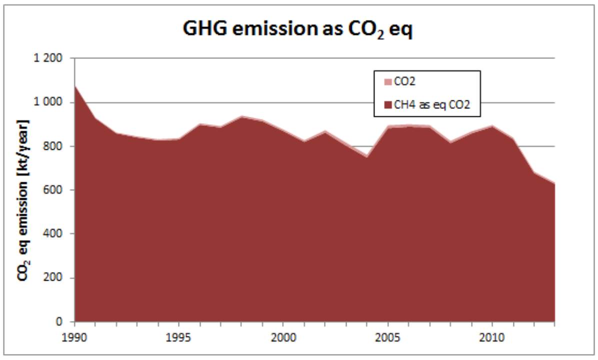


Fig. 3-64 The trend of GHG emissions and the relationship between CO_2 and CH_4 emissions (1.B.2)

The graph on Fig. 3-64 shows that the proportion of total CO_2 emissions from the total GHG emissions is negligible (approximately 0.1%).

The contribution of the individual subsectors (Oil and Natural Gas) to the total CH_4 emissions throughout the period in the category 1.B.2 is shown on Fig. 3-65.

As shown on Fig. 3-65 for the amount of CH_4 emissions in sector 1.B.2. Oil and Natural Gas are therefore crucial the emissions, produced in the gas industry.

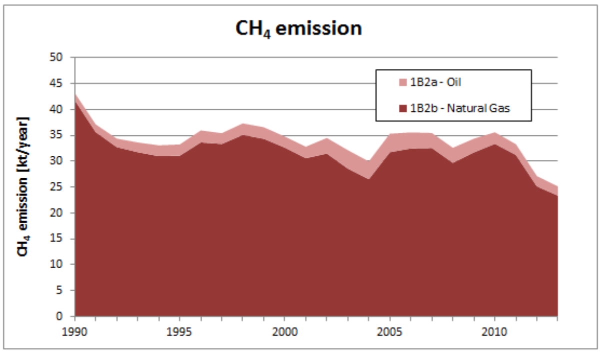


Fig. 3-65 The ratio of methane emissions from subsector Oil (1.B.2.a) and Natural Gas (1.B.2.b)

3.3.2.1.1 Oil (CRF 1.B.2.a)

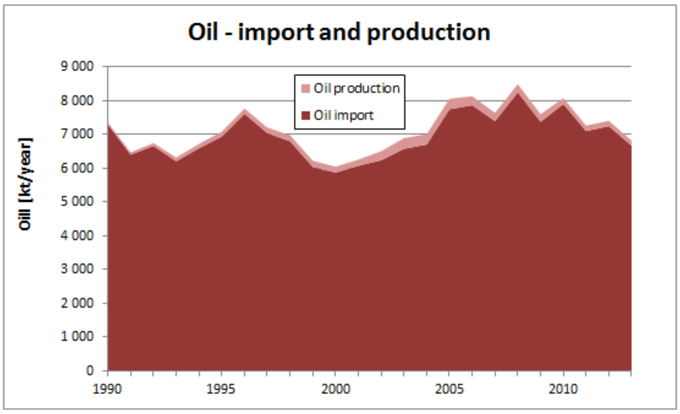


Fig. 3-66 Crude Oil production end import in the CR in 1990 – 2013

In subcategory Oil are reported emissions from mining, processing of domestic crude oil and emissions from refining of imported crude oil. The share of domestic crude oil is very small - about 3% (from 0.7 to 4.8%). The time profile of domestic production and imports of crude oil in the Czech Republic is shown on Fig. 3-66.

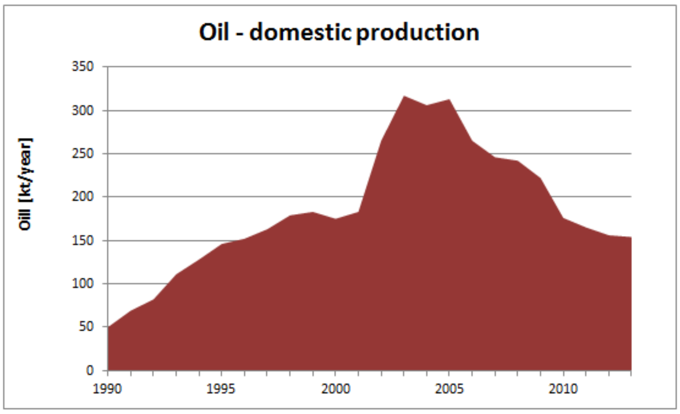
GHG emissions from Crude Oil transport and refining and from Crude Oil production, which is performed in the Czech Republic in combination with mining of Natural Gas, are reported in this category. CO_2 emissions from the refinery resulting from combustion processes (including flaring) are included in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

Exploration (1.B.2.a.iii.1)

Exploration is not systematically performed in the Czech Republic.

Production and Upgrading (1.B.2.a.iii.2)

Crude Oil is mined in the Czech Republic in Southern Moravia. The following Fig. 3-67 gives the amount of mined Crude Oil in the territory of the Czech Republic.



The quantity of crude oil extracted in each year depends on the amount of recoverable reserves. From Fig. 3-67 is visible that the maximum extraction was in the period from 2003 to 2006. It is expected that the decline in production until 2013 will continue.

Fig. 3-67 Crude Oil production in the CR in 1990 – 2013

Transport (1.B.2.a.iii.3)

Transport of Crude Oil in the territory of the Czech Republic is performed only in closed systems (pipeline transport – Oil pipeline Družba from Russia and Ingolstat from Germany). Default emission factors were used to calculate fugitive CH_4 and CO_2 emissions in this subsector.

Refining (1.B.2.a.iii.4)

Crude Oil is processed in the territory of the Czech Republic in two main refinery facilities. The total volume of Crude Oil processed in the Czech Republic is presented in Fig. 3-66.

Distribution of Oil Products (1.B.2.a.iii.5)

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.

Other (1.B.2.a.iii.6)

No other operations are considered.

3.3.2.1.2 Natural Gas (CRF 1.B.2.b)

In the subcategory Natural Gas are reported GHG emissions from domestic natural gas production and emissions related to the operation of individual parts of the gas system (import, transit, storage and distribution to end users). The share of the domestic natural gas production is very small - about 3% (from 1.4 to 4.8%). The time profile of domestic production and import of natural gas in the Czech Republic is shown on Fig. 3-68.

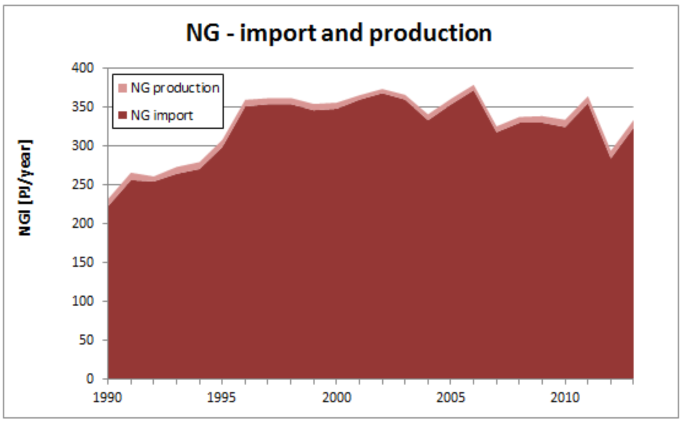


Fig. 3-68 Natural Gas production end import in the CR in 1990 – 2013

Exploration (1.B.2.b.iii.1)

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

Production (1.B.2.b.iii.2)

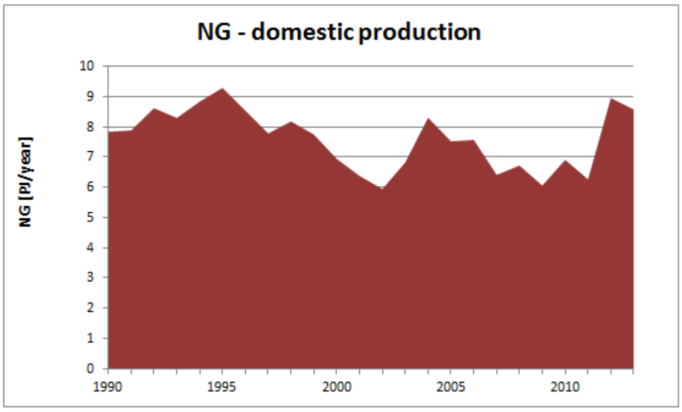


Fig. 3-69 Natural Gas production in the area of CR in 1990 – 2013

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 hard coal deposits. The following Fig. 3-69 gives the amount of production Natural Gas in the territory of the Czech Republic.

The development of domestic extraction is relatively stable over time. Fluctuations in individual years are due to technical and geological conditions of mining and market demand.

Processing (1.B.2.b.iii.3)

Gas treatments, except for drying, are not performed in the Czech Republic. The drying process is not a source of GHG emissions.

Transmission and Storage (1.B.2.b.iii.4)

The calculation of GHG emissions in this subcategory, is carried out in two steps: independently in the first step is carried out an estimation of the emissions for the transit system and high-pressure gas pipelines, and in the second step emissions from underground gas storage facilities are estimated. For each part of the gas system is used a different methodological approach.

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 2013, the high-pressure gas pipelines had an overall length of 13,049 km.

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.

Methane 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.

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 4,709 mil. m^3 in 2013.

Distribution (1.B.2.b.iii.5)

Emissions from distribution gas pipelines, with an overall length in 2013 of 48,334 km, and during consumption at the end consumer are reported in this category. The distribution networks are being continuously lengthened and the number of customers is increasing.

Other (1.B.2.b.iii.6)

No additional emissions are reported.

3.3.2.1.3 Venting and Flaring (CRF 1.B.2.c)

In the Czech Republic there is only one deposit, which is in South Moravia. Crude oil extraction takes place there, along with natural gas production.

Tab. 3-35 gives the CH_4 and CO_2 emissions from Venting for domestic production (mining) of Crude Oil; N_2O emissions are not included in this subcategory since no emission factor is available for their calculation. Tab. 3-35 further contains values of emissions CH_4, CO_2 and N_2O from Flaring in domestic production of Crude Oil. From the table it is clear that this is a minor proportion from the total emissions in whole subcategory Oil and Gas (1.B.2.a).

Tab. 3-35 Emissions of CH_4, CO_2 and N_2O from Venting and Flaring in 1990 – 2013

	Venting - emissions [t/year]		Flaring - emissions [t/year]		
	CH_4	CO_2	CH_4	CO_2	N_2O
1990	0.49	0.10	0.001	1.92	0.00003
1991	0.68	0.14	0.002	2.64	0.00004
1992	0.80	0.17	0.002	3.14	0.00005
1993	1.09	0.23	0.003	4.25	0.00007
1994	1.25	0.26	0.003	4.90	0.00008
1995	1.43	0.30	0.003	5.59	0.00009
1996	1.49	0.31	0.004	5.82	0.00009
1997	1.60	0.33	0.004	6.24	0.00010
1998	1.75	0.36	0.004	6.85	0.00011
1999	1.81	0.37	0.004	7.06	0.00011
2000	1.73	0.36	0.004	6.76	0.00011
2001	1.81	0.37	0.004	7.06	0.00011
2002	2.62	0.54	0.006	10.24	0.00016
2003	3.13	0.65	0.008	12.23	0.00019
2004	3.02	0.62	0.007	11.78	0.00019
2005	3.08	0.64	0.007	12.05	0.00019
2006	2.62	0.54	0.006	10.23	0.00016
2007	2.44	0.50	0.006	9.52	0.00015
2008	2.39	0.50	0.006	9.35	0.00015
2009	2.19	0.45	0.005	8.58	0.00014
2010	1.76	0.36	0.004	6.86	0.00011
2011	1.65	0.34	0.004	6.44	0.00010
2012	1.56	0.32	0.004	6.08	0.00010
2013	1.54	0.32	0.004	6.01	0.00010

3.3.2.2 Methodological issues

During the 1990's, 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.

3.3.2.2.1 Oil (CRF 1.B.2.a)

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 1.A.1.b Crude Oil Refining.

Exploration (1.B.2.a.iii.1)

Exploration is not systematically performed in the Czech Republic. For this reason, there are no known procedures for the determination of emissions in this subsector.

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

Production and Upgrading (1.B.2.a.iii.2)

Activity data for determining CH_4 and CO_2 emissions are taken from the CzSO – IEA questionnaires and controlled using data from the Mining Yearbook.

CH_4 emissions are determined as the product of annual Crude Oil mining and the emission factor. The emission factor has a value of 4,792 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).

CO_2 emissions are estimated based on the default emission factor (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52).

EF CO_2: 2.8E-04 Gg per 10^3 m^3 total oil production = 7 576 kg/PJ

For the estimation of N_2O emissions, no emission factor was available.

Transport (1.B.2.a.iii.3)

In this case, the activity data correspond to the total amount of petroleum transported through the territory of the Czech Republic by the pipeline system in the individual years. This amount corresponds to the Total Crude Oil input to refineries. The default emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52 are employed to calculate the CH_4 and CO_2 emissions.

EF CH_4: 5.4E-06 Gg per 10^3 m^3 oil transported by pipeline = 146 kg/PJ

EF CO_2: 4.9E-07 Gg per 10^3 m^3 oil transported by pipeline = 13 kg/PJ

These emission factors were used to calculate fugitive emissions for the years since 1990.

For the estimation of N_2O emissions, no emission factor was available.

Refining (1.B.2.a.iii.4)

Methane emissions from refining are calculated using IPCC Tier 1 methodology (Table 4.2.4 in 2006 IPCC Guidelines). Emissions are calculated by multiplying the amount of Crude Oil input to refinery by the emission factor. The emission factor value used was 585 kg/PJ.

This emission factor is based on the data from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52

EF CH_4: 2.6×10^{-6} to 41.0×10^{-6} Gg per 10^3 m^3 oil refined = 585 kg/PJ (average)

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

Distribution of Oil Products (1.B.2.a.iii.5)

The available IPCC methodology does not provide any EF for CO_2, CH_4 or N_2O – notation key – NA. The products which originate during oil processing cannot contain CO_2 or CH_4. There isn't known process by which could arise fugitive CO_2 or CH_4 emissions during the distribution of oil products.

Other (1.B.2.a.iii.6)

Activity data: notation key: NO; CH_4, CO_2 and N_2O emissions – notation key NO.

3.3.2.2.2 Natural Gas (CRF 1.B.2.b)

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. (IPCC, 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 (Table 4.2.8. Classification of Gas losses as low, medium or high at selected types of Natural gas facilities, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 4.71)

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 1.B.2 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.

Exploration (1.B.2.b.iii.1)

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.

Production (1.B.2.b.iii.2)

Transmission and Storage (1.B.2.b.iii.4)

Distribution (1.B.2.b.iii.5)

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.

Tab. 3-36 Model calculation of CH_4 emissions in the Natural Gas sector (2013)

	EF		Activity data		Losses of NG
	value	units	value	units	mil.m^3/year
production	0.2	% vol.	252	mil. m^3	0.50
high pressure pipelines	600	m^3/km.year	13 049	km	7.83
transmission pipelines*)					1.15
compressors**)					0.20
storage***)					1.10
regulation stations	1 000	m^3/station	4 465	pcs	4.47
distribution network	300	m^3/km.year	48 334	km	14.50
final comsumption	2	m^3/consumer	2 860 345	pcs	5.72
Total					**35.47**
	Emissions in Gg (0.67 kg/m^3)				**23.34**

*) data from IRZ (Integrated Pollution Register of Czech Republic – Czech version of E-PRTR) - company NET4GAS

**) data from operating records of leakage Natural Gas - company RWE

***) data from operating records of leakage Natural Gas - company RWE Gas Storage

Emissions calculated in this model are then transformed to the structure of the sectors and subsectors according to the IPCC methodology.

3.3.2.2.3 Venting and Flaring (CRF 1.B.2.c)

The estimations of CO_2, CH_4 and N_2O emissions from venting and flaring in the course of oil production were obtained by using the default EFs provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (see table 4.2.4, pages 4.48 – 4.54). In this case the following EFs were taken:

Venting (Default Weighted Total)

CH_4: 8.7E-03 Gg per 10^3 m^3 total oil production

CO_2: 1.8E-03 Gg per 10^3 m^3 total oil production

N_2O: NA

Flaring (Default Weighted Total)

CH_4: 2.1E-05 Gg per 10^3 m^3 total oil production

CO_2: 3.4E-02 Gg per 10^3 m^3 total oil production

N_2O: 5.4E-07 Gg per 10^3 m^3 total oil production

Owing to the fact that activity data are required in kg/PJ, the value was converted to kg/PJ by using the typical value of density for crude oil of 880 kg/t and value NCV was taken from CzSO questionnaires IAE as a simple average for domestic oil (42 MJ/kg):

Venting

CH_4: 235 390 kg/PJ

CO_2: 48 701 kg/PJ

Flaring

CH_4: 568.2 kg/PJ

CO_2: 919 913 kg/PJ

N_2O: 14.61 kg/PJ

3.3.2.3 Uncertainties 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 2009. Uncertainties in determining the activity data are estimated at 7%. This estimate is based on the precision of measurement of the volumes of Crude Oil, Crude Oil products and Natural Gas.

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 1.B.2 Oil and Natural Gas is estimated to equal 75%.

Summary of uncertainty values provides Tab. 3-37.

Tab. 3-37 Uncertainty estimates for fugitive emissions from Oil and Natural Gas

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.B.2 Oil and Natural Gas	7	75	V. Neuzil, P. Fott, AD and EF unc. in line with 2006 Guidelines
CH_4	1.B.2 Oil and Natural Gas	7	75	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement

3.3.2.4 Category-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 sector compiler. 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 CzSO data were compared with the data from the Mining Yearbook (Mining Yearbook, 2013) 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 sector compiler.

3.3.2.5 Category-specific recalculations

No recalculations were performed in this submission.

3.3.2.6 Category-specific planned improvements

Currently there are no planned improvements in this category.

3.4 CO_2 transport and storage (CRF 1.C)

Not performed in the Czech Republic.

4 Industrial processes and product use (CRF Sector 2)

The sector of industrial processes of GHG emission inventory includes emissions from technological processes and not from fuel combustion used to supply energy for carrying out these processes. Consistent emphasis is put on the distinction between the emissions from fuel combustion in the Energy sector and the emissions from technological processes and production.

For example, in the production of cement, consideration is given only to emissions derived from the thermal decomposition of mineral raw materials (specifically CO_2 emissions from the decomposition of limestone) and not from fuel used to heat the rotary kiln (considered in category 1.A.2.f). 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.

In this submission due to the implementation of new methodology IPCC 2006 Guidelines (IPCC, 2006) significant changes were performed in this category. These changes apply to categorization and in some cases to approach in calculations of emissions (e.g. new emission factors). The most significant of all changes was the fusion of sectors Industrial processes and Solvent and Other Product Use. Furthermore the new methodology abandon monitoring of potential emissions (e.g. in 2.F), remain only actual emissions. Further innovations in the sector IPPU are: definite reallocation of non-energy fuels, emissions from prevention of decomposition of carbonates and sink of emissions from ammonia productions

In 2013, the total aggregate GHG emissions from industrial processes were 14 122.69 Gg of CO_2 equivalents, which represent increase of 4% compared to the previous year. Emissions decreased by 17% compared to the reference year 1990.

4.1 Overview of sector

4.1.1 General description and key categories identification

The major share of CO_2 emissions in this sector comes from sub-source categories 2.C.1 Iron and Steel Production and 2.A Mineral Products.

N_2O emissions coming from 2.B Chemical Industry and F-gas emissions and consumption are less significant. Iron and steel, Cement production, F-gases Use, Lime production and Nitric acid production can be considered to be key categories (KC) according to IPCC 2006 Guidelines (IPCC, 2006). Tab. 4-1 gives a summary of the main sources of direct greenhouse gases in this sector, shows share of national emissions in 2013 and lists type of key category analysis for key categories.

Tab. 4-1 Overview of key categories in sector Industrial Processes (2013)

Category	Gas	Character of category	% of total GHG*
2.C.1 Iron and Steel Production	CO_2	LA,TA	4.28
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	LA,TA	1.71
2.A.1 Cement Production	CO_2	LA,TA	0.87
2.B.8 Petrochemical and carbon black production	CO_2	LA,TA	0.62
2.A.2 Lime Production	CO_2	LA,TA	0.40
2.B.1 Ammonia Production	CO_2	LA	0.39
2.B.2 Nitric Acid Production	N_2O	TA	0.14
2.C.2 Ferroalloys Production	CH_4	TA	0.28

** 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*

4.1.2 Emissions trends

This chapter describes the emissions of greenhouse gases in more disaggregated way than chapter 2: Trends in Greenhouse Gas emissions.

GHG emissions in this category are driven mainly by economic development, supply and demand of products, where abatement technology is used only in specific cases (e.g. nitric acid production) or the driving force is different (e.g. ozone depleting substances).

GHG emission trends for the principal categories of industrial processes are depicted on Fig. 4-1 and Fig. 4-2. Emissions in 2009 and 2010 were rather influenced by the economic crisis. A brief description of the relevant category trends is provided for all the categories in the following chapters.

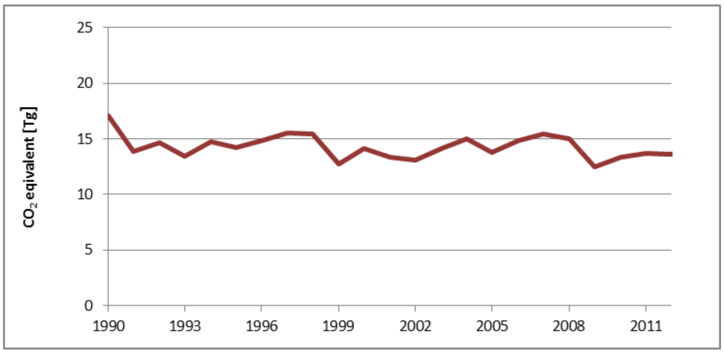


Fig. 4-1 GHG emissions trend from Industrial Processes, 1990 – 2013 [Tg CO_2 eq.]

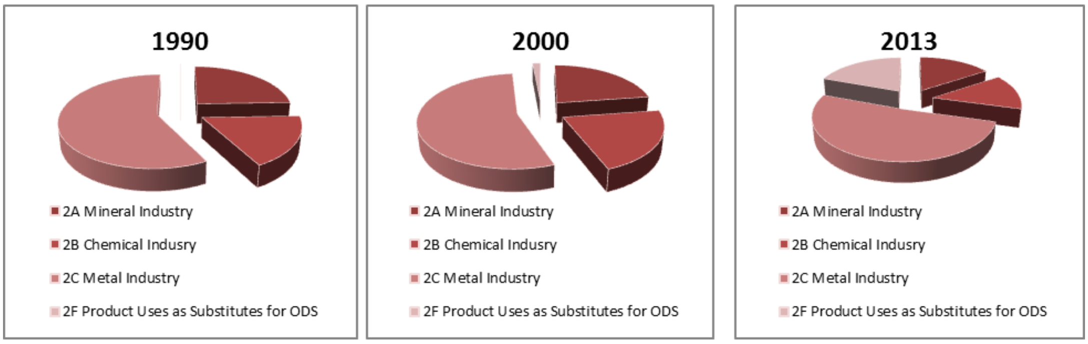


Fig. 4-2 Share of GHG emissions from individual subcategories on the whole sector of Industrial Processes in 1990, 2000, 2013 [Gg CO_2 eq.]

Category 2.A Mineral Products includes practically only emissions of CO_2 as well as category 2.C Metal Production. CO_2 emissions from the 2.B Chemical Industry comes from 2.B.1 Ammonia Production, while

N_2O emissions originate from 2.B.2 Nitric Acid Production. Industrial CH_4 emissions are insignificant. Emissions from the use of F-gases (2.E, mainly category 2.F and 2.G) are classified in greater detail in the Fig. 4-2.

4.2 Mineral Industry (CRF 2.A)

This category describes GHG emissions from the non-combustion processes from the following categories: 2.A.1 Cement Production, 2.A.2 Lime Production, 2.A.3 Glass Production, 2.A.4 Other Process Uses of Carbonates.

Fig. 4-3 depicts the share of CO_2 emissions in this category. The major share (62%) belongs to 2.A.1 Cement Production, 28% belongs to 2.A.2 Lime Production, 5% 2.A.3 Glass Production and 5% to 2.A.4 Other Process Uses of Carbonates. Tab. 4-2 lists the CO_2 emissions in the individual subcategories in 2.A Mineral Products in 2013.

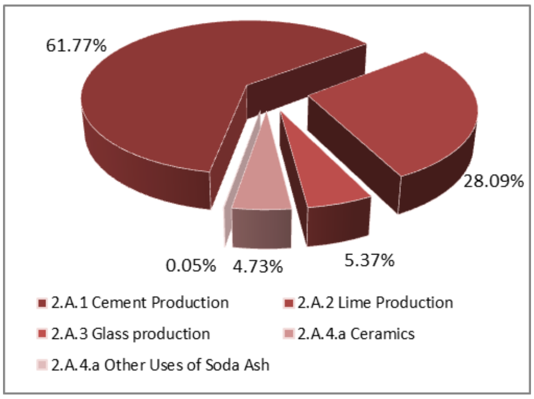


Fig. 4-3 The share of individual categories in CO_2 emissions from category 2.A Mineral Products in 2013 [Gg CO_2]

Tab. 4-2 CO_2 emissions in individual subcategories in 2.A Mineral Products category in 1990 – 2013

	Category 2.A - CO_2 emissions [Gg]				
	2.A.1 Cement Production	2.A.2 Lime Production	2.A.3 Glass production	2.A.4.a Ceramics	2.A.4.b Other use od Soda Ash
1990	2 489.18	1 336.65	123.66	153.37	NO
1991	2 308.92	844.66	106.02	127.93	NO
1992	2 468.42	831.46	104.61	123.12	NO
1993	2 194.55	778.67	101.47	147.18	NO
1994	2 208.38	806.53	109.71	150.98	NO
1995	2 005.01	817.53	83.20	144.39	NO
1996	2 116.49	830.73	87.50	175.76	NO
1997	2 083.36	852.73	97.00	213.49	NO
1998	2 067.65	797.00	101.20	271.46	NO
1999	1 962.91	787.47	104.20	210.67	NO
2000	1 936.86	828.53	119.70	225.50	NO
2001	1 628.84	827.06	120.30	201.58	0.1031
2002	1 403.48	815.33	134.90	151.81	0.2098
2003	1 484.85	808.00	141.60	161.55	0.3266
2004	1 626.76	808.73	166.20	160.78	0.4359
2005	1 624.53	762.82	165.40	181.00	0.4682
2006	1 748.45	758.02	175.00	153.92	0.3458
2007	2 043.08	794.07	168.80	184.36	0.5016
2008	1 996.15	742.01	151.92	161.32	0.5597
2009	1 566.08	625.43	132.93	126.25	0.4129
2010	1 469.27	678.18	102.25	119.73	0.8604

	Category 2.A - CO_2 emissions [Gg]				
	2.A.1 Cement Production	2.A.2 Lime Production	2.A.3 Glass production	2.A.4.a Ceramics	2.A.4.b Other use od Soda Ash
2011	1 664.53	675.83	138.08	122.14	1.0620
2012	1 517.03	596.99	108.84	106.38	1.0875
2013	1 331.79	605.53	115.76	101.90	1.0340

Tab. 4-3 gives an overview of the emission factors used for computations of emissions in category 2.A Mineral Products in 2013.

Tab. 4-3 CO_2 emission factors used for computations of 2013 emissions in category 2.A

	Emission factor CO_2	unit	Source or type of EF
2.A.1 Cement Production	0.5387	t CO_2/t sinter	EU ETS
2.A.2 Lime Production	0.7575	t CO_2/t CaO	CS
2.A.3 Glass production	0.10	t CO_2/t Glass	Default (IPCC, 2006)
2.A.4.a Ceramics	1.26	t CO_2/tiles thousand m^2	CS
	0.09	t CO_2/brick unit	CS
	0.028	t CO_2/t roofing tiles	CS
2.A.4.b Other use od Soda Ash	0.415	t CO_2/t soda ash	IEF

The column source or type of EF indicates the way how was the certain emission factor determined. Detailed information for each emission factor is given in the relevant chapters.

4.2.1 Cement Production (CRF 2.A.1)

CO_2 emissions from cement production have decreased since 1990 by 45.5%. The decrease in the emissions during 1990's was caused by the transition from planned economy to market economy. This led to decline in industrial production and consequently to decrease in emissions. Since 2003, the cement production began to recover and production has increased. Decrease in emissions since 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. Approx. 60% of the CO_2 is emitted during transformation of raw materials (mainly decarbonisation of limestone). 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 1 500 °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 1.A.2.f 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 2006 Guidelines (IPCC, 2006) describes an 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 in the EU ETS system. EU ETS system covers all cement kiln operators in the Czech Republic. Information submitted directly by cement kiln operators is available for years 1990, 1996, 1998 - 2002 and 2005 - 2013. For these years, the emission factor value was derived from individual installation data collected for EU ETS (emissions) and from CCA data (activity data about production of clinker). For other years the EFs were interpolated. The content of calcium/magnesium oxide (CaO/MgO) and composition of the limestone and dolomite are measured and independently verified. These parameters are used for calculation of the CO_2 emissions and, therefore, substantial attention is devoted to their determination.

The methodology used for CO_2 emissions must be in accordance with national legislation (Zákon 383/ 2012 o podmínkách obchodování s povolenkami na emise skleníkových plynů/Act No. 383/2012 Coll., the Greenhouse Gas Emission Allowance Trading Act) and the EU legislation (Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council).

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.

Data on cement clinker production is published by the Czech Cement Association (CCA) (CCA, 2013), which associates all Czech cement producers. Clinker production data together with interpolated 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 0.527 to 0.553 t CO_2/t clinker.

Tab. 4-4 introduces the activity data for clinker production, emission factor and CO_2 emissions for the whole time series.

Tab. 4-4 Activity data, CO_2 emission factor and CO_2 emissions in 2A1 Cement Production category in 1990 - 2013

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Clinker production	kt	4 726	4 368	4 653	4 122	4 134	3 740	3 934	3 829	3 758	3 547	3 537	2 954
EF CO_2	t CO_2/t clinker	0.527	0.529	0.531	0.532	0.534	0.536	0.538	0.544	0.550	0.553	0.548	0.551
Emissions CO_2	Gg	2 489	2 309	2 468	2 195	2 208	2 005	2 116	2 083	2 068	1 963	1 937	1 629

	unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Clinker production	kt	2 549	2 725	3 017	3 045	3 288	3 837	3 759	2 923	2 748	3 132	2 838	2 472
EF CO_2	t CO_2/t clinker	0.551	0.545	0.539	0.533	0.532	0.532	0.531	0.536	0.535	0.531	0.535	0.539
Emissions CO_2	Gg	1 403	1 485	1 627	1 625	1 748	2 043	1 996	1 566	1 469	1 665	1517	1 332

4.2.1.3 Uncertainties and time-series consistency

In 2012 a research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are based on the 2006 Guidelines (IPCC, 2006). Since Tier 3 method is used for determining emissions in this category the uncertainties were estimated at the level of 2% both for activity data and emission factors. Overall uncertainty data are given in Chapter 1.6.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

4.2.1.4 Source-specific QA/QC and verification

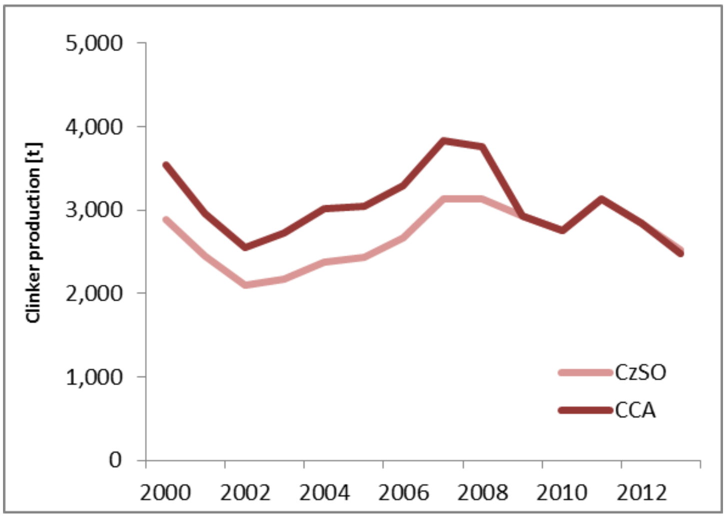


Fig. 4-4 Comparison of clinker production data provided by CzSO and CCA

The input information and calculations are archived by the sectoral expert and the coordinator of NIS. In addition to verification of the input data, the inter-annual changes of the implied emission factors are analysed.

The quality control was held by fulfilling the QA/QC form presented in Annex 5.

4.2.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.2.1.6 Source-specific planned improvements, including tracking of those identified in the review process

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

4.2.2 Lime Production (CRF 2.A.2)

In this year's submission will be used EU ETS data for period 2005-2013. For the period 2010-2013 the ETS data are available in electronic form for each lime factory and each process. For the period 2005-2009 are EU ETS data available only in form of total emissions for each plant (including emissions which are reported in Energy sector). However, it is possible to calculate emissions from each process for this period by using extrapolation on the basis of period 2010-2013. EU ETS data are in Tier 3 level. For the period 1990-2004 in which EU ETS was not implemented in the Czech Republic, were kept data Tier 1 from CLA (Czech Lime Association).

In 2015, a research concerning the country specific emission factor from lime production was carried out (Beck, 2015). This research clarified very small fluctuation of emission factor (depending on the composition of limestone), further successfully defended connection of Tier 1 data for period 1990-2004 and Tier 3 data for period 2005-2013. Detailed information about the research is provided in Annex 3.

CO_2 emissions from lime production have decreased considerably since 1990 by 54%. The decrease in emissions between 1990 and 1991 was caused by the transition from a planned economy to a market economy and closing of lime kilns, together with a decrease in industrial production. Since then, lime production has varied slightly around 1 100 kt/year. In 2012 the production of lime dropped to a minimum for the whole period of 830 kt. After that in 2013 production of lime slightly increased to 849 Gg.

4.2.2.1 Source category description

From a chemical point of view, lime is calcium oxide. CO_2 is released during calcination. During the production of lime, the limestone is heated up which lead to decomposition (i.e. calcination) of $CaCO_3$/$MgCO_3$ to the lime (CaO, CaO·MgO) and CO_2 is being released into the atmosphere.

4.2.2.2 Methodological issues

Emissions from lime production are calculated in line with IPCC 2006 Guidelines (IPCC, 2006). Only CO_2 emissions generated in the process of the calcination step of lime treatment are considered in this category. CO_2 emissions from combustion processes (heating of kilns and furnaces) are reported under category 1.A.2.f. 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 the Czech Republic.

Activity data are based on EU ETS data (EU ETS, 2014), which publishes data on pure lime production. These data were considered to be more accurate than data provided by CzSO which do not differentiate between lime and hydrated lime.

Tab. 4-5 lists activity data for lime production, emission factors and CO_2 emissions for the whole time series.

Tab. 4-5 Activity data, CO_2 emission factor and CO_2 emissions in 2.A.2 Lime Production category in 1990 - 2013

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Lime production	**kt**	1 823	1 152	1 134	1 062	1 100	1 115	1 133	1 163	1 087	1 074	1 130	1 128
EF CO_2	**t CO_2/t $CaCO_3$**	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733
Emissions CO_2	**Gg**	1 337	845	831	779	807	818	831	853	797	787	829	827

	unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Lime production	**kt**	1112	1102	1103	1040	1034	1083	1012	853	850	874	773	799
EF CO_2	**t CO_2/t $CaCO_3$**	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.798	0.773	0.772	0.758
Emissions CO_2	**Gg**	815	808	809	763	758	794	742	625	678	676	597	606

4.2.2.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006). Since activity data are based on the EU ETS, which include all the lime producers in the Czech Republic, the uncertainty in the activity data was estimated at the level of 2%. The country-specific emission factor is used and the uncertainty was estimated to be at the same level as that for the activity data, i.e. 2%. The overall uncertainty data are given in Chapter 1.6.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

4.2.2.4 Source-specific QA/QC and verification

Sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System.

The calculations in the lime production category are based on data taken from the EU ETS and Czech Lime Association and are used for verification of the CO_2 emissions. The EU ETS reports are proved by independent verifiers. The lime production data provided by the Czech Lime Association are compared with data provided by the Czech Statistical Office. Emission estimates are compared with the sum of the emissions from technological processes reported by individual kiln operators. The country-specific emission factor was compared with the emission factors used by individual operators for the calculation. Differences in the last year indicate that the country-specific emission factor is slightly overestimated. Verification of this difference is planned for future submissions.

4.2.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed. Also this year a research of emission factor from lime production were preformed and used for this submission. Detailed information on this research is provided in Annex 3.

4.2.2.6 Source-specific planned improvements, including tracking of those identified in the review process

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

4.2.3 Glass production (CRF 2.A.3)

4.2.3.1 Source category description

CO_2 emissions from Glass Production (2.A.3*)* are derived particularly from the decomposition of alkaline carbonates added to glass-making sand.

4.2.3.2 Methodological issues

The emission factor value for Tier 1 method of 0.20 t CO_2/t glass was taken from the 2006 Guidelines (IPCC, 2006). Cullet ratio of 50% was taken likewise from 2006 Guidelines (IPCC, 2006).

Activity data were collected and published by the Association of the Glass and Ceramic Industry of the Czech Republic in previous years. Starting last submission, the activity data are available from CzSO.

4.2.3.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006), i.e. at the level of 5% for the activity data and 10% for the CO_2 emission factor. Overall uncertainty data are given in Chapter 1.7.

4.2.3.4 Source-specific QA/QC and verification

The data on glass production provided by CzSO were discussed with a representative of the Association of the Glass and Ceramic Industry, who confirmed their reliability.

Sector-specific QA/QC plan is formulated, closely related to the QA/QC plan of the National Inventory System.

4.2.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations performed in this submission.

4.2.3.6 Source-specific planned improvements, including tracking of those identified in the review process

In further submissions it is planned to implement EU ETS (European Union Emission Trading System) data which are available since 2010. This data are in Tier 3 level. However this data are not available for the whole time series thus using this data leads to a problem with consistency of the time series. This issue will be resolved in future research in an upcoming submissions. After comprehensive solution to this problem is available, it will be possible to implement EU ETS data not only in this category but also in 2.A.2 Lime Production and 2.A.4.a Ceramics.

4.2.4 Other process uses of carbonates (CRF 2.A.4)

The 2.A.4 category Other Process Uses of Carbonates (2.A.4) summarizes, in the Czech Republic, emissions from Ceramics (2.A.4.a – CO_2) and from Other uses of Soda Ash (2.A.4.b – CO_2). CO_2 emissions from 2.A.4.a Ceramics equalled to 102 Gg in 2013. CO_2 emissions from Other uses of Soda Ash (2.A.4) amounted to 1.03 Gg CO_2 in 2013.

4.2.4.1 Source category description

CO_2 emissions from 2.A.4.a Ceramics 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 CzSO (production). The calculation is based on the total production of ceramic products (fine ceramics, tiles, roofing tiles, and bricks) and the emission factor value.

CO_2 emissions from Other Uses of Soda Ash (2.A.4.b - CO_2) category come from soda ash use for the Glass production category, soda ash is used in only one other installation. CO_2 emissions from this category are small and insignificant (varied between 0.1 and 1.1 Gg CO_2) compared to the other categories. The maximum value of the emissions reported in this category is 1.09 Gg CO_2 in 2012.

4.2.4.2 Methodological issues

For each mole of soda ash use, one mole of CO_2 is emitted, so that the mass of CO_2 emitted from the use of soda ash can be estimated from a consideration of the consumption data and the stoichiometry of the chemical process.

The data about the amount and purity of the soda ash used were obtained directly from the installation operator.

4.2.4.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006), i.e. at the level of 5% for the activity data and 10% for the CO_2 emission factor. Overall uncertainty data are given in Chapter 1.6.

For 2.A.4.b Other uses of Soda Ash the time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year of 2001, when the use of soda started, to 2013.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

4.2.4.4 Source-specific QA/QC and verification

Sector-specific QA/QC plan is formulated, closely related to the QA/QC plan of the National Inventory System.

The calculations are based on data provided directly by the operators, who verify the data annually.

4.2.4.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.2.4.6 Source-specific planned improvements, including tracking of those identified in the review process

It is planned to verify emission estimates with data from the EU ETS system and other available sources.

Since plant-specific data and simple stoichiometry are used for computation in this category there is no significant improvement planned in this category.

4.3 Chemical Industry (CRF 2.B)

Of the categories of sources classified under the Chemical industry (2.B), categories 2.B.1, 2.B.2, 2.B.4.a, 2.B.6 and 2.B.8 are relevant for the Czech Republic, while Adipic Acid Production (2.B.3), Glyoxal (2.B.4.b), Glyoxylic Acid (2.B.4.c), Carbide Production (2.B.5), Soda Ash Production (2.B.7) and Fluorochemical Production (2.B.9) are not occurring.

4.3.1 Ammonia production (CRF 2.B.1)

The production of ammonia constitutes an important source of CO_2 derived from non-energy use of fuels in the chemical industry. CO_2 emissions from ammonia production in 2013 equalled 601.1 kt of CO_2, corresponding to approx. 0.47% of total greenhouse gas emissions without LULUCF. These emissions decreased by 45.2% compared to 1990; however, emissions in period 2005 - 2012 are almost constant, with slight fluctuations. In 2013, slight decrease of emissions from ammonia production was noticed. Ammonia production (CO_2 emissions) was identified as a key category in this year’s submission, however only on level assessment.

4.3.1.1 Source category description

Industrial ammonia production is based on the catalytic reaction between nitrogen and hydrogen:

$$N_2 + 3H_2 = 2NH_3$$

Nitrogen is obtained by cryogenic rectification of air and hydrogen is prepared using starting materials containing bonded carbon (such as, e.g., Natural Gas, Residual Oil, Heating Oil, etc.). Carbon dioxide is generated in the preparation of these starting materials.

In the Czech Republic, hydrogen for ammonia production is derived from residual oil from petroleum refining, which undergoes partial oxidation in the presence of water vapour. In order to increase the hydrogen production, the second step involves conversion of carbon monoxide, which is formed by partial oxidation, in addition to carbon dioxide and hydrogen. The final products of this two-step process are hydrogen and carbon dioxide. The production technology has practically not changed since 1990.

4.3.1.2 Methodological issues

Emissions are calculated from the corresponding amount of ammonia produced, using the default emission factor provided in IPCC 2006 3.273 kt CO_2/kt NH_3. This emission factor was obtained from IPCC 2006 Volume 3, Chapter 3 page 3.15 table 3.1, corresponding to the total fuel requirement, which was 44.65 GJ (NCV)/tonne NH_3 in 2013. Total CO_2 emissions from ammonia production where lowered by CO_2 used in urea production, that is why the portion of CO_2 emissions to NH_3 is not constant as mentioned in the study (Bernauer and Markvart, 2014).

A potential uncertainty in the emission factor for ammonia would not influence the total sum of CO_2 emissions, because a corresponding amount of oil is not considered in the energy sector. The relevant activity data and corresponding emissions are given in Tab. 4-5 Activity data and CO_2 emissions from ammonia production in 1990 – 2013.

Tab. 4-5 Activity data and CO_2 emissions from ammonia production in 1990 – 2013

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Residual fuel oil used for NH_3 product., *[TJ]*	14 997	14 534	14 985	14 012	15 644	13 812	14 865	13 623
Ammonia produced, *[kt]*	335.86	325.51	335.59	313.80	350.35	309.32	332.91	305.10
CO_2 from 2.B.1, *[kt]*	990.80	933.44	989.89	933.98	1055.82	903.19	989.20	931.15
CO_2 consumed in urea production [kt]	108.48	131.94	108.48	93.09	90.89	109.22	100.42	67.44

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Residual fuel oil used for NH_3 product., *[TJ]*	14 044	11 963	13 690	11 522	10 052	13 084	12 987	11 326
Ammonia produced, *[kt]*	314.52	267.91	306.59	258.04	225.12	293.03	290.84	253.65
CO_2 from 2.B.1, *[kt]*	886.50	788.90	936.02	761.75	638.58	850.60	843.43	721.70
CO_2 consumed in urea production [kt]	142.94	87.96	67.44	82.83	98.22	108.48	108.48	108.48

Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Residual fuel oil used for NH_3 product., *[TJ]*	10 802	10 119	11 453	11 793	11 484	10 278	10 659	8 212
Ammonia produced, *[kt]*	241.91	226.62	256.49	264.10	257.19	230.18	238.72	183.91
CO_2 from 2.B.1, *[kt]*	683.27	617.11	700.21	744.18	705.45	628.05	653.79	601.13
CO_2 consumed in urea production [kt]	108.48	124.61	139.27	120.21	136.34	125.34	127.54	0.81

4.3.1.3 Uncertainties and time consistency

Uncertainty estimates of activity data and emission factors have so far been based mainly on expert judgment.

In 2013, estimates of the uncertainty parameters were again verified in the study (Markvart and Bernauer, 2013) which, in addition to an expert opinion, also takes into account data given in the 2006 Guidelines (IPCC, 2006). The uncertainty in the activity data remains unchanged at 5% and the uncertainty in the emission factor (CO_2 EF) was also left at a value of 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 2013.

4.3.1.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention was focused on identifying gaps and imperfections using the 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. Therefore CO_2 emissions from residual oil used for ammonia production are not taken into account in Energy sector. This part of QA/QC procedure is carried out in cooperation with KONEKO marketing, Ltd. (see Chapter 3.6).

4.3.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of IPCC 2006 Guidelines, recalculations in the whole sector were performed. During the entire time series recalculation of CO_2 emissions from 2.B.1 caused two main changes. The value of the emission factor for the production of hydrogen for ammonia production 2.402 kt CO_2/kt NH_3 was substituted for 3.273 kt CO_2/kt NH_3 and the total amount of CO_2 emissions from ammonia production was lowered by the consumption of the CO_2 portion from ammonia production, used in urea production.

4.3.1.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvement is planned for the next submission.

4.3.2 Nitric acid production (CRF 2.B.2)

The production of nitric acid constitutes one of the most important sources of N_2O in the chemical industry. N_2O emissions from production of nitric acid in 2013 equalled 1.38 kt N_2O, corresponding to approx. 0.4% of total greenhouse gas emissions without LULUCF. These emissions have decreased by 62% compared to 1990; the substantial decrease in recent years has been a consequence of the gradual introduction of mitigation technology and improving its effectiveness. In 2013, the production of nitric acid (N_2O emissions) was identified as a key category by trend assessment. In former years, when N_2O emissions reached greater values, this category was identified as a key source by level assessment.

4.3.2.1 Source category description

The production of nitric acid is one of the traditional chemical processes in the Czech Republic. It is carried out in three factories, where one of them manufactures more than 60% of the total amount. Nitric acid is produced by the classical method by high-temperature catalytic oxidation of ammonia (Ostwald process) and subsequent absorption of nitrogen oxides in water. Nitrous (dinitrogen) oxide is formed at ammonia oxidation reactor as an unwanted side product.

The nitric acid is manufactured at three pressure levels (at atmospheric pressure, slightly elevated pressure (approx. 0.4 MPa) and at elevated pressure (0.7 - 0.8 MPa). While production processes prior to 2003 mostly progressed at atmospheric pressure and only to a lesser degree at medium elevated pressure, the process at elevated pressure had predominated since 2004.

All the nitric acid production processes in the Czech Republic are equipped with technologies for removal of nitrogen oxides, NO_X, based on selective or non-selective catalytic reduction. Non-selective catalytic reduction also makes a substantial contribution to removal of N_2O. Since 2004, the technology to reduce

N_2O emissions, based on catalytic decomposition of this oxide, has been gradually introduced at units working at elevated pressure. It has been possible to substantially improve the effectiveness of this process in recent years.

4.3.2.2 Methodological issues

Nitrous oxide emissions from 2.B.2 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. 4-6. The emission factors for the basic process (without $DENO_X$ 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, 2000, 2003).

Tab. 4-6 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 $DENO_X$	--	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, 2000, 2003, 2004).

During 2003, conditions changed substantially as a result of the installation of new technologies operating under higher 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. 4-7 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**
$DENO_X$ 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. 4-11

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, and became the most important such unit 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 - 2013, the mitigation unit described above was utilized in a more effective way, see (Markvart and Bernauer, 2007 - 2013). 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.

Two high temperature N_2O decomposition catalytic systems were used in the above-mentioned high pressure nitric acid technology (0.7 MPa) in 2009; these systems were more efficient in comparison with the catalytic systems used in previous years. The first system consisting of Raschig rings provided by Heraeus was used in the January-June 2009 period and the measured EF N_2O was 3.10 kg N_2O/ t HNO_3 (100%); in the July-November 2009 period, EF N_2O was 3.30 kg N_2O/ t HNO_3 (100%). The second system consisting of high temperature N_2O decomposition catalyst developed by YARA company, decreased EF N_2O in the November-December 2009 period to the value 0.95 kg N_2O/ t HNO_3 (100%) in a high-pressure nitric plant. The catalytic activity of the high temperature decomposition system has decreased slightly due to both increasing selectivity of the Pt-Rh ammonia oxidation catalyst towards N_2O and slow deactivation of the N_2O decomposition catalyst. Thus, the mean value of EF N_2O for this high pressure nitric acid technology in 2009 was assessed at a value of 2.85 kg N_2O/ t HNO_3 (100%) (Tab. 4-8).

The most efficient decomposition catalyst provided by YARA was used in this high pressure nitric acid technology during whole year of 2010. It is expected that, if high temperature N_2O decomposition catalyst (i.e. YARA catalyst) is employed, the EF N_2O could be approximately close to 1.3 kg N_2O/ t HNO_3 (100%).

YARA's catalyst, which was also used in 2012, exhibits excellent stability with respect to N_2O conversion and the catalyst efficiency was practically constant during the last three years in the high-pressure (0.7 MPa) nitric acid unit.

Tab. 4-8 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	2009	2010	2011	2012	2013
EF, kg N_2O/t HNO_3 (100%)	7.8	7.02	5.94	4.37	4.82	2.85	1.29	1.30	1.45	1.65
Effectiveness of mitigation,%	-	10	23.9	43.9	38.2	63.4	83.4	83.3	81.4	78.8

[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, 2006) in the Tab. 4-9.

Tab. 4-9 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
Plants with NSCR (all processes) Plants with processed integrated or tailgas N_2O destruction Atmospheric presssure plants (low pressure) Medium pressure combustion plants High pressure plants	2 ± 10% 2.5 ± 10% 5 ± 10% 7 ± 20% 9 ± 40%	(IPCC, 2006)
Czech Republic Atmospheric pressure plants Medium pressure plants with SCR Medium pressure plants with NSCR High pressure plants SCR (no N_2O decomposition) High pressure plants SCR (with N_2O decomposition)	 9.05 4.9 1.09 7.8 4.82 – 1.29	(Markvart and Bernauer, 2009, 2010)

Tab. 4-10 gives the N_2O emissions from production of nitric acid, including the production values.

Tab. 4-10 Emission trends for HNO_3 production and N_2O emissions

	Production of HNO_3, *[kt HNO_3 (100%)]*	Emissions of N_2O *[kt N_2O]* from HNO_3 production	Implied Emission Factor IEF *[Mg N_2O/ kt HNO_3]*
1990	530.00	3.52	6.65
1991	349.56	2.26	6.46
1992	439.39	2.87	6.52
1993	335.95	2.16	6.44
1994	439.79	2.83	6.43
1995	498.34	3.26	6.46
1996	484.80	3.13	6.45
1997	483.10	3.23	6.69
1998	532.50	3.48	6.53
1999	455.00	2.84	6.24
2000	505.00	3.25	6.43
2001	505.08	3.21	6.35
2002	437.14	2.76	6.32
2003	500.58	2.75	5.50
2004	533.73	3.16	5.92
2005	532.21	2.98	5.59
2006	543.11	2.65	4.88
2007	554.22	2.17	3.91
2008	506.96	2.02	3.99
2009	505.17	1.52	3.01
2010	441.70	1.09	2.48
2011	561.82	1.24	2.21
2012	550.46	1.27	2.30
2013	514.94	0.71	1.39

While the slight fluctuations in IEF to 2004 were caused by slow changes in the relative contributions of the individual technologies with various technologically specific emission factors given in Tab. 4-6 and

Tab. 4-7, since 2005 the reduction in IEF has been caused mainly by the gradual increase in the effectiveness of the mitigation units employed for the dominant technology (see Tab. 4-8) to 2010. A further reduction in IEF in 2011 was then caused by an increasing contribution of this dominant technology (0.7 MPa) to 56% of the annual production of HNO_3.

4.3.2.3 Uncertainties and time-series consistency

All uncertainty estimates for the activity data and emission factors have so far been based on expert judgment. Their improvement is ongoing and some uncertainty values for HNO_3 production have been recently revised and used in the two last submissions: uncertainty in activity data was lowered from 10% to 5% and uncertainty of the mean N_2O EF was lowered from 25% to 20%.

This year, the estimates of the uncertainty parameters were again refined on the basis of in the study (Markvart and Bernauer, 2013), which takes into account the data in the 2006 Guidelines (IPCC, 2006). The uncertainty in the activity data following adjustment equalled 4% and the uncertainty in the average emission factor (N_2O EF) was reduced to 15% in relation to the increasing number of direct measurements.

Time series consistency is ensured as inventory approaches concerned are employed identically across the whole reporting period from the base year of 1990 to 2013.

4.3.2.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention is focused on identifying gaps and imperfections using the reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs.

According to the QA/QC plan, data and calculations are 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.

4.3.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emissions trend

In this submission, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.3.2.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvement is planned for the next submission.

4.3.3 Adipic acid production (CRF 2.B.3)

Adipic Acid production is not occurring in the Czech Republic.

4.3.4 Caprolactam, glyoxal and glyoxylic acid production (CRF 2.B.4)

4.3.4.1 Source category description

There is only one facility for production of caprolactam in the Czech Republic. Glyoxal and Glyoxylic Acid is not produced in the Czech Republic. Information provided in this chapter is related to caprolactam production.

4.3.4.2 Methodological issues

As mentioned in the references (Markvart and Bernauer, 2004 – 2013) and (Bernauer and Markvart, 2014), there is only one caprolactam production plant in the Czech Republic; this is not a very important source of N_2O emissions. CzSO does not monitor production data on the production of caprolactam; however, the series of studies by Bernauer and Markvart (Bernauer and Markvart, 2014), based on a study in the production factory, yields an approximate value of 0.246 kt N_2O which is reported/which is used as a constant value for each year.

4.3.4.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2.B.4, uncertainties derived from the sources included in this category have no great impact on the overall uncertainty in the determination of GHG emissions in the Czech Republic. Thus, it does not matter greatly that the uncertainty in emissions from these sources was determined by an expert estimate.

4.3.4.4 Category-specific QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2.B.4, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

4.3.4.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.3.4.6 Category-specific planned improvements, including tracking of those identified in the review process

More exact data on N_2O emissions should be available in the coming years, when the N_2O emissions from the production of caprolactam will be continuously measured beginning in 2012 as a consequence of inclusion of the production in the emission trading scheme (EU ETS) and thus recording in the relevant register. No further improvement is planned for methane emissions in this category.

4.3.5 Carbide production (CRF 2.B.5)

Carbides are not produced in the Czech Republic.

4.3.6 Titanium dioxide production (CRF 2.B.6)

In the Czech Republic titanium dioxide is produced using sulphate route process and as it is stated in the IPCC 2006 Guidelines this process does not give rise to process greenhouse gas emissions that are of significance.

4.3.7 Soda ash production (CRF 2.B.7)

Soda Ash is not produced in the Czech Republic.

4.3.8 Petrochemical and Carbon Black Production (CRF 2.B.8)

4.3.8.1 Source category description

This category includes carbon dioxide and methane emissions from the production of carbon black, ethylene, ethylene dichloride and styrene. These are all less important sources (excluding emission of CO_2 from ethylene production).

4.3.8.2 Methodological issues

Default emissions from the IPCC methodology (IPCC, 2006) are employed to determine carbon dioxide and methane emissions from the production of carbon black, ethylene, ethylene dichloride and styrene. Due to the implementation of the IPCC 2006 Guidelines, the GHG emissions from above mentioned productions are reported in 2.B.8 for the first time.

CO_2 and CH_4 emissions from the production of ethylene

Ethylene in the Czech Republic is produced by pyrolysis of petroleum fractions, composed of a very wide range from fractions of C3-C4 (propane) to the higher boiling fractions. The ethylene unit contains several pyrolysis furnaces that process raw gas (LPG, ethane and propane) and liquids (HCVD - hydrocracked vacuum distillate, naphtha, and in very limited quantities of diesel fuel). Basically, a thermal, non-catalytic fission in the presence of steam is performed and its major products are ethylene, propylene, benzene and C4 fraction. Reliable data for the production of ethylene are available from CzSO. The IPCC methodology provides a value of 1.73 tonnes CO_2/tonne ethylene produced (with correction factor 110% for countries of Eastern Europe) and 3 kg CH_4/tonne ethylene produced as default emission factors. In the period 1990 – 2013, CO_2 emissions varied between 545 to 959 kt CO_2 and methane emissions varied between 0.9 and 1.5 kt CH_4 (emissions equalled 1.28 kt CH_4 in 2013).

CO_2 and CH_4 emissions from the production of ethylene dichloride

1,2-dichloroethane known, also as ethylene dichloride, is produced in the Czech Republic at the same integrated facility as vinyl chloride monomer (VCM), which is subsequently used for PVC production (Bernauer and Markvart, 2014). The data on production of PVC are obtained from CzSO. While CzSO does not publish information on the amount of VCM, it does give data on the amount of PVC produced, which are practically the same as VCM data. The IPCC 2006 Guidelines methodology provides a value of emissions of carbon dioxide 0.294 tonne CO_2/tonne VCM produced and for methane 0.0226 kg CH_4/tonne VMC produced as default emission factors. Carbon dioxide emissions varied in the period 1990 - 2013 between 16.7 kt CO_2 and 40.3 kt CO_2. Due to the low emission factors' value, the values of methane emissions varied in the period 1990 – 2013 between 0.001 and 0.003 kt CH_4, which is considered as insignificant value. In 2013, emissions of carbon dioxide equalled to 29.8 kt and methane emissions equalled to 0.002 kt CH_4.

CO_2 and CH_4 emissions from the production of carbon black

The production of carbon black is approximately 26 kt of p.a. Exact information on activity data is available since 2013; thus, the data for other years were taken from the study (Bernauer and Markvart, 2014). The emission factor taken from the IPCC 2006 methodology equals to 0.06 kg CH_4/tonne carbon black produced and 2.62 t CO_2 /t carbon black produced. The highest value of methane emissions over the past few years is practically insignificant (0.00153 kt).

CO_2 and CH_4 emissions from the production of styrene

Because of the growing consumption of polystyrene, the production of styrene has gradually increased since 1990. CzSO also does not publish any information on the production of styrene. Thus, the necessary activity data were estimated on the basis of production capacities:

1990-1998	70 kt styrene p.a.
1999	80 kt styrene p.a.
2000-2003	110 kt styrene p.a.
2004	140 kt styrene p.a.
2005-2010	150 kt styrene p.a.
from 2011	exact production from yearbook of producer

These estimates on the amount of styrene produced, mentioned in the study (Bernauer and Markvart, 2014), are based on the data given in the article (Dvořák and Novák, 2010). The emission factor taken from the IPCC methodology equals to 0.004 kt CH_4/kt styrene. The emission factor for CO_2 emissions is 0.27 kt CO_2/kt styrene (Bernauer and Markvart, 2014). In the period 1990 – 2013, methane emissions varied between 0.3 and 0.7 kt CH_4 and carbon dioxide emissions varied between 18.9 and 40.5 kt CO_2 (emissions equalled to 38.5 kt CO_2 and 0.57 kt CH_4 in 2013).

4.3.8.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2.B.8, uncertainties derived from the sources included in this category have no great impact on the overall uncertainty in the determination of GHG emissions in the Czech Republic. Thus, it does not matter greatly that the uncertainty in emissions from these sources was determined by an expert estimate.

4.3.8.4 Source-specific QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2.B.8, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

4.3.8.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.3.8.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned.

4.3.9 Fluorochemical Production (2.B.9)

Fluorinates are not produced in the Czech Republic.

4.3.10 Other (2.B.10)

No other chemical production is performed in the Czech Republic.

4.4 Metal Industry (CRF 2.C)

This category includes mainly CO_2 emissions from 2.C.1 Iron and Steel Production. CO_2 emissions from iron and steel are identified as a key category (by both level and trend assessments). A small amount of CH_4 is also emitted. Ferro-alloys were manufactured in limited amounts in a small production unit in the Czech Republic; this process could constitute an unsubstantial source of CO_2 emissions. Unfortunately, CzSO does not monitor any data on this production process. This year specific data from Ministry of Industry and Trade were obtained for the Ferroalloys Production for 2011 - 2013. CzSO does not monitor production of Lead nor Zinc. The data about production was obtained from Ministry of Industry and Trade.

Investigation revealed one smaller production plant, which reported that aluminium was used as a reducing agent; this did not lead to CO_2 emissions. In 2009 this production was stopped.

4.4.1 Iron and Steel Production (CRF 2.C.1)

4.4.1.1 Category description

Iron is produced in the Czech Republic in two large metallurgical facilities located in the cities of Ostrava and Třinec in the Moravian-Silesian Region, in the north-eastern part of the Czech Republic. Both these metallurgical works employ blast furnaces and also lines for the production of steel, coking furnaces and other supplementary technical units. Another large steel plant is located immediately next to the metallurgical works in Ostrava, taking raw iron (in the liquid state) from the nearby blast furnaces (located in the area of the Ostrava metallurgical works).

4.4.1.2 Methodological issues

The CO_2 emissions from iron and steel production were calculated using national approach which can be considered as Tier 2. However Tier 2 emissions estimation based in IPCC 2006 Guidelines (IPCC, 2006) includes recommendations to include also emissions arising from combustion of Blast Furnace and Oxygen Steel Furnace Gas in other than metallurgical complexes (for instance in Energy category 1.A.1.a). However in the Czech Republic is expected, that all Blast Furnace and Oxygen Steel Furnace Gases are combusted directly in the metallurgical complexes. This means that national approach for emission estimations contains few aspects from Tier 1, since there are some parts of the equation which are available for the computation. Important aspect of the computation is amount of carbon in reducing agent (i.e. in metallurgical coke), and since also amount of carbon in scrap and in steel. Form this reason can be presented approach considered as close to Tier 2 based on IPC 2006 Gl. (IPCC, 2006).

Additional part of calculation in IPCC 2006 Gl. (IPCC, 2006), is also emissions CO_2 from limestone and dolomite use in iron and steel metallurgy. These emissions were till last submission reported under 2.A.3 Limestone and Dolomite Use, however since this submission these emissions are reported in 2.C.1, which is in line with IPCC 2006 Gl. For these emissions were used data reported under EU ETS.

Overall the computational approach as well as the parameters used were consulted with representative of The Steel Federation, Inc.

Tab. 4-11 The amounts of blast furnace coke consumed and CO_2 emissions from iron and steel in 1990 – 2013

	Coke consumed in blast furnaces	CO_2 from 2.C.1 [Gg]
1990	4 222	12 431
1991	2 959	8 674
1992	3 447	10 106
1993	2 582	7 580
1994	2 724	8 088
1995	2 587	7 398
1996	2 701	7 721
1997	2 846	8 365
1998	2 750	8 086
1999	1 941	5 829
2000	2 327	6 890
2001	2 175	6 492
2002	2 252	6 724
2003	2 459	7 316
2004	2 628	7 638
2005	2 260	6 559
2006	2 480	7 426
2007	2 570	7 603
2008	2 366	7 019
2009	1 742	5 191
2010	2 004	5 801
2011	1 910	5 503
2012	1 825	5 250
2013	1 900	5 606

The amounts of blast furnace coke consumed and corresponding emissions are given in Tab. 4-11.

Estimation of CH_4 from metal production is based on the IPCC 2006 Guidelines Tier 1 methodology. Default emission factors 0.1 g CH_4 per tonne of coke produced and 0.07 kg CH_4 per tonne of sinter produced were used. 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 and official statics data of sinter produced.

Emission estimates of precursors for the relevant subcategories have been transferred from NFR to CRF, as described in previous chapters and in Chapter 9.

4.4.1.3 Uncertainties and time consistency

The uncertainty estimates have so far been based on expert judgment. Their improvement is ongoing and some uncertainty estimates for Iron and steel production have been revised in last submission (CHMI, 2012b). The new estimate of EF (CO_2) is now 10%, which is in accordance with the 2006 Guidelines (IPCC, 2006) and is slightly higher than the former value (5%). The estimate for AD (7%) remained unchanged, because this value is in good agreement with the recommendation in the Regulation of Commission (EU) No. 601/2012 (EU, 2012).

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 2013.

4.4.1.4 Source-specific 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 (see Chapter 3.2).

Activity data available in the official CzSO 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. For another QA, especially QA of computational approach, is also used former coordinator of National Inventory System.

The quality control was held by fulfilling the QA/QC form presented in Annex 5.

4.4.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since this submission CO_2 emissions are determined based on the Tier 2 methodology presented in IPCC 2006 Guidelines. However since the national approach was used before, there are no significant changes in the emission calculations. Additionally since this submission CO_2 emissions from Limestone and Dolomite Use in metallurgy is reported.

4.4.1.6 Source-specific planned improvements, including tracking of those identified in the review process

In future submission is planned to investigate data relevant for potential implementation of Tier 3 methodology in this category.

4.4.2 Ferroalloys Production (CRF 2.C.2)

4.4.2.1 Source category description

Ferroalloys Production is production of concentrated alloys of iron and or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten.

Only limited amounts of Ferroalloys are produced in the Czech Republic.

4.4.2.2 Methodological issues

The activity data were obtained from Ministry of Industry and Trade for the time-series 2011-2013. The data for 1990-2003 were obtained from original CzSO database and last submission data. The emission computation using default emission factors from IPCC 2006 Guidelines. Composition of ferroalloys produced in the facility of main producer of ferroalloys was used for consideration of composition of ferroalloys in the Czech Republic. Default emission factors from table 4.5 in IPCC 2006 Guidelines (IPCC, 2006) were used for CO_2 emission estimation. Tier 1 methodology for CH4 emission estimation was used using default emission factors from table 4.7 in IPCC 2006 Guidelines (IPCC, 2006).

4.4.2.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainty of emission factors were considered as given in table 4.9 in IPCC 2006 Guidelines (IPCC, 2006) as 25%. The uncertainty of activity data is considered 5%.

4.4.2.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of The Steel Federation, Inc.

4.4.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were performed in this submission.

4.4.2.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned in this category.

4.4.3 Lead Production (2.C.5)

4.4.3.1 Source category description

Till this submission the Lead production wasn't included in greenhouse gas inventories. In the Czech Republic there is no primary production of lead, however secondary production and recycling is happening. There is one major installation specialised for this production.

4.4.3.2 Methodological issues

A research of potential Lead producers in the Czech Republic was performed. Data were obtained from Ministry of Industry and Trade, for 2011-2013 were obtained detailed data, for 1900-2010 were estimated constant value 20 kt lead production. The CO_2 emissions were estimated on the level Tier 1 methodology based on IPCC 2006 Guidelines (IPCC, 2006) using default CO_2 emission factor 0.52 t CO_2/t of lead. CO_2 emissions in 2013 equalled 36.4 kt.

4.4.3.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainties were based in IPCC 2006 Gl. recommendation, i.e. 10% for activity data and 50% for emission factor.

4.4.3.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of The Steel Federation, Inc.

4.4.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were performed in this submission.

4.4.3.6 Source-specific planned improvements, including tracking of those identified in the review process

In future submissions is planned further investigation of activity data.

4.4.4 Zinc Production (2.C.6)

4.4.4.1 Source category description

There is no primary production of Zinc in the Czech Republic, however secondary production is occurring. The reported emission are all from secondary production.

4.4.4.2 Methodological issues

The research of potential Zinc producers in the Czech Republic were performed. Detailed data were obtained from Ministry of Industry and Trade for 2011-2013; however for 1990-2010 no reliable data was obtained. The CO_2 emissions were estimated on the level Tier 1 methodology based on IPCC 2006 Guidelines (IPCC, 2006) using default CO_2 emission factor 1.72 t CO_2/t of lead. CO_2 emissions in 2013 equalled 0.26 kt, which presents negligible share in the whole inventory.

4.4.4.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainties were based in IPCC 2006 Gl. recommendation, i.e. 10% for activity data and 50% for emission factor.

4.4.4.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of Ministry of Industry and Trade.

4.4.4.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations were performed in this submission.

4.4.4.6 Source-specific planned improvements, including tracking of those identified in the review process

In future submissions is planned further investigation of activity data.

4.5 Non-energy products from fuels and solvent use (CRF 2.D)

This subcategory is newly included in IPCC 2006 Guidelines, which means, that this is a first submission when this category is reported separately. In this subcategory are reported emissions from first use of fossil fuels as products, when their primary use is other than combustion for energy purposes or use as a reducing agent in industrial purposes.

Products reported in this subcategory include Lubricants, Paraffines, Asphalts and Solvents. Emissions from other (secondary) use or disposal of these products are included in relevant sectors (e.g. Energy, Waste).

4.5.1 Lubricant Use (2.D.1)

4.5.1.1 Source category description

Lubricants are produced from refining of crude oil in petrochemical installations. There can be distinguished between engine oils and industrial oil or grease.

4.5.1.2 Methodological issues

Till last submission the non- energy use of Lubricants was reported under 1.A.D Feedstocks, non-energy use of fuels category. This activity data are now used for emission estimation in this category. Tier 1 methodology from IPCC 2006 Guidelines was used for CO_2 emission estimation. Default emission factor 20 kg C/GJ was used, Oxidised During Use (ODU) factor was used default equal to 0.2. CO_2 emission in 2013 from this category were equal to 94.9 kt CO_2.

4.5.1.3 Uncertainties and time consistency

Since the activity data used are from official statics, the suggested 5% uncertainty (IPCC, 2006) was applied for this category. Since default ODU factor was used, suggested 50% uncertainty from IPCC 2006 Gl. was applied for emission factor uncertainty.

4.5.1.4 Source-specific QA/QC and verification

Standard QA/QC procedures were applied for this subcategory. Special attention was paid to cross-sectoral issues, so no emissions are omitted, nor counted twice.

4.5.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

This category is newly incorporated in the reporting since this submission.

4.5.1.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned in this subcategory.

4.5.2 Paraffin Wax Use (2.D.2)

4.5.2.1 Source category description

Paraffin Wax Use is newly reported category since this submission. This category includes use of products separated from fossil fuels called paraffins, waxes or vaseline. From chemical point of view they are mixtures of solid paraffinated hydrocarbons obtained from crude oils. Different types are characterised by point of solidification and amount of oil contained.

4.5.2.2 Methodological issues

Activity data reported in official Energy balance of CzSO as Non-energy use are used for emission estimation in this category. . Tier 1 methodology from IPCC 2006 Guidelines was used for CO_2 emission estimation. Default emission factor 20 kg C/GJ was used, Oxidised During Use (ODU) factor was used default equal to 0.2. CO_2 emissions in 2013 from this category were equal to 5.9 kt CO_2.

4.5.2.3 Uncertainties and time consistency

Since the activity data used are from official statics, the suggested 5% uncertainty (IPCC, 2006) was applied for this category. Since default ODU factor was used, suggested 50% uncertainty from IPCC 2006 Gl. was applied for emission factor uncertainty.

4.5.2.4 Source-specific QA/QC and verification

Standard QA/QC procedures were applied for this subcategory. Special attention was paid to cross-sectoral issues, so no emissions are omitted, nor counted twice.

4.5.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

This category is newly incorporated in the reporting since this submission.

4.5.2.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned in this subcategory.

4.5.3 Other (2.D.3)

4.5.3.1 Source category description

Solvent Use

This category includes particularly emissions of NMVOC (ozone precursor) from the use of solvents, which based in IPCC 2006 Guidelines (IPCC, 2006) are not considered to be a source of CO_2 emissions.

Road Paving With Asphalt

This category includes particularly emissions of ozone precursors in 1990 – 2005 time - series. Based on the IPCC 2006 Gl. (IPCC, 2006) only NMVOC emission should be reported. Since 2005 no data in reporting for the UNECE/CLRTAP inventory in NFR were estimated (notation key NE). Emissions from Road Paving with Asphalt are not considered to be a source of CO_2 emissions (IPCC, 2006).

4.5.3.2 Methodological issues

Solvent Use

The IPCC methodology (IPCC, 2006) 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.

Inventory of NMVOC emissions for 2013 for this sector is based on a study prepared by SVÚOM Ltd. Prague (Geimplová, 2014). This study is elaborated annually for the UNECE/CLRTAP inventory in NFR and is also adopted for the National GHG inventory.

Solvent Use activity data 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 for Solvent Use were extracted from the official Energy balance. Form the whole amount of non-energy use of Other oil products were extracted the Oil needed for NH_3 production. Sum of the rest of Other Oil and non-energy use of White spirit was considered as the best available data for Solvent Use. This approach was approved with relevant experts from CzSO.

Road Paving With Asphalt

The activity data from last submission were used. Emissions are used from UNECE/CLRTAP inventories, where relevant NMVOC emissions were not estimated for 2013.

4.5.3.3 Uncertainties and time consistency

Solvent Use

Uncertainty of NMVOC emissions is considered to be quite large, based on IPCC 2006 Gl. (IPCC, 2006) it is considered as 50%. The uncertainty of activity data is considered based on expert judgement as 25%.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

Road Paving With Asphalt

Since no CO_2, CH_4 or N_2O emission were estimated in this category, no uncertainties were considered in this category.

4.5.3.4 Source-specific QA/QC and verification

Solvent Use

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 since 1998. Following transfer of the emission data to the new CRF Reporter, it was apparent that trends in the emissions 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.

Road Paving With Asphalt

Since emissions are reported as NE, no specific QA/QC or verification procedures is applied.

4.5.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Solvent Use

No recalculations performed in this submission.

Road Paving With Asphalt

No recalculations performed in this submission.

4.5.3.6 Source-specific planned improvements, including tracking of those identified in the review process

Solvent Use

No improvements are planned in this category.

Road Paving With Asphalt

No improvements are planned in this category.

4.6 Electronics industry (CRF 2.E)

4.6.1 Integrated Circuit or Semiconductor (CRF 2.E.1)

4.6.1.1 Source category description

Basic data about new equipment and services was obtained from questionnaires, conducted by Řeháček, 2014. This equipment is produced by only one company and is serviced by several other companies. The share of 2.E. category in the total actual emissions has decreased rapidly since 1995 due to a decrease in the use of SF_6 in this category.

The manufacturers of electrical equipment maintain very eco-friendly policies (involving treatment, training of staff, certificate etc.). Operational leakages are not measured (legislation does not force operators to do so) but can be estimated based on stock change. After a consultation with the main operator in the country the leakages are virtually non-existent and depend solely on accidents. Leakages represent less than 100 kg/yr in total. Such a low amount of SF_6 is not required to be reported from the operator into national database "Integrated system of reporting obligations" (*Integrovaný systém plnění ohlašovacích povinností* - ISPOP).

4.6.2 Methodological issues

This category includes gases HFC-23, CF_4, C_2F_6, SF_6 and NF_3. Due to lack of detailed information the data are reported for category 2.E.1 Integrated Circuit or Semiconductor. Emissions from this category are calculated using Tier 2a described in IPCC, 2006 equation 6.2 without of using a_i and d_i fractions, which are considered as negligible by expert judgement. Default emission factors for gases HFC-23, CF_4, C_2F_6, SF_6 and NF_3 were chosen from IPCC, 2006, volume 3, part 2 Electronic Industry emissions, table 6.3. Trend of F-gases emissions from category 2.E.1 Integrated Circuit of Semiconductor is illustrated on Fig. 4-5.

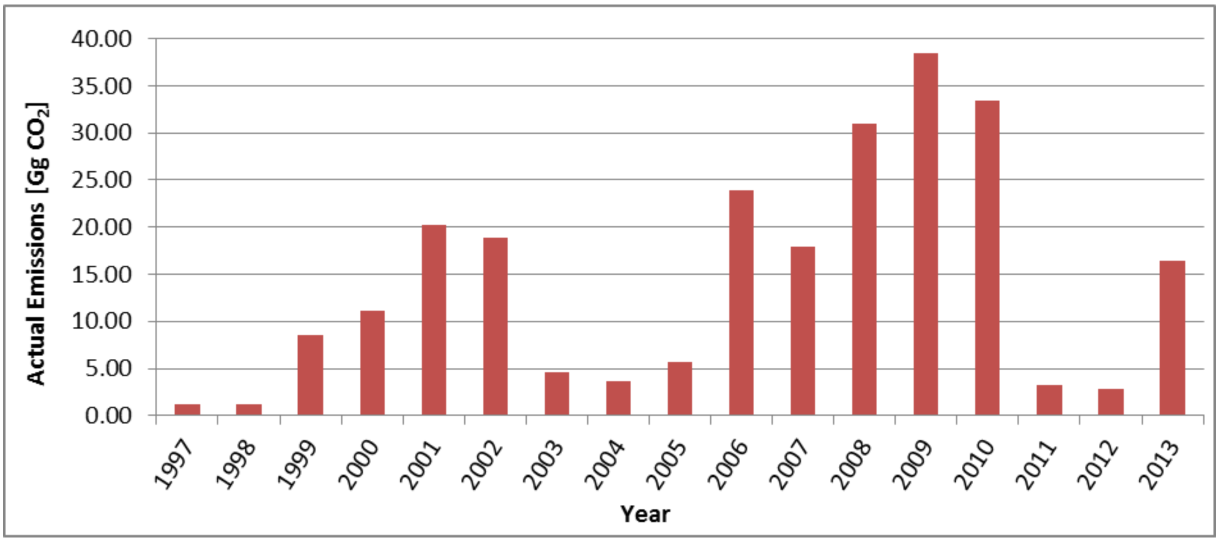


Fig. 4-5 Trend of F-gases actual Emissions for Integrated Circuit or Semiconductors [Gg CO_2 eq]

The 2013 submission, applies methodology, based on last year model, however compared to previous years categorization of sources has been changed. Source categories from 2.F, related to electronic industry, have been reallocated to the updated 2.E and 2.G category, as you can see in Tab. 4-12.

Tab. 4-12 Comparison of F-gases (electronic industry only) categorisation reported in 2014 and 2015 submissions

2014		2015	
CRF category	Category description	CRF category	Category description
2.F.7	Semiconductor Manufacture	2.E.1	Integrated circuit or semiconductor
2.F.8	Electrical Equipment	2.E.2	TFT flat panel display
2.F.9	Other	2.E.3	Photovoltaics
		2.E.4	Heat transfer fluid
		2.E.5	Other
		2.G.1	Electrical equipment
		2.G.1.a	Manufacture of electrical equipment
		2.G.1.b	Use of electrical equipment

Category 2.E was also extended with the data on monitoring of NF_3, which is used for manufacturing of LCD displays, solar panels and etching of semiconductors.

Furthermore in this category are included gases C_2F_6, CF_4 and CHF_3 (HFC-23). All of these gases are used for manufacturing of semiconductors. As the GWPs of these gases indicate, they are persistent pollutants with the time of presence in the atmosphere reaching up to thousands of years.

In 2.E category SF_6 is used in semiconductor industry for etching and melting Mg and Al. Huge energy companies are the main contributors to the SF_6 emissions. The main environmental concern connected with SF_6 is its presence in the atmosphere for a long time.

4.6.3 Uncertainties and time-series consistency

Gases SF_6 and NF_3 are significant for semiconductor manufacturing. SF_6 consumption can be considered as stagnant in the last years. For semiconductor manufacturing (etching, cleaning), this year a new substance NF_3 was added.

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.6.4 Source -specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment. This comparison revealed a number of errors that were subsequently corrected.

4.6.5 Source -specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed. The most significant improvement was in updating emission factors. Emission factors from 2000 GPG (IPCC) and 2006 Guidelines (IPCC) are compared in Tab. 4-13.

Tab. 4-13 Comparison of EFs for F-gases from 2.E electronic industry

F-gas	2000 GPG (IPCC)	2006 Guidelines (IPCC)
	(1-Ci)	(1-Ui)
HFC-23 (CHF_3)	0.3	0.4
CF_4	0.8	0.9
C_2F_6	0.7	0.6
SF_6	0.5	0.2
NF_3	0.2	0.2

Where Ci is use rate of gas (fraction destroyed or transformed in process) and Ui is use rate of gas i (fraction destroyed or transformed in process).

4.6.6 Source -specific planned improvements, including tracking of those identified in the review process

Although the current survey considered factors a_i and d_i in Tier 2a methodology as negligible, it is planned to explore this technology further in more details in future submissions, no later than the introduction of F-gases in the EU ETS trading.

Improvement of uncertainty estimation is in progress.

4.7 Product uses as substitutes for ozone depleting substances (ODS) (CRF 2.F)

4.7.1 Source category description

Emissions of F-gases (HFCs, PFCs, SF_6) in the Czech Republic are at relatively low level due to the absence of large industrial sources. Furthermore all of the F-gases in the Czech Republic are imported; 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 primary aluminium and magnesium industry in the Czech Republic.

In 2013 actual emissions increased by 236.60 Gg in CO_2 equivalent. The higher level in 2013 compared to 2012 could be explained by growth of large users, such as automotive industry and manufacturing of stationary air-conditioning. The vast majority of F-gases remain from production of refrigerators and air conditioners. Other categories carry only a small proportion of F-gases emissions.

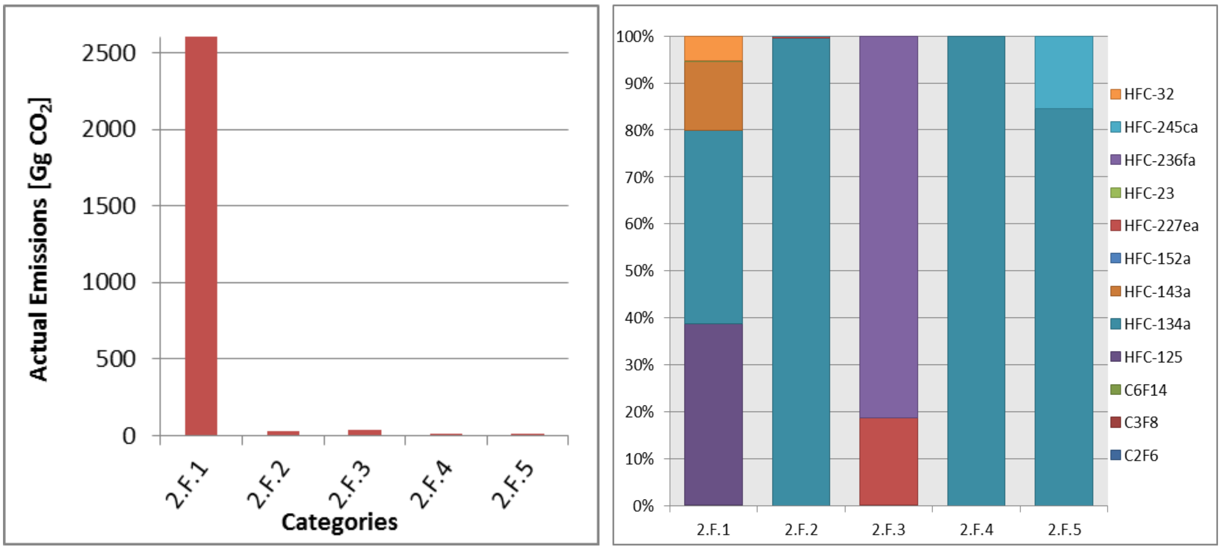


Fig. 4-6 Comparison of actual emissions for individual categories of HFCs, PFCs Gg CO_2 eq.

HFC emissions from 2.F.1 category dominate F-gases emissions as illustrated on Fig. 4-6. Compared to 2012, in 2013 only actual emissions have been calculated. The actual emissions in 2.F show modest growth.

No official statistics that would allow easy disaggregated reporting or use of the higher tiers are currently available in the Czech Republic. Inventory of actual emissions of F-gases is based on customs statistics, "Integrated system of reporting obligations" (ISPOP) and individual verification of this data by sectoral experts. Detailed data on the use of F-gases are collected on the basis of voluntary cooperation between sectoral experts and private companies.

Actual emissions of F-gases increased from 0.38 Gg CO_2 eq. in 1995 to 2 696.50 Gg CO_2 eq. in 2013. This significant leap forward by orders of magnitude has been driven mainly by substantial increase in the use of HFCs in refrigeration and much less by the already in 2010 peaked use of PFCs. Detailed information about actual emissions is given in Tab. 4-14 and in the CRF Tables. For detailed Information please examine Fig. 4-6.

Tab. 4-14 Actual emissions of HFCs and PFCs in 1995 - 2013 [Gg CO_2 eq.]

	HFCs	PFCs	Total
	[Gg CO_2 eq.]	[Gg CO_2 eq.]	[Gg CO_2 eq.]
1995	0.37	0.01	0.38
1996	44.60	0.48	45.08
1997	130.96	0.44	131.41
1998	162.81	0.41	163.21
1999	174.71	0.64	175.35
2000	232.56	1.38	233.93
2001	333.26	2.18	335.44
2002	428.75	2.56	431.31
2003	540.21	5.46	545.67
2004	640.36	6.86	647.22
2005	738.90	7.24	746.14
2006	984.28	7.80	992.08
2007	1322.83	8.50	1331.33
2008	1555.70	9.28	1564.98
2009	1682.95	9.35	1692.30
2010	1989.67	9.14	1998.81
2011	2265.05	8.40	2273.45
2012	2452.75	7.15	2459.90
2013	2690.62	5.88	2696.50

4.7.2 Methodological issues

Currently, the national F-gas inventory is based on the method of actual emissions, according to the 2006 Guidelines (IPCC, 2006). Due to the relatively short time of use of F-gases, the disposed amount is rather small and considered negligible for the inventory process. In 2013, a small amount of destroyed F-gases was reported. They were usually mixtures of old CFC-12 and HCFC-22. Five companies in the country are reported to provide disposal services for used F-gases. One of these is reported to experiment with regeneration using the distilling process but is still not officially operating on the market. The main part of F-gases was imported to CR for destruction and did not come from equipment operating in CR. The actual emissions methodology is specified for each category.

As these substances are not produced nationally, import and export information coming from official customs authorities is of key importance. Individual F-gases do not have separate custom codes in the customs tariff list as individual chemical substances. HFCs and PFCs are listed as totals 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) types of substances (or their mixtures), (c) the amounts and types of disposed F-gases and also (d) the areas of usage. Data about direct import/export, use and destruction were also obtained from ISPOP. ISPOP is the national system of environmental reporting; all importers, exporters and users of more than a threshold amount of 100 kg are obliged to report information about the type and amount of F-gas used. All the importers, exporters and users were 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. More detailed description of the methodology is available under separate document (Řeháček and Michálek, 2005) - a study which also contains all the relevant information on calculations of actual emissions.

4.7.2.1 Refrigeration and Air conditioning (CRF 2.F.1)

This chapter specifies the actual emission methodology used for a given category. In the following chapters, individual categories with similar methodology are combined. Detailed information on the data and methodology used are included in a special report prepared by external sector expert, Ing. Řeháček (Řeháček, 2014).

The most important category in the range of actual emissions is Refrigeration and Air Conditioning Equipment (CRF 2.F.1), which is responsible for 96.89% of actual F-gases emissions.

In the CRF Tables, emissions from this category are divided into only two sub-categories:

2.F.1.a Commercial Refrigeration and 2.F.1.e Mobile Air-Conditioning; emissions from other subcategories are included in these two categories due to lack of detailed information. The methodology used in these calculations underestimates the real emissions, as the information about marketed products containing F-gases is not taken into account. Measures to obtain relevant data to split the emission categories are in progress.

Tab. 4-15 Parameters for use in slightly modified eq. 7.3 IPCC 2006 GL (IPCC, 2006)

Sub-application	Lifetimes (years)	Emission Factors (% of initial charge/year)		End-of-Life Emission (%)	
Factor in Equation	D	k	X	ηrec,d	p
		Initial Emission	Operation Emission	Recovery Efficiency	Initial Charge Remaining
Stationary refrigeration	14.493	0.816	8.854	75.224	73.881
Mobile refrigeration	9.429	0.348	15.571	60.476	42.619

Parameters for assessment following the (IPCC, 2006) methodology were adjusted to fit the level of aggregation. Methodology implementation has been thoroughly revised also incorporating emissions from decommissioning of refrigeration and air-conditioning appliances.

Emissions from decommissioning are calculated using Gaussian distribution model with mean at lifetime expectancy (see Tab. 4-15 above). The model takes into account different approach for serviced equipment and newly filled equipment, assuming only half life-expectancy for the serviced equipment, resp. the amount of service-filled gas.

The main coolant media type used for the purpose of mobile air-conditioning is HFC-134a and the main type used for stationary air conditioning/refrigeration is R-410, a mixture of HFC-32 and HFC-125 in a ratio of 1:1. Other types of HFCs like HFC-23, HFC-32 and HFC-245ca (in 2.F.1.a Commercial Refrigeration) are used in small amounts in refrigeration mixtures as additive for adjustment of properties of mixtures of refrigerants.

In 2013 no significant changes occurred in the collection and treatment policies of discarded refrigeration appliances, with exception of new company, which is occupied with disposal of old cooling devices and coolant. Only two companies in Czech Republic are dealing with regeneration of HCF coolants.

They used privately constructed distilling machinery to process app. 5 tonnes of HFC-134a contaminated with mineral oil fractions. The HFC was collected and stored during previous years. Emissions from this process are not included in the inventory.

Most of the discarded refrigeration appliances contained old refrigerant's media - CFC-12 and HCFC-22 and old insulating materials - CFC-11. Appliances containing HFCs are still being disposed in negligible amounts, considering their 6-30 year life cycle (IPCC 2006, Volume 3, Chapter 7, table 7.9.) which depends on the type of device. However in the next 5 years we can expect an increase in appliances disposal with a lifetime of about 20 years such as industrial refrigeration, residential and commercial air-conditioning etc.

A mixture of retrieved cooling media is being incinerated in specialized facilities. In one case, the retrieved mixture of ODS is exported as a raw material for a different industrial processes than air-conditioning or refrigeration. A very small amount of coolant medium (R 410) is exported for purposes of regeneration, where this amount depends on claims in the automobile market and remains at a level of in 0-3 t p.a.

Emissions from Mobile Air-Conditioning include emissions from the “First-Fill” in three Czech automobile factories and from servicing old equipment. This fact is also supported by the information on disposed refrigerants (Řeháček, 2014). The contribution of this category to total actual 2.F emissions was 30.55% in 2013. It can be anticipated that emissions from this category will increase in the future.

Emissions from Commercial Refrigeration include emissions from servicing old equipment and emissions from production of new air-conditioning equipment. This category has the biggest share in the total actual emissions of 2.F, which equalled to 66.29% in 2013. The development of F-gases emissions from Refrigeration and Air-Conditioning is illustrated on Fig. 4-7.

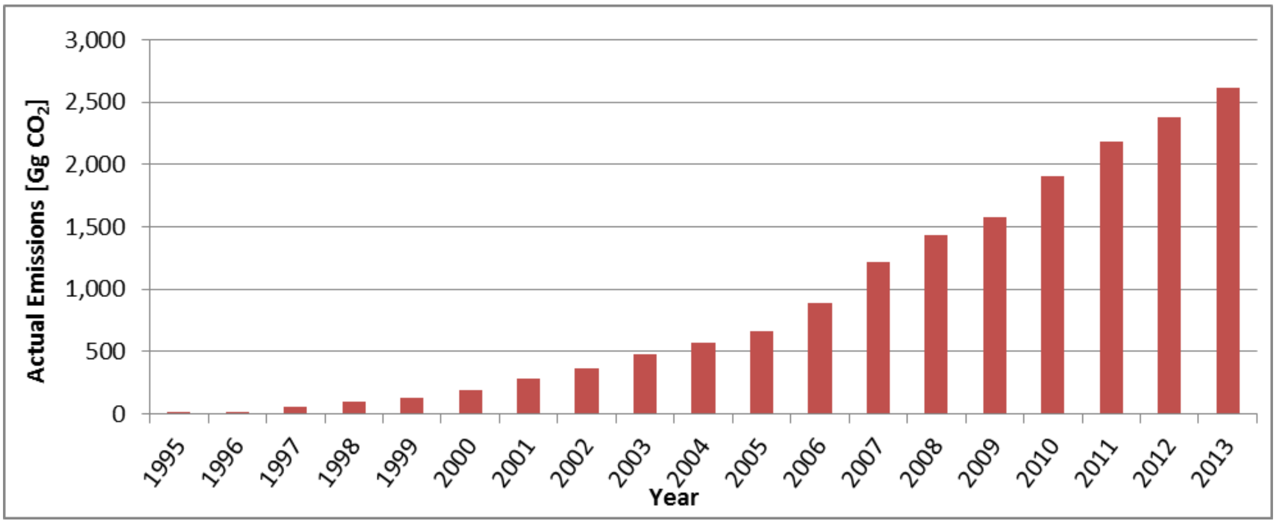


Fig. 4-7 Trend of F-gases actual Emissions for Refrigeration and Air-Conditioning [Gg CO_2 eq]

4.7.2.2 Foam Blowing Agents (CRF 2.F.2)

F-gases are used in the Czech Republic only for producing hard foam. Solely HFC-143a is used regularly for foam blowing. HFC-227ea and HFC-245ca were used occasionally in previous years for testing purposes. Use of HFC for foam blowing was not reported in 2013. Due to high costs, HFCs are being replaced by other hydrocarbons.

Emissions from this category are calculated by default methodology and EF described in IPCC, 2006 equation 7.7 for foam blowing. The contribution of foam blowing to total emissions of 2.F category equals to 0.99% in 2013. Trend of F-gases emissions from Foam Blowing Agents is illustrated on Fig. 4-8.

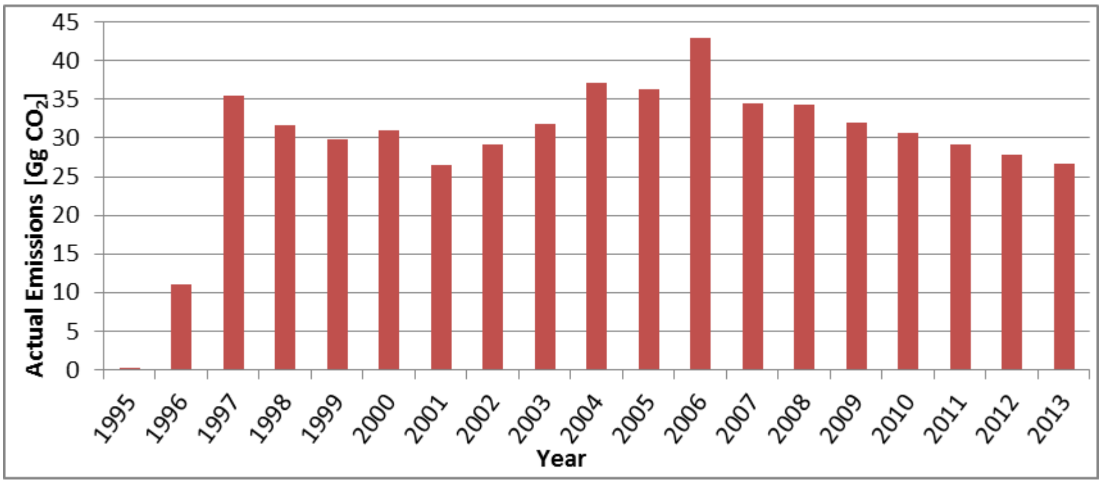


Fig. 4-8 Trend of F-gases actual Emissions for Foam Blowing Agents [Gg CO_2 eq]

4.7.2.3 Fire Protection (CRF 2.F.3)

Emissions from this category are calculated on the basis of IPCC, 2006, equation 7.17. Calculations are based on data concerning production of new equipment and servicing the old equipment. The share of this category in the total actual emissions from 2.F was 1.53% in 2013. Trend of F-gases emissions from Fire Protection is illustrated on Fig. 4-9.

It was revealed in consultations with servicing companies that first-fill leakages are very low and remain below 2% of the total emissions. Operational leakages are virtually non-existent and depend solely upon activation of fire alarms.

In the equipment servicing process, the original halons are sucked out and usually re-used again. The halons are recycled either with simple filtration or distillation. Re-use of original media without any treatment may also occur. Old types of halons (prohibited in the years before 2000) can no longer be manufactured but some of the mixtures can be reused after regeneration. A major part of new equipment employs HFC-227, while some installations are filled with HFC-236. Due to reuse of regenerated old halon mixtures, HFCs are being introduced rather slowly.

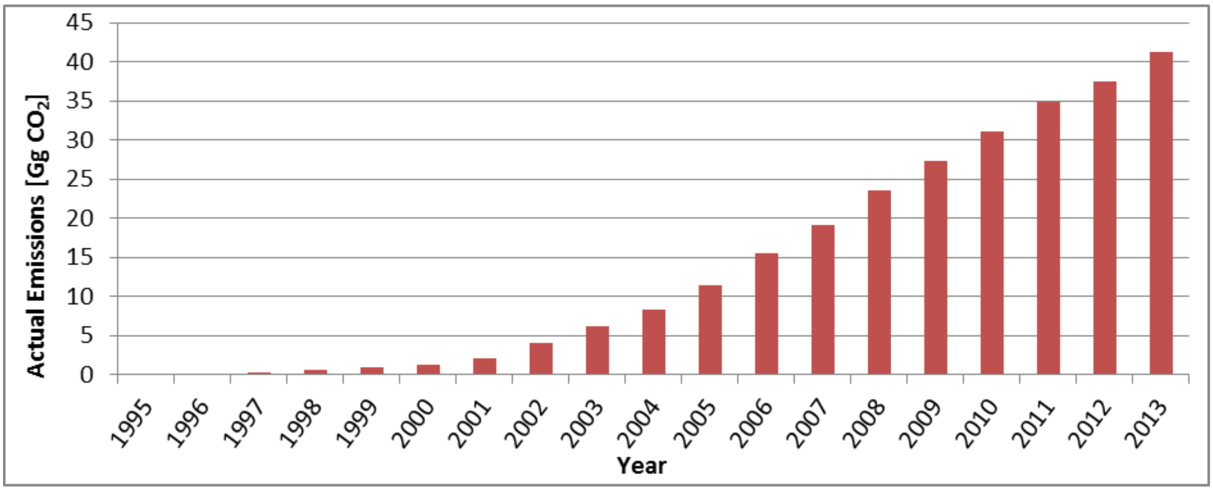


Fig. 4-9 Trend of F-gases actual Emissions for Fire Protection [Gg CO_2 eq]

4.7.2.4 Aerosols (Propellants and Solvents) (CRF 2.F.4)

Emissions from this category are based on IPCC, 2006, equation 7.6; EF equals 50% (default). A small amount of F-gases used as solvents was reported in the Czech Republic in 2013. The contribution of this category to the total actual 2.F emissions equals to 0.45% in 2013. Trend of F-gases emissions from Aerosols is illustrated on Fig. 4-10.

In this year consumption of HFC-134a, used like propellant for aerosols decreased. F-gases as propellants for aerosols are currently being replaced by cheaper propellants, specifically dimethyl ether and other hydrocarbons (butane, isobutane and propane).

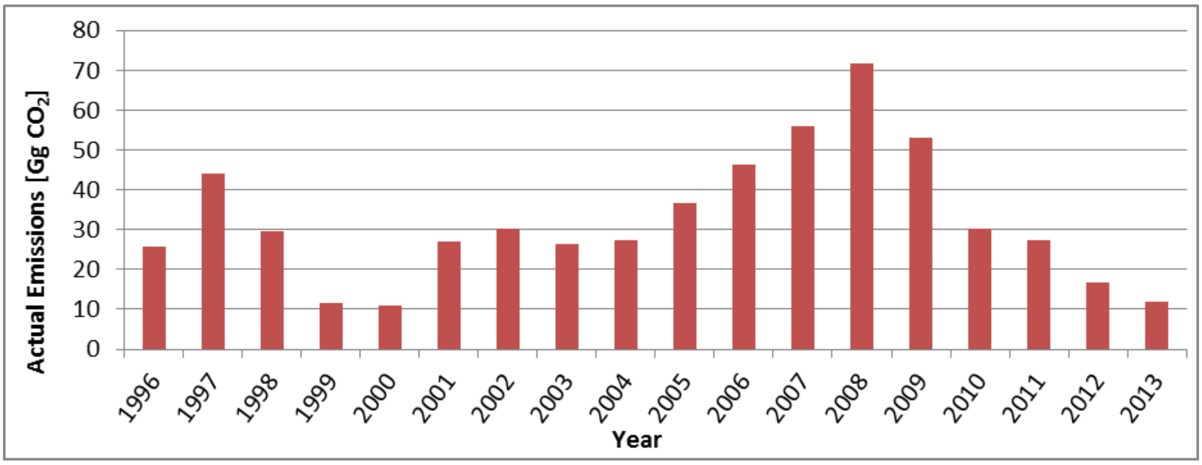


Fig. 4-10 Trend of F-gases actual Emissions for Aerosols [Gg CO_2 eq]

4.7.2.5 Solvents (Non-Aerosol) (CRF 2.F.5)

Emissions from this category are based on IPCC, 2006, equation 7.5; EF equals 50% (default). A small amount of F-gases used as solvents was reported in the Czech Republic in 2013. The contribution of this category to the total actual 2.F emissions equals to 0.15% in 2013. Trend of F-gases emissions from Solvents is illustrated on Fig. 4-11.

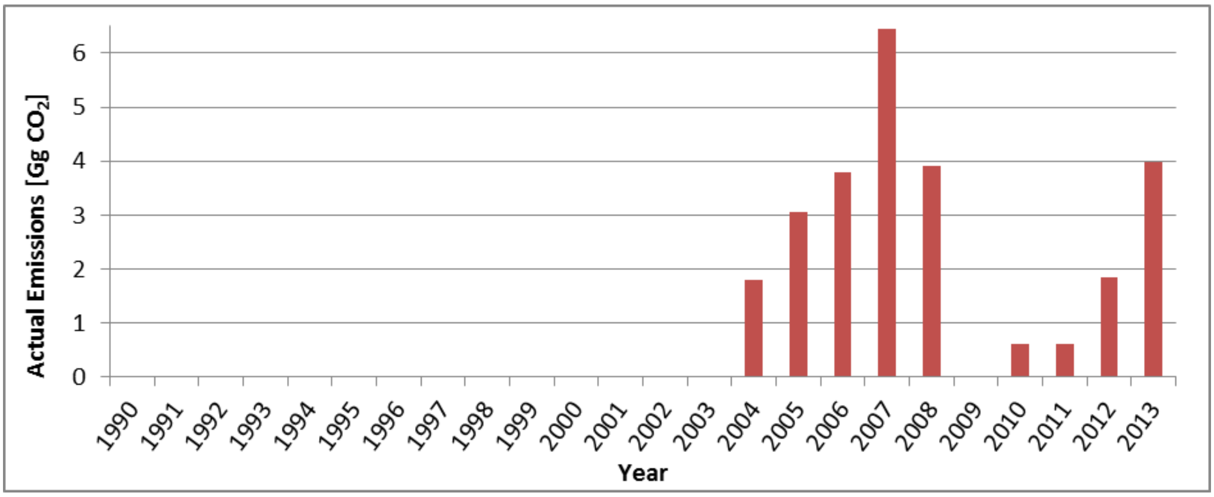


Fig. 4-11 Trend of F-gases actual Emissions for Solvents [Gg CO_2 eq]

4.7.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006, volume 1, Chapter 3, Uncertainties). Improvement of uncertainty estimation is in progress.

4.7.4 Source-specific QA/QC and verification

Verification has been performed by comparison of data received from the customs authorities, from submitted questionnaires and from reports to MoE by important importers and/or exporters. The methodology and calculations were performed twice independently and were compared. This comparison indicated few errors, which had been corrected.

4.7.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

Expert Review Team (ERT) raised repeatedly question of transparency in F-gas emission estimates calculation and reporting. In order to enhance transparency and comply with good practice, sectoral experts performed revision of methodology implementation in the whole category which resulted in revisions of the calculation spreadsheets.

Emission estimates from refrigeration have been partially revised, although there are no reliable data which would allow split of category 2.F.1 into its correct subcategories. Necessary steps have been taken to improve the emission estimate in aggregated form where expert judgement was used.

4.7.6 Source-specific planned improvements, including tracking of those identified in the review process

Accounting for F-gases contained in products is still being developed and its inclusion is planned for future submissions.

4.8 Other product manufacture and use (CRF 2.G)

4.8.1 Electrical Equipment (2.G.1)

4.8.1.1 Source category description

This category includes SF_6 used like insulation in electrical equipment. Basic data about new equipment and services was obtained from questionnaires, conducted by Řeháček, 2014. SF_6 for use in electrical equipment is mainly imported as part of the equipment, which is filled below operational amount. First servicing could be then considered as "first fill". Bulk imports are mostly being transferred for the purpose of operational stock-in-trade.

Emissions of SF_6 keeps very steady trend in the whole time series, thanks to their irreplaceable role in electrical equipment insulation. High price of SF_6 on the market prevents its expansion in the fields of other possible use.

SF_6 is still used in older types of heavy current electrical engineering devices. Huge energy companies are the main contributors to the SF_6 emissions. Reason of frequent use of SF_6 is long lifetime of installed devices with this charge. However there is no detailed information about number of devices with SF_6.

4.8.1.2 Methodological issues

Emissions from this category are calculated in line with IPCC 2006, specifically Equation 8.1, which is called the Tier 1 method. Default emission factors for Sealed Pressure Electrical Equipment were chosen from IPCC, 2006, volume 3, part 2 Other Product And Manufacture Used, table 8.2.

Operational leakage is not measured (legislation does not force operators to do so) but operators usually distinguish between amount of SF_6 used for servicing or filling to new equipment. According to consultations with the main operator in the country, the leakage is virtually non-existent and depends solely on accidents; leakage usually remains below 100 kg p.a. in total. Such a low amount of SF_6 does not even require the operator to report SF_6 usage in ISPOP.

SF_6 for use in electrical equipment is mainly imported as the part of the equipment which is filled below the operational amount. First servicing is then considered as "first fill". Bulk imports are mostly imported for the purpose of operational stock-in-trade.

4.8.1.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.1.4 Source -specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.1.5 Source -specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.8.1.6 Source -specific planned improvements, including tracking of those identified in the review process

No improvements are currently planned in this category in next submission.

4.8.2 SF_6 and PFCs from Other Product Use (CRF 2.G.2)

4.8.2.1 Source category description

This category includes estimates emissions from double-glazed sound-proof windows (CRF - 2.G.2.c). In the Czech Republic for several years SF_6 for manufacturing sound-proof windows is not used. Lifetime of windows filled with SF_6 is assumed to be 25 years. SF_6 was replaced by nitrogen and argon. Emissions occur only from stocks, which can be in the current situation difficult to estimate.

4.8.2.2 Methodological issues

Emissions from this category (Sound-proof glazing) are calculated in line with IPCC 2006, specifically Equation 8.20, 8.21 and 8.22.

4.8.2.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.2.4 Source-specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.2.5 Source-specific recalculations, including changes made in response to the review process

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed. The most significant improvement was in updating emission factors for sealed pressure electrical equipment containing SF_6 in Use phase (EF value decreased tenfold). Emission factors from 2000 GPG (IPCC) and 2006 Guidelines (IPCC) are compared in Tab. 4-16.

Tab. 4-16 Comparison of Default EFs for Sealed Pressure Electrical Equipment Containing SF_6

Phase	2000 GPG (IPCC)	2006 Guidelines (IPCC)
Manufacturing (Fraction SF_6 Consumption by Manufacturers)	0.15	0.07
Use (Fraction per Year of Nameplate Capacity of All Equipment Installed)	0.02	0.002
Retired Equipment (Fraction of charge remaining at retirement)	0.95	0.93

4.8.2.6 Source-specific planned improvements, including those in response to the review process

No improvements are currently planned in this category in next submission.

4.8.3 N_2O from Product Uses (CRF 2.G.3)

4.8.3.1 Source category description

This category (2.G.3) includes N_2O emissions from the use of this substance in the food industry (aerosol cans) and in health care (anaesthesia).

4.8.3.2 Methodological issues

Calculation of emissions from this category, are based on IPCC, 2006, Volume 3 Chapter 8 equation 8.24. 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, 2010, 2011, 2012, 2013, 2014).

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

4.8.3.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

Uncertainties for activity data in this category at the level of 50% were estimated. No uncertainty was determined for the emission factor since we assumed that all the gas is emitted (the emission factor is equal 1 t/t N_2O). Overall uncertainty data are given in Chapter 1.7.

4.8.3.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention is focused on identifying gaps and imperfections using the reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs.

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

4.8.3.5 Source-specific recalculations, including changes made in response to the review process

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.8.3.6 Source-specific planned improvements, including those in response to the review process

No improvements are currently planned in this category in next submission.

4.8.4 Other (CRF 2.G.4)

4.8.4.1 Source category description

This category includes estimated emissions from Laboratory (experimental) use. This category was included in the 2006 submission for the first time and encompasses emissions of SF_6 from laboratory use. Emissions of F-gases were not identified in this category in 2013.

4.8.4.2 Methodological issues

Data were obtained from the customs authorities and sectoral expert Ing. Řeháček.

4.8.4.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.4.4 Source-specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.4.5 Source-specific recalculations, including changes made in response to the review process

In this year, due to the implementation of 2006 Guidelines, recalculations in the whole sector were performed.

4.8.4.6 Source-specific planned improvements, including those in response to the review process

No improvements are currently planned in this category in next submission.

4.9 Acknowledgement

The authors would like to thank representatives from the Czech Ministry of the Environment, Department of Climate Change, Unit of Emission Trading for providing EU ETS. However, these data are still not available for the complete time-series.

The authors would also like to thank representatives of companies that willingly respond to our surveys and therefore help to bring to life these emission estimates.

5 Agriculture (CRF Sector 3)

5.1 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), agricultural soils (N_2O emissions only), urea application and liming (CO_2 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 emissions originated 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.

Carbon oxide emissions are derived from utilizing of non-organic fertilization on agricultural soils, mainly based on industrial produced urea and limestone application on the soils.

5.1.1 Key categories

For Agriculture, five out of six relevant categories of sources were evaluated by analysis decribed in IPCC (2006) as key categories. An overview of sources, including their contribution to aggregate emissions, is given in Tab. 5-1.

Tab. 5-1 Overview of significant categories in this sector (2013)

Category	Gas	Character of category	% of total GHG*
3.A Enteric Fermentation	CH_4	LA,TA	1.58
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	LA,TA	1.45
3.B Manure Management	N_2O	LA,TA	0.78
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	LA	0.48
3.B Manure Management	CH_4	TA	0.38

** 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*

5.1.2 Quantitative overview

Agriculture is the third largest sector in the Czech Republic with 4.85% of total GHG emissions (incl. LULUCF) in 2013 with 7 263.3 Gg CO_2 eq.; 41% of emissions is coming from Agricultural Soils, 33% from Enteric Fermentation and 24% from Manure Management. Carbon dioxide emissions from liming and urea application on managed soils, which are reported under the Agriculture sector for the first time in the 2015 submission, contribute 2% towards 2013 total agricultural emissions. During period 1990-2013 emissions from Agriculture decreased by more than 50%. The quantitative overview and emission trends in reported period are provided in Fig. 5-1 and Tab. 5-2.

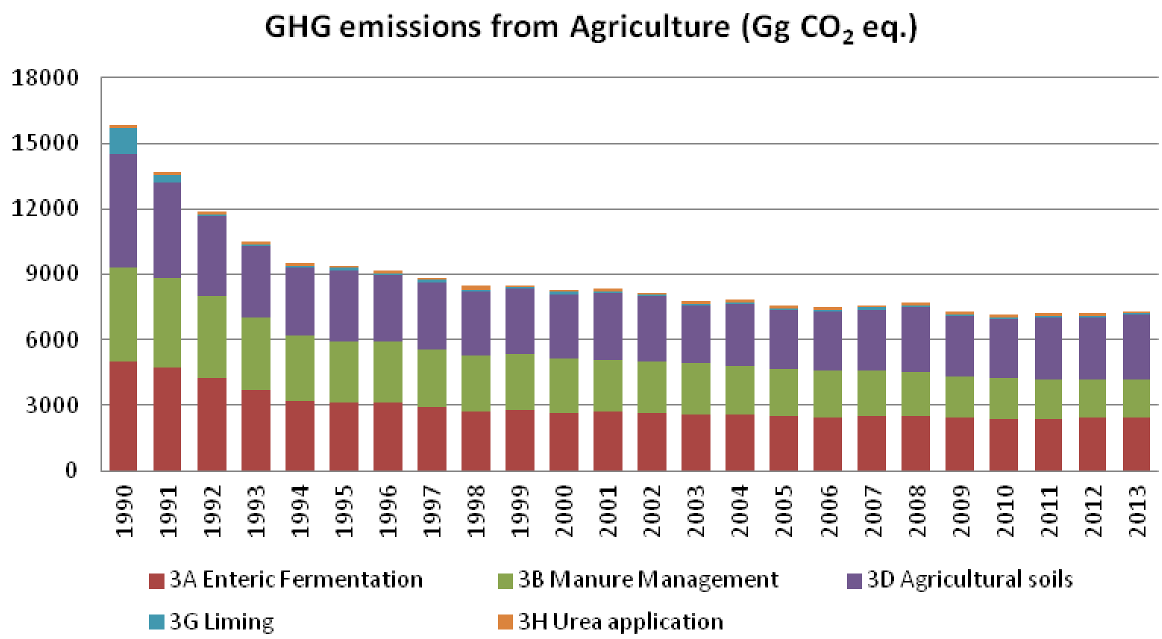


Fig. 5-1 The emission trend in agricultural sector during reporting period 1990-2013 (in Gg CO_2 eq.)

Tab. 5-2 Emissions of Agriculture in period 1990-2013 (sorted by categories)

Year	TOTAL	Enteric Fermentation (3.A)	Manure Management (3.B)	Managed soils (3.D)	Liming (3.G)	Urea Application (3.H)
	Unit [Gg CO_2 eq.]					
1990	15 820	5 023	4 261	5 250	1 178	109
1991	13 676	4 738	4 061	4 432	313	132
1992	11 887	4 247	3 716	3 707	108	109
1993	10 477	3 676	3 350	3 254	103	93
1994	9 490	3 220	2 949	3 127	103	91
1995	9 403	3 133	2 767	3 283	110	109
1996	9 158	3 105	2 773	3 067	112	100
1997	9 503	2 900	3 371	3 072	92	67
1998	8 445	2 719	2 544	2 949	90	143
1999	8 494	2 778	2 579	2 962	87	88
2000	8 248	2 668	2 459	2 941	112	67
2001	8 313	2 687	2 410	3 029	105	83
2002	8 159	2 630	2 381	2 951	99	98
2003	7 770	2 602	2 333	2 647	79	109

Year	TOTAL	Enteric Fermentation (3.A)	Manure Management (3.B)	Managed soils (3.D)	Liming (3.G)	Urea Application (3.H)
	Unit [Gg CO_2 eq.]					
2004	7 857	2 546	2 241	2 885	76	109
2005	7 574	2 493	2 150	2 758	64	109
2006	7 496	2 457	2 122	2 730	78	109
2007	7 605	2 480	2 111	2 809	80	125
2008	7 712	2 503	2 046	2 929	95	139
2009	7 293	2 437	1 906	2 766	64	120
2010	7 138	2 379	1 838	2 723	61	136
2011	7 219	2 385	1 774	2 855	80	125
2012	7 238	2 413	1 746	2 836	116	128
2013	7 263	2 412	1 759	2 956	135	1

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 while the decrease in emissions derived from 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.

An overview of formerly recalculations is performed in Chapter 10.

Recalculations approved for the 2015 Inventory submission in the Agriculture sector:

The Czech Republic has made a number of improvements in its 2015 annual submission. The Czech Republic has also ensured that its submission is in line with the IPCC 2006 Guidelines.

The implementation of the IPCC (2006) method is consistent with the requirements:

- The report to contain activity data of application of a small quantity of sewage sludge to agricultural land.
- N_2O emissions from manure management to be reported by livestock category.
- Indirect N_2O emissions are now calculated for Manure management and Agricultural soils categories.
- A report has been produced on pasture renewal and this activity is now included under the calculation for N_2O released from crop residues.
- Urea production data are used to meet the new requirement to report CO_2 emissions from urea fertilizers
- CO_2 emissions from Liming on managed soils (incl. forest) are now reported under the Agriculture sector (formerly provided under the LULUCF sector).
- The global warming potentials (GWPs) have been updated to values recommended in the IPCC Fourth Assessment Report (AR4) (CH_4 GWP=25; N_2O GWP=298), in line with UNFCCC decision 24/CP. 19.
- All Agriculture outputs have been updated into a new format compatible with the online CRF Reporter.

These activities will result in recalculations in Enteric fermentation, Manure management, and Agricultural soils categories, and sections have been added in the 2015 Inventory submission to include the reporting of Liming, Urea application and Sewage sludge to direct emissions from agricultural soils. These are discussed in further detail in the relevant sector recalculation sections.

To quantify the effect of the changes made in the Agriculture sector calculations due to the improvements and the migration to IPCC (2006) Guidelines, the Czech Republic has compared the 2015 submission with the previous submission using the GWPs. These improvements and methodological changes have resulted in 3.0 per cent (-487 kt CO_2 eq.) increase of agricultural emissions in 1990, and

9.9 per cent (795 kt CO_2 eq.) decrease of emissions in 2013 in the 2015 submission.

A detailed description of GHG emission estimation in the Czech Republic using 2006 IPCC Guidelines is presented in the following chapters.

5.1.3 Overview of 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. Czech University of Life Sciences, Institute of Animal Science Prague, Research Institute for Cattle Breeding and Research Institute of Agricultural Engineering are other institutes contributing information used in the sector of Agriculture. Slovak agricultural experts (SHMI) also participate in debates on the inventory improvements.

The 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, annual crop production, amount of synthetic fertilizers, sewage sludge, liming and urea applied to managed soils (Czech official statistics, urea production data)
- The consistency of time-series activity data and emission factors
- The 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 (CzSO), are inserted into the excel spreadsheets. The excel files are verified by other IFER experts. Some more specific parameters, not available from CzSO, are required to estimate the country-specific emission factors for cattle (Tier 2). The zoo-technical national data (esp. cattle breeding) are supplied by experts from agricultural institute (see above). 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 completeness check of CRF tables was performed for final time-series approval.

A responsible person (IFER expert) fills in QA/QC forms, including information from checking and verifying activity data, CRF data and NIR content separately for the reported emission inventory categories. The QA/QC forms are archived in IFER and CHMI (ftp server). 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.

5.2 Livestock (CRF 3.1)

The methods for estimating CH_4 and N_2O emissions from livestock require definitions of livestock sub-categories, annual populations (see Tab. 5-3) and, for higher Tier 2 methods (cattle), also feed intake and other characterization. A coordinated livestock characterization was used to ensure consistency across the following source categories for the whole emission inventory.

Tab. 5-3 Animal population in the period 1990-2013 (heads)

	1990	1991	1992	1993	1994	1995
Cattle	3 506 222	3 359 976	2 949 574	2 511 737	2 161 438	2 029 827
Pigs	4 789 898	4 569 304	4 609 149	4 598 821	4 070 898	3 866 568
Sheep	429 714	429 106	342 069	254 301	196 030	165 345
Poultry	31 981 100	33 278 468	30 756 308	28 219 580	24 974 149	26 688 376

	1996	1997	1998	1999	2000	2001
Cattle	1 988 810	1 865 902	1 700 789	1 657 337	1 573 530	1 582 285
Pigs	4 016 246	4 079 590	4 012 943	4 000 720	3 687 967	3 469 802
Sheep	134 009	120 921	93 557	86 047	84 108	87 539
Poultry	27 875 356	27 572 714	29 035 455	30 222 187	30 784 432	28 864 561

	2002	2003	2004	2005[1)]	2006	2007
Cattle	1 520 136	1 473 828	1 428 329	1 397 308	1 373 645	1 391 393
Pigs	3 440 925	3 362 801	3 126 539	2 876 834	2 840 375	2 830 415
Sheep	96 286	103 129	115 852	140 197	148 412	168 910
Poultry	29 946 846	26 873 408	25 493 559	25 372 333	25 736 003	24 592 085

	2008	2009	2010	2011	2012	2013
Cattle	1 401 607	1 363 213	1 349 286	1 343 686	1 353 685	1 352 822
Pigs	2 432 984	1 971 417	1 909 232	1 749 092	1 578 827	1 586 627
Sheep	183 618	183 084	196 913	209 052	221 014	220 521
Poultry	27 316 866	26 490 848	24 838 435	21 250 147	20 691 308	23 265 358

5.2.1 Enteric fermentation (CRF 3.A)

5.2.1.1 Source category description

This chapter describes estimation of CH_4 emissions from Enteric Fermentation. In 2013, 81% of agricultural CH_4 emissions arose from this source category. This category includes emissions from cattle (dairy and non-dairy), 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.

5.2.1.2 Methodological issues

Emissions from enteric fermentation of domestic livestock have been calculated by using Tier 1 and Tier 2 (cattle category) methodologies presented in the 2006 IPCC Guidelines, that are linked to the previous methodologies IPCC (1997 and 2000). Methane emissions for cattle, which are a dominant source in this category, have been calculated using Tier 2 method, while for other livestock Tier 1 method was used. The contribution of emissions from livestock other than cattle to the total emissions from enteric fermentation is not significant.

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. is proportional to the daily food intake and the conversion factor. It thus holds that

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

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

In principle, this equation should be solved for each cattle subcategory, denoted by index i. The Czech Statistical Office, see Statistical Yearbooks (CzSO, 1990–2013), provides following categorization of cattle:

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

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 suckler cows, where the fraction of suckler cows (suckler/all cows) gradually increased in the 1990-2013 time period. Based on the ERT recommendation (2011) the sub-category "Suckler cows" was reallocated from Dairy cattle to Non-dairy cattle.

According to the IPCC methodology, Tier 2 (IPCC 2006, 2000 and 1997), the “daily food intake” for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight, 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 and 2011. Examples of input data used (Hons and Mudřík, 2003, Mudřík and Havránek, 2006, Kvapilík J. 2010 and 2011 –

[1] *Since 2009 the age limit for “Calves” shifted up to 8 months.*
[2] *Since 2009 the age limit for “Young bulls and heifers” shifted up to 8 -12 months.*

pers.com.) are given below, Tab. 5-4 (incorrect data for *Bulls 6-12 months* was corrected) and Tab 5-5. The numbers of grazing days for individual cattle categories are presented in the Tab. 5-6.

Tab. 5-4 Weights of individual categories of cattle, 1990–2013, in kg

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Mature cows (dairy and suckler)	520	540	580	585	590
Heifers > 2 years	485	490	505	510	515
Bulls and bullocks > 2 years	750	780	820	840	850
Heifers 1-2 years	380	385	395	395	390
Bulls 1-2 years	490	510	530	540	560
Heifers 6-12 months	275	280	285	285	290*
Bulls 6-12 months	325	330	335	340	350*
Calves to 6 months	128	132	133	135	135*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

Tab. 5-5 Feeding situation, 1990–2013, in% of pasture, otherwise stall is considered

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Dairy cows	10	20	20	22	15
Suckler cows	10	20	20	50	95
Heifers > 2 years	30	30	30	35	50
Bulls > 2 years.	30	40	40	40	25
Heifers 1-2 years	30	40	40	40	50
Bulls 1-2 years	30	40	40	40	25
Heifers 6-12 months	30	40	40	40	50*
Bulls 6-12 months	30	40	40	40	50*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

Tab. 5-6 Grazing days for individual cattle categories

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Dairy cows	18	20	36	40	27
Suckler cows	18	20	36	90	171
Heifers > 2 years	54	54	54	63	90
Bulls > 2 years.	54	72	72	72	45
Heifers 1-2 years	54	72	72	72	90
Bulls 1-2 years	54	72	72	72	45
Heifers 6-12 months	54	72	72	72	90*
Bulls 6-12 months	54	72	72	72	90*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

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. 5-7), in which only milk from dairy cows is considered, increased to 20.39 liters/day/head in 2013, with an average fat content of 3.85%. A relevant daily milk production of non-dairy cows is 3.5 l/day/head. The activity data of milk production comes from the official statistics (CzSO) and these are verified in Yearbook of cattle in Czech Republic (annual report).

As the official statistics, specifically from CzSO, provide population values for cows and other cattle, the resulting EFs in the CRF Tables are defined for the categories of "Dairy cows" and "Non-dairy 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.).

The country-specific parameter DE (digestibility, in%) for cattle was estimated based on existing publications. Considering the individual OMD (organic matter digestibility) values for the most common feed (e.g. corn silage, hay and straw, green fodder – alfalfa and clover, etc.) the average digestibility for cattle was estimated. The estimated average digestibility corresponds to approximately 70% (Koukolová and Homolka 2008 and 2010, Tománková and Homolka 2010, Jančík et al. 2010, Petrikovič et al. 2000, Petrikovič and Sommer 2002, Sommer 1994, Zeman et. al. 2006, Třináctý 2009, Čermák et al. 2008). Dr. Pozdíšek (expert from the Research Institute for Cattle Breeding, Ltd., pers. com.) determined the conservative average digestibility values for 3 basic cattle sub-categories. These digestibility values were employed for the emission estimation:

- Dairy cattle DE = 67%
- Suckler cows DE = 62%
- Other cattle DE = 65%

Details of the calculation are given in the above-mentioned study (Kolar, Havlikova and Fott, 2004) and the results are illustrated in Tab. 5-8. 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 from enteric fermentation of cattle dropped during the 1990-2013 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

Tab. 5-7 Milk production of dairy cows and fat content (1990–2013)

	Dairy cows	Daily production	Fat content
	[thousands]	[liters/day head]	[%]
1990	1206	10.67	4.03
1991	1165	9.63	4.09
1992	1006	10.13	4.07
1993	902	10.18	4.10
1994	796	10.79	4.04
1995	732	11.34	4.02
1996	713	11.69	4.08
1997	656	11.29	4.02
1998	598	12.44	4.05
1999	583	12.85	4.03
2000	548	13.55	4.00
2001	529	14.00	4.03
2002	496	15.08	3.98
2003	490	15.77	3.98
2004	476	16.41	3.98
2005	438	17.13	3.90
2006	424	17.45	3.90
2007	410	17.94	3.88
2008	406	18.51	3.86
2009	400	18.82	3.85
2010	384	18.91	3.86
2011	374	19.53	3.88
2012	373	20.31	3.85
2013	367	20.39	3.88

Tab. 5-8 Methane emissions from enteric fermentation, cattle (Tier 2, 1990–2013)

	Dairy cows	Other cattle	EF. cows	EF. other	Em. cows	Em. other	Emissions
	[thous.]	[thous.]	[kg CH_4/hd]	[kg CH_4/hd]	[Gg CH_4]	[Gg CH_4]	[Gg CH_4]
1990	1206	2300	82.35	39.25	99.33	90.28	189.61
1991	1165	2195	79.01	39.41	92.08	86.50	178.58
1992	1006	1943	80.67	40.38	81.17	78.48	159.65
1993	902	1609	80.96	40.08	73.06	64.49	137.56

	Dairy cows [thous.]	Other cattle [thous.]	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]
1994	796	1366	82.81	40.03	65.90	54.67	120.56
1995	732	1298	86.29	41.98	63.18	54.47	117.66
1996	713	1275	87.78	42.28	62.63	53.91	116.55
1997	656	1210	86.09	42.88	56.50	51.87	108.37
1998	598	1103	90.27	43.04	53.97	47.48	101.44
1999	583	1074	94.16	45.57	54.90	48.96	103.86
2000	548	1026	96.42	45.92	52.82	47.10	99.92
2001	529	1053	98.17	46.52	51.97	48.98	100.96
2002	496	1024	101.59	47.29	50.42	48.42	98.83
2003	490	984	103.98	47.60	50.99	46.81	97.80
2004	476	952	106.20	47.53	50.54	45.27	95.80
2005	438	960	108.46	48.31	47.49	46.36	93.84
2006	424	950	109.56	48.35	46.45	45.91	92.36
2007	410	981	111.07	48.45	45.58	47.53	93.11
2008	406	996	112.85	48.88	45.76	48.69	94.45
2009	400	964	113.82	48.77	45.47	47.00	92.47
2010	384	966	114.26	47.91	43.82	46.27	90.09
2011	374	970	116.55	48.29	43.57	46.84	90.41
2012	373	981	118.93	48.23	44.38	47.29	91.67
2013	367	985	119.48	48.43	43.89	47.73	91.62

Enteric fermentation of other livestock

Compared to the cattle, the contribution of other farm animals to the whole CH_4 emissions from enteric fermentation is much smaller, only about 5.5%. Therefore, CH_4 emissions from enteric fermentation of other farm animals (other than cattle) are estimated using 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 (CzSO) publishes data on the number of goats, sheep, swine, horses and poultry annually in the Statistical Yearbooks (1990-2013).

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.

5.2.1.3 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. 5-1 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 Expert 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 decisions:

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 Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighboring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed.

Increased attention was firstly 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 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.

The national zoo-technical inputs (mainly weight, weight gain, daily milk production including the percentage of fat and the feeding situation) were updated in this submission in conjunction with an expert from the Research Institute of Animal Production. Also in this submission, the sub-category "Suckler cows" was reallocated from “Dairy cattle” to “Non-dairy cattle”; more accurate cattle population data was used. Additionally, the new digestibility values (DE) were employed for cattle (detailed in Chapter 6.2.2.1), affecting the implied emission factors for cattle categories. These changes in the activity data and input parameters resulted in changes in emissions for the entire reporting period.

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data equals to 5%. The uncertainty in the emission factor equals to 20%. The combined uncertainty, calculated according to IPCC Tier 1 methodology, equals to 20.6%.

5.2.1.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 6.1.3.

5.2.1.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The 2006 IPCC Guidelines methodology was implemented to the agriculture sector of the Czech national emission inventory for the entire period 1990-2013. New GWPs were utilized to calculate CO_2 eq. emissions. After implementation of 2006 IPCC Guidelines, the values of emissions in the Enteric Fermentation category remained unchanged in the whole entire period. The changes of emissions are caused by applying new GWP´s only.

5.2.1.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is currently in progress.

5.2.2 Manure management (CRF 3.B)

This chapter describes the estimation of CH_4 (32%) and direct (45%) and indirect (23%) N_2O emissions coming from animal manure management. Total emissions are 1758.9 Gg CO_2 eq. in 2013. For detailed information see Tab. 5-9.

The good agricultural practices were developed based on agricultural policies and structures that support the trends in animal waste management system allocation. These practices aim to use techniques to reduce emissions, protecting the environment while incurring the low costs. Among these procedures are included inexpensive and austerity measures, such as the incorporation of relevant proteins in livestock feed, regular cleaning of the stables or proper timing of manure applications to agricultural land in the period when plants absorb the maximum amount of nutrients. Such measures may also involve complicated procedures, such as using low-emission techniques for application and storage of manure, livestock housing.

5.2.2.1 Source category description

During period 1990-2013 the emissions from Manure Management decreased by 60%. The emissions from cattle and swine dominate this trend. The reduction in the cattle 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. 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.

Tab. 5-9 List of emissions from Manure Management during 1990-2013 (in Gg CO_2 eq.)

	TOTAL	CH_4 emissions	N_2O emissions	
			Direct	Indirect
1990	4260.9	1279.9	1995.6	985.5
1991	4060.6	1220.2	1899.0	941.4
1992	3716.5	1116.6	1725.8	874.1
1993	3350.4	1009.9	1545.2	795.3
1994	2949.2	881.2	1369.7	698.3

	TOTAL	CH_4 emissions	N_2O emissions	
			Direct	Indirect
1995	2767.5	832.6	1278.0	656.9
1996	2773.2	786.4	1325.6	661.2
1997	3371.1	735.9	1995.6	639.6
1998	2543.8	707.6	1221.5	614.7
1999	2578.9	721.0	1235.8	622.1
2000	2459.1	713.1	1154.5	591.5
2001	2409.7	718.6	1112.6	578.5
2002	2380.6	742.9	1065.2	572.6
2003	2333.5	754.8	1019.2	559.4
2004	2241.5	724.7	982.0	534.7
2005	2149.8	698.6	939.5	511.7
2006	2122.4	690.5	926.4	505.5
2007	2110.8	693.2	916.4	501.2
2008	2046.0	676.0	890.6	479.4
2009	1906.2	630.1	837.1	439.0
2010	1837.9	584.5	826.5	426.9
2011	1773.7	567.3	798.1	408.3
2012	1745.8	559.1	788.6	398.1
2013	1758.9	564.2	792.4	402.2

5.2.2.2 Methodological issues

Methane emissions (CRF 3.B.1)

CH_4 emissions from manure management were identified as a *key source* only by trend assessment (TA). The estimation of methane emissions from Manure Management is provided of cattle by Tier 2. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (see Tab. 5-1).

Cattle category

The activity data as cattle population distributed by age comes from the Czech statistical office (CzSO). This is a consistent time series of number of animals during entire reported period (1990-2013). Gross energy (GE) values are estimated based on the national study Kolář *et al*. (2004). These GE parameters are reported in CRF as a country-specific data for the entire reported period (Tab. 5-10).

Tab. 5-10 Gross Energy (GE, MJ/head/day) of cattle in period 1990-2013

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Dairy cows	209.3	200.8	205.0	205.7	210.4	219.3	223.1	218.8	229.4	239.3	245.0	249.5
Other cattle	99.7	100.1	102.6	101.8	101.7	106.7	107.4	109.0	109.4	115.8	116.7	118.2
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Dairy cows	258.1	264.2	269.9	275.6	278.4	282.2	286.8	289.2	290.3	296.2	302.2	303.6
Other cattle	120.2	121.0	120.8	122.8	122.9	123.1	124.2	123.9	121.7	122.7	122.6	123.1

The current updated data of AWMS distribution were applied for emission estimation. The other specific parameters for estimation of emission factors for cattle were obtained (Bo, MCF) from Dämmgen *et al.* (2012). The specific parameters recommended for use by study in neighbouring states (Dämmgen *et al.* 2012) are comparable to the default values (2006 IPCC Guidelines) and corresponds to Czech climate conditions. The parameters recommended in Dämmgen *et al.* (2012) were utilized for the emission estimation (Tab. 5-11). The VS parameters calculated based on B_0, ASH and MCF values by Dämmgen *et al.* (2012) and EF for estimation of methane emissions are presented in Table 5-12.

Tab. 5-11 List of parameters for methane emission factor estimation in Manure Management in Czech conditions

Parameters	Dairy cows	Other cattle
B_o	0.24	0.17
ASH	8%	
MCF values:		
Liquid system	17%	
Daily spread	0.1%	
Solid storage and dry lot	2%	
Pasture range and paddock	1%	

Tab. 5-12 Parameter VS, EF (kg CH_4/h/yr) and methane emissions from Manure Management in period 1990-2013

	Dairy cows		Other cattle		CH_4 emissions
	VS	EF	VS	EF	Gg CH_4
1990	3.95	13.14	2.28	7.98	34.21
1991	3.80	12.62	2.30	8.05	32.38
1992	3.87	12.88	2.25	7.91	28.34
1993	3.89	12.93	2.23	7.86	24.32
1994	3.97	12.91	2.23	7.87	21.02
1995	4.12	12.82	2.33	7.84	19.56
1996	4.19	9.94	2.34	7.91	17.18
1997	4.11	8.02	2.36	8.05	14.99
1998	4.31	8.40	2.37	8.10	13.95
1999	4.50	8.89	2.50	8.61	14.43
2000	4.60	11.11	2.52	8.70	15.01
2001	4.69	11.44	2.54	9.47	16.03
2002	4.85	14.30	2.58	9.68	17.01
2003	4.96	17.06	2.59	9.76	17.96
2004	5.06	17.41	2.59	9.75	17.57
2005	5.16	17.60	2.64	9.97	17.28
2006	5.22	17.78	2.64	10.00	17.03
2007	5.29	18.02	2.65	9.78	16.99
2008	5.37	18.31	2.67	9.61	17.00
2009	5.42	18.46	2.68	9.34	16.37
2010	5.45	19.18	2.64	8.75	15.81
2011	5.56	19.56	2.66	8.73	15.78
2012	5.67	19.95	2.66	8.65	15.92
2013	5.69	20.04	2.67	8.67	15.90

The equations for determination of emission factors and estimation of methane emissions were taken from the IPCC (2006).

1. To estimate the methane emissions the Eq. 10.22 (2006 IPCC, p. 10.37) was used:
   *CH_4 emissions (Gg/year) = Σ (EF * cattle population /10^6 (kg/Gg))*
2. To estimate the VS parameter the Eq. 10.24 (2006 IPCC, p. 10.42) was utilized:
   *VS = GE * [(1-DE/100)+(UE*GE)] * (1-ASH/18.45)*
3. The estimation of methane emission factors by Eq. 10.23 (2006 IPCC, p. 10.41) was done: EF = VS*365*Bo*0,67* Σ (MCF*MS)

Other livestock category

The emissions for other than cattle farm animals are estimated by Tier 1 approach. Default EFs for Western Europe were employed for similar reasons as in the previous paragraph (Tab. 5-13). Similarly as for enteric fermentation, the obsolete national approach used in the past was abandoned because of lack of comparability with other countries. In relation to the decreasing trend in animal population (especially cattle and swine) the emissions from Manure Management rapidly declined during 1990-2003.

Tab. 5-13 Table 6.8 IPCC default emission factors used to estimate CH_4 emissions from Manure Management

Livestock type	EF (kg/head/yr)
Sheep	0.19
Goats	0.12
Horses	1.39
Swine	3.00
Poultry	0.078

Nitrous oxide emissions (CRF 3.B.2)

N_2O emissions from manure management were identified as a key source; Tier 2 methodology is used for emission estimation for the cattle category (Tier 2 for other animals). 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.

Input data consists in the mass fraction Xi,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 Xi, 1 + Xi, 2 + ... + Xi, 6 = 1. For Tier 1, gives only the values of matrix X for typical means of management of animal excrement in Eastern and Western Europe. AWMS parameters presented in the IPCC methodology (IPCC 2006) were determined for the Czech conditions. The Czech specific AWMS parameters are distributed to dairy and non-dairy cattle categories (Tab. 5-15).

A capacity of manure storage corresponds to their actual production for 6 months. This does not apply to storage of solid manure on agricultural land prior to use. On agricultural land may be solid manure stored for a maximum period of 24 months (Decree No. 274/1998 Coll.). If the company manages in vulnerable areas, the solid storage is permitted on the agricultural land a maximum period for 12 months (Regulation 103/2003 Coll.). On the same site of agricultural land the company/owner can save fertilizer again after four years after soil cultivation of the agricultural land. Liquid manure will be stored in leak-proof tanks or scrub areas in the stables. Reservoirs and tanks or areas in the stables match the capacity of at least four months estimated production of liquid manure or share a minimum of three months estimated production of liquid manure and dung, depending on climatic conditions of the region.

In response to the list of potential problems and further questions raised by the ERT, the Czech Republic revised the Nex values for dairy and non-dairy cattle (see Tab. 5-14) and changed the distribution ratio of manure per AWMS (see Tab. 5-15) according to the national conditions based on expert judgment (Hons and Mudřík 2004 and Kvapilík J. 2010 and 2011 – pers.com.).

The IPCC default nitrogen excretion (Nex) values and distribution of AWMS systems for other animal categories (excl. cattle) are presented in Tab. 5-16. According to GPG (IPCC, 2000), the IPCC default values for swine were taken from Tables B-3 through B-6 and the IPCC default values for all the other animal species were taken from Table 4-21. The emissions are then summed over all the manure management systems. A manure production data for individual AWMS are reported in Tab. 5-17.

Tab. 5-14 Czech national Nex (nitrogen excretion) values used to estimate N_2O emissions from Manure Management

	Nitrogen excretion (Nex)	
	Dairy cows	Non-dairy cattle (AVG value)
	[kg/head/year]	
1990	101.94	58.51
1991	99.06	58.66
1992	100.51	59.66
1993	100.85	59.17
1994	102.38	59.09
1995	105.93	61.27
1996	107.45	61.61
1997	105.75	62.28
1998	109.63	62.52
1999	114.61	65.43
2000	116.57	65.87
2001	118.26	66.58
2002	121.16	67.47
2003	123.33	67.90
2004	125.32	67.78
2005	127.15	69.00
2006	128.13	69.00
2007	129.39	69.00
2008	130.89	69.51
2009	131.71	69.99
2010	132.59	68.76
2011	133.83	69.17
2012	135.78	69.10
2013	136.07	69.30

Tab. 5-15 Czech national distribution of AWMS systems for cattle category only

Dairy cows	Fraction of Manure Nitrogen per AWMS (in%)			
	Liquid	Daily spread	Solid	PRP
1990	25	2	68	5
1995	23	1	66	10
2000	15	1	74	10
2005	26	1	62	11
2010 - now	27	1	65	7
Non-dairy cattle (AVG)	**Liquid**	**Daily spread**	**Solid**	**PRP**
1990	45	1	42	12
1995	43	1	39	17
2000	44	1	38	17
2005	49	1	34	16
2006	49	1	34	16
2007	48	1	33	18
2008	47	1	32	20
2009	45	1	32	22
2010	43	1	32	24
2011 - now	42	1	32	25

Tab. 5-16 IPCC default nitrogen excretion (Nex) and distribution of AWMS systems for other animal categories

Livestock type	Nex (kg/head/yr)	Type of AWMS				
		Liquid	Daily spread	Solid	PRP	Other
		Fraction of Manure Nitrogen per AWMS (in%)				
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

Tab. 5-17 Manure production distributed by individual AWMS in 2013

AWMS	Nitrogen Production in Manure (kg N/yr)
Liquid systems	68 021 295
Solid storage & drylot	61 311 853
Other	12 586 535
Daily spread	1 111 693
Pasture range and paddock (PRP)	26 803 854
Total	**169 835 229**

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 Table 10.21 (2006 IPCC), see Tab. 5-18.

Tab. 5-18 IPCC default emission factors of animal waste per different AWMS

AWMS	Emission Factor (EF3) (kg N_2O-N per kg N excreted)
Liquid	0.005
Solid Storage	0.02
Other Systems	0.01

Indirect Emissions from Manure Management (CRF 3.B.2.5)

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and NOx. The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time, and to a lesser degree temperature. Simple forms of organic nitrogen such as urea (mammals) and uric acid (poultry) are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air. Nitrogen losses begin at the point of excretion in houses and other animal production areas and continue through on-site management in storage and treatment systems (i.e., MMS – manure management systems). Nitrogen is also lost through runoff and leaching into soils from the solid storage of manure at outdoor areas, in feedlots and where animals are grazing in pastures.

Tier 1 calculation of N volatilization in forms of NH_3 and NO_x from MMS is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each MMS by a fraction of volatilized nitrogen (Eq. 10.26). N losses are then summed over all MMS´s. Tier 1 method is applied using default nitrogen excretion data, default MMS data (Annex 10A.2, Tables 10A-4 to 10A-8) and default fractions of N losses from MMS due to volatilization (Table 10.22). In order to estimate indirect N_2O emissions from Manure Management, two fractions of nitrogen losses (due to volatilization and leaching/runoff), and two default indirect N_2O emissions factors associated with these losses (EF_4 and EF_5) were applied (Table 11.3, IPCC 2006 Guidelines). Default values for volatilization N losses are presented in the Table 10.22. The fraction of manure nitrogen that leaches from manure management systems ($Frac_{leachMS}$ = 30%) is highly uncertain. The sum of indirect emissions from Manure Management is presented in the last column in Tab. 5-9.

5.2.2.3 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 the latter was prepared at the level of Tier 1, excluding the cattle, where the emissions are calculated by Tier 2 since submission 2012.

The Czech team accepted critical remarks put forth by the International Expert Review Teams (ERT). A concept, in accordance with the plan for implementing Good Practice, is based on decision, that CH_4 emissions from manure management for all farm animals are estimated by 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 2009, 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 IPCC default values. The total emissions from the category “N_2O emissions from Manure Management” were not affected.

According to the recommendations of ERT 2011 (ARR), the recalculation of emissions from Manure Management was performed using new national parameters: feed consumption, nitrogen feed intake and protein content of milk and feed (revised Nex value). In addition, the values of digestible energy expressed as a percentage of gross energy (DE) for cattle were revised (the default values were substituted by national values). Further national data on the distribution of manure management practices across AWMS were collected and updated (Kvapilík J. 2010 and 2011– pers.com.).

According to the previous reiterated ERT recommendation (ARR 2011), the Czech Republic recalculated the methane emissions from Manure Management of cattle. In line with the IPCC a higher-tier method to estimate the CH_4 emissions from Manure Management (cattle only) was implemented in 2014 submission. The aim of the recalculation was to review the estimation of methane emissions from Manure Management of cattle by Tier 2. The recalculation of methane emissions from manure management of cattle resulted in an increase in emissions from cattle category approx. 12% in 1990, resp. 42% in 2011. Total methane emissions from Manure Management increased after recalculation by 7% in 1990, resp. by 26% in 2011 (Tab. 5-12). The study Exnerova (2013, in Czech) describing a new method was elaborated.

Application of the higher-tier method to methane emission estimation in 2014 submission has the effect of reducing the uncertainties of this sub-category.

On the basis of the recommendations of the ERT 2011, based on new zoo-technical data and updated country-specific parameters and activity data the emissions from Manure management for dairy and non-dairy cattle categories were calculated by Tier 2 method over the entire 1990-2011 reporting period. The estimation of N_2O emissions from Manure management was performed using the revised Nex values for dairy and non-dairy cattle with the updated parameters (feed consumption, nitrogen feed intake and protein content of milk, to estimate the amount of N retained in milk). Equations 10.32 and 10.33 (2006 IPCC) were used to revise Nex and to calculate the variables for nitrogen intake and nitrogen retained (milk production and growth). The results served as an input for Eq. 10.31. The parameters for estimation of the revised Nex for cattle were collected from literature and from personal communications with agricultural experts. The protein content in milk was determined to 3.3% (Poustka 2007, Ingr 2003 and Turek 2000) and protein content in feed (in dry matter) to 18% (Zeman - Czech feed standards 12-21%, Central Institute for Supervising and Testing in Agriculture 18%, Karabcová pers. commun. 16-18%). The country-specific redistribution of manure management practices across AWMS for cattle (Tab. 5-15) was taken from Hons and Mudrik (2004) for the 1990-1999 period and updated data from Kvapilík J. (2010 and 2011– pers.com.) was used for the 2000-2011 period. Dr. Kvapilik (author of the Annual report of Czech cattle breeding of the Institute of Animal Science in Prague) also provided national data on grazing animals (cattle feed situation, see Tab. 5-5 and Tab. 5-6).

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data equals to 5%. The uncertainty in the emission factor for estimation of CH_4 emissions equals to 20%; for estimation of N_2O emissions, this value equals to 30%. The combined uncertainty for CH_4 emissions equals to 20.6% and that for N_2O emissions equals to 30.41%.

5.2.2.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 6.1.3.

5.2.2.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The 2006 IPCC Guidelines methodology was implemented to agriculture sector of Czech national emission inventory for the entire period 1990-2013. New GWPs were utilized to calculate CO_2 eq. emissions. In the current submission one subsector was added in Manure Management. Newly the emissions from Indirect N_2O Emissions from manure management are reported. The change of emission factors (EF_3) for estimation of emissions from AWMS and change of GWP´s generates also changes in sum of these emissions from Manure Management.

5.2.2.6 Source-specific planned improvements, including tracking of those identified in the review process

According to recommendation of ERT a revision of the estimated N excretion rate for goats would be solved in the future. The analysis of uncertainties is in progress.

5.3 Rice cultivation (CRF 3.C)

At present, no commercial rice cultivation is being carried out in the Czech Republic. The “NO” notation key is reported in the CRF tables.

5.4 Agricultural soils (CRF 3.D)

5.4.1 Source category description

This source category includes direct and indirect nitrous oxide emissions from agricultural soils. Both of these categories (direct and indirect) are key sources of N_2O soil emissions (Tab. 5-1). 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/renewal and sewage sludge enhance the formation of nitrous oxide emissions.

Nitrous oxide emissions from agriculture include these subcategories:

- The direct emissions (synthetic fertilizers, animal manure applied to soils, crop forage residues/renewal and sewage sludge)
- The emissions from pasture manure (PRP)
- The indirect emissions (atmospheric deposition and nitrogenous substances flushed into water courses and reservoirs -leaching)

In 2013, 75% of total N_2O emissions from Agriculture originated from Agricultural Soils, while the rest originated from Manure Management (25%). The trend in N_2O emissions from this category is during reporting period 1990-2013 decreasing. Tab. 5-19 and Fig. 5-2 present the N_2O emissions of Agricultural soils by the individual sub-categories.

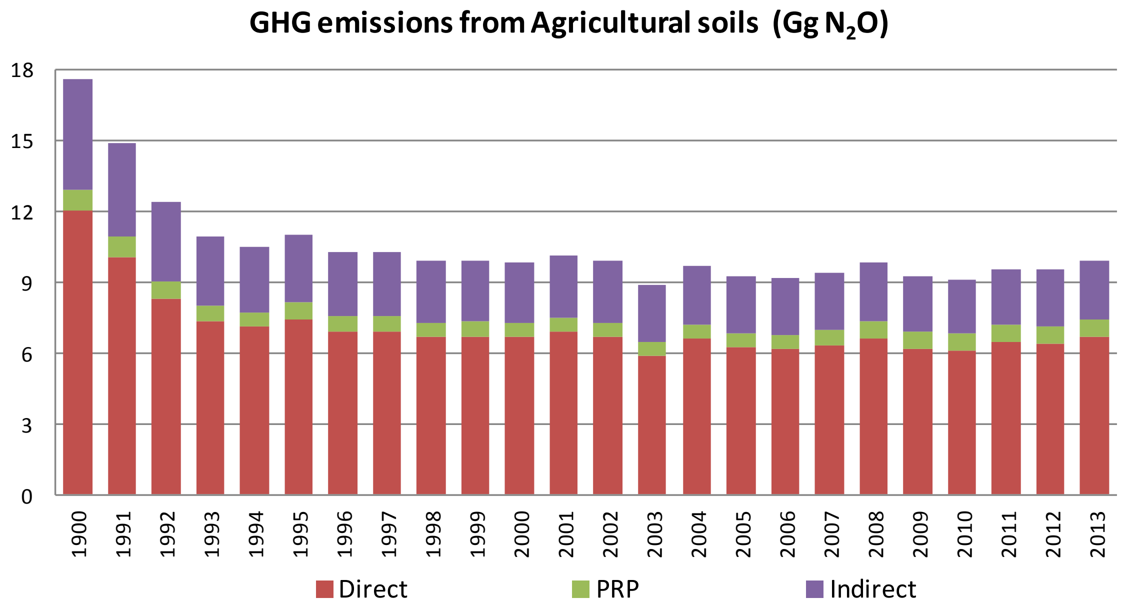


Fig. 5-2 Nitrous oxide emissions from Agricultural soils sorted by sub-categories

Tab. 5-19 N_2O emissions come from Agricultural Soils in period 1990-2013 in Gg N_2O

Year	Total emissions	Direct emissions				Pasture Manure	Indirect emissions	
		a	b	c	d		Atmosph. deposition	Leaching
1990	17.62	5.91	3.35	2.78	--	0.88	1.86	2.83
1991	14.87	4.21	3.21	2.65	--	0.85	1.62	2.34
1992	12.44	3.20	2.95	2.14	--	0.75	1.41	1.99
1993	10.92	2.55	2.65	2.16	--	0.63	1.23	1.70
1994	10.49	2.87	2.32	1.97	--	0.53	1.15	1.65
1995	11.02	3.24	2.18	1.98	--	0.73	1.16	1.71
1996	10.29	2.69	2.20	2.01	--	0.72	1.10	1.58
1997	10.31	2.91	2.12	1.91	--	0.67	1.10	1.60
1998	9.89	2.87	2.03	1.77	--	0.62	1.06	1.55
1999	9.94	2.83	2.06	1.81	--	0.63	1.06	1.55
2000	9.87	3.01	1.96	1.69	--	0.60	1.05	1.55
2001	10.16	3.19	1.94	1.78	--	0.61	1.05	1.59
2002	9.90	3.21	1.92	1.55	0.01	0.59	1.04	1.58
2003	8.88	2.71	1.86	1.31	0.02	0.58	0.97	1.43
2004	9.68	3.06	1.79	1.77	0.02	0.57	0.98	1.49

Year	Total emissions	Direct emissions				Pasture Manure	Indirect emissions	
		a	b	c	d		Atmosph. deposition	Leaching
2005	9.26	2.92	1.72	1.63	0.02	0.59	0.95	1.43
2006	9.16	3.04	1.70	1.40	0.03	0.58	0.95	1.45
2007	9.43	3.16	1.69	1.45	0.03	0.64	0.97	1.49
2008	9.83	3.36	1.64	1.60	0.03	0.70	0.98	1.52
2009	9.28	3.14	1.52	1.53	0.02	0.73	0.91	1.42
2010	9.14	3.20	1.48	1.40	0.04	0.70	0.91	1.42
2011	9.58	3.37	1.42	1.67	0.04	0.73	0.91	1.45
2012	9.52	3.51	1.39	1.44	0.03	0.75	0.92	1.47
2013	9.92	3.69	1.41	1.55	0.03	0.76	0.94	1.52

Note: a, b, c, d = individual sources of direct emissions; (a) Synthetic fertilizers, (b) Animal manure applied to soils, (c) Crops (fixing and residues) and (d) Sewage sludge

5.4.2 Methodological issues

Although agricultural soils are key source, emissions of N_2O are estimated and analyzed using Tier 1 approach of the IPCC methodology (2006 IPCC). 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. The nitrogen from manure that is spread daily is consistently included in the manure nitrogen applied to soils.

5.4.2.1 Activity data

The standard calculation of Tier 1 required the following input information based on Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990-2013):

- An amount of nitrogen applied in the form of industrial nitrogen fertilizers (CzSO data);
- A farm animal population data (CzSO data presented in Tab. 5-3);
- An annual yields (i.e. harvests, see Tab. 5-20)
- A manure production during grazing of animals (PRP category, see Tab. 5-17).
- An annual sewage sludge directly applied to the agricultural soils

Tab. 5-20 Annual yield of agricultural products (t/ha)

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
1990	5.42	2.68	16.00	33.89	6.77	3.67
1991	4.84	2.74	17.95	33.73	7.43	10.67
1992	4.14	2.22	17.78	31.11	5.67	6.17
1993	4.03	2.42	22.83	40.19	6.55	1.12
1994	4.08	2.26	16.03	35.53	5.74	1.02
1995	4.17	2.38	17.04	39.63	6.13	1.29
1996	4.19	2.40	20.80	41.45	6.27	1.42
1997	4.12	2.01	19.24	39.39	6.16	1.37
1998	3.97	2.29	21.08	40.71	5.97	1.25
1999	4.37	2.55	19.67	45.55	5.74	1.53
2000	3.92	2.09	21.32	45.62	5.60	1.25
2001	4.51	2.38	20.82	45.33	5.79	1.59
2002	4.33	1.91	23.51	49.45	6.21	2.13
2003	3.97	1.98	18.97	45.20	4.91	1.55
2004	5.47	3.11	23.96	50.35	6.06	1.43
2005	4.81	2.44	28.08	53.31	6.20	2.04
2006	4.18	2.24	23.05	51.48	6.08	1.85
2007	4.58	2.13	25.71	53.25	5.98	1.75
2008	5.39	2.15	25.83	57.26	6.39	2.17

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
2009	5.13	2.14	26.19	57.91	6.57	2.26
2010	4.71	1.86	24.56	54.36	6.05	1.69
2011	5.64	2.85	30.45	66.84	7.01	2.36
2012	4.57	1.94	27.98	63.26	6.75	2.29
2013	5.26	2.14	23.12	60.00	6.55	2.07

5.4.2.2 Direct emissions from managed soils (CRF 3.D.1)

Synthetic N fertilizers (CRF 3.D.1.1)

The application of agricultural fertilizers was intensive in the Czech Republic, but decreased radically during the 1990s. The amount of nitrogen fertilizers applied in 1990 equalled to over 418 kt decreased to 261 kt in 2013. This corresponds to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Sálusová et al., 2006).

Organic N applied as fertilizer (animal manure, sewage sludge) (CRF 3.D.1.2)

The amount of organic N inputs applied to soils is calculated using Equation 11.3 (2006 IPCC Guidelines). This includes applied animal manure, sewage sludge and compost applied to soils. In order to estimate the amount of animal manure nitrogen that is directly applied to soils, or used in feed, fuel, or construction purposes, it is necessary to reduce the total amount of nitrogen excreted by animals in managed systems by the losses of N through volatilisation, conversion to N_2O and losses through leaching and runoff. To coordinate with reporting for N_2O emissions from managed soils the Eq. 10.34 and the default values for nitrogen loss from Table 10.22 (2006 IPCC) were used to estimate the amount of animal manure nitrogen that is directly applied to soils.

A newly reported sub-category includes the emissions generated by direct application of sewage sludge to agricultural soils. The verifiable activity data from CzSO are available since 2002 in tones of dry mass. The national specific value of nitrogen content 3.7% (Černý *et al.* 2009) and default emission factor (EF_1, see Table 11.1., 2006 IPCC Guidelines) were utilized to estimate the emissions from sewage sludge.

Urine and dung N deposited on pasture by grazing animals (PRP) (CRF 3.D.1.3)

The annual amount of N deposited on pasture, range and paddock soils by grazing animals is estimated using Eq. 11.5 from the number of animals in each livestock species, the annual average amount of N excreted by each livestock species, and the fraction of this N deposited on pasture, range and paddock soils by each livestock species. The data needed for this estimation can be obtain from PRP (cattle, swine and poultry) from the livestock category. The default emission factors (Tab. 5-21) are used to estimate emissions from different animal category.

Tab. 5-21 IPCC default emission factors of animal waste for PRP

	EF_3 (kg N_2O-N per kg N excreted)
PRP (cattle, swine, poultry)	0.02
PRP (cattle, swine, poultry)	0.01

The fraction of livestock N excreted and deposited onto soil during grazing (FracGRAZ) varied from 0.085 in 1990 to 0.158 in 2013.

N-crop residues (CRF 3.D.1.4)

This category includes an amount of N in crop residues (above-ground and below-ground), including N-fixing crops, returned to soils annually. It also includes the N from N-fixing and non-N-fixing forages mineralised during forage or pasture renewal. It is estimated from crop yield statistics (CzSO) and default factors for above-/belowground residue: yield ratios and residue N contents (see Tab. 5-22).

Tab. 5-22 Data from Table 11.2 (2006 IPCC)

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
Dry mater	0.88	0.91	0.22	0.22	---	0.91
R_{AG}	calc	calc	calc	calc	calc	calc
AG_{DM}	calc	calc	calc	calc	calc	calc
FR_{remove}	0.5	0.5	0.5	0.5	0.5	0.5
N_{AG}	0.006	0.008	0.019	0.019	0.027	0.008
R_{BG}-BIO	0.22	0.19	0.2	0.2	0.4	0.19
N_{BG}	0.009	0.008	0.014	0.014	0.022	0.008

Note: The parameters R_{AG} and AG_{DM} are calculated by using Eq. 11.6 (2006 IPCC Guidelines), and adequate parameters.

Since different crop types vary in residue: yield ratios, renewal time and nitrogen contents, separate calculations are performed for major crop types and then nitrogen values from all crop types are summed up. Crops are segregated into: 1) non-N-fixing grain crops; 2) N-fixing grains and pulses; 3) potatoes 4) sugar beets; 5) N-fixing forage crops (alfalfa, clover); and 6) soya. Eq. 11.6 is used to estimate N from crop residues and forage/pasture renewal, for a Tier 1 approach.

Data on crop yield statistics (yields and area harvested, by crop) was obtained from national sources (CzSO). Since yield statistics for many crops are reported as field-dry or fresh weight, a correction factor was applied to estimate dry matter yields where appropriate (Eq. 11.7). The default values for dry matter content were utilized from Table 11.2. Only forage production activity data are presented as a dry matter in CzSO statistics.

The emission factors used for calculation of direct N_2O emissions from the other agriculture products are shown in Tab. 5-23. The default fraction values used to estimate N_2O emissions are presented in Tab. 5-24. The value of EF_1 has been changed from 1.25% to 1%, as compared to the 1996 IPCC Guidelines, as a result of new analyses of the available experimental data (Bouwman et al., 2002a,b; Stehfest and Bouwman, 2006; Novoa and Tejeda, 2006 in press).

Tab. 5-23 IPCC default parameters/fractions used for the direct emissions

Parameters/Fractions	Default values
$Frac_{GASM}$	0.20
$Frac_{NCR0}$	0.015
$Frac_{NCRBF}$	0.03
$Frac_{R}$	0.45
$Frac_{BURN}$	0.00

Tab. 5-24 Emission factors (EFs) for the direct and PRP emissions

Direct emissions	Synthetic fertilizer	**EF_1 = 0.01 kg N_2O-N/kg N**
	Animal Waste	
	Sewage Sludge	
	N-crop residues	
Pasture, range & paddock manure	Cattle, pigs, poultry	EF_3 = 0.02 kg N_2O-N/kg N
	Sheep, others	EF_3 = 0.01 kg N_2O-N/kg N

5.4.2.3 Indirect emissions from managed soils (CRF 3.D.2)

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e. directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways. The first of these ways is the volatilization of N as NH_3 and oxides of N (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters.

Volatilization

The N_2O emissions from atmospheric deposition of N volatilized from managed soil are estimated using Equation 11.9. Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by factor 44/28.

Leaching/Runoff

The N_2O emissions from leaching and runoff in regions, where leaching and runoff occurs, are estimated using Equation 11.10. Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by factor 44/28.

The method for estimating indirect N_2O emissions includes two emission factors (Tab. 5-26): one associated with volatilized and re-deposited N (EF_4), and the second associated with N lost through leaching/runoff (EF_5). The overall value for EF_5 has been changed from 0.025 to 0.0075 kg N_2O-N/kg N leached/ in runoff water. The method also requires values for the fractions of N that are lost through volatilization ($Frac_{GASF}$ and $Frac_{GASM}$) or leaching/runoff ($Frac_{LEACH}$). The default values of these fractions are presented in the Tab. 5-25.

Tab. 5-25 IPCC default parameters/fractions used for indirect emission estimation

Parameters/Fractions	Default values
$Frac_{GASM}$	0.20
$Frac_{GASF}$	0.10
$Frac_{LEACH-(H)}$	0.30

Tab. 5-26 Emission factors (EFs) for indirect emission estimation

Indirect emissions	Atmospheric Deposition	EF_4 = 0.01 kg N_2O-per kg emitted NH_3 and NO_X
	Nitrogen Leaching	EF_5 = 0.0075 kg N_2O - per kg of leaching N

5.4.3 Uncertainty and time-series consistency

In relation to the consistency of the emission series for N_2O (agricultural soils) should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology of IPCC 2006 Guidelines (IPCC, 2006). 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. Since in 2015 submission 2006 IPCC methods were applied to estimate the emissions.

The quantitative overview and emission trends during period 1990-2013 are shown in Fig. 5-2 and trend in N_2O emissions from agricultural soils is summarized in Tab. 5-19.

During 1990-2013 the total emissions from agricultural soils decreased by 47% (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 expert common consensus (I. Skorepova, P. Fott, E. Cienciala and 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 (2009), several recalculations were performed (N_2O emissions from Animal manure applied to soils, Crop residues, N-fixing crops) and technical errors were corrected in the emission inventory of agricultural soils in the 2010 submission (see Chapter 10 - Recalculations).

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), which led to changes in N_2O emissions from i) animal manure applied to soils, ii) PRP, iii) atmospheric deposition and iv) N lost through leaching and run-off. These changes apply to the entire reporting period.

During the centralized review in September 2012, the expert review team (ERT) identified a potential problem in the estimation of N_2O Direct emissions from Agricultural soils. The ERT noted that: i) the Czech Republic has not included N-fixing forage crops such as alfalfa and clover in the calculations of N_2O emissions for the entire time series and ii) the Czech Republic has not included potatoes and sugar beet crops produced in the country in the estimations of N_2O emissions from crop residues returned to soils for the entire time series. The ERT noted that this is not in line with the Revised 1996 IPCC Guidelines, and thus it was requested that these emission categories to be revised. The recalculation was submitted to ERT as a resolved issue of the "Saturday paper" regarding the 2012 NIR submission. Based on these recommendations and newly obtained country-specific data, the following improvements were implemented in the 2013 submission:

1. N-fixing forage crops such as alfalfa and clover were included in the calculations of N_2O emissions for the entire time series and
2. potatoes and sugar beet crops produced in the country were included in the estimations of N_2O emissions from crop residues returned to soils for the entire time series

On the basis of the recommendations of ERT (in-country review in August-Sept 2011 in Prague) and the following ARR document, N_2O emissions from agricultural soils were recalculated in the 2012 submission. Given that the value of Nex for cattle was revised in the Manure Management category, which led to changes in N_2O emissions from i) animal manure applied to soils, ii) pasture, range and paddocks, iii) atmospheric deposition and nitrogen lost through leaching and run-off. These changes apply to the entire reporting period.

On the basis of the recommendations of ERT (centralized review in September 2012, Bonn) Direct N_2O emissions from agricultural soils were recalculated and reported in the 2012 resubmission. This led to changes in N_2O emissions from N-fixing crops and crop residues.

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data for estimation of direct and indirect emissions from agricultural soils equals to 20%; for Pasture, Range and Paddock

Manure (PRP) this value equals to 10%. The uncertainty in the emission factor for estimation of direct and indirect emissions from agricultural soils equals to 50%; for estimation of emissions from PRP this value equals to 100%. The combined uncertainty for the direct and indirect emissions from agricultural soils equals to 53.85%; for N_2O emissions from PRP Manure this value equals to 100.5%.

5.4.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.4.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The 2006 IPCC Guidelines methodology was implemented to agriculture sector of Czech national emission inventory for the entire period 1990-2013. New GWPs were utilized to calculate CO_2 eq. emissions. In the current submission one source of emissions was added - direct application of sewage sludge to managed soils. The emission factors provided by IPCC 2006 Guidelines for emission estimations from Direct and Indirect emissions from managed soils (EF1 and EF5) were updated.

5.4.6 Source-specific planned improvements, including tracking of those identified in the review process

According to recommendation of ERT an adding data of sewage sludge for the entire reporting period will be conducted in the next submission. The analysis of uncertainties is in progress.

5.5 Prescribed burning of savanna (CRF 3.E)

This activity is prohibited by the Czech Law (Air Protection Act), thus prescribed burning of savanna does not occur in the Czech Republic**.**

5.6 Field burning of agricultural residues (CRF 3.F)

This activity is prohibited by the Czech Law (Air Protection Act), thus field burning of agricultural residues does not occur in the Czech Republic.

5.7 Liming (CRF 3.G)

5.7.1 Source category description

Liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., limestone or dolomite) leads to CO_2 emissions as the carbonate lime dissolve and release bicarbonate, which evolves into CO_2 and water. The liming on all managed soils is reported under this category, i.e. arable lands, grasslands and forest lands.

5.7.2 Methodological issues

However, the reactions associated with limestone application also lead to evolution of CO_2, which must be quantified. The source of activity data is official national statistics (CzSO and Green Report of Forestry, see Tab. 5-27). Of the reported total limestone use in agriculture, 95% was described to agricultural soils in cropland (5% to grassland) based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – pers. comm. 2005). The share of liming on forest lands of total liming in the Czech Republic was the highest in the period of 2000-2002, when the value was over 10%, in 2000 even 18%. In 2013, the liming in the forests presents only 0.01%.

Tab. 5-27 Limestone quantity applied to managed soils (in thousand tons)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CL+GL	2650	700	230	220	230	248	255	210	204	196	209	210
FL	26.9	12.1	16.2	13.9	4.8	2.4	0.3	0.0	1.0	1.0	46.7	27.8
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
CL+GL	196	172	158	143	160	174	203	145	135	182	263	308
FL	29.2	6.5	15.3	2.6	16.8	7.2	12.3	0.1	5.1	0.0	0.0	0.0

Notes: CL = Cropland, GL = Grassland, FL = Forest land

The quantification followed the Tier 1 method (Eq. 11.12., IPCC 2006 Guidelines), with an emission factor of 0.12 t C/t $CaCO_3$. To convert CO_2–C emissions into CO_2 factor 44/12 was used. 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 equalled over 2.5 mil tones, but decreased to less than 200 thousand tons annually during the most recent years. 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 (Sálusová *et al.*, 2006). The application of limestone on agricultural land in 2013 reached almost 308 thousand tons.

5.7.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgment (AD) and default value (EF). The uncertainty in the activity data for estimation of emissions from Liming equals to 20%, the uncertainty in the emission factor equals to 50%. The combined uncertainty of emission estimation from Liming equals to 53.85%.

5.7.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.7.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The 2006 IPCC Guidelines methodology was implemented to agriculture sector of Czech national emission inventory for the entire period 1990-2013. In the current submission this source of emissions was removed from LULUCF to Agriculture sector.

5.7.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is in progress.

5.8 Urea Application (CRF 3.H)

5.8.1 Source category description

Adding urea to soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process. Urea is converted into ammonium, hydroxyl ion and bicarbonate, in the presence of water and urease enzymes. This source category is included because the CO_2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector).

5.8.2 Methodological issues

Tier 1 and Eq. 11.13 are utilized to estimate CO_2 emissions. Domestic production records on urea were used to obtain an approximate estimate of the amount of urea applied to soils on an annual basis (Tab. 5-28). The default emission factor is 0.20 for carbon emissions from urea applications, which is equivalent to the carbon content of urea on an atomic weight basis. To estimate the total CO_2-C emissions the product of the amount of urea is multiplied by the emission factor. CO_2-C emissions are converted into CO_2 by multiplying 44/12.

Until 2013 the values of urea application on agricultural land have ranged from 92 till 190 thousand tons. In 2013, an extreme decline of urea production and its application on managed soils was recorded (1100 tons only), due to significant restrictions on Czech production and a transition to the import policy. The import of urea is planned to prioritize for the future period.

Tab. 5-28 Domestic production of urea (IPPU) applied to managed soils

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Urea (kt)	148	180	148	127	124	149	137	92	195	120	92	113
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Urea (kt)	134	148	148	148	148	170	190	164	186	171	174	1.1

5.8.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgment (AD) and default value (EF). The uncertainty in the activity data for estimation of emissions from Urea application equals to 20%, the uncertainty in the emission factor equals to 50%. The combined uncertainty of emission estimation from Urea application equals to 53.85%.

5.8.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in a section 5.1.3.

5.8.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The 2006 IPCC Guidelines methodology was implemented to agriculture sector of Czech national emission inventory for the entire period 1990-2013. In the current submission this source was newly added to this sector.

5.8.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is in progress.

6 Land Use, Land-Use Changes and Forestry (CRF Sector 4)

6.1 Overview of sector

The emission inventory of the 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 originally 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 the Parties (COP) to UNFCCC. The reporting guidelines were revised at 24th COP in 2013, by decision 24/CP.19. It demands that since 2015, Parties included in Annex I to the Convention should apply the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) and encourages the use of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC 2014) in preparing the annual inventories under the Convention due in the year 2015 and beyond. Hence, the current inventory submission is the first one prepared under the updated reporting guidelines (IPCC 2006, 2014).

The reporting of the LULUCF sector in the Czech Republic has been gradually incorporating the specific requirements on the inventory based on both IPCC (2003) and IPCC (2006) already in the previous submissions. The current inventory of the LULUCF sector adopts the newly revised reporting structure, including the now mandatorily estimated contribution of harvested wood products (HWP). The Czech LULUCF inventory 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. The estimation of emissions and removals of CO_2 and non-CO_2 gases for the sector was performed according to Guidelines for National Greenhouse Gas Inventories – Agriculture, Forestry and Other Land Use (IPCC 2006) that are linked to the previous used methods presented in Chapter 3 of GPG for LULUCF (IPCC 2003). Although the Czech LULUCF inventory is still under process of further refinement and consolidation, it 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 major LULUCF land-use categories, namely 4.A Forest Land, 4.B Cropland, 4.C Grassland, 4.D Wetlands, 4.E Settlements and 4.F Other Land, which were linked to the Czech cadastral classification of lands. It also includes the contribution of Harvested Wood Products (HWP). It is newly reported under the category 4.G Harvested Wood Products. 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 2013. The currently reported estimates changed in comparison with the previously reported values both due to the new reporting structure of the LULUCF sector and the revised estimates for some categories that resulted in recalculations for the entire reporting period. The currently and previously reported sectoral estimates of greenhouse-gas emissions and removals are visualized in Fig. 6-1. The implemented changes led to somewhat different estimates for individual years compared to the previously reported emission removals. However, the mean for the entire period remained practically identical: the removals increased by about one percent. Most of the observed differences are due to including the contribution of HWP in the current estimates. The detailed information on the implemented changes and performed recalculations is provided below for the respective land-use categories.

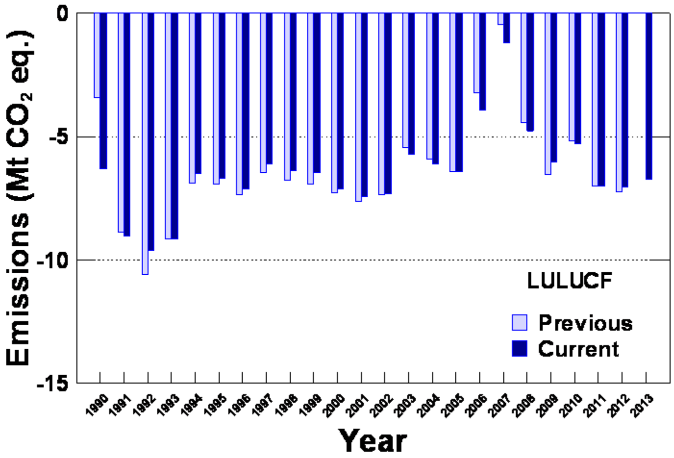


Fig. 6-1 The current and previously reported estimates of emissions for the LULUCF sector. The values are negative, hence representing net removals of green-house gases.

6.1.1 Estimated emissions

Tab. 6-1 provides a summary of the LULUCF GHG estimates for the base year 1990 and the most recently reported year 2013. In 2013, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equalled -6 742 Gg 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 2013, the removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 5.3%. Correspondingly, for the base year of 1990, the total emissions and removals in the LULUCF sector equalled -6 320 Gg CO_2 eq. In relation to the emissions generated in all other sectors, the inclusion of the LULUCF estimate reduces the total emissions by 3.27% for the base year of 1990. It is important to note that the emissions within the LULUCF sector exhibit high inter-annual variability (Fig. 6-1) and the values shown in Tab. 6-1 should not be interpreted as trends. The entire data series can be found in the corresponding CRF Tables.

Tab. 6-1 GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2013

Sector/category	Emissions 1990 Gg CO_2 eq.	Emissions 2013 Gg CO_2 eq.
4 Total LULUCF	-6 320	-6 742
4.A Forest Land	-4 731	-7 403
4.A.1 Forest Land remaining Forest Land	-4 511	-7 047
4.A.2 Land converted to Forest Land	-221	-357
4.B Cropland	98	75
4.B.1 Cropland remaining Cropland	-19	-15
4.B.2 Land converted to Cropland	117	90
4.C Grassland	-135	-322
4.C.1 Grassland remaining Grassland	6	-1
4.C.2 Land converted to Grassland	-141	-321
4.D Wetlands	22	29
4.D.1 Wetlands remaining Wetlands	(0)	(0)
4.D.2 Land converted to Wetlands	22	29
4.E Settlements	84	83
4.E.1 Settlements remaining Settlements	(0)	(0)
4.E.2 Land converted to Settlements	84	83
4.F Other Land	(0)	(0)
4.G Harvested Wood Products	-1 667	792

Note: Emissions of non-CO_2 gases (CH_4 and N_2O) are also included.

6.1.2 Key categories

Tab. 6-2 Key categories of the LULUCF sector (2013)

Category	Gas	Character of category	% of total GHG*
4.A.1 Forest Land remaining Forest Land	CO_2	LA, TA	4.66
4.G Harvested wood products	CO_2	LA, TA	0.52

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. 6-1, two of them were identified as key categories according to the IPCC Good Practice (2006 IPCC Guidelines). Of these LULUCF categories, the largest effect on the overall emission inventory in the country is attributed to 4.A.1 Forest Land remaining Forest Land. With a contribution of 4.74%, it is the major LULUCF category identified by the level assessment for the year 2013 (Tab. 6-2). 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 4.G Harvested wood products category was identified as a key category by the level and trend assessment.

6.1.3 Coverage of pools and methodological tiers

The current inventory submission of the LULUCF sector includes all mandatory categories and carbon pools, as well as emissions related to harvested wood products (HWP). The specific information related to methodological tiers and pools included in the category estimates is provided under individual chapters by IPCC land use categories (Chapters 6.4 to 6.9) and HWP (Chapter 6.10).

6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The reporting format requires the estimation of GHG emissions into the atmosphere by sources and sinks for six land-use categories and since the reporting year 2013 also for one land-unspecific category, namely Harvested wood products (HWP). The land-use categories are 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 (IPCC 2003) and its follow up 2006 IPCC Guidelines (IPCC 2006) outline 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 2006 IPCC Guidelines. The adopted land-use representation and land-use change identification system was built gradually. Since the 2008 NIR submission, it has been exclusively based on cadastral land use information of the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). The Czech land-use representation and the land-use change identification system uses annually updated COSMC data, elaborated at the level of about 13 thousands individual cadastral units. The 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 (IPCC 2006), permitting accounting for all land-use transitions in the annual time step. The individual steps are described below.

6.2.1 Source data compilation

The methodology requirements and principles associated with the approaches recommended by the GPG for LULUCF (2006 IPCC Guidelines) imply that, for the reported period of 1990 to 2013, 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 (1992-2013) and individual districts (1969-2013). There are over 13 000 cadastral units, the number of which varies due to separation or division for various administrative reasons. In the period of 1992 to 2013, the total number of cadastral units varied between 13 027 and 13 079.

To identify the administrative separation and division of cadastral units within a year, the cadastral units were crosschecked by comparing the areas in subsequent years using a threshold of one hectare difference. Neighbouring cadastral units mutually swapping 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 labelled 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 reporting years since 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 2013, there were 14 integrated cadastral units, which affected a total of 45 individual cadastral units. This further increased the spatial resolution of the system, as the land use change identification could be analysed for 13 009 individual units in 2013 as compared to 12 624 units for the years until 2006 (Fig. 6-2).

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 spatial coverage of cadastral and district units is also shown in Fig. 6-2.

6.2.2 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 Guidelines for LULUCF (IPCC 2006). The specific definition content can be found in the respective Chapters 6.4 to 6.10 devoted to each of the major land-use categories.

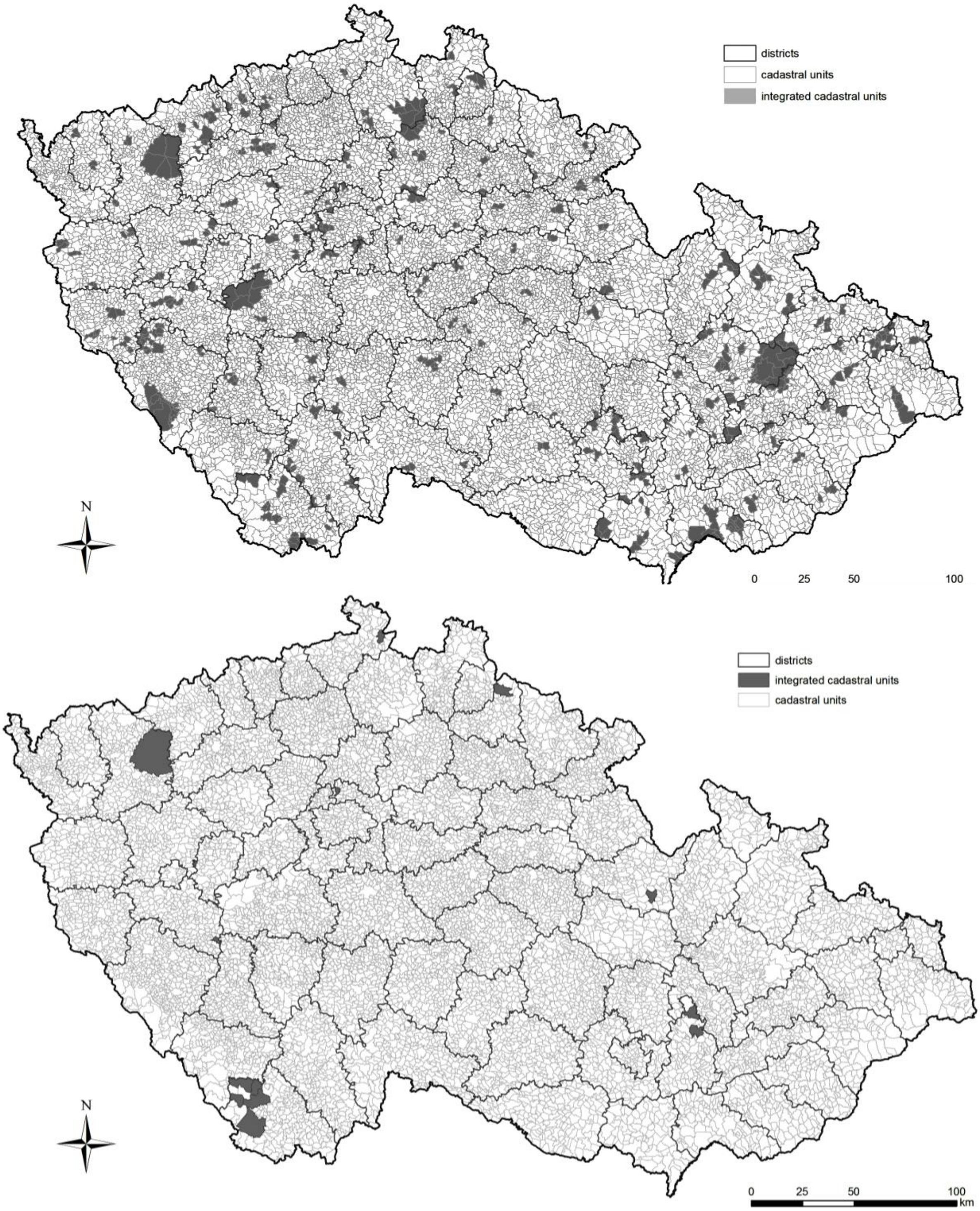


Fig. 6-2 Cadastral units (grey lines), integrated cadastral units (shading) and district borders (black lines) as used until year 2006 (top) and the currently refined situation for year 2013 (bottom).

6.2.3 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 (13 009 units in year 2013) on an annual basis using the subsequent years of the available period. The approach is exemplified in Fig. 6-3. In the example of the cad astral unit of Jablunkov (ID 656305), 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. 6-3 Example of land-used change identification for year 2006 and cadastral unit 656306 (Jablunkov); all spatial units are given in m^2.

6.2.4 Complementing time-series

The above described calculation of land-use change at the level of individual cadastral units was performed for the years 1993 to 2013, because the data on that spatial resolution 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. Due to the IPCC default time period of 20 years used for reporting the converted land, the source information involves data on land use in the Czech Republic since 1969.

6.2.5 Land use representation and land use change identification system - status and development

Development of the Czech LULUCF land use representation and land use change identification system as described above involved consultations at the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz), which administers the source information on land use used in the LULUCF emission inventory[3]. Based on the internal analysis and the recommendations of COSMC, the current inventory retains the exclusive use of the original data on land use without any further corrections. However, the inventory team works on a further improvement of the system, which will use data with

[3] *The Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) works on digitizing cadastral land use information in the Czech Republic, which is planned to be finalized in 2017. This major reconciliation of land use information is in progress and explains the nature of the ongoing area rectifications in the official reports on areas of land and land use categories in the country. This actual information on this process is available at request from the inventory team.*

explicitly expressed land-use conversions across all major land use categories. It will use a unique set of input cadastral data prepared by COSMC specifically for the use in the Czech GHG emission inventory following the IPCC (2006).

6.3 Land- use definitions and the classification systems used and their correspondence to the land use, land-use change and forestry categories

The IPCC land use categories were linked to the Czech cadastral classification system, namely that of "Aggregate areas of cadastral land categories" (AACLC), centrally collected and administered by COSMC, as described in detail in Section 6.2 above. The specific attribution and linking of cadastral land use categories to IPCC land use categories is given in source category description text under the corresponding Sections 6.4 to 6.9 below.

6.3.1 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 2013 period are shown in Fig. 6-4. The largest quantitative change is associated with the Cropland and Grassland land-use categories.

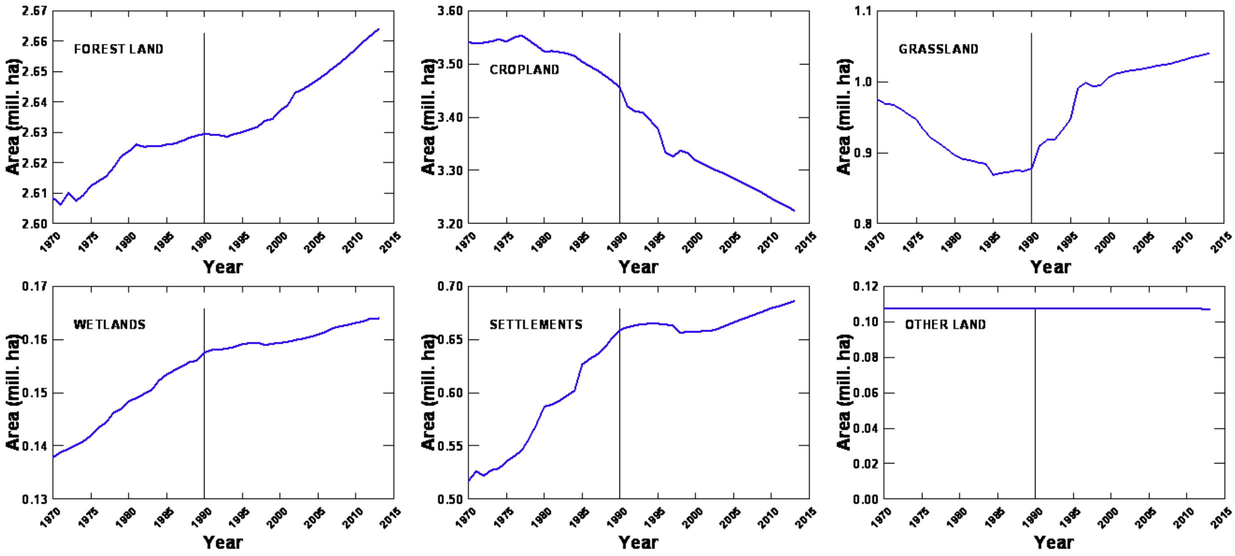


Fig. 6-4 Trends in areas of the six major land-use categories in the Czech Republic between 1970 and 2013 (based on information from the Czech Office for Surveying, Mapping and Cadastre).

An insight into the net trends shown in Fig. 6-4 gives the analysis of gross land-use changes as described in Section 6.2. Tab. 6-3 shows a product of that analysis, namely the areas of land-use change among the major land-use categories over the 1990 to 2013 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 the recommended assumption of IPCC (2006) 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 forest. 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. 6-3 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 2013.

Year 1990		Initial (1989)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1990)	Forest Land	2 628.6	0.4	0.5	0.0	0.0	0.0	2 629.5
	Grassland	0.1	869.3	8.8	0.0	0.0	0.0	878.2
	Cropland	0.0	0.3	3 454.6	0.0	0.1	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)	2 629.0	874.0	3 468.0	156.1	652.1	107.2	7 886.4

Year 1991		Initial (1990)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1991)	Forest Land	2 629.0	0.1	0.2	0.0	0.0	0.0	2 629.3
	Grassland	0.3	877.8	31.3	0.0	0.3	0.0	909.8
	Cropland	0.0	0.0	3 420.3	0.0	0.0	0.0	3 420.4
	Wetland	0.1	0.1	0.5	157.5	0.0	0.0	158.1
	Settlements	0.1	0.2	2.7	0.0	658.6	0.0	661.6
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 629.5	878.2	3 455.0	157.5	658.9	107.2	7 886.4

Year 1992		Initial (1991)						*Area (kha)*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	
Final (1992)	Forest Land	2 628.9	0.1	0.1	0.0	0.0	0.0	2 629.1
	Grassland	0.2	909.3	8.3	0.1	0.0	0.0	917.9
	Cropland	0.0	0.1	3 410.7	0.0	0.0	0.0	3 410.9
	Wetland	0.0	0.0	0.1	157.9	0.0	0.0	158.1
	Settlements	0.2	0.3	1.2	0.1	661.6	0.0	663.3
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 629.3	909.8	3 420.4	158.1	661.6	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)	2 628.6	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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	(kha)
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
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

Year 2009		Initial (2008)						*Area*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
Final (2009)	Forest Land	2 652.6	0.7	0.8	0.1	1.1	0.0	2 655.2
	Grassland	0.1	1 023.3	4.7	0.0	0.3	0.0	1 028.4
	Cropland	0.0	0.5	3 255.4	0.0	0.2	0.0	3 256.2
	Wetland	0.0	0.2	0.3	162.9	0.1	0.0	162.8
	Settlements	0.3	0.8	3.2	0.2	672.2	0.0	676.6
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 653.0	1 025.4	3 264.3	162.5	674.0	107.2	7 886.5

Year 2010		Initial (2009)						*Area*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
Final (2010)	Forest Land	2 654.6	0.6	1.1	0.1	0.9	0.0	2 657.4
	Grassland	0.1	1 026.1	4.8	0.0	0.5	0.0	1 031.5
	Cropland	0.1	0.6	3 246.7	0.0	0.2	0.0	3 247.6
	Wetland	0.1	0.2	0.4	162.3	0.2	0.0	163.1
	Settlements	0.3	1.0	3.2	0.3	674.7	0.0	679.6
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 655.2	1 028.5	3 256.2	162.8	676.6	107.2	7 886.5

Year 2011		Initial (2010)						*Area*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
Final (2011)	Forest Land	2 656.9	0.6	0.8	0.1	1.4	0.0	2 659.8
	Grassland	0.1	1 029.6	4.8	0.0	0.5	0.0	1 035.0
	Cropland	0.1	0.6	3 238.7	0.1	0.5	0.0	3 239.9
	Wetland	0.1	0.2	0.3	162.8	0.1	0.0	163.1
	Settlements	0.2	0.7	3.1	0.2	677.1	0.0	681.3
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 657.3	1 031.6	3 247.7	163.1	679.6	107.2	7 886.5

Year 2012		Initial (2011)						*Area*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
Final (2012)	Forest Land	2 659.3	0.7	0.8	0.0	1.0	0.0	2 661.9
	Grassland	0.1	1 032.5	4.0	0.0	0.5	0.0	1 037.2
	Cropland	0.1	0.8	3 231.6	0.0	0.4	0.0	3 232.9
	Wetland	0.0	0.2	0.3	163.2	0.2	0.0	164.0
	Settlements	0.3	0.8	3.0	0.2	679.2	0.0	683.5
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 659.8	1 035.0	3 239.9	163.4	681.3	107.2	7 886.6

Year 2013		Initial (2012)						*Area*
	Category	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land	*(kha)*
Final (2013)	Forest Land	2 661.4	0.5	0.8	0.1	0.9	0.0	2 663.7
	Grassland	0.1	1 035.6	4.0	0.0	0.5	0.0	1 040.1
	Cropland	0.1	0.4	3 224.7	0.0	0.2	0.0	3 225.4
	Wetland	0.1	0.1	0.4	163.7	0.2	0.0	164.4
	Settlements	0.2	0.6	3.0	0.2	681.7	0.0	685.8
	Other Land	0.0	0.0	0.0	0.0	0.0	107.2	107.2
	Area (kha)	2 661.8	1 037.2	3 232.9	164.0	683.6	107.2	7 886.7

6.4 Forest Land (CRF 4.A)

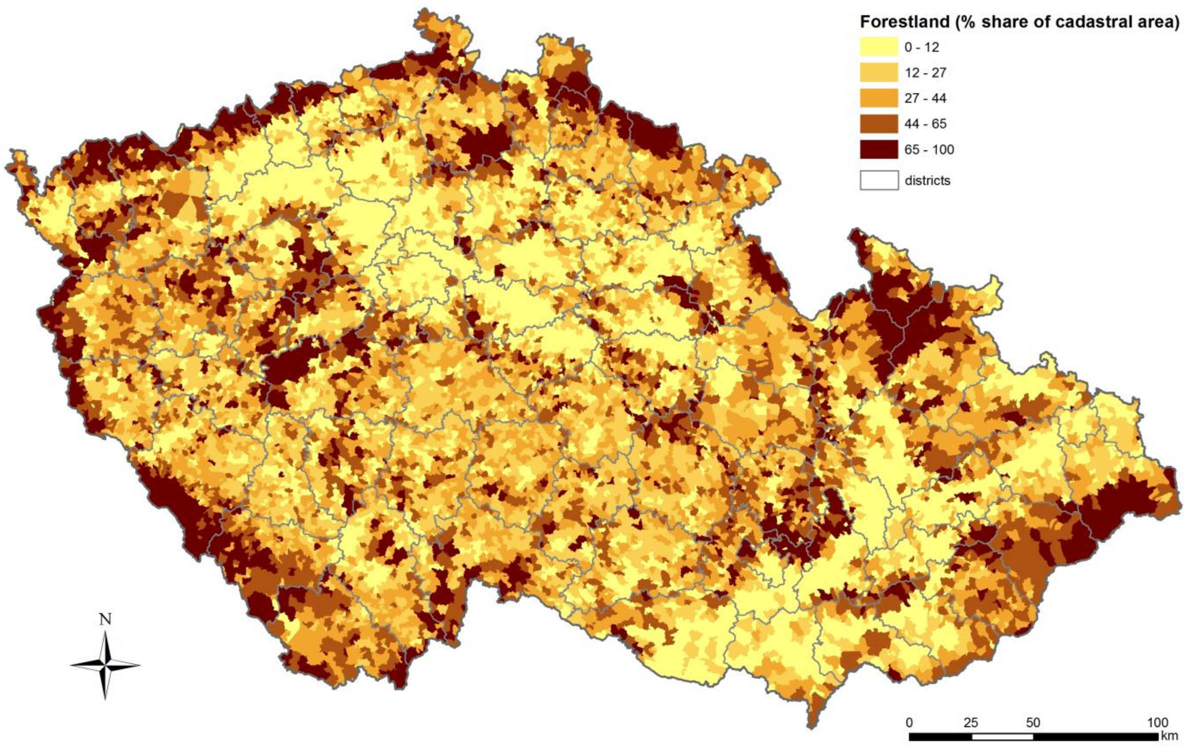


Fig. 6-5 Forest Land in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2013).

6.4.1 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 (2006 IPCC Guidelines, Volume 4). 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[4]. 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 that category. Hence, Forest Land in this emission inventory corresponds to the national definition of timberland (Czech Forestry Act 84/1996). In 2013, the stocked forest area (timberland) qualifying under the category of Forest Land in this emission inventory equalled 2 610 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 33.9% of the area of the country (MA, 2014). The tree species composition is dominated by conifers, which represent 72.9% of the timberland area. The four

[4] *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*

most important tree species in this country are spruce, pine, beech and oak, which account for 51.1, 16.6, 7.8 and 7.1% of the timberland area, respectively (MA, 2014). Broadleaved tree species have been favoured in new afforestation since 1990. The proportion of broadleaved tree species increased from 21% in 1990 to almost 26% in 2013. 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 687 mil. m^3 (under bark) in 2013 (MA, 2014).

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 and supervised (since 2012) by the Czech Forests, s.e. 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 represents the data from the first cycle of the statistical (sample based, tree level) National Forest Inventory (NFI) performed during 2001-2004 by FMI. The results of the first NFI cycle were published in 2007 (FMI, 2007)[5]. The second NFI cycle is currently in operation, scheduled for years 2011 to 2015. The most recent statistical information on forests at a county level gives the Czech landscape inventory (CzechTerra; www.czechterra.cz), a project funded by the Ministry of Environment (Černý 2009, SP/2d1/93/07)[6]. It complemented its first cycle in 2008/2009. Its second cycle is currently (2014/2015) ongoing as a part of the project funded by the Czech Science Foundation (GA ČR 14-12262S). However, with no repeated statistical inventory data available yet, this emission inventory is still dominantly based on the FMP data. These have also been used for all international reporting on forests of the Czech Republic to date. Whenever feasible, the auxiliary information from the above mentioned inventory programs and/or other sources were also utilized.

The 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. 6-6 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 2013, clear-cut areas represented 1.2% of Forest Land.

[5] 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 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.

[6] The results of the CzechTerra national landscape inventory for the cycle 2008/2009 (CZT 2009) show a mean growing stock volume of 305 m^3/ha under bark (IFER, 2010), i.e., lower than the estimates of FMI (2007). The results of the second cycle (CZT 2015) are expected to be available by the end of 2015.

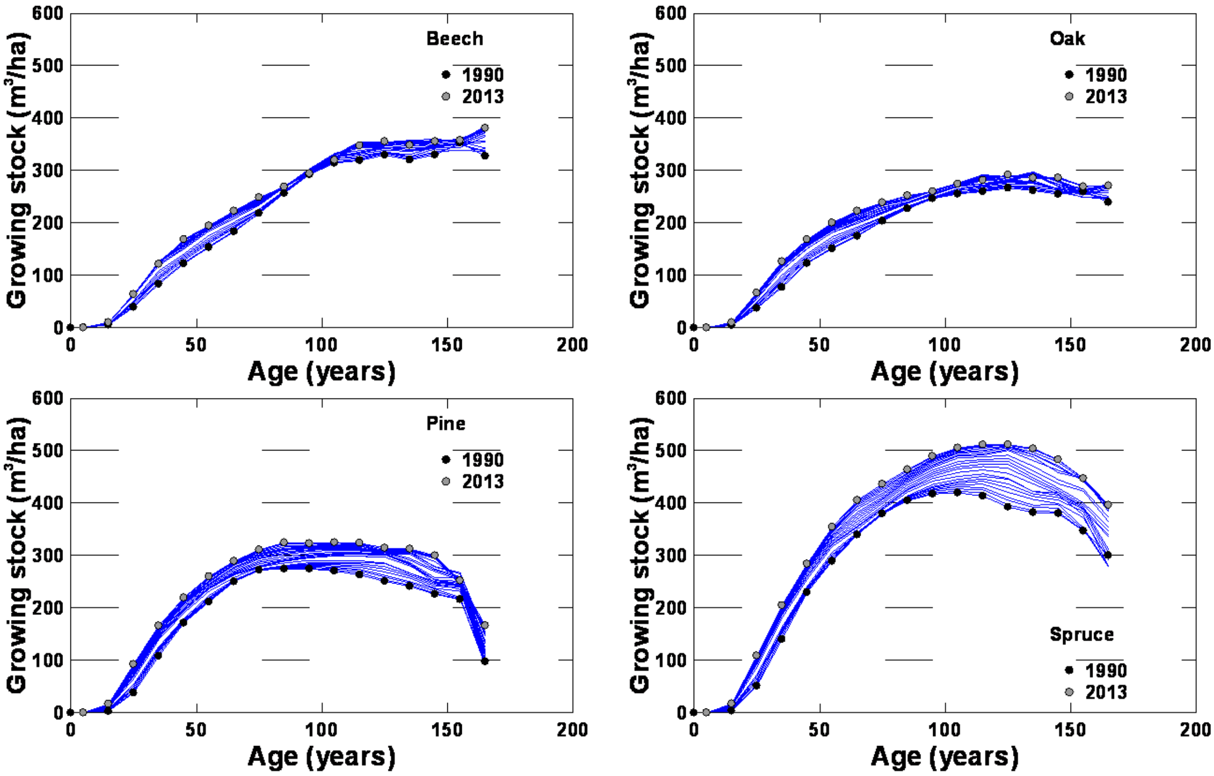


Fig. 6-6 Activity data – mean growing stock volume against stand age for the four major groups of species during 1990 to 2013; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2013.

The annual harvest volume constitutes the other key information related to forestry. This value is available from the Czech Statistical Office (CzSO). CzSO collects this information on the basis of about 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. According to this information, the total drain of merchantable wood from forests increased from 13.3 mil. m^3 in 1990 to 15.3 mil. m^3 (under bark) in 2013, down from the all-time high 18.5 mil. m^3 harvested in 2007 (all data refer to under-bark volumes, MA 2014).

The Czech emission inventory also includes the harvest loss due to disturbance events and other reasons, the estimate of which has been revised for this inventory submission. Specifically, it includes the officially reported estimates from the Czech Statistical Office (CzSO), which became available since year 2009. This complements the previously applied harvest loss estimates increasing the reported harvest by extra 5 and 15% is applied to final and salvage logging volumes, respectively (see Section 7.3.2 below). The salvage logging operations concern dominantly stands hit by windstorms, snow and bark-beetle calamities in this country. Thereon, the Czech emission inventory includes an explicit estimate of disturbance, which includes the categories of natural disasters, pollution, insects and other (CzSO, J. Kahuda, personal communication 2013). Therefore, the total applicable harvest loss is linked to the actual share of salvage logging that is annually reported by CzSO and elsewhere (MA 2014). In 2013, the applicable volume of total annual harvest drain reached 17.1 mill. m^3, down from the maximum of nearly 21 mill. m^3 estimated for 2007. The harvest drain applicable for the emission inventory for the entire reporting period since 1990 to 2013 is shown in Fig. 6-7, and for years 1990 and 2013 also in Tab. 6-4.

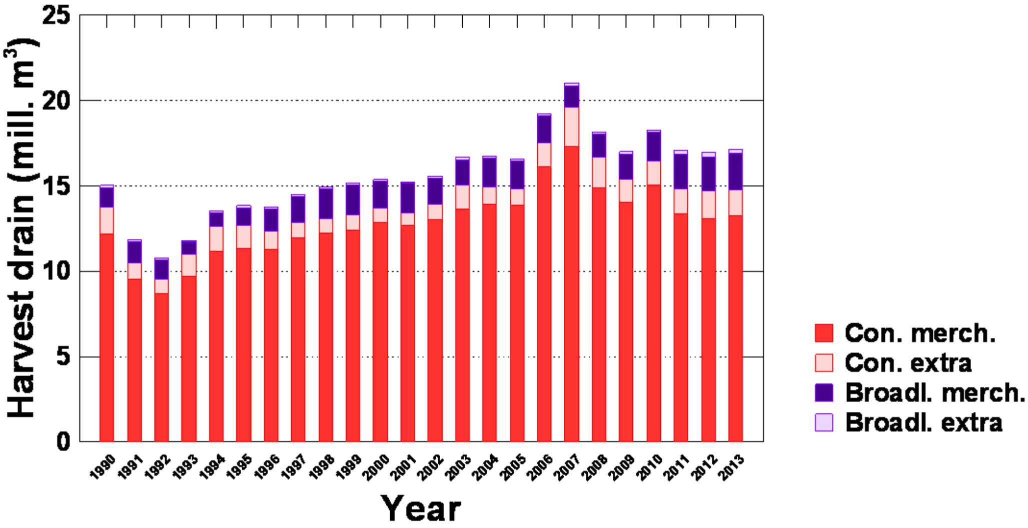


Fig. 6-7 The applicable total annual harvest drain for coniferous (Con.) and broadleaved (Broadl.) tree species, which includes both the reported quantities of merchantable wood for the two categories (Con. merch, Broadl. merch.) and the associated harvest loss (Con. extra, Broadl. extra) for the entire reporting period 1990 to 2013.

Tab. 6-4 The reported harvest, mean share of salvage logging and associated applicable additional harvest loos (1990 and 2013 shown) for beech, oak, pine and spruce species groups, respectively.

Variable	Unit	Year 1990	Year 2013
Reported harvest	mill. m^{-3}	0.84; 0.31; 1.33; 10.84	1.62; 0.48; 1.88; 11.35
Share of salvage logging	%	71	28
Additional loss (IFER, CSU)	mill. m^{-3}	0.10; 0.04; 0.16; 1.31	0.18; 0.06; 0.22; 1.33

6.4.2 Methodological issues

Category 4.A 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 4.A.1 Forest Land remaining Forest Land, and 4.A.2 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 6.1.2 distinguish the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory 4.A.1 Forest Land remaining Forest Land. The other part represents subcategory 4.A.2 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., 4.A.1 and 4.A.2 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 6-3 above.

6.4.2.1 Forest Land remaining Forest Land

Carbon stock change in category 4.A.1 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[7] according to eq. 2.7 of 2006 IPCC Guidelines 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. 2.9 and 2.10 of 2006 IPCC Guidelines 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 at FMI[8] (FMP database administrator; see also Acknowledgment) 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 actual increment for the latest reported year, has been made to the increment in the inventory submissions thereafter (Fig. 6-8).

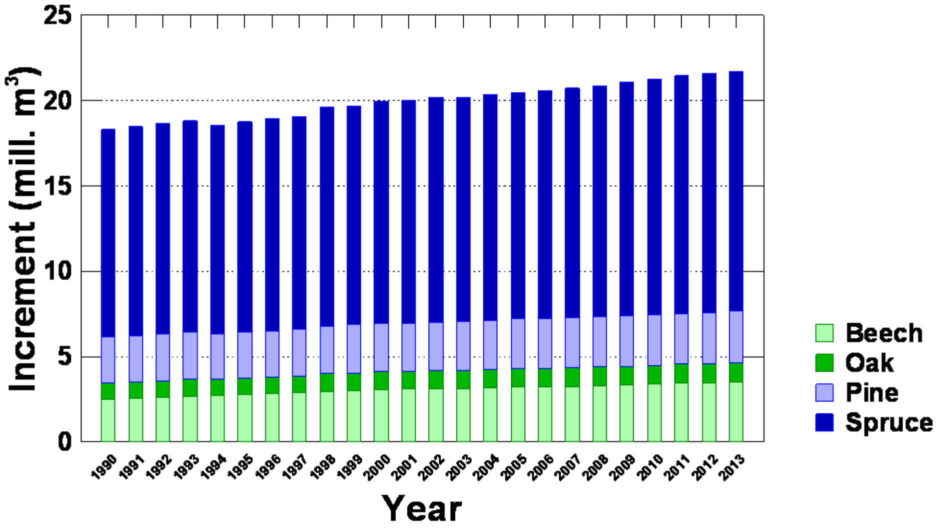


Fig. 6-8 Current annual increment (Increment, mill. m^3 underbark) by the individual tree species groups as used in the reporting period 1990 to 2013.

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:

$$\Delta C_G = \sum_j (A_j * G_{Total_j} * CF_j) \qquad (1)$$

[7] *Alternative approaches of the stock-change method (Eq. 2.8; IPCC 2006) 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.*

[8] *Since 2012, the Czech Forests, s.e., supervises the administration of FMP and the estimates of increment are provided on request by the Czech Ministry of Agriculture, which is responsible for the forestry sector including the Czech Forests, s.e.*

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. 6-5 lists the factors used in the calculation of the biomass carbon stock increment.

Tab. 6-5 Input data and factors used in carbon stock increment calculation (1990 and 2013 shown) for beech, oak, pine and spruce species groups, respectively

Variable or conversion factor	Unit	Year 1990	Year 2013
Area of forest land remaining forest land (*A*)	Kha	374; 153; 457; 1510	476; 180; 427; 1 442
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	0.48; 0.48; 0.49; 0.49	0.48; 0.48; 0.49; 0.49
Root/shoot ratio (*R*)	-	0.20	0.20
Volume increment (I_v)	$m^3 ha^{-1}$	6.55; 5.96; 5.84; 7.89	7.21; 6.09; 6.97; 9.61

In Tab. 6-5, *A* represents only the areas of 4.A.1 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 Tab. 6-5 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. Since 2014 inventory submission, carbon fraction in woody biomass (*CF*) of 0.50, a generally accepted default constant (IPCC 2003) was replaced by somewhat more conservative values of 0.48 and 0.49 for broadleaved and coniferous tree species, respectively (Tab. 6-5). This is in line with the values suggested by IPCC (2006) based on a more extensive literature survey. *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. 3) in the category 4.A.1 Forest Land remaining Forest Land basically follows eqs. 2.11, 2.12 and 2.13 (AFOLU, 2006). It uses the annual amount of total harvest removals reported by the CzSO for individual tree species in the country as well as the associated harvest loss, which is newly (since 2009) explicitly reported by CzSO. Therefore, the total harvest drain (*H*) covers thinning and final cut, the amount of fuel wood, which is reported as an assortment under the conditions of Czech Forestry, as well as the associated harvest loss. To include the biomass loss associated with harvest, the factor F_{HL} was applied to reported harvest volume; 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. Hence, the harvest volume entering the actual emission calculation (*H* in eq. 3 below) does include the correction by the above described factor, F_{HL}. This estimate was used to account for harvest loss associated the reported harvest of merchantable wood volume until 2010. Since year 2011, however, the newly introduced harvest loss estimate of CzSO is exclusively used. The calculation of the total carbon drain (*L*; loss of carbon) associated with wood removals 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. 6-5. The specific values of input variables and conversion factors used to calculate *L* are listed in Tab. 6-6.

Tab. 6-6 Specific input data and factors used in calculation of carbon drain (1990 and 2013 shown) for beech, oak, pine and spruce species groups, respectively

Variable or conversion factor	Unit	Year 1990	Year 2013
Harvest drain volume (*H, incl.*F_{HL})	mill. m^3	0.95; 0.35; 1.49; 12.16	1.81; 0.54; 2.10; 12.68
Biomass expansion factor ($BCEF_h$)	Mg m^{-3}	0.69; 0.81; 0.52; 0.59	0.70; 0.82; 0.52; 0.57

The impact of disturbances (Eq. 2.14, AFOLU, 2006) is in full included in the total harvest drain volume (*H*). The available data on salvage logging from CzSO (and MA 2014) can be even traced as of the disturbance origin by categories including natural disaster, air pollution, insect and other. This information is mandatorily reported by the forestry practice, which must always prioritize salvage logging on account of the planned harvest. However, to the present time, the disturbance in Czech forests since 1990 has generally 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 it is thereby accounted for in the reported harvest volumes within Eq. 3.

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 2006). This concerns both mineral and organic soils. The organic soils occur only in the areas of the Spruce sub-category on 4.A.1 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 the other sub-categories with the predominant species of Beech, Oak and Pine.

Emissions in category 4.A.1 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. 2.27 and the emission and combustion factors in Table 2.5 and 2.6 (Tier 1, IPCC 2006). Under the conditions in this country, part of the biomass residues is burnt in connection with final cut. Hence, this practice is limited to category 4.A.1 and does not occur on 4.A.2 Land converted to Forest land. There is no official estimate of the biomass fraction burnt in forests of the country. The expert judgment employed in this inventory considers that 15% of the biomass residues including bark is burnt. This is less than assumed for the inventory years until 2010, which corresponds with the trend in current forest management practices in the country. The biomass fraction burnt 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 burnt (dry matter) was estimated as 590 Gg in 1990 and 331 Gg in 2013.

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. 2.14 (IPCC 2006). This equation used a default factor of biomass left to decay after burning (0.45; Table 2.6). The associated amounts of non-CO_2 gases (CH_4, CO, N_2O and NO_X) were estimated according to eq. 2.27. The amount of biomass (dry matter) burned in wildfires was estimated as 10.2 Gg in 1990 and 6.8 Gg in 2013. 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.

6.4.2.2 Land converted to Forest Land

The methods employed to estimate emissions in the 4.A.2 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 (IPCC 2003) and AFOLU (IPCC 2006).

For estimation of the net carbon stock change in living biomass on Land converted to Forest Land by the Tier 1 method (IPCC 2006), 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 2013 was 3.23 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 6.2.1 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 are implicitly accounted for within the category Forest Land remaining Forest Land. It is also important to note (in response to the previous inventory reviews) that in the conditions of the country, there no biomass loss due to disturbance on the land converted to forest land. It actually represents a land of newly established forest with age of 1 to 20 years. As also apparent from the national statistics, there is no volume of salvage logging reported for this category, which reflects the actual conditions of forest ecosystems of the age concerned.

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 2006).

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; see Fig. 6-9). 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=13 009 in 2013), 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 4.A Forest Land, 4.B Cropland and 4.C 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 (IPCC 2006). These quantities, together with the accumulated areas under the specific conversion categories, were used for estimation of emissions and removals of CO_2.

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 2006).

Non-CO_2 emissions from burning are not estimated for category 4.A.2 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.

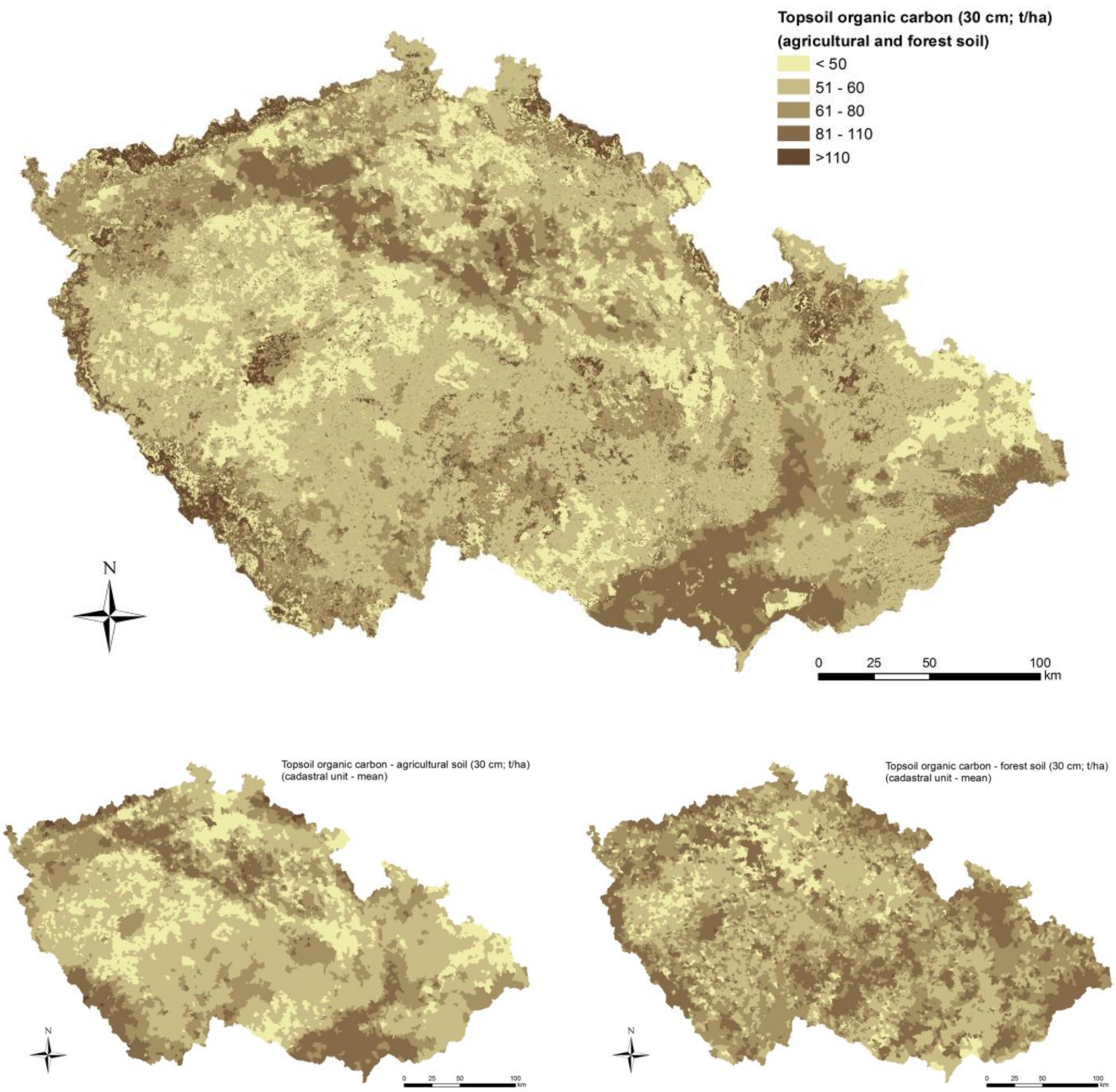


Fig. 6-9 Top - topsoil (30 cm) organic carbon content map adapted from Macků et al. (2007), Šefrna and Janderková (2007); bottom –topsoil carbon content for agricultural (left) and forest (right) soils estimated as cadastral unit means from the source maps. The unit (t/ha) and unit categories are identical for all maps.

6.4.3 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 2013.

The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003), employing the following equations:

$$U_{Total} = \sqrt{U_1^2 + U_1^2 + \ldots + U_n^2} \qquad (4)$$

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. 3.1, Volume 1, Chapter 3, IPCC 2006).

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. 3.2, Volume 1, Chapter 3, IPCC 2006).

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 equation 5 may easily produce unrealistically high uncertainties and theoretically lead to a division by zero, which is not possible. In this respect, this approach is not correct. In previous inventory reports, we stressed this issue and recommended focusing to individual uncertainty components prior the resulting product of Eq. 5.

This inventory report follows the recommendations of the recent reviews and the revision of the uncertainty values and calculations made in the two earlier NIR reports. The currently adopted uncertainty values are listed below and/or under the corresponding subchapters of other land use categories. Apart the IPCC (2006), the source information for adjusted uncertainty values was the recently conducted statistical landscape inventory of the Czech Republic CzechTerra (Černý et al., 2009). Otherwise, 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 (7%), root/shoot factor (30%), and factor (1-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%.

The approach of uncertainty combination for individual sub-categories of tree species is based on calculating the mean error estimate from the components of carbon stock increase and carbon stock loss, which are both given in identical mass units of carbon per year. At the same time, we preserve the recommended logics of combining uncertainties on the level of entire land use category or on the level of entire LULUCF sector according Eq. 5. This is calculated on the basis of CO_2 or CO_2 eq. units and the corresponding uncertainty estimates respect the actual direction of source and sink categories to be combined.

For 2013, the uncertainty estimates for the categories 4.A.1 Forest Land remaining Forest Land and 4.A.2 Land converted to Forest Land using the above described approach reached 18 and 39%, respectively. Correspondingly, the uncertainty for the entire category 4.A Forest Land reached 17%.

6.4.4 Source-specific QA/QC and verification

Following the recommendation of the previous 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 and the 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 6.1 of 2006 IPCC Guidelines (Volume1, Chapter 6, IPCC 2006).

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.

In 2014, a supplementary review of the Czech LULUCF inventory was conducted with the frame of EU MS Assistance Program. Specifically, it was reviewed by Dr. Zoltan Somogyi, who together with the Czech LULUCF experts discussed the reporting issues and suggested improvements to be considered for a gradual implementation. The full report of this expert venue is available on request from the Czech LULUCF inventory team.

6.4.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the corrections associated with the adopted revised activity data and emission factors implemented in the previous submission (NIR 2014). The effect of these corrections performed for the category 4.A Forest Land can be seen in Fig. 6-10. On average, the emission removals decreased by 0.6% as compared to the previously reported estimates.

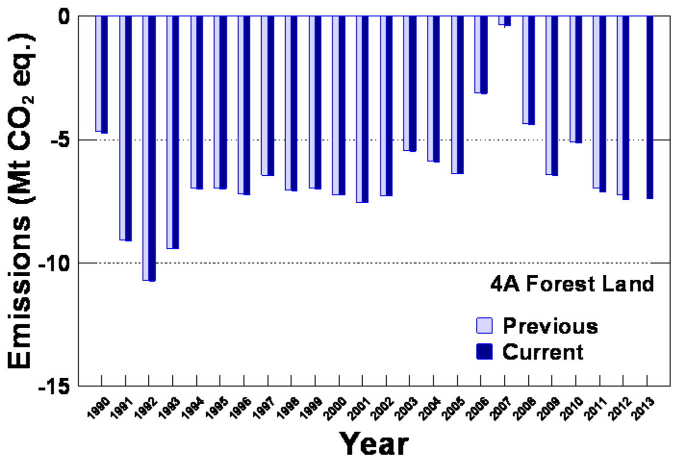


Fig. 6-10 Current and previously reported assessment of emissions for category 4.A Forest Land. The values are negative, hence representing net removals of green-house gases

6.4.6 Source-specific planned improvements, including those in response to the review process

The current inventory report applicable for 4.A Forest Land finalized the implementation of the improvements from the previous (2014) NIR submission. It followed the suggestions of the recent inventory reviews, including rectified land area information for the entire data set required for the LULUCF inventory and improved emission estimates for the biomass carbon stock change, the most important category of the LULUCF sector and the key category of the entire emission inventory. Other improvements remain under planning. 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, more extensive utilization of the new data from the statistical inventory programs is planned, once the data from the repeated survey of the Czech National Forest Inventory or Landscape inventory CzechTerra (field survey of both programs finalized as of 2015) will be available. Also, a new revision of activity data on land use areas will be implemented in the coming NIRs, which will also concern this land use category.

6.5 Cropland (CRF 4.B)

6.5.1 Source category description

In the Czech Republic, Cropland is predominantly represented by arable land (92.6% of the category in 2013), 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. 6-4). While, in 1990, Cropland represented approx. 44% of the total area of the country, this share decreased to 41% in 2013. It can be expected that this trend will continue. 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.

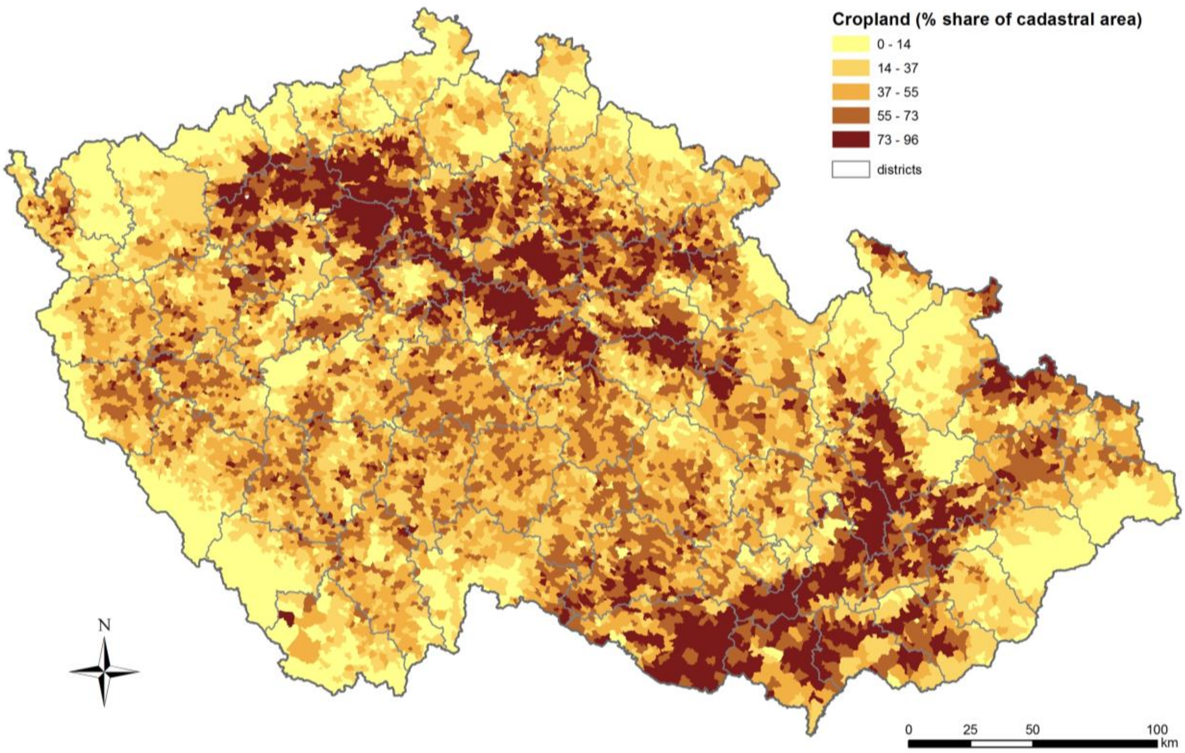


Fig. 6-11 Cropland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2013).

6.5.2 Methodological issues

The emission inventory of Cropland concerns sub-categories 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland. The emission inventory of Cropland considers changes in living biomass, dead organic matter and soil. In addition, N_2O emissions associated with soil disturbance during land-use conversion to cropland are quantified for this category.

6.5.2.1 Cropland remaining Cropland

For category 4.B.1 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 5.1, IPCC 2006) 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 specifically for each of the 13 009 cadastral units from the detailed soil carbon maps (Fig. 6-9), 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 the specific 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.

Until the NIR submission 2014, the Cropland category also included emissions due to liming. Due to the specific trend in lime application in this country, emissions from liming made the former 4.B.1 Cropland remaining Cropland the key category by trend. However, emissions from liming are currently excluded from 4.B.1 Cropland remaining Cropland and reported under category 3.G Liming in the sector of Agriculture instead.

Non-CO_2 greenhouse gas emissions from burning do not occur in category 4.B.1 Cropland remaining Cropland, as there is no such practice on Cropland in this country.

6.5.2.2 Land converted to Cropland

Category 4.B.2 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 4.B.2 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 (5t C/ha; Table. 5.9, IPCC 2006), 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 4.A Forest Land category in Section 6.2.1 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 4.B 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 (Cerny, 2009; www.czechterra.cz). It provides data on the mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood (7.5 m^3/ha) 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 4.B.2 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 6.4.2.2 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. 2.25 and 11.8. (IPCC 2006). Accordingly, direct N_2O emissions were quantified on the basis of the detected changes in mineral soils employing a default emission factor 0.01 kg N_2O-N/kg N (EF1, IPCC 2006), and C:N ratio of 15. Linked to this, indirect N_2O emissions from atmospheric deposition of N volatized from managed soils were estimated using eq. 11.11 and emission factor 0.01 (EF4, IPCC 2006). However, the indirect emissions are formally not included under Cropland land use category, but they are entered under Table 4(IV) in the newly adopted CRF format.

Other non-CO_2 emissions may be related to those from burning. However, this is not a common practice in this country and no other non-CO_2 emissions besides the above described are reported in the LULUCF sector.

6.5.3 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 2013, which applies also for the land use category of Cropland. The uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006). The following uncertainty values were used: land use areas 3%, biomass accumulation rate 75%, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%, 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%, reference biomass carbon stock prior and after land-use conversion 75%, average amount of standing deadwood 27%, average amount of lying deadwood 20%, carbon fraction of dry woody matter 7%. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007). The adopted uncertainty associated with emission factors involved in estimation of direct and indirect N_2O emissions was 250%.

For 2013, using the above uncertainty values, the total estimated uncertainty for category 4.B.1 Cropland remaining Cropland was 51%. The corresponding uncertainty for category 4.B.2 Land converted to Cropland was 39%. The overall uncertainty for category 4.B Cropland was estimated to be 49%.

6.5.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of 2006 IPCC Guidelines (IPCC 2006). 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.

6.5.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified emission factors associated with the changes implemented in the previous (2014) submission. The changes included revised land use area data and updated carbon fraction in woody biomass, applicable for land-use conversions from Forest land. However, the major change in the category estimate is due to exclusion of emissions associated with lime application. These are currently reported in the sector of Agriculture. The current emission estimates for the category 4.B Cropland are shown in Fig. 6-12. On average, the emissions decreased by 60% as compared to the previously reported estimates. The differences are almost exclusively due to excluding emissions from lime application from 4.B Cropland.

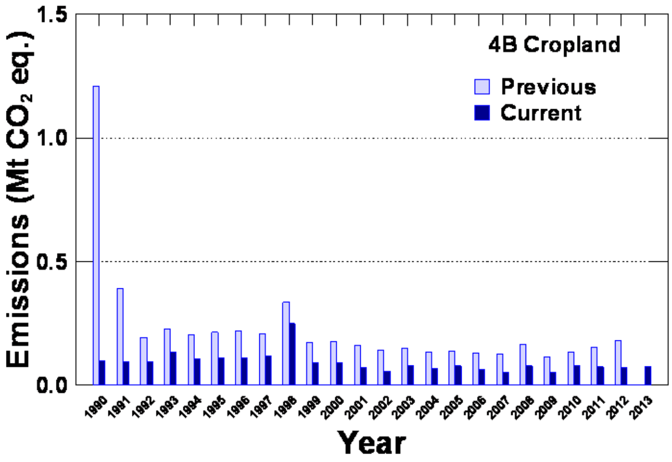


Fig. 6-12 Current and previously reported assessment of emissions for category 4.B Cropland

6.5.6 Source-specific planned improvements, including those in response to the review process

Similarly as for other categories, additional efforts will be exerted to further consolidate the current estimates for Cropland. Specific attention will be paid to a likely overall formalization and enhancement of the QA/QC procedures. Also, a more detailed stratification of Cropland area to allow a more specific application of appropriate factors used in emission estimation is being explored as also suggested by the latest in-country review under (a specific contract with the Czech Ministry of the Environment).

6.6 Grassland (CRF 4.C)

6.6.1 Source category description

Through its spatial share of about 13% in 2013, the category of Grassland ranks third among land-use categories in the Czech Republic. Its area has been growing since 1990, specifically in early 1990s (Fig. 6-4). 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 over 18% (in 2013) since 1990.

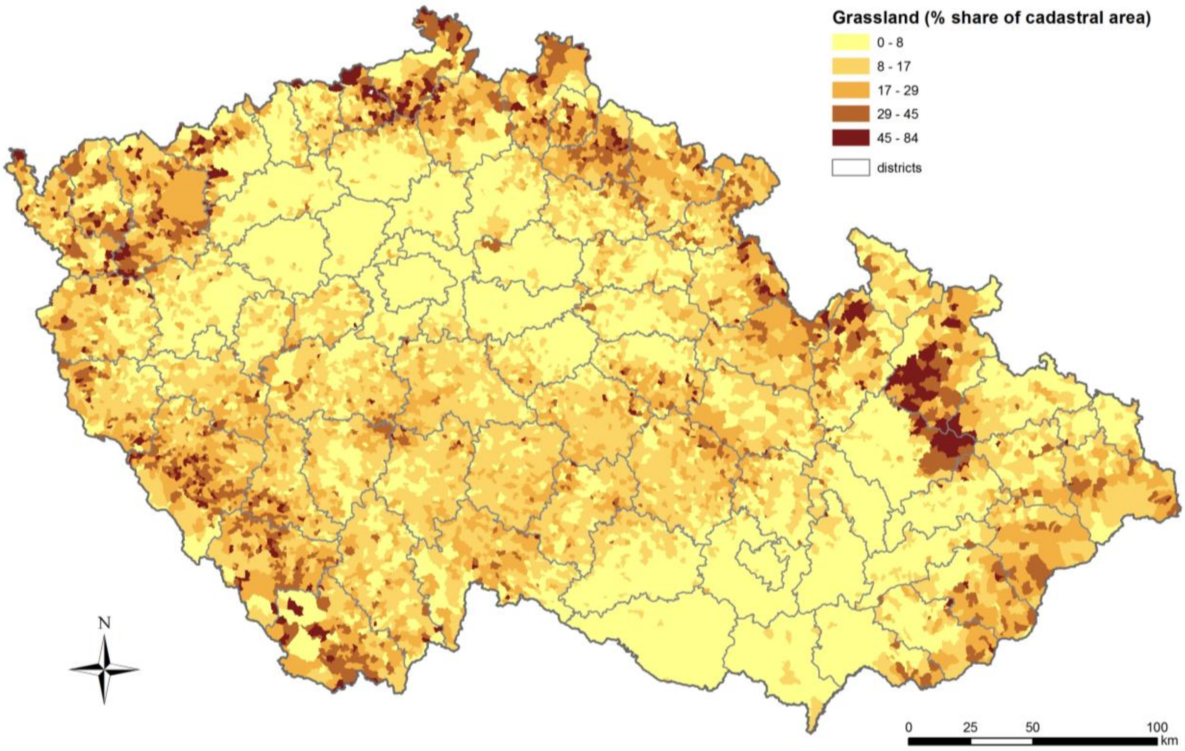


Fig. 6-13 Grassland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2013).

6.6.2 Methodological issues

The emission inventory of 4.C Grassland concerns sub-categories 4.C.1 Grassland remaining Grassland and 4.C.2 Land converted to Grassland. The emission inventory of 4.C Grassland considers changes in living biomass, dead organic matter and soil.

6.6.2.1 Grassland remaining Grassland

For category 4.C.1 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 (2006). 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 carbon stock changes.

The emissions estimates from changes in soil carbon stock were estimated for category 4.C.1. These changes are due to an effect of different management regimes and the changing proportion of the concerned subcategories of 4.C.1. The changes also concern permanently unstocked cadastral Forest Land, which has the attributes of Grassland and is treated accordingly in the emission estimates (see Section 6.4.1). 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 6.2; 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.

Until the NIR submission 2014, the Grassland category also included emissions due to liming. However, similarly as for Cropland, emissions from liming are currently and reported under category 3.G Liming in the sector of 3 Agriculture instead.

Non-CO_2 gases on category 4.C.1 Grassland remaining Grassland do not concern the LULUCF sector in the Czech Republic.

6.6.2.2 Land converted to Grassland

For category 4.C.2 Land converted to Grassland, the estimation concerns carbon stock changes in living biomass, dead organic matter and soils.

For living biomass, the calculation used eq. 2.11 (IPCC 2006) with the assumed carbon content before the conversion of 4.B Cropland set at 5t C/ha (Table 364; IPCC 2006) 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 6.5 t C/ha (Table 6.4; IPCC 2006).

For dead organic matter, emissions are reported due to changes in deadwood that concern the category 4.C.2 Forest Land converted to Grassland. Apart from the actual areas concerned, the emission estimation is identical as described in Section 6.5.2.2 above.

The estimation of carbon stock change in soils for category 4.C.2 Land converted to Grassland in the Czech Republic concerns the changes in mineral soils. The soil carbon stock changes following the conversion from 4.A Forest Land and 4.B Cropland were quantified by the country-specific Tier 2/Tier 3 approach described in detail in Section 6.4.2.2 above.

6.6.3 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 2013. The uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty 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 amount of standing deadwood 27%, average amount of lying deadwood 20%, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%, 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 2013, the total estimated uncertainty for category 4.C.1 Grassland remaining Grassland reached 17%. The corresponding uncertainty for category 4.C.2 Land converted to Grassland reached also 17%. The overall combined uncertainty for category 4. Grassland is 17%.

6.6.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of the adopted 2006 IPCC Guidelines (IPCC 2006). 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 6.4.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.6.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified emission factors associated with the changes implemented in the previous (2014) submission. The changes included revised land use area data and updated carbon fraction in woody biomass, applicable for land-use conversions from Forest land.

The resulting effect of the recalculation performed for the category 4.C Grassland can be seen in Fig. 6-14. On average, the emission removals increased 1.9% as compared to the previously reported estimates. The differences are largest for the years at the beginning of the reporting period and decreased towards the more recent reporting years.

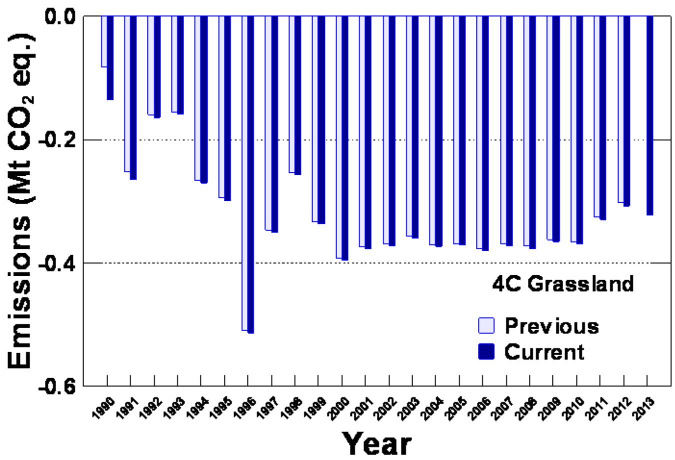


Fig. 6-14 Current and previously reported assessment of emissions for category 4.C Grassland. The values are negative, hence representing net removals of green-house gases

6.6.6 Source-specific planned improvements, including those in response to the review process

Further efforts to consolidate the emission estimates are expected for the category of Grassland. Specific attention will be paid to a likely overall formalization and enhancement of the QA/QC procedures. Also, a likely more detailed stratification of Grassland area to allow a more specific application of factors used in emission estimation is currently being explored.

6.7 Wetlands (CRF 4.D)

6.7.1 Source category description

Category 4.D 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[9] 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 4.D emission category.

The area of 4.D Wetlands currently covers 2.1% of the total territory. It has been growing steadily since 1990 (Fig. 6-4) with even a stronger trend since 1970. It can be expected that this trend would continue and that the area of Wetlands would increase further. This is mainly due to programs aimed at increasing the water retention capacity of the landscape[10].

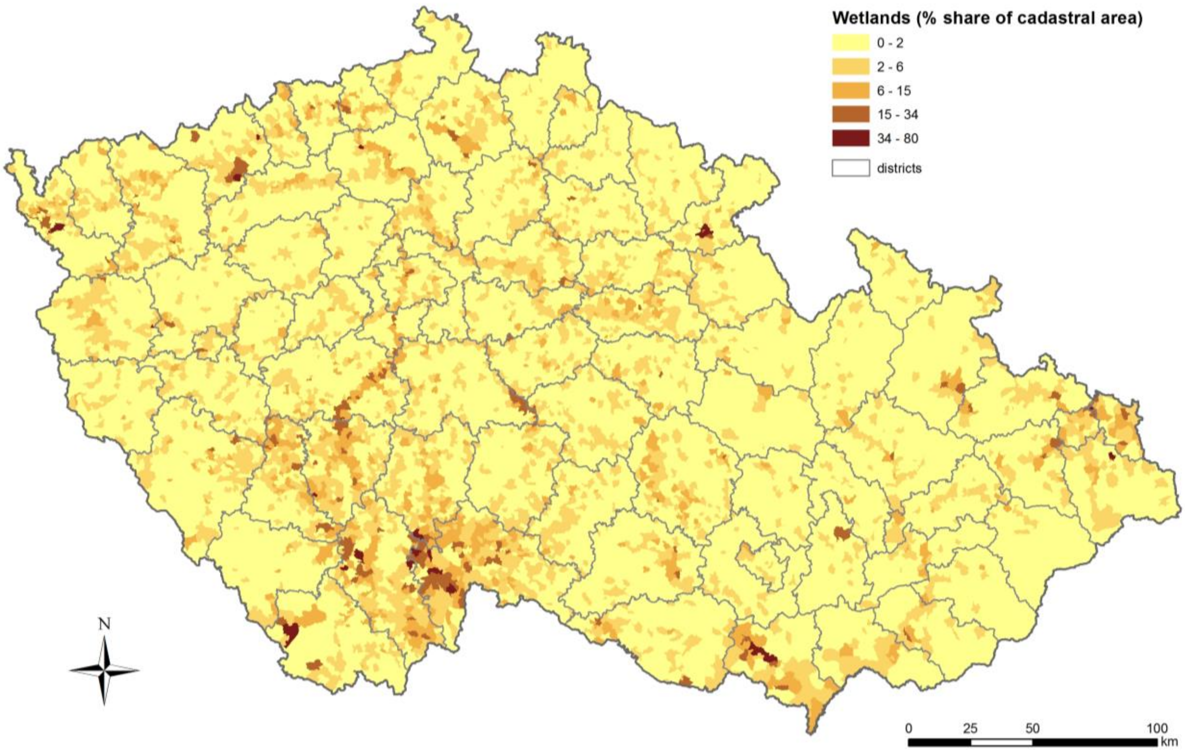


Fig. 6-15 Wetlands – distribution calculated as a spatial share of the category within individual cadastral units (as of 2013).

6.7.2 Methodological issues

The emission inventory of sub-category 4.D.1 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 under the conditions in this country. Hence, the emissions for 4.D.1 Wetlands remaining Wetlands were not explicitly estimated and they can safely be considered negligible.

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

[10] 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)

Sub-category 4.D.2 Land converted to Wetlands encompass conversion from 4.A Forest Land, 4.B Cropland and 4.C 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. 2.11 of 2006 IPCC Guidance for LULUCF, which simply relates the biomass stock before and after the conversion. The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion in the 4.A Forest Land, 4.B Cropland and 4.C Grassland categories was estimated and/or assumed identically as described above in Sections 6.4.2.2 and 6.5.2.2. The latter section also describes the estimation of emissions related to deadwood component, which was applied identically in this land use category.

6.7.3 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 2013. Similarly as for the other land-use categories, the uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). As reported above in chapter 7.3.3, uncertainty estimation was revised for this submission, which applies also to this land use category. The following uncertainty 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 amount of standing deadwood 27%, average amount of lying deadwood 20%, carbon fraction of dry woody matter 7%, and average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%. 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 4.D.2 Land converted to Wetlands, the uncertainty is estimated for this category. For 2013, the estimated uncertainty for category 4.D.2 was 73%.

6.7.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of IPCC 2006 Guidelines (IPCC 2006). 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 6.4.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.7.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates differ insignificantly, incorporating only occasional formal corrections, rounding of numbers and similar. There is no quantifiable mean effect of these corrections and the estimates of the previous and current emissions and removals for category 4.D Wetlands are basically identical (Fig. 6-16).

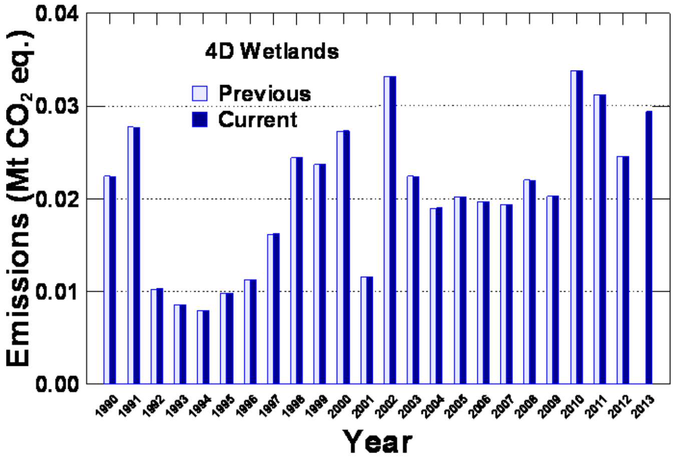


Fig. 6-16 Current and previously reported assessment of emissions for the category 4.D Wetlands

6.7.6 Source-specific planned improvements, including those in response to the review process

For the category of 4.D Wetlands, attention will be paid to a further consolidation of the uncertainty assessment and to overall formalization and enhancement of the QA/QC procedures. Also, a new revision of activity data on land use areas will be implemented in the coming NIRs, which will also concern this land use category.

6.8 Settlements (CRF 4.E)

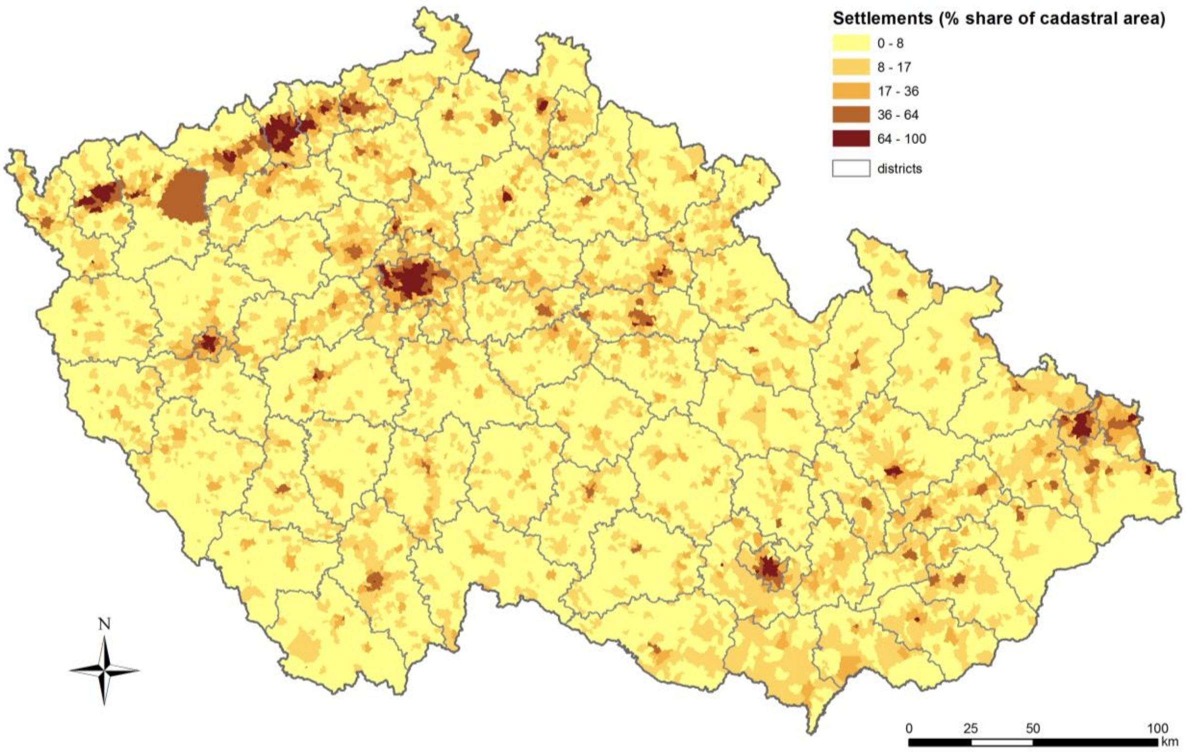


Fig. 6-17 Settlements – distribution calculated as a spatial share of the category within individual cadastral units (as of 2013).

6.8.1 Source category description

Category 4.E Settlements is defined by IPCC (2006) as all developed land, including transportation infrastructure and human settlements. For this emission inventory, the area definition under category 4.E Settlements was revised to better match the IPCC (2006) 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 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks.

The category of Settlements as defined above currently represents about 8.7% of the area of the country. The area of this category has increased since 1990, especially during the most recent years (see Fig. 6-4).

6.8.2 Methodological issues

Following Tier 1 assumption, the carbon stocks in biomass, dead organic matter and soil are considered in balance for the category 4.E.1 Settlements remaining Settlements. Hence, the emission inventory for this category concerns primarily 4.E.2 Land converted to Settlements. As for category 4.E.1 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 4.E.2 Forest Land converted to Settlements. The emissions result mainly from the biomass carbon stock change, which was quantified based on eq. 2.11 (IPCC 2006).

The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion was estimated and/or assumed identically as described above in Sections 6.4.2.2 and 6.5.2.2. The latter section also describes the estimation of emissions related to deadwood component, which was applied identically in this land use category. The carbon stock prior conversion was estimated as described in Section 6.4.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of Guidelines for LULUCF. Additional contribution to emissions is from deadwood component, using the actual areas of the land use change concerned.

6.8.3 Uncertainties and time series consistency

The methods used in this inventory for 4.E Settlements were consistently employed across the whole reporting period from the base year of 1990 to 2013. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 6.4.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). As reported above, uncertainty estimation was revised for this submission, which applies also to this land use category. The following uncertainty values were used: carbon fraction in dry matter 7%, land use areas 3%, reference biomass carbon stock prior and after land-use conversion 75%, average growing stock volume in forests 8%, average amount of standing deadwood 27%, average amount of lying deadwood 20%, and average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007).

The emission estimate concerns only category 4.E.2 Land converted to Settlements; therefore, the uncertainty is estimated only for this category. For 2013, the estimated uncertainty for the category 4.E.2 was 102%.

6.8.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of 2006 IPCC Guidelines (IPCC 2006). 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 6.5.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.8.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates incorporate only occasional formal corrections, rounding of numbers and similar. There is no quantifiable mean effect of these corrections and the estimates of the previous and current emissions and removals for category 4.E Settlements are identical (Fig. 6-18).

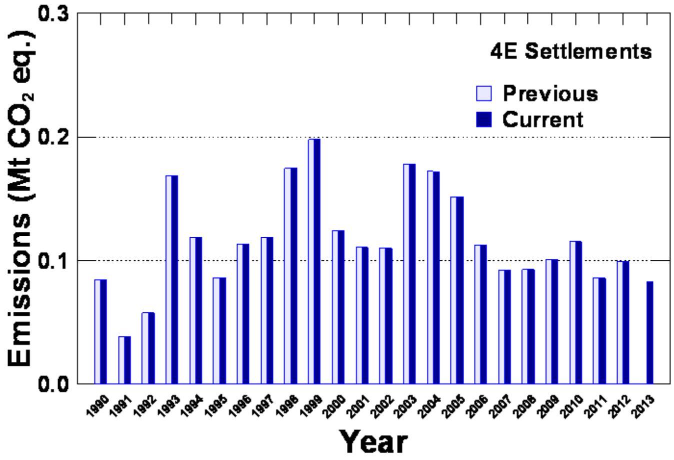


Fig. 6-18 Current and previously reported assessment of emissions for the category 4.E Settlements

Further efforts to consolidate the emission estimates are expected for the category of Settlements. The inventory team considers using the data the from the statistical landscape inventory project CzechTerra (Cerny, 2009) once the repeated land use inventory cycle is finalized. Attention will also be paid to further improvement of the uncertainty assessment and overall formalization and enhancement of the QA/QC procedures. Also, a new revision of activity data on land use areas will be implemented in the coming NIRs, which will also concern this land use category.

6.9 Other Land (CRF 4.F)

6.9.1 Source category description

Since NIR 2008 submission, the category 4.F Other Land represents unmanaged (unmanageable) land areas, matching the IPCC (2006) 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.

6.9.2 Methodological issues

Change in carbon stocks and non-CO_2 emissions are not considered for 4.F.1 Other Land remaining Other Land (IPCC 2006). Since no land-use conversion involving "Other land" is assumed by this inventory, no emissions were considered in the entire category 4.F Other Land.

6.9.3 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 2013.

6.9.4 Source-specific QA/QC and verification

The QA/QC elements were adopted in the same manner as described in Section 6.5.4 above, following the application of the QA/QC plan applicable for the LULUCF sector 7, limited to those elements relevant for this specific land-use category.

6.9.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations concern category 4.F Other Land.

6.9.6 Source-specific planned improvements, including those in response to the review process

A new revision of activity data on land use areas is under preparation, which will be implemented in the coming NIRs. It will also concern this land use category.

6.10 Harvested Wood Products (CRF 4.G)

6.10.1 Source category description

The contribution of Harvested wood products (HWP), by Decision 2/CMP7 mandatorily included in emission inventories under UNFCCC and KP since 2015 inventory submission, is newly estimated for the Czech emission inventory. Changes in the pool of HWP may represent CO_2 emissions or removals, which are included within the LULUCF sector as a specific category (CRF 4.G) besides the six IPCC land use categories. The HWP pool considers primary woody products generated from wood produced in the country. Hence, the origin is the land use category 4.A Forest land. The eventual fraction of wood from deforested land, i.e., Forest land converted to any other land use categories, is also considered, though treated differently (see Section 6.10.2 below).

6.10.2 Methodological issues

The methodology for estimating the contribution of HWP to emissions and removals was based on IPCC (2006) and IPCC (2014). The latter material was followed to adopt the agreed principles on accounting HWP, which includes only domestically produced and consumed HWP. The estimation follows Tier 2 method of first order decay, which is based on Eq. 2.8.5 (IPCC 2014). This equation considers carbon stock in the particular HWP categories, which is reduced by an exponential decay function using the specific decay constants. The default half-life constants were used for the major HWP categories: 35 years for sawnwood, 25 years for wood-based panels and 2 years for paper and paperboard. The second part of Eq. 2.8.5 (IPCC 2014) adds the material inflow in the particular year and HWP categories.

The activity data (production and trade of sawnwood, wood-based panels and paper and paperboard) were derived and/or directly used from the FAO database on wood production and trade (http://faostat3.fao.org/download/F/FO/E). The data are available since 1961 as an aggregate for the former Czechoslovakia. Since 1993, when Czechoslovakia was split into the Czech Republic and Slovakia, data are available specifically for the two countries. To estimate the corresponding share of HWP in the period 1961 to 1992, the data applicable for Czechoslovakia were multiplied by a country-specific share that was derived for each HWP category from the data reported for each follow-up country in the period 1993 to 1997 (Cienciala and Palán 2014). The conversion factors used for disaggregated HWP categories as in Table 2.8.1 (IPCC, 2014).

The fraction corresponding to source material originating from deforested land was estimated based on deforested areas as reported under Act. 3.3 Deforestation of the Kyoto protocol. Although quantitatively insignificant (0.016 and 0.017% in 1990 and 2013, respectively), the HWP contribution of this fraction was estimated using instantaneous oxidation, which is the formal requirement of IPCC guidelines (IPCC 2014).

Tab. 6-7 The country-specific shares applicable for the HWP quantities as given for the former Czechoslovakia in FAO database, derived from the period 1993-1997.

	Production		Import		Export	
Country / HWP category	Czech Republic	Slovakia	Czech Republic	Slovakia	Czech Republic	Slovakia
Sawn wood	0.834	0.166	0.868	0.132	0.723	0.277
Wood-based panels	0.716	0.284	0.719	0.281	0.851	0.149
Paper and paperboard	0.655	0.345	0.772	0.228	0.598	0.402

The resulting estimates reported for HWP produced and consumed domestically (Approach A) for the reporting period 1990 to 2013 are shown in Fig. 6.19. The emissions fluctuate during the reporting period, the mean contribution reached 153 kt CO_2/year.

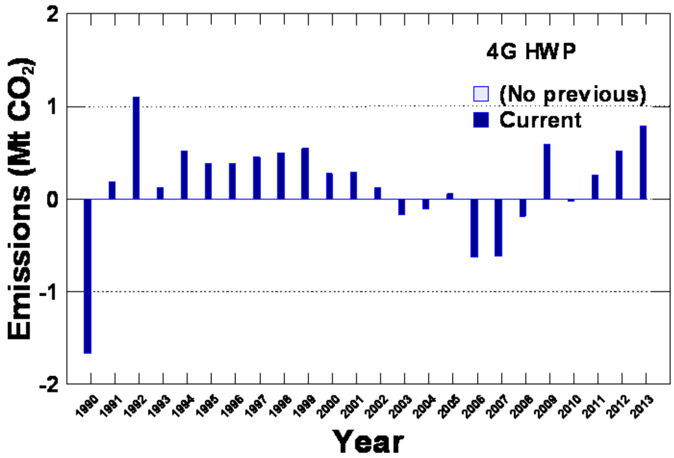


Fig. 6-19 The reported assessment of HWP contribution to emissions in the LULUCF sector for the category 4.G HWP

6.10.3 Uncertainties and time series consistency

The uncertainty estimates use the following input: roundwood harvest ±20%, sawnwood, wood panel and paper products ±15%, wood density factors ±25%, carbon content in wood products ±10%, half-life factors ±50%. Using Eq. 4 for combining uncertainties, this gives an approximate uncertainty estimation of ±62% for the HWP contribution, which is general for all HWP categories.

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 2013.

6.10.4 Source-specific QA/QC and verification

The QA/QC elements were adopted in the same manner as described in Section 6.5.4 above, following the application of the QA/QC plan applicable for the LULUCF sector 7, limited to those elements relevant for this specific land-use category.

6.10.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations concern category 4.G HWP.

6.10.6 Source-specific planned improvements, including those in response to the review process

No specific improvements are planned for this category for the next submission.

Acknowledgement

The authors would like to thank Jan Hána, Patrik Pacourek and Miroslav Zeman, Forest Management Institute in Brandýs n. Labem, for compiling the required increment data concerning forests in previous years. 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. We greatly acknowledge the help of the staff from the Czech Office for Surveying, Mapping and Cadastre, namely Petr Souček, Zuzana Loulová, Bohumil Janeček and Helena Šandová, concerning data on land use areas and advice in related issues. The authors also thank Jan Apltauer, the former employee of IFER, for his contribution to the previous NIRs, and Ondřej Černý and Šárka Holá, the employees of IFER, for their technical assistance with the current NIR submission.

7 Waste (CRF sector 5)

7.1 Overview of sector

The waste sector consists of several categories. The main source category of this sector is 5.A Solid waste disposal. In 2013, this category emitted 133 Gg of CH_4, equalling to 3 325 Gg of CO_2 eq. The second biggest source category is 5.D Wastewater Treatment and Discharge, 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 emitted 23.57 Gg of CH_4, equalled to 589.25 Gg CO_2 eq. In the sector are three additional categories, respectively dealing with waste incineration, anaerobic digestion of waste and composting. The last source category in this sector is 5.C Incineration of waste, which was recalculated last year and split between two subcategories. Waste, used as a fuel for energy purposes, was calculated and reported in category 1.A.1.a Other fuels. The incineration of industrial and hazardous waste remained in this sector.

Tab. 7-1 Overview of significant categories in this sector (2013)

Category	Gas	Character of category	% of total GHG*
5.A Solid Waste Disposal	CH_4	LA, TA	2.18
5.D Wastewater treatment and discharge	CH_4	LA	0.39
5.B Biological treatment of solid waste	CH_4	TA	0.36

** 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*

Year 2013 is noteworthy, due to the implementation of the new IPCC methodology and various factors, associated with GHG inventories changed in a way that this years chapter is inconsistent with previous year's NIR. Due to the change in GWP values, all numerical values in CO_2 eq. had to be reclaculated.

The Waste sector is quantified and managed by the Charles University Environmental Center (CUEC).

7.2 Solid waste disposal (CRF 5.A)

7.2.1 Source category description

The treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). The 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 the 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). Only CH_4 is addressed in this report in line with the IPCC 2006 methodology.

7.2.2 Methodological issues

Waste disposal to SWDS

The key activity data for methane quantification from 5.A.1 is the amount of waste, disposed in landfills. Annual disposal is shown in Tab. 7-2. The data for annual disposal are obtained from mixed sources, since the application of the FOD model requires data from 1950 to the present day. These data are not available in the country and therefore assumptions about the past must be used. These assumptions are described in the working paper, published in this issue (Havránek, 2007), but the method can be simply described as intrapolation and extrapolation between points in time; correlation of waste production with social product (predecesor of current GDP) as a test method was performed. The higher of the two estimates was used in the quantification.

The data, used for present dates, are based on the information system of waste management in the Czech Republic (ISOH), managed by CENIA – Czech Environmental Information Agency. The system contains bottom up data from about 60 000 respondents and reporting obligation to this system is based on national legislation. In the year 2011, a slight decline in waste deposited in to landfills was experienced for a first time in modern history. The decrease of landfilled waste is a long term target of the Czech national environmental policy.

National legislation about landfill management is based on European legislation. In general, it sets the conditions: how landfilling can be done; the relevant actors and state bodies responsible for admionistration and control; duties and obligation of all stakeholders. Main regulations in this area are 185/2001 Coll. "Act on waste" and the main directive relevant for the landfilling 294/2005 Coll. "Decree on the conditions of depositing waste in landfills and its use on the surface of the ground". Management of waste is complicated and full regulative framework can be found on the website of the Ministry of Enviroment.

Tab. 7-2 MSW disposal in SWDS in the Czech Republic [Gg], 1990-2013

Year	MSW in SWDS	Year	MSW in SWDS	Year	MSW in SWDS	Year	MSW in SWDS
1990	2371	**1997**	2739	**2004**	3000	**2011**	2981
1991	2388	**1998**	2804	**2005**	3070	**2012**	2786
1992	2484	**1999**	2632	**2006**	3221	**2013**	2692
1993	2543	**2000**	2803	**2007**	3314		
1994	2561	**2001**	2826	**2008**	3424		
1995	2621	**2002**	2920	**2009**	3406		
1996	2683	**2003**	2952	**2010**	3185		

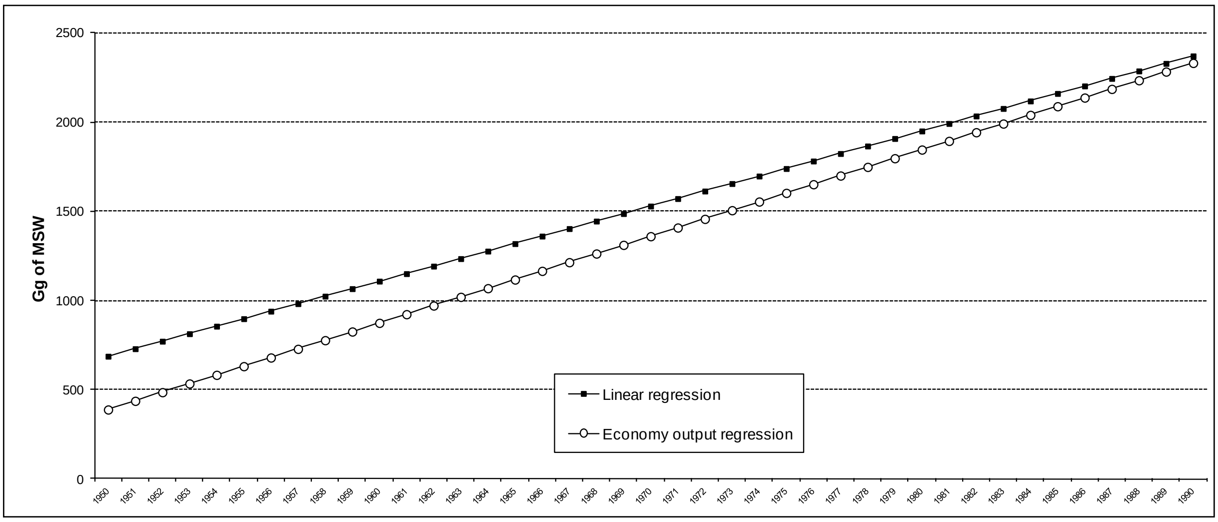


Fig. 7-1 MSW disposal in SWDS in the Czech Republic, 1950-1990

The method, used for estimation of methane emissions from this source category, is the Tier 1 FOD approach (first-order decay model). The first-order decay (FOD) model assumes gradual decomposition of waste, disposed in landfills. The GHG emissions were calculated from the IPCC Spreadsheet for Estimating Methane Emissions from Solid Waste Disposal Sites, which is part of the 2006 Guidelines (IPCC, 2006) referred further to as IPCC model (IPCC, 2006).

Waste composition, sludge, k-rate and DOC

The waste composition is crucial for emission estimations. Several attempts to obtain country-specific data about waste composition were made (Tab. 7-3). The greyed data (1990-1995) are based on the IPCC default values for Eastern Europe, blackened data (1996-2000 and 2002-2004) are based on intrapolation between data points. The data in the white rows (2001 and 2005-2009) are based on waste surveys performed in R&D projects, dealing with waste composition. There are no data for current years and therefore latest available data was used. Endeavour to encourage continuation of waste composition monitoring was made.

As it can be noted, the table does not include all possible waste streams, which might be deposited into a landfill. The missing item is sludge. The reason is that the projects, from which the expert derived the waste composition, did not include any sludge as part of the waste mixture. However, the inventory team is aware, that the research covered only limited number of landfills. Furthermore since the practice of sludge deposition is not wide spread, the researchers did not encounter its deposition. Therefore sludge is not calculated into the waste mixture, although in reality some small part of the sludge might end up in landfills. Doing so emissions were not underestimated however, because the mass, deposited to landfills already include sludge (data are bottom up total mass data from landfills) and the average DOC, using current waste mixture is higher than default DOC of sludge.

The table also contains the methane generation rate (k-rate) employed. This rate is closely related to the compostion of a particular substance and the available moisture. The IPCC default k-rates for a wet temperate climate (as the average temperature of the Czech Republic is about 7 °C and the annual precipitation is higher, than the potential evapotranspiration) were used. The average DOC for particular waste stream is also based on the IPCC default values for individual categories of waste. The average DOC for each particular year is in the last column of the Tab. 7-3.

Tab. 7-3 MSW composition for the Czech Republic used in the quantification (fractions of total, 1990-2013)

	Paper	Food	Textil	Wood and straw	DOC (calculated)
k-*rate*	0.06	0.185	0.06	0.03	
DOC (default)	0.4	0.15	0.24	0.43	
	Share of particular waste streams				
1990	0.22	0.30	0.05	0.08	0.176
1991	0.22	0.30	0.05	0.08	0.176
1992	0.22	0.30	0.05	0.08	0.176
1993	0.22	0.30	0.05	0.08	0.176
1994	0.22	0.30	0.05	0.08	0.176
1995	0.22	0.30	0.05	0.08	0.176
1996	0.22	0.29	0.05	0.08	0.179
1997	0.23	0.28	0.06	0.08	0.181
1998	0.24	0.27	0.06	0.08	0.184
1999	0.25	0.26	0.07	0.08	0.187
2000	0.26	0.25	0.07	0.08	0.191
2001	0.27	0.23	0.08	0.08	0.195
2002	0.24	0.25	0.08	0.09	0.194
2003	0.22	0.27	0.07	0.11	0.193
2004	0.19	0.30	0.07	0.13	0.192
2005	0.16	0.32	0.07	0.14	0.191
2006	0.16	0.32	0.07	0.14	0.187
2007	0.17	0.32	0.08	0.13	0.193
2008	0.16	0.32	0.07	0.14	0.188
2009	0.16	0.35	0.08	0.13	0.193
2010*	0.16	0.35	0.08	0.13	0.193
2011	0.16	0.35	0.08	0.13	0.193
2012	0.16	0.35	0.08	0.13	0.193
2013	0.16	0.35	0.08	0.13	0.194

* *Since 2010 last available data is used*

Methane correction factor

The methane correction factor (MCF) is a value, expressing overall management of the landfills in the country. Better-managed and deeper landfills have higher MCF value. Shallow SWDS ensure that far more oxygen penetrates into the body of the landfill to aerobically decompose DOC. The suggested IPCC values are given in Tab. 7-4.

In table 7-5 are shown the values, used in this inventory. The choice of the values is based on data in recent years (1992+) and an expert judgement in early years of the timeline.

Tab. 7-4 Methane correction values (IPCC, 1997)

	MCF
Unmanaged, shallow	0.4
Unmanaged, deep	0.8
Managed	1.0
Managed, semi-aerobic	0.5
Uncategorised	0.6

Tab. 7-5 MCF values employed, 1950-2013

	MCF
1950 – 1959	0.6
1960 – 1969	0.6
1970 – 1979	0.8
1980 – 1989	0.9
1990 – 2012	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 the intensity of the oxidation of methane. The 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 the oxidation factor are available for the Czech Republic. Some studies are quoted in Straka, 2001, which mention a non-zero oxidation factor, but these figures seem to be site-specific (and with really high values compared to default). Therefore they 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 the report.

Delay time

When waste is disposed in SWDS, decomposition (and methanogenesis) do not start immediately. The assumption, used in the IPCC model, is that the reaction starts on the first of January in the year after deposition, that 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 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. Revision of these values was made, based on collected data from MIT (MIT, 2005+). MIT receives annual reports from landfills, capturing LFG; SWDS report the net calorific value of their captured LFG. This value was compared with the gross calorific value of pure methane and yielded a value of 0.55, which well fits within the IPCC range and therefore is used in the quantification.

Recovered methane

On SWDS in the country, methane is sometimes collected by an LFG collection systems and incinerated for energy purposes. Based on Good Practice Guidelines (IPCC, 2000), this methane, that is being converted to CO_2 and, having biogenic origin, is not considered to constitute an emission of GHG, hence recovered methane (R) is substracted from the emission. There is no default value for R, so country estimates were used, based on various sources. As mentioned in the previous paragraph, the Ministry of Industry and Trade conducts an annual survey of all SWDS. All the energy data about LFG, used for energy purposes, is collected. An attempt to update old estimates as much as possible is made. Since the start of the survey in 2005, it was possible to provide estimates for the time series between 2003 and 2013. The estimates in Straka, 2001 were used for the 1990-1996 period. Linear intrapolation of recovered methane was used for the period between 1996 and 2003. In 2013 more than 60 facilities in the country were recovering LFG.

Tab. 7-6 Emissions of methane from SWDS [Gg], Czech Republic, 1990-2013

	CH_4 generation	CH_4 recovery	CH_4 oxidized	CH_4 emission
1990	91	3.3	9.1	79.2
1991	95	3.3	9.5	82.8
1992	99	3.5	9.9	86.0
1993	103	3.5	10.3	89.5
1994	107	3.5	10.7	93.0
1995	110	3.5	11.0	96.2
1996	114	6.0	11.4	97.1
1997	118	6.6	11.8	99.9
1998	121	7.1	12.1	102.6
1999	125	7.7	12.5	105.5
2000	127	8.2	12.7	107.3
2001	131	8.8	13.1	109.8
2002	134	9.3	13.4	112.3
2003	138	9.9	13.8	115.1
2004	142	15.6	14.2	113.4
2005	145	18.0	14.5	114.7
2006	149	20.6	14.9	116.0
2007	154	25.9	15.4	114.8
2008	158	24.6	15.8	120.4
2009	163	24.5	16.3	124.5
2010	168	24.7	16.8	129.0
2011	171	26.6	14.4	130.2
2012	173	26.5	14.6	131.9
2013	174	25.9	15.0	133.0

7.2.3 Uncertainties and time-series consistency

This sector was recalculated in 2013 reporting period. Year 2013 is noteworthy as there was a change of methodology and various factors associated with GHG inventories changed in a way that this year chapter has changed in comparison with previous year's NIR. Due to the change in GWP values, all numerical values in CO_2 eq. had to be reclaculated.

Overall quantification of the uncertainity for this category is still incomplete. This will be conducted in the following years as soon as budget constraints permit.

Furthermore the chapter address the uncertainty for the whole waste sector (tab. 7-7). The activity data required by the Guidelines are mostly derived from different data. These additional step(s) are increasing the uncertainty of real activity data. Moreover data providers do not produce any relevant statistics that would help to determine standard deviation or other data characteristic. The main data provider is the Czech Statistical Office. The Czech Statistical Office does not produce descriptive statistics about its data. The data, produced by the office are often the only one available, based on total survey. Another difficulty with estimating uncertainty in category SWDS is the time scale. For emission in 2013 data estimates from 1950 on are used. Further the uncertainty varies among particular years and there is no tool how to handle this correctly. Therefore most of the time an expert judgment to assess the uncertainty is used.

Tab. 7-7 Uncertainties for Waste sector

Gas	Category	AD uncertainity [%]	EF uncetrainity [%]	Origin of the parameters
CO_2	1.A.1.a MSW incineration	20	20	AD Expert judgement M. Havránek; EF IPCC default
N_2O	1.A.1.a MSW incineration	20	70	AD Expert judgement M. Havránek; EF IPCC default
CH_4	1.A.1.a MSW incineration	20	80	AD Expert judgement M. Havránek; EF IPCC default
CH_4	5.A.1 SWDS	30	40	Combined uncertainty of quantification parameters Expert judgement M. Havránek, verification P. Slavíková (CENIA)
CH_4	5.B.1 Composting	20	NA	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)
N_2O	5.B.1 Composting	20	NA	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)
CH_4	5.B.2 Anaerobic digestion	20	NA	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)
CO_2	5.C.1 HW/IW incineration	15	5	AD Expert judgement M. Havránek; EF IPCC default
N_2O	5.C.1 HW/IW incineration	20	70	AD Expert judgement M. Havránek; EF IPCC default
CH_4	5.C.1 HW/IW incineration	20	80	AD Expert judgement M. Havránek; EF IPCC default
CH_4	5.D.1 Domestic wastewater	21	50	Combined uncertainty of quantification parameters Expert judgement M. Havránek
N_2O	5.D.1 Domestic wastewater	26	50	AD Expert judgement M. Havránek; EF IPCC default
CH_4	5.D.2 Industrial wastewater	40	50	Combined uncertainty of quantification parameters + IPCC Default values, Expert judgement M. Havránek

7.2.4 Source-specific QA/QC and verification

During the year 2015 the QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since the waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from the national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.2.5 Source-specific recalculations, including changes made in response to the review process

This sector was recalculated in 2013 reporting period. Year 2013 is significant as there was a change of methodology and various factors associated with GHG inventories changed in a way that this year chapter is inconsistent with previous year's NIR. Due to change in the GWP values all numerical values in CO_2 eq. had to be reclaculated.

7.2.6 Source-specific planned improvements, including those in response to the review process

There are not improvements, planned for this category.

7.2.7 Unmanaged Waste Disposal Sites (CRF 5.A.2)

This category is not relevant for the Czech Republic.

7.2.8 Uncategorized Waste Disposal Sites (CRF 5.A.3)

This category is not relevant for the Czech Republic.

7.3 Biological treatment of solid waste (CRF 5.B)

The biological treatment of waste includes two subcategories. Aerobic processes for treating organic waste include Composting (5.B.1) and Anaerobic digestion (5.B.2). Composting is mostly aerobic process; therefore the production of methane is insignificant. Anaerobic digestion is increasing in the recent years, as there is an active support from the state for this type of waste treatment (i.e. energy production). However, it is controlled process, which has capturing of produced biogas as a main objective; hence emissions from this source category are also relatively small.

7.3.1 Composting (CRF 5.B.1)

Composting is a new category in the GHG inventory. In previous methodology this category was omitted (as it is generally aerobic process that does not produce significant amount of GHGs). According to the IPCC 2006 methodology, this category should be included.

7.3.1.1 Source category description

This category quantifies emissions from industrial composting facilities. Estimation of emissions from household composts were not attempted, as this would introduce high levels of uncertainty in the results (no data is available) and those emissions are considered to be negligible, as household composts are in general very small, ensuring that the processes are not generating methane emissions at all.

7.3.1.2 Methodological issues

This source category quantifies emissions from composting, based on statistical data about management of waste. The data about composting are obtained from ISOH – Information system of waste management, managed by CENIA - Czech environmental information agency (for more details about ISOH see chapter 7.2.2).

In line with the IPCC 2006, composted waste was split in to two groups – municipal solid waste (MSW) and other waste. Composted MSW is a self-explanatory category. Composted other waste is collection category of all waste streams, that are noted in ISOH as composted, but the exact nature of the waste stream is unknown. However being composted one can assume that a certain composition standards are met; therefore both categories use identical EF. For both streams fresh (wet) weight data and default EF from IPCC 2006 were used. Both of the categories have no data before 2005 so a further research is launched to determine the reasons for this case. Considering that the industrial composting is a new field in the country the data for earlier years could be non-existing because no such activity occurred. The amount of composted MSW is gradually increasing, which is long term aim of Czech environmental policy.

Tab. 7-8 is presents the estimation of GHG emissions from composting for the period 2005-2013, including EFs, recovered methane and total amount of MSW composted.

Tab. 7-8 Emissions of GHG from composting [Gg], Czech Republic, 2005-2013

	2005	2006	2007	2008	2009	2010	2011	2012	2013
MSW (tons)	48 760	61 475	79 801	114 437	134 601	144 136	181 914	153 500	202 832
Other waste (tons)	288 814	222 672	296 390	428 739	221 276	358 242	190 058	228 284	247 045
Emission factor (kg CH_4/ton)	4	4	4	4	4	4	4	4	4
Emission factor (kg N_2O/ton)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Recovered CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total Composting CH_4 (Gg)	1.35	1.14	1.50	2.17	1.42	2.01	1.49	1.53	1.80
Total Composting N_2O (Gg)	0.10	0.09	0.11	0.16	0.11	0.15	0.11	0.11	0.13
Total composting GHG (Gg CO_2 eq.)	63.94	53.81	71.25	102.88	67.40	95.15	70.45	72.31	85.21

7.3.1.3 Uncertainties and time-series consistency

This category has default uncertainty, as there is only default factors used. See chapter 7.2.3.

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external CzSO 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, CzSO is informed about this fact and is requested to provide an explanation.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

7.3.1.4 Source-specific QA/QC and verification

During the year 2015 QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insights in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.3.1.5 Source-specific recalculations, including changes made in response to the review process

Since this category is newly added in to the inventory, recalculations were not performed.

7.3.1.6 Source-specific planned improvements, including those in response to the review process

A research was initiated to obtain data about composting before 2005. In future submissions, if the resources permit an attempt to estimate the emissions from household composts will be performed. However, with respect to the almost negligible emissions from industrial composting, currently this is not of a high priority.

7.3.2 Anaerobic digestion at biogas facilities (CRF 5.B.2)

7.3.2.1 Source category description

Anaerobic digestion (AD) accounts for emissions from digestion facilities. AD in the Czech Republic is increasing, going from 21 digesting facilities to 388 facilities in 2013. This rapid growth is fuelled by technological availability and massive support on energy from biogas produced using AD. AD is also a new category that was added into the inventory for the first time.

7.3.2.2 Methodological issues

For the estimation of emissions from AD default method and emission factors were not used (Tab. 7-9). Since production of biogas from AD facilities is carefully monitored (due to government subsidies) the data about biogas production was used as an activity data. The Ministry of Industry and Trade monitors the amount of biogas and additional data, such as calorific value of produced gas, energy produced and total volume of gas. The heating value of methane was used to convert abovementioned values to mass unit of produced methane. The production does not mean emission of biogas, yet. The IPCC 2006 states that in controlled AD facilities, focused on energy production, leakages are very small, ranging between 0- 10%. For the estimation of emissions of biogas from AD, a mean value of 5% for all produced methane was used.

Since data about production are used as an activity data, all possible emissions from AD are calculated, not just emissions from digested waste. Some of the material used in AD might not be waste by definition (e.g. agricultural residues, industrial by-products etc.).

Tab. 7-9 Emissions from anaerobic digestion stations for the period 2007-2013

	2007	2008	2009	2010	2011	2012	2013
Number of biogas stations (count)	21	49	86	115	186	317	388
Amount of gas (cu.m)	27841876	51382715	132287587	223170256	364320920	628824719	995619603
Average NCV (MJ/cu.m)	19.918	19.606	18.919	20.078	20.022	20.086	20.090
Energy (TJ)	554.559	1007.388	2502.769	4480.915	7294.445	12630.462	20001.998
Convertsion (TJ/Gg)	50.009	50.009	50.009	50.009	50.009	50.009	50.009
Activity data (Gg of CH_4) - R	11.089	20.144	50.046	89.602	145.863	252.564	399.968
Emission (default 5%) Gg CH_4	0.554	1.007	2.502	4.480	7.293	12.628	19.998

7.3.2.3 Uncertainties and time-series consistency

Uncertainty in this source category is given by the range of EF from -100% to +100%. See chapter 7.2.3.

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external MIT data, they cannot affect the variation in the time series of activity data during processing.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

7.3.2.4 Source-specific QA/QC and verification

During the year 2015 QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insights in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.3.2.5 Source-specific recalculations, including changes made in response to the review process

Since this category is newly added to the inventory, no recalculations were performed.

7.3.2.6 Source-specific planned improvements, including those in response to the review process

Improvements in this category are planned in terms of reviewing the data sources of emissions before 2007 and verifying the factor for estimated leakages, which is crucial for the whole quantification.

7.4 Incineration and open burning of waste (CRF 5.C)

7.4.1 Waste incineration (CRF 5.C.1)

This category contains emissions from waste incineration in the Czech Republic. The types of waste, incinerated include industrial, hazardous and clinical waste. The 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 time, 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.

This year, the whole category was changed as a part of the incinerated MSW was shifted to the energy chapter. MSW in the country is used as fuel, so the logic behind this change is in accordance with the suggestions of the Good Practice Guidelines (IPCC, 2000). At the present, this category consists of emissions from incineration of hazardous and industrial waste (clinical waste CW and sludge is part of hazardous waste) – HW/IW.

7.4.1.1 Source category description

There are three MSW incineration facilities and also 76 other facilities, incinerating or co-incinerating industrial and hazardous waste with a total capacity of 600 Gg of waste. Most of this capacity is not used however. Some of the incinerators have energy recovery, but the amount of the incinerated waste that is used for energy purposes is still under review. As soon as this information is available, it will be used for identification and division of the total HW/IW, used for energy/non-energy purposes and this particular part of the category will be transferred to the energy sector.

In recent years we observe steady decreasing trend of waste incineration. Interpretation of the reasons behind this trend is not researched enough, but factors like recycling, reuse, stricter legislation and waste fee system definitely are influential.

7.4.1.2 Methodological issues

In this source category only CO_2 emissions resulting from oxidation of fraction of fossil carbon in waste (e.g. plastics, rubber, liquid solvents, and waste oil) during incineration are considered in the net emissions and are included in the national CO_2 emissions estimates. Additionally, incineration plants produce small amounts of methane and nitrous oxide. All emissions are reported in category 5.C.1. Estimations of emissions from HW/IW biomass are reported under the same category, but the CO_2 emissions are described as an information item and are not included in the national totals.

Estimation of CO_2 emissions from HW/IW incineration is based on the Tier 1 approach (IPCC, 2006). It assumes that the total fossil carbon dioxide emissions are dependent on the amount of carbon in the waste, on the fraction of fossil carbon and on the combustion efficiency of the waste incineration. Due to the lack of country-specific data for the necessary parameters, the default data for the calculations were taken from the IPCC 2006 Guidelines, see Tab. 7-9. To save place in the table, the results are divided into biogenic and non-biogenic fractions of the waste only for important gases – CO_2. Methane and nitrous oxide are listed together in the table although they are reported in the UNFCCC reporter separately from the biogenic and fossil fractions of the waste.

The activity data are based on the statistical surveys, performed by ISOH – waste management information system operated by MoE/CENIA and the missing data (system does not contain data before 2002) was obtained from MIT. An MIT questionnaire is sent to all the facilities, incinerating waste and alternative fuels. There is a certain simplification, because the questionnaires do not allow assessment of the exact nature of the waste (i.e. composition, calorific value) and use simplified grouping of waste as MSW and waste that is hazardous, industrial (HW/IW). Also part of this waste stream is incinerated clinical waste and sludge. Czech legislation does not discern explicitly between types of wastes because clinical waste, industrial waste and sludge are all hazardous waste from management point of view. Underestimation is avoided by using hazardous waste emission factors for the whole HW/IW/CW/Sludge mixture that is incinerated in HW/IW facilities as HW emission factors are far higher than sludge and CW.

Tab. 7-10 HW/IW incineration in 1990 – 2013 with used parameters and results

	Used factors											
Amount of carbon fraction	0.5											
Fosil carbon fraction	0.9											
Combust efficiency fraction	0.995											
C-CO_2 ratio	3.7											
Emission factor Gg CH_4/Gg	5.6E-07											
Emission factor Gg N_2O/Gg	1.0E-04											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	
H/IW incinerated (Gg)	14.1	16.9	19.8	27.1	38.4	43.1	43.3	45.4	45.6	46.6	38.4	
Total CO_2 (Gg CO_2) Fossil	23.1	27.7	32.5	44.4	63.0	70.7	71.1	74.5	74.8	76.5	63.0	
Total CO_2 (Gg CO_2) Bio.	2.6	3.1	3.6	4.9	7.0	7.9	7.9	8.3	8.3	8.5	7.0	
Total CH_4 (Gg CH_4)	7.9E-06	9.5E-06	1.1E-05	1.5E-05	2.1E-05	2.4E-05	2.4E-05	2.5E-05	2.6E-05	2.6E-05	2.2E-05	
Total N_2O (Gg N_2O)	1.4E-03	1.7E-03	2.0E-03	2.7E-03	3.8E-03	4.3E-03	4.3E-03	4.5E-03	4.6E-03	4.7E-03	3.8E-03	
	2001	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
H/IW incinerated (Gg)	52.5	117.0	109.9	106.7	116.1	122.9	146.6	121.2	109.4	114.1	111.0	107.0
Total CO_2 (Gg CO_2) Fossil	86.1	192.1	180.5	175.2	190.7	201.8	240.7	198.9	179.7	187.4	182.2	175.7
Total CO_2 (Gg CO_2) Bio.	9.6	21.3	20.1	19.5	21.2	22.4	26.7	22.1	20.0	20.8	20.2	19.5
Total CH_4 (Gg CH_4)	2.9E-05	6.6E-05	6.2E-05	6.0E-05	6.5E-05	6.9E-05	8.2E-05	6.8E-05	6.1E-05	6.4E-05	6.2E-5	6.0E-05
Total N_2O (Gg N_2O)	5.2E-03	1.2E-02	1.1E-02	1.1E-02	1.2E-02	1.2E-02	1.5E-02	1.2E-02	1.1E-02	1.1E-02	1.1E-02	1.1E-02

The suggested default emission factors for hazardous waste incineration were 100 kg of N_2O per Gg of incinerated HW and 0.56 kg of methane per Gg of incinerated HW. Recently the biogenic emissions of

CO_2 from this category were estimated. The approach is based on the default factor for fossil carbon, assuming that the rest of the carbon in the material is from non-fossil origin.

7.4.1.3 Uncertainties and time-series consistency

Uncertainties considering the activity data are based on expert judgement. See chapter 7.2.3.

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external ISOH and MIT data, they cannot affect the variation in the time series of activity data during processing.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

7.4.1.4 Source-specific QA/QC and verification

The QA/QC plan of the National inventory system was used for the whole waste category. For this particular subcategory, we used bottom-up data provided by the official sources (Ministry of Industry and Trade, MIT) and additionally the data from ISOH – information system on waste management run by the MoE/CENIA. However, the inaccuracy or uncertainty of this data is not quantified, but it is estimated by expert judgment. The data on incineration was cross-checked with the top-down data, produced by other state agencies.

7.4.1.5 Source-specific recalculations, including changes made in response to the review process

No recalculations performed in this submission.

7.4.1.6 Source-specific planned improvements, including those in response to the review process

In future submissions, the inventory team considers dividing the reported part of waste, used for energy production and adding it to the energy sector, as the data on the topic becomes available. The inventory team continuously encourages the state administration to gather data useful for GHG inventories.

7.4.2 Open burning of waste (CRF 5.C.2)

Open burning of waste is illegal in the country; thus this category is considered as not occurring. Although to prove that this category is occurring, currently a research on exceptional phenomenon like fires of landfills or in general, where significant amount of material might be openly burned, is launched

7.5 Waste-water treatment and discharge (CRF 5.D)

7.5.1 Domestic Wastewater Treatment (CRF 5.D.1)

7.5.1.1 Source category description

This category consists of four separately calculated subcategories. Methane from anaerobic processes, produced during treatment of domestic wastewater and emissions of N_2O from nitrogen in wastewater. There is a bit crossover with 5.D.2 as emissions of N_2O are corrected by factor indicating that industry is often allowed to discharge wastewater in municipal sewers.

Treatment of domestic wastewater is in the Czech Republic mostly centralised, more than 82% of population is connected to sewage systems. Wastewater treatment plants treat about 97% of all collected water (Tab. 7-10). Rest of the population, mainly rural population in small municipalities, have on-site treatment – septics, sump tanks, latrines or household treatment plants.

7.5.1.2 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 1997 Guidelines (IPCC, 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 wastewater and sludge and COD for industrial wastewater. The new method is also extended to include determination of emissions from sludge that are primarily the products of various methods of treatment of wastewater and, under anaerobic conditions, may contribute to methane production and methane emissions. The amount of nitrous oxide, emitted from wastewater is a function of protein consumption in the population rather than BOD or COD.

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 the 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 mainly due to increasing water savings in water use (aprox. 10-20%). The total amount of organic pollution is the same, but the density is higher than for the period before 2003. From 2003 onwards, was assumed that 40% of the BOD is separated as sludge. (Zábranská, 2004).

Other data, entering the calculation, also include the number of inhabitants, connected to the sewers and the percent of treated wastewater, collected to the sewers giving the amounts for the time series. According to the Good Practice Guidance (IPCC, 2000), the maximum theoretical methane production B_0 equals 0.25 kg CH_4/kg COD, corresponding to 0.6 kg CH_4/kg BOD. This data is used to determine the emission factors for municipal wastewater and sludge. In determining the emission factor for sludge, it is necessary to evaluate the technology, used to treat the particular sludge and to assign a conversion factor to it - MCF - Methane Conversion Factor - giving the part of the organic material that will be transformed to methane (the remain to CO_2) Description of the MCF and the individual technologies through the whole time period is demonstrated in Tab 7-11. The literature (Dohanyos and Zábranská, 2000; Zábranská, 2004) contains a survey of the nationally specific factors for the ratio of aerobic and anaerobic technologies for 1990-2004. There is also a certain fraction of sewage that does not enter the sewer system and is treated on site. For this situation, this particular category in wastewater and sludge was not separated (this corresponds to latrines, septic tanks, cesspools, household treatment plants, root plants 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 of sludge is considered to be removed (recovered for energy purposes or flared). The remaining methane is considered to be emitted. This assumption is based on the 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. A leakage might occur only during accidents, but the amount of methane emitted is assumed to be insignificant (the estimate based on expert judgment is less than 1% of the total amount) (Zábranská, 2004).

Tab. 7-11 Population connection to sewers and share of treated water, 1990-2013, 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	**2002**	10 201	77.4	92.6
1991	10 308	72.3	69.6	**2003**	10 202	77.7	94.5
1992	10 317	72.7	78.7	**2004**	10 207	77.9	94.9
1993	10 330	72.8	78.9	**2005**	10 234	79.1	94.6
1994	10 336	73.0	82.2	**2006**	10 267	80.0	94.2
1995	10 330	73.2	89.5	**2007**	10 323	80.8	95.8
1996	10 315	73.3	90.3	**2008**	10 486	81.1	95.3
1997	10 303	73.5	90.9	**2009**	10 492	81.3	95.2
1998	10 294	74.4	91.3	**2010**	10 517	81.9	96.2
1999	10 282	74.6	95.0	**2011**	10 496	82.6	96.8
2000	10 272	74.8	94.8	**2012**	10 509	82.5	97.1
2001	10 224	74.9	95.5	**2013**	10 511	82.8	97.4

Tab. 7-12 Methane conversion factors (MCF) and share of individual technology types [%], 1990-2013

	MCF	1990	1993	1996	1999	2002	2005	2008	2010	2011	2012	2013
On-site treatment[11]	0.15	100	100	100	100	100	100	100	100	100	100	100
River discharge	0.05	27	21	10	5	7	5	5	4	3	3	3
Aerobic water	0.05	48	54	65	70	68	72	73	73	74	74	74
Anaerobic water	0.50	25	25	25	25	25	23	23	23	23	23	23
Aerobic sludge	0.10	45	40	35	30	20	15	15	15	15	15	15
Anaerobic sludge	0.50	55	60	65	70	80	85	85	85	85	85	85

The method of quantification is described as a Tier 1 approach and it is followed it in this subcategory without any modification. The amount of methane emitted from 5.D.1 is given by the equation:

$$\text{Total Gg } CH_4 \text{ p.a.} = \text{Gg } CH_4 \, (tos) + \text{Gg } CH_4 \, (wwt) + \text{Gg } CH_4 \, (sld) - R$$

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. 7-12 and share of individual technology types [%], 1990-2013), multiplied by an emission factor.

[11] *Amount of organic pollution, associated with this technology is the average pollution per capita multiplied by the number of people not connected to sewers (Tab. 7-11)*

Particular MCFs are calculated as the 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 2013 are presented in Tab. 7-13.

Tab. 7-13 Emissions of CH_4 and N_2O [Gg] from 5.D.1 and 5.D.2, 1990-2013, Czech Republic

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2009	2011	2012	2013
CH_4 production	22.3	23.9	24.9	25.1	27.0	27.0	27.3	27.5	27.7	28.3	28.5	28.5	28.5
Oxidized CH_4	7.4	9.7	11.1	11.4	14.8	14.8	15.1	15.3	15.5	15.9	16.1	16.1	16.2
Total CH_4 emissions	14.9	14.3	13.9	13.8	12.3	12.3	12.2	12.2	12.2	12.4	12.3	12.3	12.3

The 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, and correction for co-discharge from industry (Tab. 7-14).

Tab. 7-14 Indirect N_2O [Gg] from 5.D.1 and 5.D.2, 1990-2013, Czech Republic

	Proteins g/capita/day	Population (number)	F_{NPR} kg N/kg protein	F non-con	F ind-com	N effluent kg N/yr	EF kg N2O/kg N	Emissions Gg N_2O
1990	105.77	10363000	0.16	1.25	1.25	100018624	0.005	0.786
1991	92.98	10309000	0.16	1.25	1.25	87465937.33	0.005	0.687
1992	87.37	10318000	0.16	1.25	1.25	82260383.98	0.005	0.646
1993	92.86	10330600	0.16	1.25	1.25	87536080.84	0.005	0.688
1994	88.4	10336200	0.16	1.25	1.25	83376957.3	0.005	0.655
1995	93.15	10330800	0.16	1.25	1.25	87811154.33	0.005	0.690
1996	95.61	10315400	0.16	1.25	1.25	89995804.7	0.005	0.707
1997	93.26	10303600	0.16	1.25	1.25	87683378.41	0.005	0.689
1998	96.83	10294900	0.16	1.25	1.25	90963033.99	0.005	0.715
1999	91.29	10282800	0.16	1.25	1.25	85657909.1	0.005	0.673
2000	90.1	10272500	0.16	1.25	1.25	84456642.81	0.005	0.664
2001	92.68	10203269	0.16	1.25	1.25	86289556.1	0.005	0.678
2002	92.9	10201000	0.16	1.25	1.25	86475152.13	0.005	0.679
2003	92.92	10201651	0.16	1.25	1.25	86499288.75	0.005	0.680
2004	95.94	10206923	0.16	1.25	1.25	89356762.58	0.005	0.702
2005	99.23	10234000	0.16	1.25	1.25	92666183.58	0.005	0.728
2006	95.13	10267000	0.16	1.25	1.25	89123848.54	0.005	0.700
2007	94.95	10322689	0.16	1.25	1.25	89437713	0.005	0.703
2008	93.67	10467542	0.16	1.25	1.25	89470137.65	0.005	0.703
2009	92.36	10492000	0.16	1.25	1.25	88425002.2	0.005	0.695
2010	92.49	10517247	0.16	1.25	1.25	88762540.97	0.005	0.697
2011	90.72	10496672	0.16	1.25	1.25	86893550.15	0.005	0.683
2012	90.72[12]	10509286	0.16	1.25	1.25	86997971.37	0.005	0.684
2013	90.72	10510719	0.16	1.25	1.25	87009834.03	0.005	0.684

The factors (Fnpr, Fnon-con,Find-com and EF), used in the estimations are default factors. Activity data about population are from the Czech Statistical Office and the amount of protein, consumed in the Czech Republic is derived from the nutrition statistics of FAO (Faostat, 2015).

[12] *Latest available data is used*

7.5.1.3 Uncertainties and time-series consistency

The uncertainty of this category is high as the data about organic pollution are based on population only and science behind formation of N_2O is also not robust and varies significantly. See chapter 7.2.3.

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external CzSO data, they cannot affect the variation in the time series of activity data during processing.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2013.

7.5.1.4 Source-specific QA/QC and verification

During the year 2015 QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.5.1.5 Source-specific recalculations, including changes made in response to the review process

Recalculation of N_2O emissions was performed, due to the implementation of IPCC 2006. (new factors are added in IPCC, 2006).

7.5.1.6 Source-specific planned improvements, including those in response to the review process

Planned improvements include to fully harmonise and streamline wastewater treatment sector to be in line with the IPCC 2006 methodology and further to reflect newest available data, concerning methane generation from WWT plants.

7.5.2 Industrial Wastewater (CRF 5.D.2)

7.5.2.1 Source category description

This source category deals with emissions from treatment of industrial wastewater. Most of the industries in the country have their own wastewater treatment, however significant amount of industries are part of municipal sewage systems. This does not create problem as both categories 5.D.1 and 5.D.2 are based on production statistics not on collection systems.

7.5.2.2 Methodological issues

The main activity data for estimation of methane emissions from this subcategory is determination of the amount of degradable pollution in industrial wastewater. In this submission, specific production of pollution (the amount of pollution per production unit - kg COD/kg product) was used. Further it was multiplied by the production, or the value obtained from the overall amounts of industrial wastewater and from a qualified estimate of their concentrations (in kg COD/m^3). The procedure used is based on the Revised 1997 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000). The necessary activity data were taken from the the annual report of CzSO (Statistical Yearbook) and the other parameters required for the calculation were obtained from the Good Practice Guidance (IPCC, 2000). On the basis of the information on the total amount of industrial wastewater, which is equal to 149 mil.m^3 (actually only 148 mil.m^3 were treated), the inventory team was able to correct the overestimation of possible wastewater generation of industry (45 mil.m^3), which was assigned an average concentration of 3 kg COD/m^3. In previous years this factor was positive; in 2008, for the first time, this correction factor started to be negative. In addition, in accordance with the Revised 1997 Guidelines (IPCC, 1997), it was estimated that the amount of sludge equaled to 10% of the total pollution in industrial water (25% was assumed in the Meat and Poultry, Paper and Pulp and in Vegetables, Fruits and Juices category). These estimates are based on Dohanyos and Zábranská (2000); Zábranská (2004), see Tab. 7-15.

Tab. 7-15 Estimation of COD generated by individual sub-categories 2013

	Production [kt/year]	COD/m^3 [kg /m^3]	Waste-water/t [m^3/t]	Share of sludge [%]	COD of sludge [t]	COD of waste-water [t]
Alcohol Refining	21	11.0	24.00	0.10	562	5 062
Dairy Products	1 229	2.7	7.00	0.10	2 323	20 911
Malt & Beer	3 281	2.9	6.30	0.10	5 994	53 950
Meat & Poultry	347	4.1	13.00	0.25	4 625	13 875
Organic Chemicals	153	3.0	67.00	0.10	3 075	27 678
Pet. ref./Petrochemicals[13]	0	1.0	0.60	0.10	0	0
Plastics and Resins	552	3.7	0.60	0.10	123	1 104
Pulp & Paper	825	9.0	162.00	0.25	300 579	901 738
Soap and Detergents	29	0.9	3.00	0.10	7	67
Starch production	81	10.0	9.00	0.10	733	6 598
Sugar Refining	570	3.2	9.00	0.10	1 642	14 774
Textiles(natural)	34	0.9	172.00	0.10	531	4 778
Vegetable Oils	123	0.9	3.10	0.10	32	292
Vegetables, Fruits & Juices	111	5.0	20.00	0.25	2 776	8 327
Wine & Vinegar	60	1.5	23.00	0.10	208	1 873
Unidentified waste-water	-45 312	3.0	1.00	0.10	-13 594	-122 342
Total					309 618	938 685

Tab. 7-16 Parameters for CH_4 emissions calculation from industrial wastewater 1990-2013

	MCF	1990	1993	1996	1999	2002	2005	2009	2010	2011	2013
Non-treated	0.05	29%	18%	13%	5%	7%	3%	2%	1%	1%	1%
Aerobic treatment of water	0.06	67%	73%	70%	70%	65%	68%	69%	70%	69%	69%
Anaerobic treatment of water	0.70	4%	8%	17%	25%	28%	29%	30%	29%	30%	30%
Aerobic treatment of sludge	0.10	40%	40%	40%	40%	30%	27%	27%	27%	27%	27%
Anaerobic treatment of sludge	0.30	60%	60%	60%	60%	70%	73%	73%	73%	73%	73%

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

[13] *Due to changes in the statistical data, we are no longer able to identify Pet. ref./Petrochemicals*

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, due to the energy advantages of this means of treating wastewater. Tab. 7-16 describes this trend. The conversion factor for anaerobic and aerobic treatment are 0.06 and 0.7 respectively.

In contrast to the quite stable ratio for wastewater treatment technologies, ratio used for sludge keeps shifting in favor of anaerobic treatment. This is mostly due to 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 5.D.1, it is assumed that all the methane from anaerobic processes is burned (mostly usefully in cogeneration units, as flaring is being phased out and cogeneration technology seems to be economically effective); however, in contrast to municipal water, methane from anaerobic sludge and wastewater is included. This assumption is based on national standards and regulations (Zábranská, 2004). For calculation of methane emissions, it is sufficient to consider only aerobic processes (where the methane is not oxidized to biogenic 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.

Total production of methane emissions from 5.D.2 are presented in Tab. 7-17.

Tab. 7-17 Emissions of CH_4 (Gg) from 5.D.2, 1990-2013, Czech Republic

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CH_4 production	49.8	63.5	66.4	77.4	75.4	77.4	76.9	80.6	80.9	78.0	76.0	79.8	79.3	77.8	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	64.2	67.5	67.0	65.9	66.0
Total CH_4 emissions	24.5	13.3	10.9	12.9	12.3	12.2	12.1	12.7	12.3	12.1	11.8	12.3	12.2	11.9	12.0

7.5.2.3 Uncertainties and time-series consistency

This particular category is methodologically consistent and is quantified each year, using the same method. The data sources for methane activity data are the same and therefore an assumption for the consistency of the activity data was made. Very few country-specific factors are used (mainly the fraction of each treatment technology in the country) and most of the activity data are based on the statistics of the Central Statistical Office.

The uncertainty in most of the factors (default IPCC values) is determined according to the Good Practice Guidelines (IPCC, 2000). The overall uncertainty of the source category is not fully quantified yet and it is anticipated that a software tool will be implemented for this purpose in the following years.

However after the ERT review of the Waste sector, new uncertainty ranges were suggested and developed. They all can be found in uncertainty chapter 7.2.3.

7.5.2.4 Source-specific QA/QC and verification

During the year 2015 QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it.

7.5.2.5 Source-specific recalculations, including changes made in response to the review process

No recalculations were performed in this category.

7.5.2.6 Source-specific planned improvements, including those in response to the review process

A review of the industry wastewater source category is planned. The reason is that due to extensive use of biogas, the Ministry of Industry and Trade started to gather data about water treatment and gas production. In the light of this data, a review of this category and recalculation of it, according to the new findings will be performed in future submissions.

7.6 Other (CRF 5.E)

This category is not relevant for the Czech Republic.

7.7 Long-term storage of carbon (CRF 5.F)

The long-term stored carbon in SWDS is reported as an information item in the Waste sector. Fossil and non-degradable biogenic carbon disposed in to SWDS remains stored underground and does not contribute to anthropogenic climate change. The amount of carbon stored in the SWDS is estimated by using the FOD model described in chapter 7.2 using same data described there. Results are shown in following Tab. 7-18.

Tab. 7-18 Long-term storage of carbon for the period 1990 till 2013

	Long-term stored carbon (Gg)	Accumulated Long-term stored carbon (since 1950) Gg
1990	209	4 243
1991	210	4 453
1992	218	4 672
1993	224	4 895
1994	225	5 120
1995	230	5 351
1996	240	5 591
1997	249	5 839
1998	259	6 098
1999	247	6 345
2000	268	6 613
2001	276	6 889
2002	283	7 172
2003	285	7 457
2004	288	7 745
2005	293	8 038
2006	302	8 340
2007	321	8 660

	Long-term stored carbon (Gg)	Accumulated Long-term stored carbon (since 1950) Gg
2008	322	8 983
2009	330	9 313
2010	309	9 621
2011	289	9 910
2012	270	10 180
2013	237	10 417

8 Other (CRF sector 6)

No sector 6 is defined in the Czech inventory.

9 Indirect CO_2 and nitrous oxide emissions

9.1 Description of sources of indirect emissions in GHG inventory

The processing of emission data is organized by CHMI in cooperation with the Czech Environmental Information Agency (CENIA). Further, emission balances are processed also with the contribution of the experts from Czech Statistical Office, Transport Research Centre, p.r.i. and Research Institute of Agricultural Engineering.

A detailed description of the methodology used to estimate these emissions should be available in *Czech Informative Report (IIR), Submission under UNECE/CLRTAP Convention*. Indirect greenhouse gases totals correspond under both submissions, the differences between reporting formats (NFR-CRF) are taken into account.

Tab. 9-1 present a summary of emissions estimates for indirect GHG and SO_x for the period from 1990 to 2013 and the National Emission Ceiling (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 2013 (NMVOC by 50.32%, CO by 42.61% and NO_x by 69.92%). SO_x (reported as SO_2) emissions decreased by 92.62% compared to 1990 level.

Tab. 9-1 summary of emissions estimates for indirect GHG and SOx for the period from 1990 to 2013 and the National Emission Ceiling

	NO_X	CO	NMVOC	SO_X (as SO_2)
1990	738.50	1067.88	300.70	1870.91
1991	723.46	1152.49	263.24	1767.49
1992	699.42	1157.76	248.04	1554.42
1993	684.05	1189.26	224.28	1466.04
1994	441.27	1070.24	247.01	1284.80
1995	418.83	926.88	207.24	1090.23
1996	437.63	959.56	257.10	931.11
1997	461.63	975.41	263.80	977.45
1998	408.19	801.39	258.61	438.27
1999	375.12	720.24	239.94	264.35
2000	383.51	677.59	237.01	257.26
2001	330.75	686.17	219.52	250.20
2002	316.90	586.21	202.33	233.47
2003	323.29	629.79	202.62	229.51
2004	332.51	622.40	197.70	225.97
2005	278.42	553.13	181.38	217.60
2006	281.25	539.18	176.71	209.61
2007	283.24	577.95	173.47	213.57
2008	261.70	495.70	164.78	173.74
2009	251.62	452.16	149.34	172.91
2010	237.83	452.41	148.50	168.92
2011	224.68	404.49	138.07	167.95
2012	209.58	366.16	126.90	156.75
2013	222.16	612.82	149.38	138.04
Trend [%]	-69.92	-42.61	-50.32	-92.62
NEC[14]	286	-	220	265

On Fig. 9-1 can be observed the overall decreasing trend, in percentage of indirect GHG emissions, where year 1990 is equal to 100%. Overall trend in percentual share of total indirect GHG can be examined on Fig. 9-2.

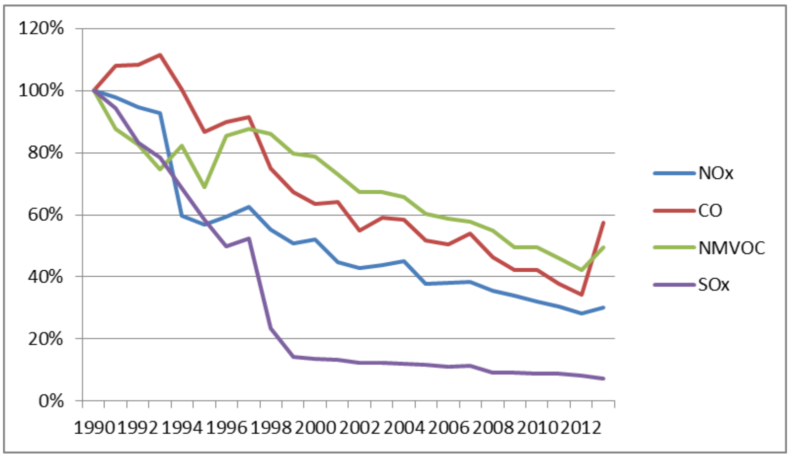


Fig. 9-1 Indexed emissions of indirect GHG for 1990-2013 (1990 = 100%), [%]

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

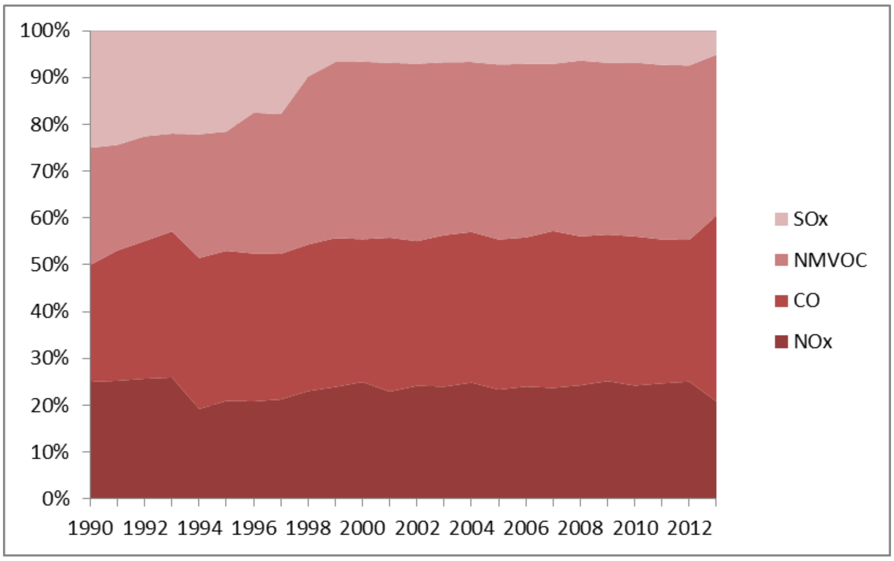


Fig. 9-2 Overall trend in percentual share of indirect GHG

The categories with highest amounts of indirect GHG for NO_X are 1.A.1 Energy Industries, 1.A.3 Transport and 1.A.4 Other sectors; for CO are 1.A.2 Manufacturing industries and construction, 1.A.3 Transport, 1.A.4 Other sectors; for NMVOC are 1.A.3 Transport, 1.A.4 Other sectors and 2.D Non-energy products from fuels and solvent use; for SO_X are 1.A.1 Energy industries, 1.A.2 Manufacturing industries and construction and 1.A.4 Other sectors. Total production from the main CRF categories can be seen on Tab. 9-2.

Tab. 9-2 Total production from the main CRF categories

	NO_X [Gg]	CO [Gg]	NMVOC [Gg]	SO_X [Gg]
Total emissions	**222.16**	**612.82**	**149.38**	**138.04**
1. Energy	218.61	562.05	72.80	136.23
1.A Fuel combustion	218.28	561.80	70.68	132.82
1.A.1 Energy Industries	63.51	9.75	5.05	89.48
1.A.2 Manufacturing industries and construction	23.01	107.95	1.82	19.38
1.A.3 Transport	80.11	141.04	31.54	0.24
1.A.4 Other sectors	50.88	302.82	32.19	23.72
1.A.5 Other	0.77	0.24	0.07	0.00
1.B Fugitive emissions from fuels	0.33	0.25	2.12	3.41
2. Industrial processes and product use	2.77	28.08	74.85	1.80
2.A Mineral industry	0.24	0.09	0.08	0.07
2.B Chemical industry	1.27	0.11	1.46	1.13
2.C Metal industry	1.20	27.84	0.28	0.58
2.D Non-energy products from fuels and solvent use	0.00	0.00	72.74	0.00
2.G Other product manufacture and use	0.06	0.04	0.29	0.01
3. Agriculture	-	-	-	-
4. LULUCF	0.64	22.67	-	-
5.Waste	0.14	0.02	1.73	0.01

9.1.1 Nitrogen oxides emissions

Emissions of NO_X are formed during the combustion of fuels, depending on the temperature of combustion, the content of nitrogen in fuels and the excess of combustion air. NO_X emissions decreased from 739 to 222 Gg during the period from 1990 to 2013. In 2013, NO_X emissions were 69.92% below the 1990 level. Slightly more than 98% of total NO_X emissions originate from 1 Energy, mainly subsectors 1.A.1 Energy industries (28.6%), with subsector 1.A.1.a Public electricity and heat production (26.9%); 1.A.3 Transport (36.1%), highest part, represented by 1.A.3.b Road transportation (34.5%) and 1.A.4 Other sectors (22.9%), mainly from 1.A.4.c Agriculture/Forestry/Fishing (16.7%) (Fig. 9-3).

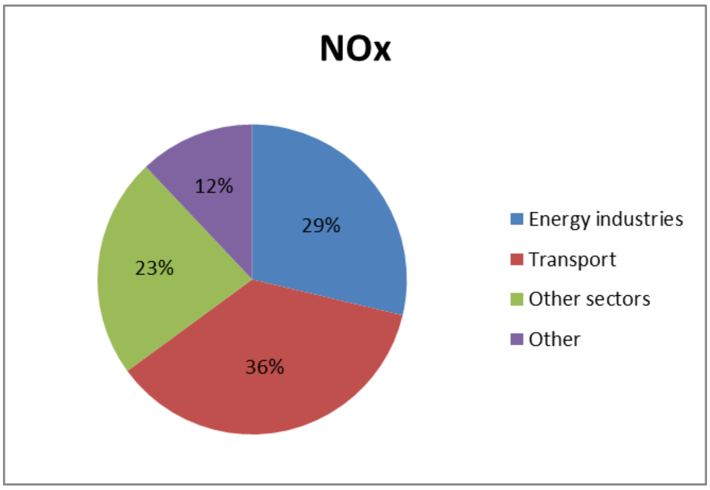


Fig. 9-3 The share of sectors on NOx emissions in 2013

The downward trend of NO_X emissions in the period 2007–2013 is primarily attributed to the natural renewal of the car fleet and to the implementation of emission ceilings for NO_X emissions from the sources in the sector 1.A.1.a Public electricity and heat production. NO_X emissions can be found mainly along the highways, in big cities and in the Ústí nad Labem region, the Central Bohemia region and the Moravia-Silesia region in which significant energy producers are located.

9.1.2 Carbon monoxide emissions

Emissions of CO are produced during the combustion of carbon-containing fuels at low temperatures and by insufficient amount of combustion air. CO emissions decreased from 1,068 to 613 Gg during the period from 1990 to 2013. In 2013 CO emissions were 42.61% below the 1990 level. In 2013, approximately 92% of total CO emissions originated from 1 Energy, subsectors 1.A.2 Manufacturing industries and construction (17.6%); 1.A.3 Transport (23.0%), mostly resulting from 1.A.3.b Road transportation (22.7%) and 1.A.4 Other sectors (49.4%), mainly from 1.A.4.b Stationary: Residential stationary combustion (46.1%) (Fig. 9-4). Further subsector 2.C Metal industry contributes with 4.5% to the total emissions.

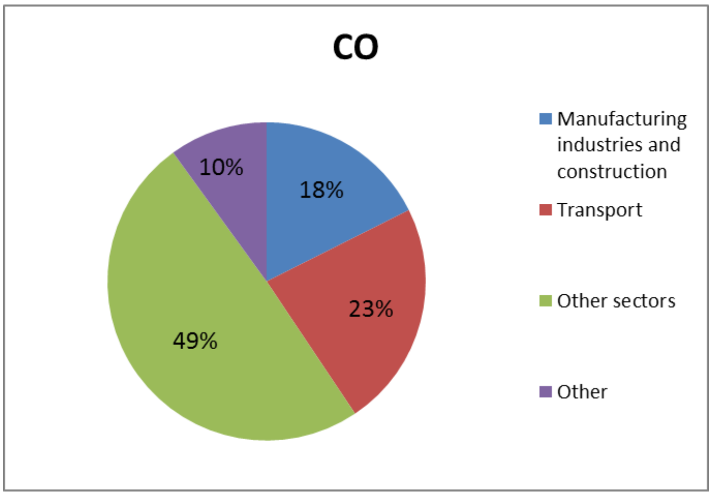


Fig. 9-4 The share of sectors on CO emissions in 2013

The downward trend of CO emissions during the years 2007–2013 was caused primarily by the natural renewal of the car fleet and by the decrease of iron and steel production after the year 2007. Due to the prevailing share of the local household heating sector carbon monoxide emissions are distributed across the entire territory in highly populated areas. The transport shows high impact along highways and in big cities. The greatest CO emissions are produced, due to the presence of iron and steel industry, in the Moravia-Silesia region.

9.1.3 Non-methane volatile organic compounds emissions

NMVOC emissions decreased from 301 to 149 Gg during the period from 1990 to 2013. In 2013, NMVOC emissions were 50.32% below the 1990 level. There are two main emission source categories, first is 2 Industrial processes and product use (50.1% of the national total, with a main subsector 2.D Non-energy products from fuels and solvent use, representing 48.7%) and second is 1 Energy (48.7% - mainly subsectors 1.A.3 Transport (21.1%) and 1.A.4 Other sectors (21.6%) (Fig. 9-5). The release of NMVOC emissions is partly regulated, but most of these pollutants are released in the form of fugitive emissions and their reduction is difficult. NMVOC emissions are also produced by insufficient combustion of fossil fuels.

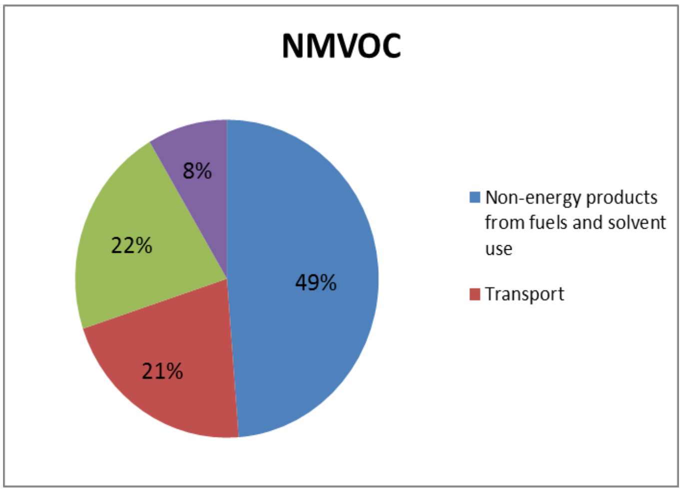


Fig. 9-5 The share of sectors on NMVOC emissions in 2013

During the period 2007–2013 the NMVOC emissions had a downward trend attributed to the usage of products with lower content of NMVOC, e.g. water-based paints or powder coating (all included in sector 2). Regarding the paints for retailers the legislative regulation sets maximum content of solvents in the products. Due to the constant renewal of the car fleet traffic emissions of NMVOC show a decreasing trend.

9.1.4 Sulphur dioxide emissions

Emissions of SO_x (reported as SO_2) were produced mainly during the combustion of sulphur-containing solid fossil fuels. SO_2 emissions decreased from 1,871 to 138 Gg during the period from 1990 to 2013. In 2013, SO_2 emissions were 92.62% below the 1990 level. In 2013, almost 99% of total SO_2 emissions originated from 1 Energy, subsectors 1.A.1 Energy industries (64.8%), with subsector 1.A.1.a Public electricity and heat production (62.2%); 1.A.2 Manufacturing industries and construction (14.0%) and 1.A.4 Other sectors (17.2%) (Fig. 9-6).

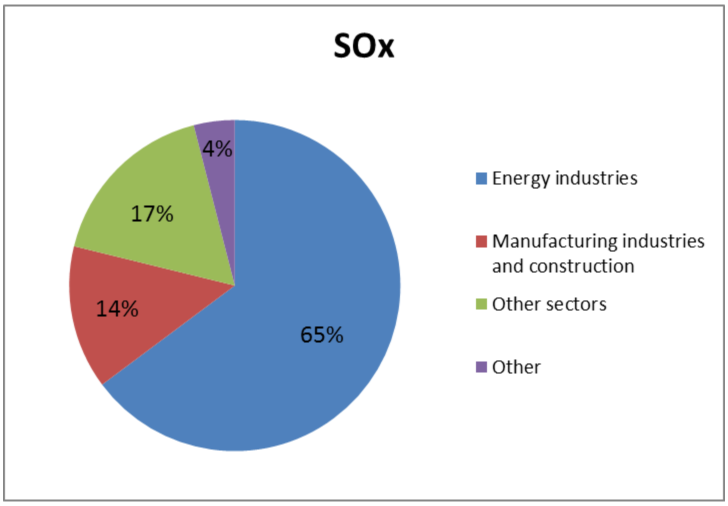


Fig. 9-6 The share of sectors on SO_X emissions in 2013

The trend of sulphur dioxide emissions is caused by meeting stricter emission limit values through the updated integrated permits or through the voluntary commitments accepted by major operators of stationary sources. The decrease of SO_2 emissions between the years 2007 and 2008 in the subsector 1.A.1.a Public electricity and heat production resulted from the implementation of the LCP emission ceilings obligation. Since 2008 the emissions of SO_2 have remained approximately at the same level. Due to the prevailing influence of the sector 1.A.1.a Public electricity and heat production SO_2 emissions show high values in the Ústí nad Labem region, Moravia-Silesia region and Central Bohemia region, where the largest producers of energy are placed.

9.2 Methodological issues

The above reported data is obtained from the *Czech Informative Report (IIR), Submission under UNECE/CLRTAP Convention.* The inventory is performed every year, in accordance with the national legislation for the prevention of air polluting and reduction of air pollution from 2012. The inventory combines the direct approach, i.e. the collection of data reported by the sources operators with the data from model calculations based on data, reported by the sources operators or gained within statistical surveys, carried out primarily by CzSO. The results of emission inventories are presented as emission balances processed according to various territorial and sector structures. Further, after obtaining the data, synchronization between the two reporting systems categorization (NFR-CRF) is conducted.

The Register of emissions and stationary sources (REZZO), used for archiving and presentation of data on stationary and mobile sources of air pollution is pursuant to the corresponding legislation (Section 7 of Air Protection Act) a part of the Air quality information system (ISKO) operated by CHMI. Air pollution sources are divided to the individually monitored sources and to sources monitored as area sources. Since 2013, in connection with the changes in categorization of sources pursuant to Annex 2 to the Air Protection Act, the REZZO sources are newly specified.

Individually monitored specified stationary REZZO 1 and REZZO 2 sources include stationary combustion plants for combustion of fuels with a total heat capacity of 0.3 MW and higher, waste incinerators and other sources (technological combustion processes, industrial production etc.). For REZZO 1 sources are emissions of CO, NO_X, NMVOC and SO_2 reported directly and for REZZO 2 sources these emissions are calculated from the reported data on fuel consumption and emission factors.

Unspecified stationary REZZO 3 sources comprise stationary combustion plants with a total nominal heat capacity lower than 0.3 MW and non-specified technological processes (domestic solvent use, building sector, agricultural activities, etc.). Emissions of CO, NO_X, NMVOC and SO_2 are calculated from activity data and emission factors. Activity data are obtained e.g. from the population and housing census, production and energy statistical surveys etc.

Mobile REZZO 4 sources include road, railway, water and air transport of persons and freight, tyre and brake wear, road abrasion and evaporation from fuel systems of vehicles, off-road vehicles and machines used for maintenance of green spaces in parks, in agriculture and in forests etc. Emissions are calculated using activity data and emission factors. Activity data are obtained e.g. from road traffic census, the register of vehicles etc.

The sources monitored individually are specified in Annex No. 2 to the Air Protection Act No. 201/2012 Coll. The operators of these sources are obliged, pursuant to Section 17 (3)(c), to describe the source and its operation, to provide information on inputs (e.g. fuel consumption, fuel properties) and outputs from the source (heat production, industrial production, etc.) and to report each year the data as the summary operational records (SPE) through the Integrated system of the fulfilment of notification obligations (ISPOP).

The data from ISPOP are then submitted to the REZZO 1 and REZZO 2 databases. Data are collected from January to the end of March for the previous year. The reported data are thus available already in early April, and in the following months the reported data are reviewed and processed and if necessary, the suppliers are asked to correct the erroneous data.

The air pollution sources, monitored collectively are registered in REZZO 3. They include emissions from local household heating, fugitive TSP emissions from building and agricultural activity, ammonia emissions from the breeding of farm animals and application of mineral nitrogenous fertilizers and NMVOC emissions from the use of organic solvents.

With the exception of emissions from household heating, the emissions from REZZO 3 sources are calculated using the data obtained from the national statistical monitoring (i.e. CzSO), and using the potential year-to-year changes calculated from the development of the respective indicators (e.g. NMVOC emissions).

Mobile sources, registered in REZZO 4 are monitored collectively, as well. Since 1996 the emission balance from mobile sources had been complied by Transport Research Centre (CDV), based on data on the sale of fuels submitted by Czech Association of Petroleum Industry and Trade (ČAPPO). Since 2000 the calculations are based on the data from Czech Statistical Office (CzSO) and own emission factors. Data on emissions from mobile sources in agriculture and forestry are processed by Research Institute of Agricultural Engineering (VÚZT).

Source category NFR 1.A.1.a Public electricity and heat production (CRF 1.A.1.a) is mainly responsible for the production of NO_X and SO_X emissions. According to the classification, here are included plants, with total thermal input equal to or greater than 50 MW. These sources are classified as Large Combustion Plants – LCP and are subjected to plan of reduction of emissions within the National Emission Reduction Program pursuant to Act 86/2002 Coll. Starting from year 2016 these plants are obliged also to meet the emission limits, set by European legislation, Annex V of the Industrial Emission Directive, which makes the previous limits stricter.

Sector NFR 1.A.2 Manufacturing industries and construction includes (CRF 1.A.2) e.g. metallurgy of ferrous and non-ferrous metals, chemical industry, pulp and paper industry etc. Some LCP are also included here. The methodology for this category is the same as for sector 1.A.1.a.

The methodology of estimation of air pollution emissions from 1.A.3 Transport in the Czech Republic is used for transport emission calculations on a national and regional level. The results are reported not only to UNFCCC, but also to other national and international bodies. The methodology was adopted by the Ministry of Transport, Ministry of Environment and Czech Hydrometeorological Institute in 2002 and was updated in 2006. The methodology includes only emissions from transport and does not include emissions from electricity production used by electric vehicles. It also does not include emissions from the engines of off-road machines and vehicles used, for example, in agriculture, the building industry, the army or households. The methodology includes CO, NO_X, NMVOC and SO_2 emissions.

The underlying principles of the methodology are categorization of vehicles, measured emission factors, distribution of fuel consumption between individual transport modes and - annual mileages in selected vehicle categories.

The methodology is based on the classification of vehicles in 23 categories using the following criteria: transport mode, fuel type, weight of vehicles (in road freight traffic) and equipment with effective catalytic converter systems (cars). Every category has associated emission factors for CO_2, CO, NO_X, N_2O, CH_4, NMVOC, SO_2, Pb and PM, based on the available measurements. Emission factors are expressed in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

Two parallel approaches are used for classification of fuel consumption. The first one is "top - down", i.e. allocating total fuel consumption according to transport performances and numbers of vehicles, and the second one is "bottom - up", i.e. from annual mileages and average consumption in 100 km^{-1}. This consumption is classified in 5 categories (motorcycles, gasoline passenger cars with or without catalytic converter systems, diesel light duty vehicles, diesel heavy duty vehicles), taken from the 23 categories mentioned above, which exhibit the largest differences in annual mileages ($km.year^{-1}$).

Mileages are reported in a manner such that the sum of the fuel consumptions in the first three categories (motorcycles, gasoline passenger cars with or without catalytic convert systems) calculated using the "bottom - up" method is identical with the fuel consumption in the individual transport categories calculated using the "top - down" method. A similar approach is employed for road freight transport. The relationship of the mileages employed must be in line with the relationships of the above mentioned categories in real situations. These are derived from the transport census. This is based on the total fuel consumption in the appropriate transport modes. Transport performances are used to derive the relative fuel consumption for the individual transport modes.

The categorization of vehicles enables separate calculation of the N_2O production from the total amount of NO_X. VOC are divided into CH_4 (which contributes to the greenhouse effect) and NMVOC. Every category has associated emission factors according to the available measurements in the Czech Republic and the recommended values from international statistics (IPCC, EMEP/EEA air pollutant emission inventory guidebook). Emission factors are given in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

The emissions from local household heating (NFR 1.A.4.b.i Residential stationary combustion- in CRF 1.A.4.b) depend primarily on the character of the heating season, which is expressed in the emission model by the number of degree days and on the changes in the composition of combustion plants.

The NFR sector 1.A.4.b.i includes emissions from small combustion sources with nominal thermal input smaller than 300 kW which are used for domestic heating. The term “domestic” covers only permanent occupied apartments. The method of estimating emissions from domestic heating (Tier 2) is based on the calculation of the average annual heat consumption for a particular type of fuel for the average apartment. The information about the structure of apartments is taken from the census of people, houses and apartments and from the annual update of the new apartments. Calculation of average annual heat consumption is based on the day-degrees method and detailed analysis of climatological data. For more accurate estimates the documentation from the suppliers of fuel and energy or the assessment of average quality parameters of solid fuels are used. The calculation is performed at the level of individual municipalities.

The total national emission of NMVOC from NFR 2.D.3 Non-energy products from fuels and solvent use sources (CRF 2.D.3) is calculated from the data of the CzSO on production, import and export of products with solvent content using the set of country specific emission factors (Decree 415/2012 Coll). For many subsectors the methodology from The EMEP/EEA air pollutant emission inventory guidebook, 2013 (Tier 2) is used.

The subsector NFR 2.D.3.d Coating applications (presented in CRF sector 2.D.3 as a sum) includes car production a repair, constructions and buildings, painting in households, coil coating, shipbuilding, wood coating, other industrial applications and other non-industrial applications. Emissions from car production are calculated according to the number of car produced (CzSO), their average surface and emission factors (Decree 415/2012 Coll). For car repairs the police statistics on accidents and average surface for reparation is used. Emission from households depends on number of households (CzSO), average painting consumption per household (internal research of SVUOM, s.r.o) and NMVOC content. For coil coating the methodology and emission factors from the inventory guidebook are used.

Emissions from subsector Degreasing (NFR 2.D.3.e - in CRF sector 2.D.3) are calculated according to the reported data from REZZO and also using the data from CzSO. Dry cleaning emissions (NFR 2.D.3.f – in CRF 2.D.3) are estimated according the activity data from REZZO using the inventory guidebook methodology (Tier 3). Emissions from Chemical products (NFR 2.D.3.g- in CRF 2.D.3) depend on production data (CzSO) and emission factors (Decree 415/2012 Coll). Tier 2 or 3 methodology of the inventory guidebook is used. For Printing (NFR 2.D.3.h- CRF 2.D.3) REZZO data on emissions are used. In subsector Domestic solvent use including fungicides (NFR 2.D.3.a-in CRF 2.D.3) activity data from CzSO and country specific emission factors are used in emission estimations.

9.3 Uncertainties and time-series consistency

In the process of calculation of emission inventories, data provided by the operators of stationary sources of air pollution, statistic data of the Czech Statistical Office (data on fuel consumption, number of vehicles, number of livestock and area of cultivated land) and data from the Population and housing census which was conducted in 2011 (information on household heating) are used. Further, emission factors and other sources of data are applied.

The data, from which the inventory has been compiled, are of varying quality. Emissions of individual point sources set on the basis of measurements are determined with less uncertainty than the emissions calculated on the basis of statistical data. The uncertainty of the emissions from point sources is below 5% (e.g. emissions from large combustion sources), the uncertainty of emission data based on a sophisticated model (e.g. emissions from household heating and exhaust emissions from transport) ranges between 10–15%. The uncertainty of emissions calculated from statistical data and predefined emission factors is estimated according to the methodology of the EMEP/EEA air pollutant emission inventory guidebook and ranged from 50 up to 200% (e.g. emissions from the use of solvents, animal production and non-combustion emissions from transport).

To ensure the time-series consistency the recalculations of data were conducted for whole time-series (e.g. local household heating emissions, emissions from mobile sources).

9.4 Source-specific QA/QC and verification

Category-specific QA/QC and verification is under preparation. Currently, operators of the individually monitored sources (specified in Annex No. 2 of the Air Protection Act. No. 201/2012 Col.) are obliged to keep operational records information regarding stationary sources (description of a source and of its operation, information on inputs and outputs from a source). Data are reported each year as the summary operational records (SPE) through the Integrated system of the fulfilment of notification obligations (ISPOP).

The data from ISPOP are then submitted to the REZZO 1 and REZZO 2 databases. The reported data are reviewed and controlled by the CHMI and, if necessary, the suppliers are asked to correct the erroneous data.

9.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Emissions in the sector of 1.A.4.b Residential stationary combustion were recalculated for the period 1990–2013 according to the new emission factors. Emission factors are based on the results of measurements carried out by VEC VŠB (Research energy centre of Technical University Ostrava) in compliance with EIG 2013 recommendation (EMEP/CORINAIR Emissions Inventory Guidebook) and the respective structure of combustion devices used in households in the CR.

These changes resulted mainly in the increase of VOC and CO emissions. A new knowledge about the structure of the car fleet resulted also in the recalculation of emissions from mobile sources for the period 2000–2012.

However, these changes have no impact on emission trend.

Further, total recalculation of the data was conducted, due to the implementation of the IPCC 2006 methodology and the changes of categorization of sources in the IIR. This recalculation resulted in small decrease of all indirect emissions. For NO_X the difference varies in the years between -0.26% and -4.08%; for CO variation is between -0.01% to -1.33%; the decrease for NMVOC varies between -0.17% and -3.77%; for SO_2 – between -0.19% and -2.72% (Tab. 9-3).

Tab. 9-3 Percentual difference between reported data in 2014 and 2015 submissions (with respect to 2014), due to the implementation of IPCC 2006 methodology

	NO_X [Gg]		%	CO [Gg]		%	NMVOC [Gg]		%	SO_X [Gg]		%
	2012	2013		2012	2013		2012	2013		2012	2013	
1990	742.34	738.50	-0.52	1070.29	1067.88	-0.22	311.27	300.70	-3.40	1875.52	1870.91	-0.25
1991	732.19	723.46	-1.19	1156.46	1152.49	-0.34	272.97	263.24	-3.57	1772.20	1767.49	-0.27
1992	708.23	699.42	-1.24	1161.72	1157.76	-0.34	257.47	248.04	-3.66	1559.14	1554.42	-0.30
1993	690.75	684.05	-0.97	1193.20	1189.26	-0.33	233.04	224.28	-3.76	1468.85	1466.04	-0.19
1994	450.84	441.27	-2.12	1074.41	1070.24	-0.39	255.31	247.01	-3.25	1290.19	1284.80	-0.42
1995	430.19	418.83	-2.64	932.20	926.88	-0.57	215.35	207.24	-3.77	1095.32	1090.23	-0.46
1996	446.69	437.63	-2.03	964.88	959.56	-0.55	265.16	257.10	-3.04	934.45	931.11	-0.36
1997	470.69	461.63	-1.93	980.75	975.41	-0.54	271.86	263.80	-2.96	980.79	977.45	-0.34
1998	414.14	408.19	-1.44	812.22	801.39	-1.33	267.15	258.61	-3.20	442.22	438.27	-0.89
1999	391.09	375.12	-4.08	726.43	720.24	-0.85	247.17	239.94	-2.93	268.92	264.35	-1.70
2000	396.70	383.51	-3.32	680.03	677.59	-0.36	244.31	237.01	-2.99	264.45	257.26	-2.72
2001	332.83	330.75	-0.62	687.10	686.17	-0.13	219.88	219.52	-0.17	250.89	250.20	-0.27
2002	319.40	316.90	-0.78	587.53	586.21	-0.23	202.86	202.33	-0.26	237.39	233.47	-1.65
2003	325.70	323.29	-0.74	630.40	629.79	-0.10	203.26	202.62	-0.31	232.13	229.51	-1.13
2004	333.56	332.51	-0.32	622.56	622.40	-0.03	198.46	197.70	-0.38	227.22	225.97	-0.55
2005	279.13	278.42	-0.26	556.14	553.13	-0.54	181.70	181.38	-0.17	218.63	217.60	-0.47
2006	283.78	281.25	-0.89	539.89	539.18	-0.13	178.60	176.71	-1.06	211.23	209.61	-0.77
2007	285.86	283.24	-0.92	581.52	577.95	-0.61	173.97	173.47	-0.29	216.96	213.57	-1.56
2008	262.75	261.70	-0.40	496.20	495.70	-0.10	165.66	164.78	-0.53	174.34	173.74	-0.34
2009	252.72	251.62	-0.44	452.23	452.16	-0.01	151.06	149.34	-1.14	173.47	172.91	-0.32
2010	240.03	237.83	-0.91	453.61	452.41	-0.26	150.89	148.50	-1.58	170.32	168.92	-0.82
2011	226.09	224.68	-0.62	404.64	404.49	-0.04	139.79	138.07	-1.23	169.01	167.95	-0.63
2012	210.77	209.58	-0.57	366.31	366.16	-0.04	128.56	126.90	-1.29	157.91	156.75	-0.73
2013		222.16			612.82			149.38			138.04	

However, these changes have no impact on emission trend. The average difference between the emission trends for NO_x between 2012 and 2013 submissions in index form, where 1990 = 100%, equals to 0.46% for the whole time period; for CO = 0.12%; for NMVOC = 0.91% and for SO_x = 0.08%.

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 2006 Guidelines (IPCC, 2006) 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.

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.

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 fulfil 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 Explanations and justifications for recalculations, including in response to the review process

10.1.1 Recalculations performed in the submission 2011

10.1.1.1 Recalculation in sector 1 Energy

Recalculation of Road Transportation (1.A.3.b)

Recalculation of emissions from road transport was performed for all the greenhouse gases (CO_2, CH_4, N_2O) and for the 1990 - 1999 interval. For the sake of consistency of the time series, the recalculation was carried out according to the methodology used for the following years. Recalculation was based on obtaining new data on the vehicle fleet composition and emission characteristics. In addition, notation symbols “NE” for N_2O emissions from biomass, CNG and LPG from 1.A.3.b (Road Transport) were substituted by emission estimates of N_2O using relevant default EFs taken from the 2006 Guidelines (IPCC, 2006).

Recalculation in sector 1B Fugitive Emissions from Fuels (1.B.2.a)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 1.B.2.a-ii (oil production). In this subcategory, the Czech Republic reported only CH_4 emissions from oil production, while CO_2 emissions and emissions of CO_2, CH_4 and N_2O from venting and flaring were not reported. Therefore, the Czech Republic prepared the resubmission of CRF (within 6 weeks) in order to respect this ERT finding. In this resubmission, the reporting of emissions from oil production was extended beginning in 1990 by incorporating CO_2 emissions from oil production and emissions of CO_2, CH_4 and N_2O from venting and flaring during oil production. Default EFs from the IPCC Good Practice Guidance (table 2.16, pages 2.86-2.87) were used.

10.1.1.2 Recalculation in sector 2 Industrial Processes

Recalculation of Soda Ash Use (2.A.4)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 2.A.4 (soda ash use). ERT found that some amount of soda ash is used in the pulp and paper industry and it emits the corresponding amount of CO_2, which was not reported. Therefore, in its resubmission of CRF mentioned above, the Czech Republic supplemented this missing source of CO_2 starting in 2001 (the year of beginning of soda ash use). Activity data were taken from EU ETS and from consultations with the operator of the relevant plant. However, emissions of CO_2 from soda ash use in the pulp and paper industry are not very significant in the Czech Republic (less than 1 Gg CO_2).

Recalculation of Mineral Products - Other (2.A.7.2)

CO_2 and CH_4 emissions were recalculated in sector 2A7.2 (Mineral products – other: bricks and ceramics) as the Czech Statistical Office has provided new and updated information about brick production for 2006 – 2008. 2.A.7.2 Brick and ceramics is not a significant category for CO_2 emissions (approximately 150 Gg CO_2) and CH_4 emissions are even lower. The effect of recalculation of the CO_2 emissions is small and results in a decrease in emissions in 2006 – 2007 by approximately 1% CO_2 and an increase in 2008 by 8%.

Recalculation of Metal Production – Iron and Steel Production (2.C.1)

The recalculation in the period 2003 - 2008 was performed in the case of CO_2 emissions from 2C1 (Iron and steel production). The estimation of these emissions in the Czech Republic is based on the amount of coke consumed in blast furnaces. This amount (directly in TJ) was originally taken from the document provided by the Czech Statistical Office (CzSO) "Development of overall and specific consumption of fuels and energy in relation to product".

Now the other official document of CzSO "CzSO (2010): Energy Questionnaire - IEA/Eurostat (CZECH_COAL, CZECH_OIL, CZECH_GAS, CZECH_REN), Prague 2010" was used as a source of data on metallurgical coke consumed in blast furnaces. This approach, which is more consistent with that used for Energy sector since 2003, was recommended by experts from CzSO because of better accuracy and reliability of coke data. However, differences between both sources of data are not too significant: e.g. for 2003 the recalculated CO_2 emission is 1.2% lower than the original value, for 2008 the recalculated CO_2 emission is 3.8% lower than the original value and for 2009 the newly estimated CO_2 emission is 4.4% higher than would be the value obtained by the older approach.

10.1.1.3 Recalculation in sector 6 “Waste”

Recalculation of Solid Waste Disposal on Land – Managed Waste Disposal in Land (6.A.1) and Waste incineration - Other (6.C.2)

Based on a suggestion of the Expert Review Team (ERT) in the recent “In-country review” (October 2009, Prague), we recalculated whole time series (since 1990) in 6.C (Waste incineration) using a consistent approach and consistent data source for the whole series. Besides, due to rollback changes in the recovered LFG activity data, the two last years were recalculated (2007, 2008) in 6.A.1 category (Managed landfills).

10.1.2 Recalculation performed in the submission 2012

10.1.2.1 Recalculation in sector 1 Energy

Recalculation of 1.A Energy - stationary combustion

Expert review team (ERT) during In country review in August/September 2011 raised recommendation to prolong data series in subcategories 1.A.2.a – 1.A.2.f towards 1990. It was possible to use data given in IEA/OECD, Eurostat, UN Questionnaires (CzSO Questionnaires) till 1995. Previous data in Questionnaires are not sufficiently reliable. The ensure consistency of data used, the recalculation was performed for all categories in whole 1.A except of 1.A.3 – mobile combustion (i.e. 1.A.1, 1.A.2, 1.A.4, 1.A.5, 1.A.D, 1.A.3.e). In 1.A.1, 1.A.4, 1.A.5, 1.A.D and 1.A.3.e was recalculation carried out using data from CzSO Questionnaires since 1995. In 1.A.2 were CzSO Questionnaires data also used since 1995; for 1990-1994 were made expert estimates of data division according to other indicators (e.g. development of relevant branch of industry).

The Reference approach needed to be recalculated as well. It was two reasons for this recalculation – new calorific values for liquid fuels and use of CzSO Questionnaires data since 1995.

Recalculation in sector 1.A Energy – Transport (mobile combustion)

Expert review team (ERT) during In country review in August/September 2011 raised recommendation (ARR 2011, para 69) to analyse the data series in subcategories 1.A.3.a and 1.C.1.a, in particular in the category Jet Kerosene. First, the fuel consumption of Jet Kerosene was divided into domestic and international fuel consumption on the basis of passenger transport and transport of goods in 1990 – 2009. New values of fuel consumption resulted in recalculation of emissions for both of these categories.

Data in other categories of sector 1.A.3 were also recalculated. It was necessary to refine and harmonize some activity data over the entire time series (1990 – 2010) in cooperation with KONEKO and possibly IEA (CzSO Questionnaire). First, the net calorific values of the individual fuels were changed. Most of these values are available from KONEKO. Second, some discrepancies were found in the data for fuel consumption in 1995 – 2010. CDV harmonized the data on fuel consumption with CzSO, which provided these data.

Recalculation in sector 1.B Fugitive Emissions from Fuels (1.B.1 Solid Fuels) - Recalculation of CH_4 emissions from underground mining activities

By FCCC/ARR/2008/CZE was recommended to update CH_4 emission factor for underground mining activities. The team raised a request to Ostrava-Karviná, Ltd. to obtain relevant data. The data were available for 2000 – 2008. According to these data was developed new EF for CH_4. The recalculation was therefore made for 2000 – 2008. For data 2008 onwards is used average EF value from 2000 - 2008 EFs. The range of CH_4 emission decrease due to this recalculation is 23 - 40%.

Recalculation in sector 1.B Fugitive Emissions from Fuels (1.B.1 Solid Fuels) - Recalculation of CO_2 emissions from underground mining activities

ERT during ICR 2011 and FCCC/ARR/2010/CZE raised recommendation to provide estimates for CO_2 emissions from underground and surface mining. We put main focus on CO_2 emissions from underground mining. A special study was performed for CO_2 emission factor. The emission factor was recalculated for 1990 – 2009 and for years onwards was also recommended specific value.

10.1.2.2 Recalculation in sector 2 Industrial Processes

Recalculation of Metal Production – Iron and Steel Production (2.C.1)

In the 2012 submission, the recalculation explained in chapter *10.1.2.2* was extended for the 1995 – 2002 period. With the exception of 1995 and 1998, the differences in CO_2 emissions calculated from the two sources are less the 2%. Similarly as for the 2011 submission, these recalculations also were harmonized with recalculations performed in the Energy sector.

10.1.2.3 Recalculation in sector 4 Agriculture

During the in-country review in August/September 2011, the expert review team (ERT) identified as a potential problem the estimation of N_2O emissions from Manure management for dairy cattle. The revision of background information and Nex values for dairy cattle was requested. Already during the review, the Czech Republic introduced revised country-specific data for emission estimation using Tier 2 methods for Manure management of dairy cattle. This recalculation was submitted to ERT as resolved issue of the “Saturday paper” regarding the 2011 NIR submission.

The assessment review report (UNFCCC/ARR/2011/CZE) provided additional recommendations to improve the inventory estimates for Agriculture. Later other country-specific data for non-dairy cattle was obtained. Based on these recommendations and additional country-specific data, the following improvements were implemented in the 2012 submission:

1) Reallocation of sub-category "Suckling cows" from Dairy cattle to Non-dairy cattle
3) More accurate animal population data (not rounded up to thousands) reported (cattle, swine, sheep, poultry).
4) More accurate data for cattle population reported (not rounded to thousands) for the period since 2006.
5) Recalculation of N_2O emissions from Manure management using revised and complemented country-specific data: Nex values for cattle, manure type distribution (AWMS), protein in milk and protein in feed.
6) Tier 2 methods implemented for the emission estimation of Manure management for non-dairy cattle

Additionally, a new country-specific parameter on digestibility (DE, in%) was determined and implemented in the 2012 submission.

The “Saturday paper” recalculation led to increased emissions by about 14% relative to the older approach. Using the new country-specific data for the 2012 submission resulted in emissions that were lower by 1.3% as compared to 2011 submission. More detailed information about recalculation will be presented in the NIR 2012.

Recalculation in sector 4.A Enteric Fermentation

Reallocation of sub-category "Suckling cows" from Dairy cattle to Non-dairy cattle, use of more accurate numbers of cattle and applying new digestibility values resulted in changed emissions for the entire reporting period.

Recalculation in sector 4.B Manure Management (N_2O)

The estimation of N_2O emissions from Manure management for 1990-2010 was performed using the revised Nex from dairy and non-dairy cattle with the updated parameters (feed consumption, nitrogen feed intake and protein content of milk to estimate the amount of N retained in milk). The equations 10.32 and 10.33 (2006 IPCC) were used to revise Nex from dairy and non-dairy cattle, and to calculate the variables for nitrogen intake and nitrogen retained (milk production and growth). The results served as an input to the eq. 10.31.

The parameters for estimation of the revised Nex from dairy cattle were collected from literature and from personal communication with agricultural experts (protein in milk 3.3%, protein in feed (% in dry matter) 18%).

Country-specific data for the distribution of manure management practices across AWMS was taken from study Hons and Mudrik (2004) for the period 1990-1999 and for the period 2000-2010 was taken updated data from Kvapilík J. (author of Annual report of Czech cattle breeding from Institute of Animal Science Prague).

As mentioned in the "Response by the Czech Republic on Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the greenhouse gas inventories of the Czech Republic submitted in 2011" the new country-specific parameters DE (digestibility, in%) for cattle was estimated based on existing publications. The average digestibility for cattle estimated based on available sources corresponds to the DE value around 70%. Dr. Pozdíšek (an agricultural expert from Research Institute for Cattle Breeding, Ltd., pers.com.) determined conservative average values of digestibility for three cattle categories (dairy cows, suckling cows and other cattle), which were applied for the N_2O emission estimation from Manure management.
Using the above changes, the N_2O emissions from Manure management were calculated with Tier 2 method for dairy and non-dairy cattle categories for the entire reporting period.

Recalculation in sector 4.D Agricultural soils (4.D.1.b, 4.D.2 and 4.D.3)

Given that the value of Nex for cattle was revised, it led to the increased N_2O emissions from:

1) animal manure applied to soils (4.D.1.b)
7) pasture, range and paddocks (4.D.2)
8) atmospheric deposition (4.D.3.1)
9) N lost through leaching and run-off (4.D.3.2)

Also these changes apply for the entire reporting period.

10.1.2.4 Recalculation in sector 5 LULUCF

Recalculation of LULUCF – Other (5.G)

New for the LULUCF sector in the Czech NIR 2012 was inclusion of emissions from lime application to Forest Land. Since the CRF Reporter does not allow inclusion of lime application under category 5.A Forest Land, the corresponding emissions are reported under 5.G Other. Information on lime application and the corresponding estimates of emissions are provided for the entire reporting period from 1990 to 2010. The annual emissions from lime application to Forest Land fluctuate irregularly from zero to 20.53 Gg CO_2 eq. (in 2000). Hence, the effect of including these quantities in the total emission balance of the LULUCF sector is minimal. On an average, this represents an emission increase by 0.1% annually with the largest relative contribution detected in 2007 (0.43% of the reported emission total for LULUCF).

10.1.2.5 Recalculation in sector 6 Waste

First recalculation was minor changes in activity data in 6.A (amount of waste landfilled). This is regular recalculation since data that are used for previous year submission are most of time preliminary and data provider is always trying to improve data consistency.

Second change was based on continual request for country specific data on waste composition. We obtained and implemented country specific waste composition. This is major change mainly because country specific values increased overall DOC of waste in recent years. Last change is amount of LFG that is recovered for energy purposes. In 2007 started regular data collection of energetically used LFG by Ministry of Industry and Trade. They are trying to obtain consistent numbers and they regularly update their estimates while prolonging time line towards the base year. This change influenced decreased emissions in recent years and increased emissions in the middle of the 1990-2010 period. None of the above-mentioned changes influence emissions beyond 1997.

Recalculation/reallocation of Municipal Solid Waste category to Energy sector

Based on the suggestion of ICR, we moved former category 6.C.2 MSW incineration under 1.A.1.a. This shift is in compliance with the suggestion of the IPCC methodology. In addition to this shift, we quantified emissions of CO_2 from the biogenic part of incinerated MSW, which is now part of memo items. In terms of total emissions, this shift was emission-neutral.

Recalculation of Hazardous and Industrial Waste (activity data)

In previous submission (2011), we acknowledged that activity data used for estimation of incinerated H/I waste are underestimated. We gathered additional data and recalculated the whole time series where relevant. The changes do not go beyond 2002.

Recalculation of Hazardous and Industrial Waste (Split)

We split hazardous waste into biogenic and non-biogenic parts and they are now reported separately in the UNFCCC reporter. Total emissions are unchanged and we also estimated memo-item biogenic CO_2 for this category.

10.1.3 Recalculation performed in the submission 2014

10.1.3.1 Recalculation in sector 1.A Energy– stationary combustion

Expert review team (ERT) during Centralised review in September 2012 raised objection to using IPCC 2006 default emission factors instead of Revised 1996 Guidelines (IPCC, 1997) default emission factors in 1995-2010 period. This issue was identified as potential problem in Saturday paper. In following resubmission in October 2012 the recalculation of the whole sector 1.A Energy – stationary combustion was provide using Revised 1996 Guidelines (IPCC, 1997) default emission factors. Country specific emission factors are used for Coking Coal, Other Bituminous Coal, Brown Coal + Lignite and since this submission also for Natural Gas. For the rest of fuels (rest of Solid Fuels, Liquid Fuels and Biomass) were used default emission factors.

This recalculation also affected Reference Approach where emission factors were also revised.

10.1.3.2 Recalculation of gaseous fuel in 1.A Energy

Another improvement provided by the Czech Republic consists in new country specific CO_2 emission factor for Natural Gas. The extensive research was performed using data of Natural Gas composition provided by NET4GAS, Ltd. company. This research was part of project assigned by State Environmental Fund of the Czech Republic. Detailed description of the research is given in Annex 2.

Since this submission updated emission factor is used for all categories in 1.A Energy.

10.1.3.3 Recalculation/reallocation of solid fuels in sectors 1.A.1.c Energy - Manufacture of Solid Fuels and Other Energy Industries and 1.A.2 Energy- Manufacturing Industries and Construction

One of the improvements implemented by the Czech Republic considers reallocation of solid fuels and associated emissions between 1.A.1.c and 1.A.2. During QA/QC procedure Energy balance in these two sectors was compared with data provided by Czech Register of individual Sources and Emissions. This QA/QC discovered discrepancy in reporting of solid fuels in 1995-2010 period. There is one installation in CR for which solid fuels are in official statistics (CzSO Questionnaires) included in 1.A.2 autoproducers. The QA/QC procedure ascertained that this consumption of solid fuels should be included in 1.A.1.c category; in this submission solid fuels were reallocated. This reallocation affects consumption of solid fuels and associated emissions in 1.A.1.c category and in 1.A.2.a-1.A.2.f (autoproducers consumption).

10.1.3.4 Recalculation in sector 1.A.2.c Energy - Manufacturing Industries and Construction, Chemicals

The ESD review team discovered during ESD review (June 2012) double counting of naphtha. Part of the naphtha is used as feedstock and as liquid fuels in 1.A.2.c, but instead of taking 20%, we had incorrectly taken 70% (in 2005) or 80% (in 2008-2010) of the naphtha as oxidized. This issue is now addressed in this submission.

10.1.3.5 Recalculation in 1.A.3 Energy - Road Transportation - Diesel Oil

QC/QC procedures identified typographic error in this category - N_2O emissions, 2010. This issue has been rectified.

10.1.3.6 Recalculation in sector 1.A.4.b Energy - Other Sectors, Residential

Expert review team (ERT) during Centralized review in September 2012 raised recommendation to include emissions associated with charcoal use. This issue was noted as potential problem in Saturday paper. In following resubmission (October 2012) the CH_4 and N_2O emissions were included in this subcategory using FAOSTAT data and Revised 1996 Guidelines (IPCC, 1997) default emission factors. To ensure consistency in reporting of greenhouse gases in this submission are included also CO_2 emissions using country specific emission factor.

10.1.3.7 Recalculation in sector 1.A.D Energy - Feedstocks and non-energy use of fuels

In category 1.A.D 10 Other was necessary to provide recalculation for Other Oil (Solvents) in 2010 since in 3 Solvent and Other Product Use sector was performed recalculation due to ERT recommendation. Detailed information please see under description of sector 3 recalculations.

10.1.3.8 Recalculation in sector 1.B.1.b Energy – Fugitive Emissions from Solid Fuels, Solid Fuel Transformation

Expert review team (ERT) raised recommendation during Centralized review in September 2012 to include emissions associated with charcoal production, which was also identified as potential problem. In following resubmission the emissions were included in this subcategory using FAOSTAT data and Revised 1996 Guidelines (IPCC, 1997) default emission factors.

10.1.3.9 Recalculation in sector Cement Production (2.A.1)

In this submission the recalculation of CO_2 emissions was performed. In 2003-2005 period was discovered computational error, which was now corrected.

10.1.3.10 Recalculation in sector Soda Ash Use (2.A.4.2)

The activity data for this category were verified for 2009 and 2010, which introduced also recalculation of CO_2 emissions.

10.1.3.11 Recalculation in sector Other – Glass Production (2.A.7.1)

For 2005 was found the error in reported CO_2 emissions in this category. This discrepancy was corrected in this submission.

10.1.3.12 Recalculation in sector 2.F.3 Industrial Processes, Fire Extinguishers

Technical Expert Review Team (TERT) raised recommendation during ESD review in July 2012 to include split for 1^{st} filled products/serviced products based on ratio recorded in previous years. The exact numbers were unknown for 2009 and 2010, but over previous period the ratio is very stable. This issue has been rectified.

10.1.3.13 Recalculation in sector 3 Solvent and Other Product Use

QC/QC procedures identified typographic errors in this sector – CO_2 emissions, 2010. This issue has been rectified.

10.1.3.14 Recalculation in sector 4 Agriculture

During the centralized review in September 2012, the expert review team (ERT) identified as a potential problem the estimation of N_2O Direct emissions from Agricultural soils. The ERT noted that: i) the Czech Republic has not included N-fixing forage crops such as alfalfa and clover in the calculations of N_2O emissions for the entire time series and ii) the Czech Republic has not included potatoes and sugarbeet crops produced in the country in the estimations of N_2O emissions from crop residues returned to soils for the entire time series. The revision of these emission categories was requested. The recalculation was submitted to ERT as a resolved issue of the "Saturday paper" regarding the 2012 NIR submission.

The ERT provided recommendations to improve the inventory estimates for Agriculture. Based on these recommendations and new obtained country-specific data, the following improvements were implemented in the 2013 submission:

1) N-fixing forage crops such as alfalfa and clover were included in the calculations of N_2O emissions for the entire time series and

10) Potatoes and sugarbeet crops produced in the country were included in the estimations of N_2O emissions from crop residues returned to soils for the entire time series

The "Saturday paper" recalculation led to increased emissions in 4.D.1 category (Direct emissions from agricultural soils) after recalculation by 6.9% in 2010. Using the above changes, the N_2O direct emissions from Agricultural soils were calculated with Tier 2 method for the entire reporting period.

10.1.3.15 Recalculation in sector 4.D Agricultural Soils (4.D.1.3, 4.D.1.4)

The estimation of N_2O Direct emissions from Agricultural soils for 1990-2010 was performed using the statistical crop production data and country-specific parameters.

Category 4.D.1.3

IPCC GPG was applied and available information on production of crops (alfalfa and clover) and national values were used to estimate N_2O emissions. The information of production comes from Czech Statistical Office (CzSO). The country-specific data of the fraction of nitrogen (FracNCRBF); and the fraction of dry matter content (FracDM) in aboveground biomass of forage crops were applied to the emission inventory. For the fraction of dry matter and fraction of nitrogen, the materials (results of research projects) of Faculty of Agronomy, South Bohemia University (Jeteloviny –internal/study material, www.zf.jcu.cz), were used.

The equation used to estimate direct N_2O emissions from Agricultural soils (N-fixing crops) has form

FBN = Crop * FracDM * FracNCRBF.

Category 4.D.1.4

N_2O Direct Soil Emissions from Crop Residue (potatoes and sugarbeet) were estimated applying the IPCC GPG and using available information on crop production. The source of information is Czech Statistical Office (CzSO). The default emission factors were used in accordance with the IPCC GPG methodology.

The equation 4.29 (Tier 1b, GPG IPCC 2000, page 4.59) of the IPCC GPG was used to estimate these emissions. The default N_2O emission factor for both crops (Table 4-17, IPCC 2000 GPG, page 4.60), the default values for the fractions of nitrogen in potatoes and sugarbeet (Table 4-16, IPCC 2000 GPG, page 4.58) and default fraction of crop residue that is removed from the field as crop (Table 4-17, IPCC 1997, Reference Manual, page 4.85) were used. The country- specific data for dry matter fraction was used: The value of FracDM for potatoes is based on study Cabajova, MU LF Brno (2009) and corresponds to other available sources. The value of FracDM for sugarbeet is based on study Blaha, CZU Praha (1986) and corresponds to other available sources. Both national parameters belong to interval of IPCC default values. The fraction of crop residue that is burned on the field equals zero.

10.1.3.16 Recalculation in sector 5 "LULUCF" (5.G)

No explicit recalculation was performed in this submission. However, the QC/QC procedures identified a typographic error in the category 5.A.1 Carbon stock change in living biomass, year 2010. Therefore, this issue was rectified.

10.1.4 Recalculation performed in the submission 2015

10.1.4.1 Recalculation in sector 1.A Energy (1.A excluding 1.A.3)

10.1.4.1.1 Recalculations due to response to the last review process

Recalculation of N_2O emissions in 1.A.1.b Petroleum Refining sector

As a response to the findings in Saturday paper provided by ERT from review process 2014, one recalculation in the Energy sector was performed. The mistake was caused during the transmission of the data into the CRF Reporter in the last submission. The correction was provided in 6 weeks after obtaining of the Saturday paper.

10.1.4.1.2 Recalculation *caused by implementation of IPCC 2006 Guidelines*

Change of the structure in the Sectoral approach

Sector **1.A.1.a Main Activity Electricity and Heat Production** is based on the IPCC 2006 Gl. split into three subsectors:

1.A.1.a.i Electricity Generation
1.A.1.a.ii Combined Heat and Power Generation (CHP)
1.A.1.a.iii Heat Plants

Activity data and greenhouse gas emission estimates were in this submission reported in the subsector 1.A.1.a.i Electricity Generation since the differentiation between all three subsectors in the official data from CzSO is not considered to be reliable. The distribution of the data into all three subsectors is included in the current Improvement plan.

Sector **1.A.1.c Manufacture of Solid Fuels and Other Energy Industries** is based on the IPCC 2006 Gl. split into two subsectors:

1.A.1.c.i Manufacture of Solid Fuels
1.A.1.c.ii Other Energy Industries

Activity data and greenhouse gas emission estimates were in this submission reported in the subsector 1.A.1.c.i Manufacture of Solid Fuels since the differentiation between the subsectors in the official data from CzSO is not considered to be reliable. The distribution of the data into all three subsectors is included in the current Improvement plan.

The amount of subsectors in **1.A.2 Manufacturing Industries and Construction** increased from originally six (1.A.2.a till 1.A.2.f) to 13 (1.A.2.a till 1.A.2.m).

In the current submission was added just one subsector:

1.A.2.f Non-Metallic Minerals

All other subsectors 1.A.2.g till 1.A.2.m were reported in one v subsector

1.A.2.g Non-specified Industry

Validity of the data in official Energy balance provided by CzSO will be examined. The distribution of the data into all subsectors is included in the current Improvement plan.

Sector **1.A.4.c Agriculture/Forestry/Fishing** is based on the IPCC 2006 Gl. split into three subsectors:

1.A.4.c.i Stationary
1.A.4.c.ii Off-road Vehicles and Other Machinery
1.A.4.c.iii Fishing (mobile combustion)

Until now the activity data from mobile sources in Agriculture, Forestry and Fishing in the CR was reported in the sector 1.A.5. This division was used in order to differentiate the activity data from stationary combustion and from mobile combustion. In the new structure are used the sectors 1.A.4.c.i (original data for subsector 1.A.4.c) a 1.A.4.c.ii (original data were reported under 1.A.5.b Agriculture, Forestry and Fishing).

Sector **1.A.5 Non-Specified** is in the IPCC 2006 Gl. Split to

1.A.5.a Stationary

1.A.5.b Mobile

Subsector 1.A.5.a is not used, since all data about combustion processes were distributed in between the sectors 1.A.1 till 1.A.4. Subsector 1.A.5.b is further split into subsectors:

1.A.5.b.i Other mobile sources not included elsewhere
1.A.5.b.ii Agriculture and Forestry and Fishing

In the subsector 1.A.5.b.i are reported all emissions from the combustion in air transport, which are not included in 1.A.3. Subsector 1.A.5.b ii includes the sources not included in 1.A.4 subsector.

Described changes were performed in the whole time-series.

Change of emission and oxidation factors

IPCC 2006 Guidelines include updated emission factors for CO_2, CH_4 and N_2O. In case, where the country-specific emission factors are available, they are used for emission estimations. In other cases are used default emission factors.

Oxidation factors provided by IPCC 2006 Guidelines are equal to 1. Only in specific cases it allows to use country specific oxidation factors. Analysis of EU ETS data was performed in order to obtain country specific oxidation factors. This way country specific oxidation factors were estimated for Bituminous Coal, Coking Coal and Lignite. These country specific oxidation factors were used in the current inventory. In other cases are used default oxidation factors equal to 1.

Recalculation due to use of country specific conditions

The methodology for development of country specific CO_2 emission factors from different kind of fuels was drawn up. Country specific oxidation factors were determined for chosen solid fuels. For the transition of the data from CzSO for different gases (which are reported in TJ using GCV) were developed country specific ratios of GCV/NCV.

For CO_2 emission estimation were used this country specific approach in the whole time series in all sectors of stationary combustion. Methodology will be discussed in detail in the March submission of the NIR in relevant Annex.

Country specific CO_2 emission factors

In the current submission are used newly determined country specific emission factors for CO_2 emission estimation for Bituminous Coal, Coking Coal and Lignite, which were determined based on the elementary analyses of each kind of fuel. The methodology for determination of country specific emission factors as a relation to the NCV was drawn up.

Country specific oxidation factors for CO_2 computation

For each kind of coal (Bituminous Coal, Coking Coal, Lignite, Briquettes) were determined country specific oxidation factors based on the EU ETS data reported for 2010-2013. Recalculation was provided for listed fuels with country specific values. For the rest of the fuels was used oxidation factor equal to 1.

Country specific coefficient for the ratio between GCV and NCV for gaseous fuels

The recalculation of activity data determination for Natural Gas and derived gases was performed. These gases are in the official data from CzSO reported in TJ, which are calculated based in GCV. So far was used for the transition to TJ correspondent to NCV the ratio 1: 1.1. This approach was many times issued by ERT. Following the recommendations the data about composition of each gas was collected and also

GCV and NCV based on the data were determined. Based on this data the specific ratio GCV/NCV for each gas was determined. This country specific ration was used for the activity data determination in the current submission.

Recalculations caused by changes in data and NCV in official CzSO data

Czech statistical office closely cooperates with national inventory system team and in its UNECE/IEA/OEXD Questionnaires it is reacting also for different requirements from the NIS team. Except of this every year the data are getting more accurate, also the data from the past years are often clarified and changed. Reallocations between different subsectors are also occurring. Based on the NIS team proposition were also some NCVs updated. Important change in the last data reporting (from CzSO) occurred in the consumption of liquid fuels.

All these changes are included in the whole recalculation of the Energy sector. The changes are reflected in the whole time series and for all kinds of fuels. It is necessary to point out, that currently all reported data are now in line with the official statistical data in energy balance of the Czech Republic which is processed in line with IEA methodology. So far in the 1990 – 1994 period was used data from the former energy balance of the Czech Republic. The most apparent changes occur in the differentiation between energy and non-energy use of fuels for liquid fuels. More precise differentiation between energy and non-energy use helped also for more precise allocation of non-energy use of liquid fuels to the IPPU sector.

In the official data are the fuels consumptions reported in kt, which means the requirement for the transition to TJ. In the last official CzSO data were also added still missing NCV, which allow also recalculation for the whole time series of NCV. Until now the missing NCV data was replacing by the average values.

It is possible to state, that this recalculation was so far the most important and huge since the GHG inventory is performed. The comparison of the values before and after recalculation was also performed. The comparison showed that despise quite significant changes for some kind of fuels and sectors, the whole fuel consumption and CO_2 and N_2O emissions didn't significantly change. CH_4 emissions indicate apparent changes, however this was caused by the apparent change in the emission factors.

10.1.4.2 Recalculation in sector 1.A.3 Energy – Road Transportation

10.1.4.2.1 Recalculation caused by implementation of IPCC 2006 Guidelines

Sector **1.A.3.b Road Transportation** is based on the IPCC 2006 Gl. split into five subsectors:

1.A.3.b.i	Cars
1.A.3.b.ii	Light Duty Trucks
1.A.3.b.iii	Heavy Duty Trucks and Buses
1.A.3.b.iv	Motorcycles
1.A.3.b.v	Other

Activity data and greenhouse gas emission estimates of subsector 1.A.3.b.ii Light Duty Trucks were in this submission included in the subsector 1.A.3.b.i Cars, because the differentiation between these two subsectors is not available. The distribution of the data into these two subsectors is included in the current Improvement plan.

10.1.4.3 Recalculation in sector 2 Industrial Processes and Product Use

10.1.4.3.1 *Recalculations due to response to the last review process*

No recalculations were needed after the last review.

10.1.4.3.2 *Recalculation caused by implementation of IPCC 2006 Guidelines*

2.A Mineral Industry

In the 2.A Mineral Industry subsector went through some reallocation issues. The subsector 2.A.3 doesn't include emissions from Limestone and Dolomite Use anymore, but includes the emissions from Glass Production (before included in the category 2.A.7.i). Category 2.A.4 includes now Other Process Uses of Carbonates and it is split into 4 subcategories

2.A.4.a	Ceramics (before included in 2.A.7.ii)
2.A.4.b	Other Uses of Soda Ash (before included in 2.A.4.ii)
2.A.4.c	Non Metallurgical Magnesia Production
2.A.4.d	Other (please specify).

The category 2.A.2 was recalculated in the 2010 - 2012 time series since new specific data were obtained. Further improvement is planned for the next submission and is included in the improvement plan. IPCC 2006 Gl. also include methodology for Glass production including emission factor and cullet ratio. Using these parameters were estimated emissions in 2.A.3 Glass Production sector.

2.B Chemical Industry

Chemical Industry is the sector with the biggest changes cause by the implementation of IPCC 2006 Gl. There are few new categories included.

Categories 2.B.1 Ammonia Production, 2.B.2 Nitric Acid Production and 2.B.3 Adipic Acid Production remained the same.

Category 2.B.4 now includes Caprolactam, Glyoxal and Glyoxylic Acid Production. Category 2.B.5 includes Carbide Production, 2.B.6 Titanium Dioxide Production, 2.B.7 Soda Ash Production. Category 2.B.8 Petrochemical and Carbon Black Production is split into categories:

2.B.8.a	Methanol
2.B.8.b	Ethylene
2.B.8.c	Ethylene Dichloride and Vinyl Chloride Monomer
2.B.8.d	Ethylene Oxide
2.B.8.e	Acrylonitrile
2.B.8.f	Carbon Black

Category 2.B.9 Fluorochemical Production is split into 2 subcategories and is not occurring in the Czech Republic. Last category in 2.B is category 2.B.10 Other, in which is included category Styrene production.

In case the process is occurring in the Czech Republic, the relevant emissions were estimated using methodology given by IPCC 2006 Gl.

2.C Metal Industry

New subcategories in the sector 2.C.1 Iron and Steel Production are 2.C.1.c Direct Reduced Iron and 2.C.1.e Pellet.

Categories 2.C.5 Lead Production and 2.C.6 Zinc Production are newly included in the IPCC 2006 Gl.

The emissions from limestone and dolomite use during the iron and steel production were included in the emission estimates in the category 2.C.1 Iron and Steel Production.

As a new source were included emissions from categories 2.C.5 Lead Production and 2.C.6 Zinc Production.

2.D Non-Energy Products from Fuels and Solvent Use

This category is newly included in the IPCC 2006 Gl. It includes use of fuels other than for combustion processes or for reducing agent in industry. This category is split into four subcategories

2.D.1	Lubricant Use
2.D	Paraffin Wax Use
2.D.3	Other (please specify)

Category 2.D.3 Other is for the purposes of the Czech Republic's inventory split into categories 2.D.3.i Solvent Use and 2.D.3.ii Road paving with asphalt.

2.E Electronic Industry

Electronic Industry includes emissions of fluorinated carbons gases used predominantly for manufacturing of semiconductors. Subsector 2.E include sources from previous category 2.F.7 Semiconductor Manufacture and was furthermore extended for five more subcategories:

2.E.1	Integrated Circuit or Semiconductor
2.E.2	TFT Flat Panel Display
2.E.3	Photovoltaics
2.E.4	Heat Transfer Fluid
2.E.5	Other (please specify).

2.F Product Uses as Substitutes for Ozone Depleting Substances

This subsector has undergone a major changes caused by the implementation of IPCC 2006 Gl. One of the most important issues is that potential emissions are not reported anymore in addition to actual emissions. Moreover, the 2.F.7 Semiconductor Manufacturer category was reallocated to 2.E Electronic Industry. Also previous 2.F.8 Electrical Equipment and 2.F.9 Other (Sound-proof windows, Laboratory use) categories were reallocated in 2.G Other Product Manufacture and Use.

In the rest of the categories (2.F.1 to 2.F.5) there were only little changes such as an adjustment of category name or altering the classification of some subcategories.

2.G Other Product Manufacture and Use

As mentioned above, this new subsector introduce categories 2.G.1 Electrical Equipment, 2.G.2.c Soundproof Windows and 2.G.4 Laboratory (Experimental) use that have been reallocated from the previous subsector 2.F. This subsector includes also category 2.G.3 N_2O from Product Uses, which was previously reported under Solvents and Other Product Use.

10.1.4.4 Recalculation in sector 3 Agriculture

10.1.4.4.1 *Recalculations due to response to the last review process*

Recalculation of CH_4 emissions in 3.A Livestock/Manure Management sector

As a response to the findings in Saturday paper provided by ERT from the review process 2014, one recalculation in the Agriculture sector was performed. The discrepancy was caused by inconsistency of time-series data. One step input of change of grazing time data for cattle was utilized, where the slightly increasing trend of data was necessary. The correction was provided in 6 weeks after obtaining of the Saturday paper.

Recalculation caused by implementation of IPCC 2006 Guidelines

Sector 3.A Livestock is based on the IPCC 2006 Gl. split into three subsectors:

3.A.1 Enteric Fermentation
3.A.2 Manure Management

Activity data and greenhouse gas emission estimates are since this submission reported after new redistribution.

Sector 3.C Aggregate sources and non-CO_2 emissions sources on land is based on the IPCC 2006 Gl. split into ten subsectors, of which only four are reported under Agriculture sector in the Czech Republic:

3.C.3 Urea application
3.C.4 Direct N_2O Emissions from managed soils
3.C.5 Indirect N_2O Emissions from managed soils
3.C.6 Indirect N_2O Emissions from manure management

Activity data and greenhouse gas emission estimates were in this submission reported in mentioned sectors.

In the current submission some subsectors were added. Newly the emissions from urea application on agricultural land (3.C.3) and Indirect N_2O Emissions from manure management (3.C.6) were reported. The data of industry production of urea was applied to estimate emissions from 3.C.3 sector. To the sector 3.C.4 was added new source of emissions - direct application of sewage sludge to managed soils.

Described changes were performed in the time-series where the activity data are available.

Change of emission factors

IPCC 2006 Guidelines include updated emission factors for CH_4 and N_2O. In case there are country-specific emission factors available, they are used for emission estimation. In other cases are used default emission factors.

The emission factors provided by IPCC 2006 Guidelines for emission estimations from Manure Management (AWMS - EF3), Direct and Indirect emissions from managed soils (EF1 and EF5) were updated.

10.1.4.4.2 Recalculation due to use of country specific conditions

Country specific CH_4 and N_2O emission factors

Country-specific emission factors are applied if they are available. In Agriculture, the national specific emission factors are used in calculation of CH_4 and N_2O emissions from Enteric Fermentation and Manure Management (both in cattle category).

The changes in country-specific factors in time period 2007-2011 were performed and reported based on recalculation due to response to the last review process.

Recalculations caused by changes in data

Czech statistical office is the main source of national inventory system data. Annually, the data are getting more accurate, reallocations between different subsectors are also occurring. All these changes are included in the recalculations of the Agriculture sector. The changes are reflected in the whole time series.

It possible to state, that this recalculation was so far the most important and huge since the GHG inventory is performed. The comparison of the values before and after recalculation was also performed. The comparison showed that emissions significantly change. Although it was added to the inventory some sources, the reported emissions were due to the different methodology, incl. updated emission factors, reduced.

10.1.4.5 Recalculation in sector 4 LULUCF and KP LULUCF activities

10.1.4.5.1 *Recalculations due to response to the last review process*

No recalculations were needed after the last review.

10.1.4.5.2 Recalculation due to use of country specific conditions

No recalculations due to use of country specific conditions performed.

10.1.4.5.3 Recalculation caused by implementation of IPCC 2006 Guidelines

The methodologies and recommendations IPCC 2006 Guidelines were implemented gradually during previous inventory submissions. Any identified difference in reported emissions at the higher grouping level is due to changes in reporting structure and moving some emission categories to sector 3 – Agriculture.

The recalculations have been made due to adopting the new global warming potential values for CH_4 and N_2O (Decision 25/CP19). This concerns the emissions from burning and wildfires, as well as emissions from soils on land converted to cropland. Hence, these changes affect the estimates for the land use categories 4.A Forest land and 4B Cropland. Correspondingly, these changes were also implemented for estimates of Forest management activity under KP LULUCF reporting.

10.1.4.6 Recalculation in sector 5 Waste

10.1.4.6.1 *Recalculations due to response to the last review process*

Centralized review noted possible underestimation of N_2O emissions from 5.D Wastewater treatment and discharge due to under estimated amount of protein in consumed food. Whole category received updated data about protein consumption from FAOSTAT for whole time series 1990 - 2013. Average change in amount of GHG in source category was about 14% per year.

10.1.4.6.2 Recalculation due to use of country specific conditions

Category 5.A Solid waste disposal was recalculated, since new activity data, including data for recovered methane and amount of waste, became available. The difference is negligible.

10.1.4.6.3 Recalculation caused by implementation of IPCC 2006 Guidelines

Category 5.B Biological treatment of solid waste is newly included in the IPCC 2006 Gl. It is split into two subcategories:

5.B.1 Composting

5.B.2 Anaerobic digestion at Biogas facilities

Each subcategory is further split into two categories, dividing the emissions between MSW treatment and other waste treatment, respectively 5.B.1.a Municipal solid waste, 5.B.1.b Other, and 5.B.2.a Municipal solid waste, 5.B.2.b Other. Calculations were performed following the 2006 Gl. for the whole time period.

The implementation of 2006 GL. caused division of category 5.C Incineration and open burning of waste into two subcategories:

5.C.1 Incineration

5.C.2 Open burning of waste

In this submission in category 5.C.1 no recalculations were conducted. Category 5.C.2 is reported as not occurring in the Czech Republic.

10.2 Implications for emission levels

Tab. 10-1 Implications on emission levels on example on 2013 emission levels

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excl. LULUCF%	Impact of recalculation on total emissions incl.LULUCF %
Total National Emissions and Removals	122032.63	122858.85	826.22	1%	1%	1%
1. Energy	107090.06	100876.57	-6,213.50	-6%	-5%	-5%
A. Fuel combustion activities	103013.82	96887.22	-6,126.60	-6%	-5%	-5%
1. Energy industries	57413.37	55919.61	-1,493.75	-3%	-1%	-1%
2. Manufacturing industries and construction	16602.53	11017.60	-5,584.94	-34%	-4%	-5%
3. Transport	16908.61	16649.55	-259.06	-2%	0%	0%
4. Other sectors	10970.03	12991.03	2,021.00	18%	2%	2%
5. Other	1119.28	309.43	-809.85	-72%	-1%	-1%
B. Fugitive Emissions from Fuels	4076.24	3989.34	-86.90	-2%	0%	0%
1. Solid fuels	3525.72	3354.91	-170.81	-5%	0%	0%
2. Oil and natural gas	550.53	634.43	83.91	15%	0%	0%
C. CO_2 transport and storage	not reported	NO	NA	NA	NA	NA
2. Industrial processes and product use	9914.06	14122.69	4208.63	42%	3%	3%
A. Mineral industry	3490.11	2156.01	-1,334.10	-38%	-1%	-1%
B. Chemical industry	1119.67	1878.80	759.13	68%	1%	1%
C. Metal industry	5304.28	7058.16	1,753.88	33%	1%	1%
D. Non-energy products from fuels and solvent use	455.57	100.80	-354.77	-78%	0%	0%
G. Other product manufacture and use	NA	239.92	NA	NA	NA	NA
H. Other	NA	NO	NA	NA	NA	NA
3. Agriculture	8058.37	7263.34	-795.03	-10%	-1%	-1%
A. Enteric fermentation	2026.88	2412.48	385.60	19%	0%	0%
B. Manure management	1130.54	1758.86	628.32	56%	0%	1%
C. Rice cultivation	NO	NO	NA	NA	NA	NA
D. Agricultural soils	4900.95	2955.69	-1,945.26	-40%	-2%	-2%
E. Prescribed burning of savannahs	NO	NO	NA	NA	NA	NA
F. Field burning of agricultural residues	NO	NO	NA	NA	NA	NA
G. Liming	not reported	135.50	NA	NA	NA	NA
H. Urea application	not reported	0.81	NA	NA	NA	NA
I. Other carbon-containing fertilizer	not reported	NO	NA	NA	NA	NA
J. Other	NA	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry (net)	-7251.97	-6741.78	510.19	-7%	0%	0%
A. Forestland	-7255.03	-7403.47	-148.44	2%	0%	0%
B. Cropland	180.92	74.50	-106.42	-59%	0%	0%
C. Grassland	-301.68	-322.01	-20.33	7%	0%	0%
D. Wetlands	24.55	29.38	4.83	20%	0%	0%
E. Settlements	99.26	83.16	-16.10	-16%	0%	0%
F. Other land	NA,NO	NO	NA	NA	NA	NA
G. Harvested wood products	not reported	791.82	NA	NA	NA	NA
H. Other	0.01	not reported	NA	NA	NA	NA
5. Waste	3766.54	4881.34	1,114.80	30%	1%	1%
A. Solid waste disposal	2769.96	3324.45	554.49	20%	0%	0%
B. Biological treatment of solid waste	not reported	585.17	NA	NA	NA	NA
C. Incineration and open burning of waste	210.77	178.86	-31.91	-15%	0%	0%
D. Waste water treatment and discharge	785.81	792.86	7.05	1%	0%	0%
E. Other	NA	NO	NA	NA	NA	NA
6. Other (As specified in summary 1.A)	NA	NA	NA	NA	NA	NA
Memo items:						
International bunkers	960.48	860.43	-100.05	-10%	0%	0%
Aviation	960.48	860.43	-100.05	-10%	0%	0%
Navigation	NA,NO	NO	NA	NA	NA	NA
Multilateral operations	NO	NO	NA	NA	NA	NA
CO_2 emissions from biomass	12238.13258	12716.68	478.55	4%	0%	0%
CO_2 captured	not reported	NO	NA	NA	NA	NA
Long-term storage of C in waste disposal sites	not reported	10416.85	NA	NA	NA	NA
Indirect N_2O	not reported	2412.90	NA	NA	NA	NA
Indirect CO_2	not reported	2248.99	NA	NA	NA	NA

10.3 Implications for emission trends, including time-series consistency

10.3.1 Implications for emission trend and time-series consistency of CO_2

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of CO_2 are illustrated on Fig. 10-1. Both curves are following the same pattern. The CO_2 emissions in 2013 are higher on average with 3%, through the whole time period.

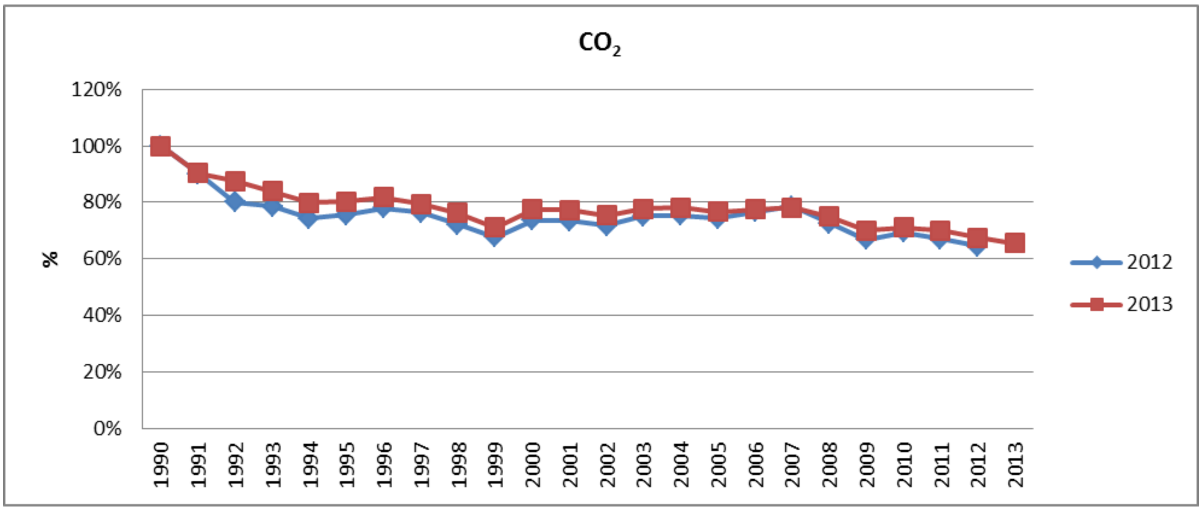


Fig. 10-1 Difference in trends of CO_2 emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

10.3.2 Implications for emission trend and time-series consistency of CH_4

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of CH_4 are illustrated on Fig. 10-2. Both curves are following the same pattern. The CH_4 emission trend in 2013 is higher on average with 2%, through the whole time period.

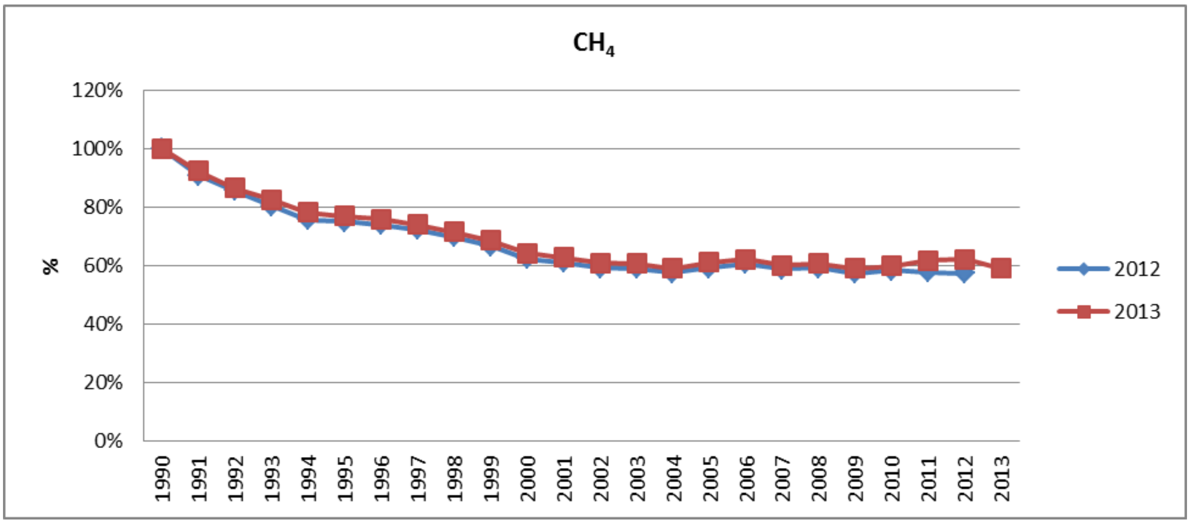


Fig. 10-2 Difference in trends of CH_4 emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

10.3.3 Implications for emission trend and time-series consistency of N_2O

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of N_2O are illustrated on Fig. 10-3. Both curves are following the same pattern. The N_2O emission trend in 2013 is higher on average with 1%, through the whole time period.

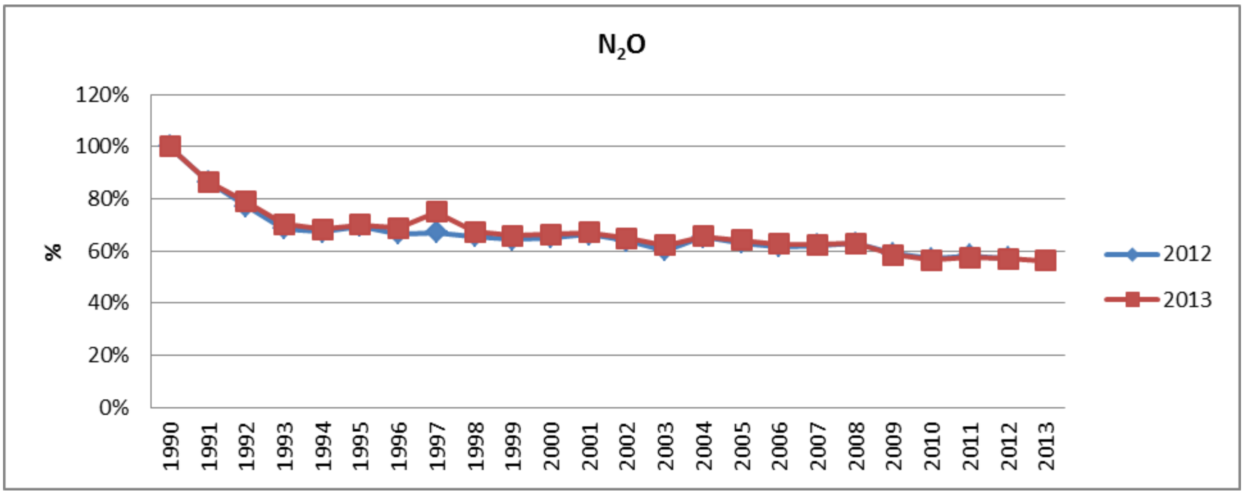


Fig. 10-3 Difference in trends of N_2O emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

10.3.4 Implications for emission trends and time-series consistency of F-gases and SF_6

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of HFCs are illustrated on Fig. 10-4. Both curves are following the same pattern. The HFCs emission trend in 2013 is higher on average with 5%, through the whole time period.

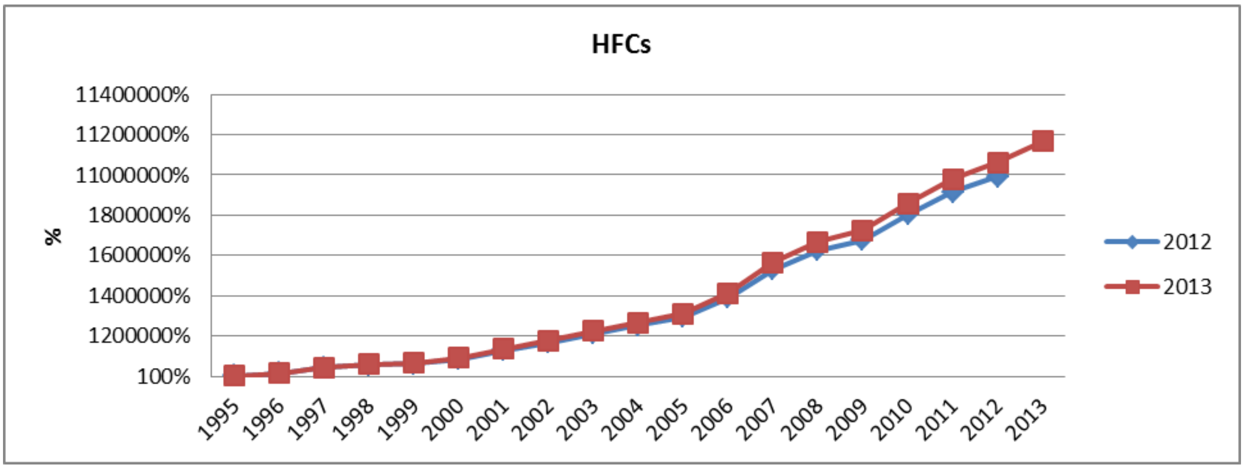


Fig. 10-4 Difference in trends of HFCs emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of PFCs are illustrated on Fig. 10-5. Both curves are following the same pattern. The PFCs emission trend in 2013 is higher on average with 38%, through the whole time period.

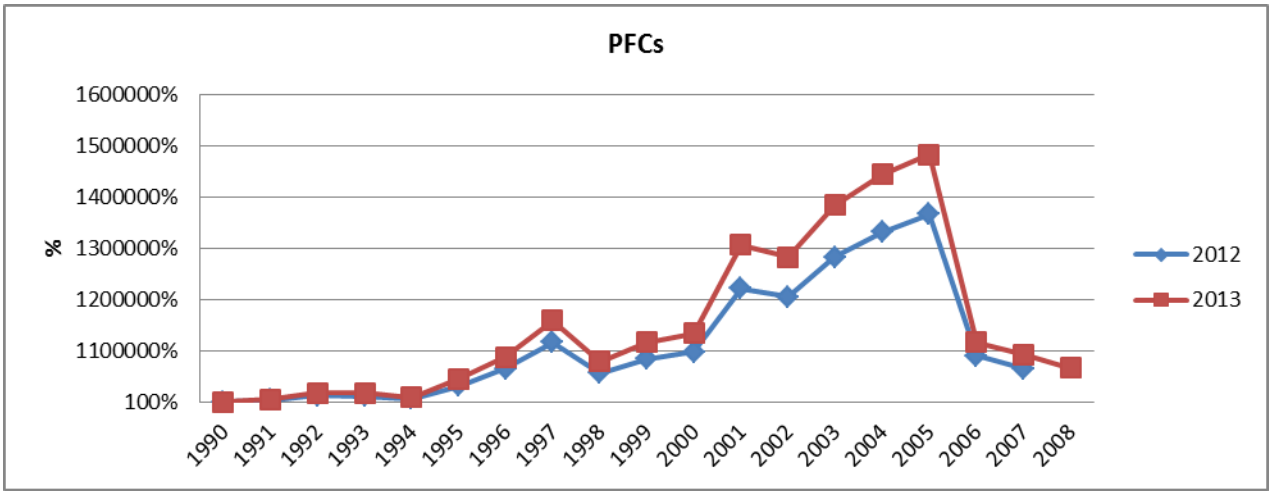


Fig. 10-5 Difference in trends of PFCs emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of SF_6 are illustrated on Fig. 10-6. Both curves are following the same pattern. The SF_6 emission trend, in 2013 is lower on average with 0,001%, through the whole time period.

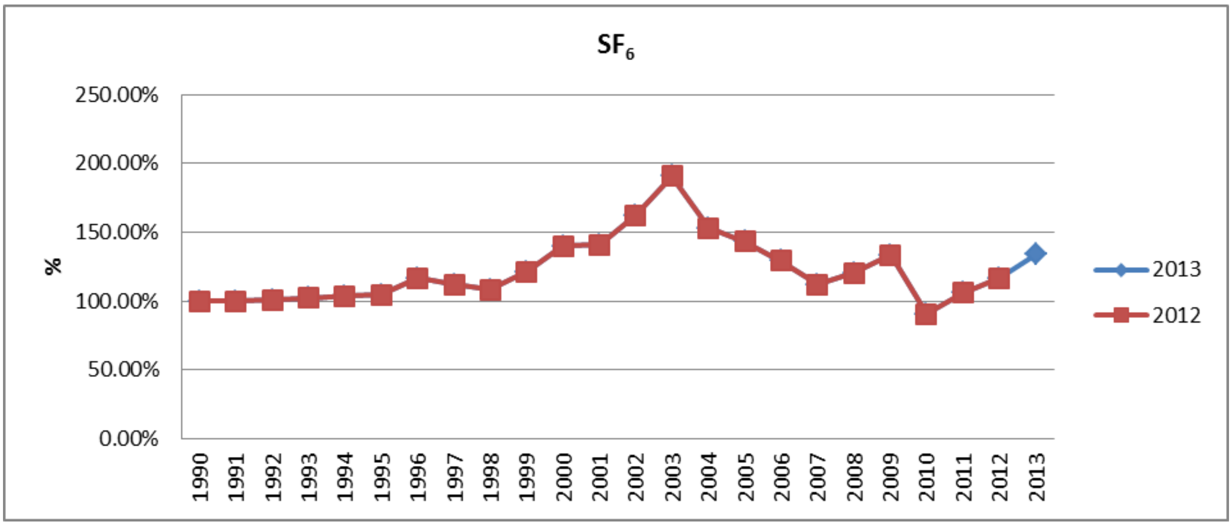


Fig. 10-6 Difference in trends of SF_6 emissions in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

10.3.5 Implications for emission trends and time-series consistency of total emissions

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of total emissions, including LULUCF are illustrated on Fig. 10-7. Both curves are following the same pattern. The total emissions including LULUCF trend, in 2013 is higher on average with 2.5%, through the whole time period.

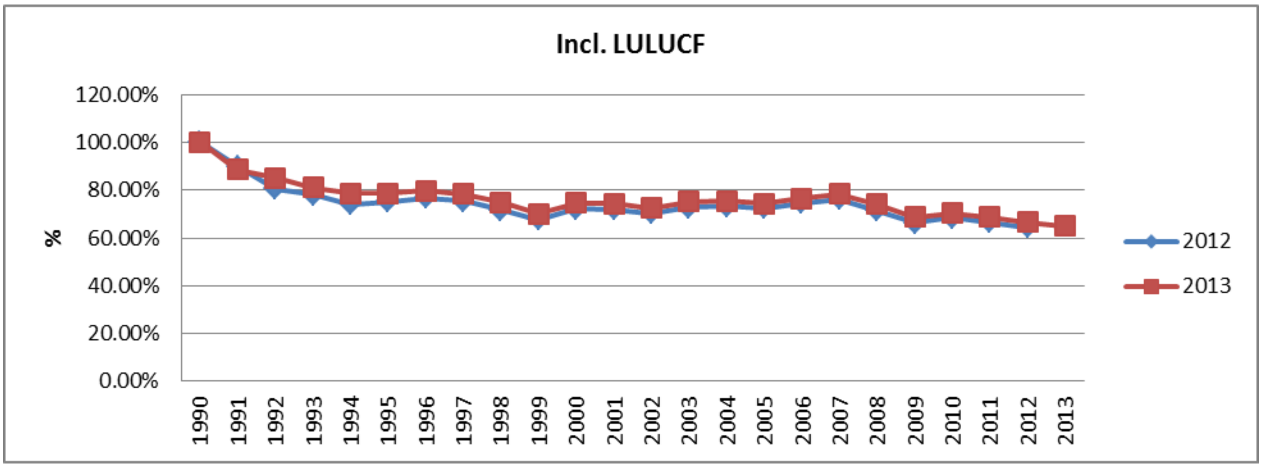


Fig. 10-7 Difference in trends of total emissions including LULUCF in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

The influence of the recalculations and implementation of the IPCC, 2006 for the emission trend of total emissions, excluding LULUCF are illustrated on Fig. 10-8. Both curves are following the same pattern. The total emissions excluding LULUCF trend, in 2013 is higher on average with 1%, through the whole time period.

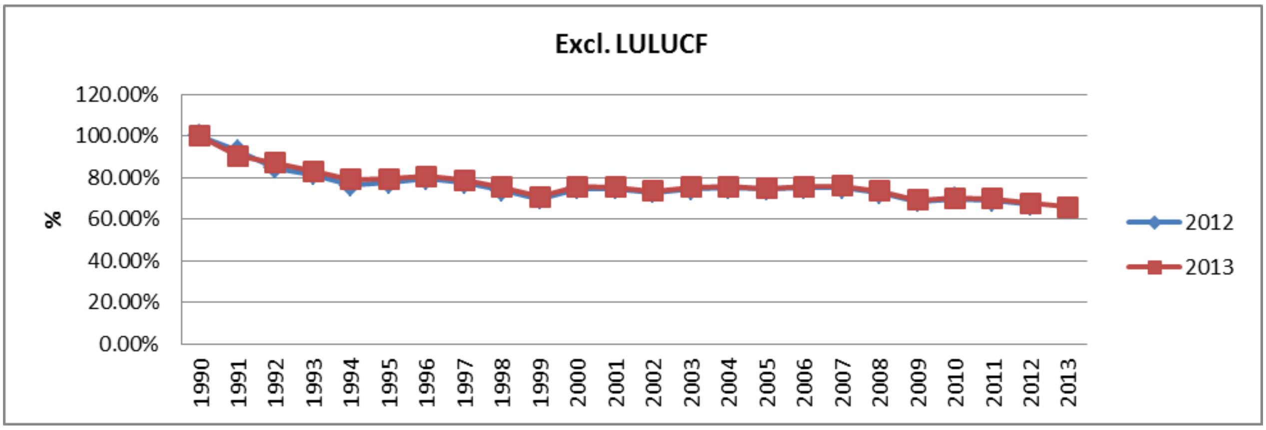


Fig. 10-8 Difference in trends of total emissions including LULUCF in index form, between the years 2012 and 2013, due to recalculations and implementation of the IPCC 2006 methodology (1990 = 100%)

10.4 Planned improvements, including in response to the review process

Each year, the Czech inventory team analyses the findings of ERT (the Expert Review Team) and attempts to improve the quality of the inventory by implementation of the relevant recommendations.

An overview of previous findings and the relevant follow up by the Czech Republic was given in the previous NIRs (CHMI, 2012 and 2013). In this report, attention is focused on the two last reviews.

In September 2010, the Czech Republic was subjected to a centralised review in Bonn. However, the relevant draft of the ARR 2010 was submitted from UNFCCC rather late, only on 17 February 2011, at the time when this report (2011 submission) was being written. The final version was issued only on 28 March 2011. Therefore it was not possible to implement most of the ERT recommendations.

During the centralised review in September 2010, the Expert Review Team (ERT) identified a potential problem in the incomplete reporting of category 1.B.2.a.ii (Oil Production). In this subcategory, the Czech Republic reported only CH_4 emissions from oil production, while CO_2 emissions and emissions of CO_2, CH_4 and N_2O from venting and flaring were not reported. Therefore, the Czech Republic prepared the resubmission of CRF (within 6 weeks) in order to respect this ERT finding. In addition, ERT highlighted the necessity for full implementation of the QA/QC plan, better harmonization of information given in NIR and in CRF, improvement of time series consistency (mainly in Energy and Waste) and correct use of the notation key in CRF Tables.

In September 2011 (ARR 2011), the Czech Republic was subjected to the In-country-review in Prague. During the review, ERT identified the following "potential problem" in Agriculture: emissions of N_2O from Manure management – 4.B.1 (even though this category was not identified as a Key Category). ERT claimed that the default factor used causes underestimation of the reported N_2O emission from Manure management. This potential problem was successfully resolved in time (during a 6 week period).

In addition, ERT reiterated some recommendations from previous reviews regarding e.g. updating and replenishment of the QA/QC plan including refinement of the existing archiving system, development of an improvement plan and increasing stress on implementation for higher Tier methods for Key Categories.

Work on an updated QA/QC plan has been completed (see Chapter 1); the improvement plan, which includes also gradual implementation of higher Tiers, is presented in this chapter, together with an overview of the main improvements implemented so far in comparison with the 2011 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.

In September 2012, the Czech Republic was subjected to the centralised review in Bonn. During the review ERT identified the "potential problem" regarding following categories:

1) CO_2 emissions from 1.A Stationary Combustion
11) CO_2, CH_4 and N_2O emissions from 1.A.3.a Civil Aviation
12) CH_4 and N_2O emissions from 1.A.4.b Residential
13) CH_4 emissions from 1.B.1.b Solid Fuel Transformation
14) N_2O emissions from 4.D.1.3 N-fixing crops
15) N_2O emissions from 4.D.1.4 Crop residue
16) CH_4 emissions from 6.A Solid Waste Disposal
17) CH_4 and N_2O emissions from 6.C Waste Incineration.

Issues 1), 3) – 6) were fully accepted by the Czech team and recalculated according to ERT instructions in time (during a 6 week period). Brief description of these recalculations is given above (Reporting under 3.1(e)). After resubmission the national GHG emissions total was by 365.5 Gg (i.e. 0.27% of total GHG emissions) higher.

Other issues 2), 7), 8) were carefully considered and were solved (without recalculation) by the Czech team by more transparent and more detailed explanation of the adequacy of used methods. Finally, ERT considered the whole “potential problem” as resolved.

In September 2013, the Czech Republic was subjected to the centralised review in Bonn. During the review ERT identified following potential problems:

1) Relevant background information and a descriptive summary of the revisions made by the Czech Republic in its 2013 inventory submission, in particular in the year 2011 with respect to HFC, PFC and SF_6 emissions from consumption of halocarbons and SF_6 and N_2O emissions from domestic and commercial wastewater handling (human sewage);

18) A complete resubmission of the 2013 CRF tables, reflecting the revised estimates;

19) Party’s revision of the calculation of the commitment period reserve, based on the recalculated emissions reported for 2011, if the calculation of the commitment period reserve is based on the inventory and not the assigned amount.

All issues were accepted and the revised estimates were submitted in time.

Unfortunately, the relevant draft of the ARR has not been made available before official submission of this report. Therefore, it was not possible to take into account in this submission (15 March 2014) possible finding of ERT except those mentioned in the Saturday paper.

Overview of all actual recalculations (compared with the April’s 2013 submission) are given above (Chapter 10.2)

10.4.1 Overview of implemented improvements in the 2015 submission

The following table summarises the main changes and that were performed in 2013 submissions in comparison with previous submissions. Most of changes were implemented in order to comply with the relevant recommendations made by the Expert Review Teams in recent UNFCCC reviews (considered mainly in ARR 2010 and ARR 2011). Other changes were motivated by endeavours of the Czech team to improve the inventory quality.

In September 2013, the Czech Republic was subjected to the centralised review in Bonn. However, the relevant draft of the ARR 2013 was not submitted so far. Therefore possible improvements based on ARR 2013 will be addressed only in the 2015 submission (except findings formulated in “Saturday paper” as potential problems that were resolved in time – resubmission in October 2013).

Other changes were motivated by endeavours of the Czech team to improve the inventory quality. Some of them were performed in accordance with Improvement Plan.

For changes in methodological descriptions please see Tab. 10-2.

Tab. 10-1 Table of implemented improvements in the 2015 submission

Topic/Category, gas	Description of the change	Reason (motive) of the change	Reference to NIR or CRF Table
Sector: General issues			
QA/QC	Improved and updated QA/QC plan	ARR 2010, para 27, 37d ARR 2011, para 30, 31, 55b	NIR, chapter 1.5 NIR, chapters 3 – 8
Improvement plan	Updated Improvement plan	ARR 2010, para 16, para 37a ARR 2011,. para	NIR, chapter 10.3.2

Topic/Category, gas	Description of the change	Reason (motive) of the change	Reference to NIR or CRF Table
		32,33	
Archiving	Revised archiving routines	ARR 2010, para 34, 38b ARR 2011, para 48	NIR, chapter 1.3.3
Sector: Energy – emissions from combustion			
1.A	New country specific CO_2 emission factor for Bituminous and Coking Coals and Lignite	Improvement suggested by Party	NIR, chapter 3.7.1, Annex 3
1.A	New country specific oxidation factors for Bituminous Coal, Lignite and Brown Coal Briquettes	Improvement suggested by Party	NIR, chapter 3.7.1, Annex 3
1.A	New country specific NCV/GCV ratio for Natural Gas and Coke Oven Gas	Improvement suggested by Party	NIR, chapter 3.7.1, Annex 5
1	Implementation of updated emission factors	Implementation of 2006 IPCC Guidelines	NIR, chapter 3.
Sector: Industrial processes and Other Product Use			
2.A.2	Updated country specific emission factor	Improvement suggested by Party	NIR, chapter 4.4
2	Updated methodology for subsectors.	Implementation of 2006 IPCC Guidelines	NIR, chapter 4
Sector: Agriculture			
3.B, N_2O	Indirect emissions from Manure Management was added to the emission inventory	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.2.
3.D, N_2O	Sewage sludge as a source of emissions was added to Organic N applied as fertilizer.	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.3
3.D, N_2O	Two different EF3 were applied to calculate emissions from Urine and dung N deposited on pasture by grazing animals..	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.3
3.D, N_2O	New method and parameters were applied to calculate the emissions from N-crop residues.	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.3
3.G, CO_2	Liming on agricultural soils (incl. forest areas) was removed from LULUCF to Agriculture sector	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.7
3.H, CO_2	Urea application was added as a new source of emissions to the emission inventory	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.8
3.B, N_2O	Indirect emissions from Manure Management was added to the emission inventory	Implementation of 2006 IPCC Guidelines	NIR, chapter 5.2.
Sector: LULUCF			
4.A, 4.B, 4.C	Correcttions, revised emission factors (GWPs) for N_2O and CH_4	Improvements suggested by Party	NIR, chapter 6.4.5, 6.5.5 , 6.6.5
4.B	Changed reporting structure – removing contribution of emissions associated with lime application	Improvements arising from implementing new reporting structure	NIR, chapter 6.5.5
4.G	Newly reported category under LULUCF	Improvement arising from new reporting requirements for LULUCF	NIR, chapter 6.10
Unassigned	Indirect emissions from atmospheric deposition of N volatized from managed soils newly reported under Table 4(IV)	Improvement arising from new reporting requirements for LULUCF	NIR, chapter 6.5.2
4	Updated methodology for subsectors.	Implementation of 2006 IPCC Guidelines	NIR, chapter 6
Sector: Waste			
5	Updated methodology for subsectors.	Implementation of 2006 IPCC Guidelines	NIR, chapter 7

Tab. 10-2 Methodological descriptions in submission 2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
Total (Net Emissions)			More detailed information for each recalculation is provided in Table 10-1 and in relevant Chapters of NIR
1. Energy	√	√	
A. Fuel Combustion (Sectoral Approach)	√	√	
1. Energy Industries	√	√	
2. Manufacturing Industries and Construction	√	√	
3. Transport	√	√	
4. Other Sectors	√	√	
5. Other	√	√	
B. Fugitive Emissions from Fuels	√	√	
1. Solid Fuels	√	√	
2. Oil and Natural Gas and Other emissions from Energy Production	√	√	
C. CO2 transport and storage			
2. Industrial Processes	√	√	
A. Mineral Industry	√	√	
B. Chemical Industry	√	√	
C. Metal Industry	√	√	
D. Non-energy Products from Fuels and Solvent Use	√	√	
E. Electronics Industry	√	√	
F. Product Uses as Substitutes for ODS	√	√	
G. Other Product Manufacture and Use	√	√	
3. Agriculture	√	√	
A. Enteric Fermentation	√	√	
B. Manure Management	√	√	
C. Rice Cultivation	NO	NO	
D. Agricultural Soils	√	√	
E. Prescribed Burning of Savannas	NO	NO	
F. Field Burning of Agricultural Residues	NO	NO	
G. Liming	√	√	
H. Urea Application	√	√	
I. Other Carbon-containing Fertilizers	NO	NO	
J. Other	NO	NO	
4. Land Use, Land-Use Change and Forestry		√	
A. Forest Land	√	√	
B. Cropland	√	√	
C. Grassland	√	√	
D. Wetlands			
E. Settlements			
F. Other Land			
G. Harvested Wood Products	√	√	
H. Other			
5. Waste	√	√	
A. Solid Waste Disposal	√	√	
B. Biological treatment of solid waste	√	√	
C. Incineration and open burning of waste	√	√	
D. Wastewater treatment and discharge	√	√	
E. Other	√	√	
6. Other (as specified in Summary 1.A)	NO	NO	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
KP LULUCF	Not reported in this submission	Not reported in this submission	
Article 3.3 activities			
Afforestation/reforestation			
Deforestation			
Article 3.4 activities			
Forest management			
Cropland management (if elected)			
Grazing land management (if elected)			
Revegetation (if elected)			
Wetland drainage and rewetting (if elected)			
Memo Items:			
International Bunkers			
Aviation		√	
Marine		√	
Multilateral Operations		√	
CO_2 Emissions from Biomass		√	
CO_2 Captured		NO	
Long-term storage of C in waste disposal sites		√	
Indirect N_2O		√	
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR includes major changes		**If ticked please provide some more detailed information**
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

10.4.2 Improvement plan

Provisional Improvement plan was included in the NIR already last year and in this submission was updated and supplemented. This plan is in accordance with the recommendation of the international Expert Review Team (ERT) and concentrates particularly on introduction the more sophisticated procedures of the higher Tiers. These procedures employ country-specific emission factors and other parameters required for determining greenhouse gas emissions. However, it is rather difficult to obtain the data required for these purposes, especially at the present time, when only limited funds are available for the national inventory. Thus, it is planned to introduce the procedures of the higher Tiers gradually, over a longer time interval. In accordance with the IPCC methodology, emphasis is simultaneously put on Key categories. The following table gives the anticipated timetable for introduction of these procedures. As announced in the last submission, the country-specific emission factor for estimating CO_2 emissions from combustion of Natural Gas has been determined (please see Annex 2). These factors were already employed in this submission (see Chapter 3).

In addition to the planned introduction of the procedures of the higher Tiers in the individual sectors, the Improvement plan also includes a more general aspect. For instance last year have been revised uncertainty estimates. A substantial improvement in this respect has already appeared in this submission (see Chapter 1).

Furthermore Improvement Plan also includes using of EU ETS data for the purposes of national inventory. Substantial effort is put into implementation of this issue. In this submission EU ETS data were used for emission estimates in some subcategories in 2.A Mineral Product (e.g. 2.A.1 Cement Production). EU ETS data would be useful tool for QA/QC procedures also in Energy sector.

With the implementation of this issue could help also MS assistance project (Assistance to MS with KP Reporting) which is now under operation. Issue of implementation of EU ETS data was raised by the Czech Republic. Another issues concerning Energy and IP sector were raised in this assistance project.

In the next submission IPCC 2006 Guidelines will be introduced in the inventory. Application of this methodology will bring several changes in categorisation and also in allocation of emissions. For instance emission from desulphurisation will be no longer reported in category 2.A.3 Limestone and Dolomite Use, but will be include in Energy sector. In Energy sector will occur more detailed categorization. The IPPU and Energy sector will require more intensive cooperation since more issues about emission allocation will occur.

The sectors Industrial Processes and Solvent Use will be coupled together in the sector Industrial Processes and Other Product Use. Similar situation will occur in the case of Agriculture and LULUCF sectors, which will be coupled in to AFOLU sector – Agriculture, Forestry and Other Land Use. Both these sectors connecting will introduce changes in categorisations. Specific changes and suggestions for improvements in the individual sectors are described in the sections entitled “Source-specific planned improvements”, which are included in all the sector chapters.

Tab. 10-3 Plan of improvements for key categories

Sector	Key Categories (KC)	GHG	% *) GHG	Type of KC	Present situation	Planned improvement	For submission
1.A.1.a.i	Public electricity and heat production	AD			Activity data reported under 1.A.1.a.i	Distribution of fuel consumption in each subsector of 1.A.1.a	2017
1.A.1.b	Petroleum Refining	AD			Activity data fluctuation in 1993 till 1995	Research and possibly update of activity data for 1993 - 1995	2016
1.A.2.a	Iron and steel	AD			Consumption of coke oven gas is all reported under 1.A.2.a	Obtaining of data of Coke Oven Gas delivery to other facilities than the main metallurgical installations; possible reallocation of activity data based on this research	2016 2017
1A	1A.3.b Transport - Road Transportation	CO_2	10.59	LA,TA	Activity data for PC and LDT are reported together	Split activity data for PC and LDT to their own categories	2018
1.A.4.a	Commertial/Institutional	AD			Activity data fluctuation in 1991 till 1995	Detailed research of data at the beginning of 90s is planned for the future submissions	2017
3	3.A Enteric Fermentation	CH_4		LA,TA	Tier 2	Update initial zoo-technical data (cattle)	2016
3	3.B Manure Management	CH_4		LA,TA	Tier 2	Data on weight, B0 and VS for both dairy and non-dairy cattle will be included in CRF tables	2016
3	3.D.1 Agricultural Soils, Direct Emissions	N_2O		LA,TA	Tier 2	Apply country-specific parameters for crops	2016
4	4.D.1 Agricultural Soils, Direct Emissions	N_2O	2.78	LA,TA	Tier 2	Defaults EFs from 2006 Guidelines, Country specific parameters for crops	2015
4	4.D.3 Agricultural Soils, Indirect Emissions	N_2O	1.79	LA,TA	Tier 1	Application of defaults EFs from 2006 Guidelines with regard to good practice principle	2015
4	4.A.1 Forest	CO_2		LA,TA	Tier 3	Revised EFs on carbon content in	2016

Sector	Key Categories (KC)	GHG	% *) GHG	Type of KC	Present situation	Planned improvement	For submission
	Land remaining Forest Land	N_2O CH_4				wood	
4	HWP	CO_2		LA,TA	Tier 2	Revision of the approach used	2016
5	5.B Biological treatment of solid waste	CH_4, N_2O			Tier 1,2	Research data availability prior 2005	2016
5	5.B.2 Anaerobic digestion	CH_4			Tier 2	Review current leakages EF used	2016
5	5.C.2 Open burning of waste	CO_2			Tier 1	Research methodology on fires and open burning of waste	2017
5	5.D Waste water treatment	CH_4		LA, TA	Tier 1	Review of method, streamlining of worksheets, critical data review	2017

Part 2: Supplementary Information Required under Article 7, paragraph 1

11 KP LULUCF

Since this submission is only under the Convention (not under KP), there is no detailed information concerning KP LULUCF provided.

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 2014 to 31st of December 2013 is provided in standard electronic format in Annex A5. 6.

12.2 Summary of information reported in the SEF tables

The total number of AAUs in the registry at the end of the year 2014 corresponded to 683,186,585 t CO_2 eq., of which 348,536,263 units were in the Party holding account, 334,650,295 in the retirement account and 27 in other cancellation accounts.

The number of ERUs in registry corresponded to 14,006 t CO_2 eq., in the party holding account and 18,735,943 in the retirement account.

The CER units in the registry corresponded to 19,888,351 t CO_2 eq., of which 5,750 units were in the party holding account, 19,874,444 in the retirement account and 8,157 in other cancellation accounts.

There 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 corresponded to 721,824,885 t CO_2 eq.

The Czech Republic's assigned amount equals 789,859,031 t CO_2 eq.

12.3 Discrepancies and notifications

No CDM notifications and non-replacements occurred in 2014.

No invalid units exist as at 31 December 2014.

No discrepant transactions occurred in 2014.

12.4 Publicly accessible information

Non-confidential information in accordance with decision 13/CMP.1, annex, chapter II.E, paragraphs 44–48, is provided in the Public Reports section of the registry website at:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

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 (2013), which is calculated below[15].

5 x 127,143,93 = 635,719,651 tonnes CO_2 eq.

[15] *For CPR calculation used Czech Republic's total CO_2 equivalent emissions without LULUCF in 2013 (source: CZE-2015-2013.xls, Table10s6, cell: Z18).*

13 Information on changes in National System

There Czech national inventory system has undergone major staffing changes.

- The role of coordinator of national inventory process was transferred to Ing. Eva Krtková, who has been part of the national inventory team for 6 years already
- Ing. Ondřej Miňovský is no longer part of the team of the Czech national inventory system
- Ing. Martin Beck has been hired as new sectoral expert to support inventory in Industrial processes and product use sector
- Denitsa Troeva Grozeva, MSc. has been hired to support national inventory team in scope of QA/QC process and Waste sector

The National Inventory Team also obtained higher funding from Ministry of Environment, which is further improving the cooperation with sectoral experts and sectoral institutions. Since 2015 the contracts with relevant sectoral institution were signed for four years. Since previous years the contracts were signed only for one year this step means significant strengthening of National System.

No other significant changes were made and the main pillars of the national inventory system declared in the Czech Republic's Initial Report under the Kyoto Protocol are operational and running.

14 Information on Changes in National Registry

14.1 Previous Review Recommendations

In document FCCC/ARR/2014/CZE ERT requested the Party to include non-confidential up-to-date holding and transaction information in its publicly available information. The non-confidential holding and transaction information was made available at the registry website:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

14.2 Changes to National Registry

The following changes to the national registry of the Czech Republic have therefore occurred in 2014:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	Registry administrators Ms Zuzana Stašková and Ms Helena Hůlová are on their maternity leaves. There are 2 new registry administrators in the team: • Mr Martin Štandera, email MStandera@ote-cr.cz, tel. +420 296 579 329 and • Ms Andrea Macková, email AMackova@ote-cr.cz, tel. +420 296 579 332.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Versions of the CSEUR released after 6.1.7.1 (the production version at the time of the last Chapter 14 submission) introduced changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was carried out in February 2015 and the test report is attached as Annex H. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is on the address: https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml There are reports: • Account Information (Paragraph 45) • Joint Implementation Project Information (Paragraph 46) • Unit Holding and Transaction Information (Paragraph 47) • Entities Authorised to hold Units (Paragraph 48)
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2015 and the test report is attached as Annex H.

15 Information on Minimization of Adverse Impact in Accordance with Art. 3, para 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. More information on EU wide policies is available in chapter 15 of the Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014 and will be also provided in the European Union submission for the year 2015. The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Tab 15-1 Actions implementation by party as 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. The introduction of carbon tax was proposed and discussed but the government decided to wait for the outcome of proposal for EU wide harmonisation.
(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. In 2009 and 2010 the project "Towards geological storage of CO_2 in the Czech Republic" (TOGEOS) was carried out. Resullts were published in article: D.G. Hatzignatiou, F. Riis, R. Berenblyum, V. Hladik, R. Lojka, J. Francu, Screening and evaluation of a saline aquifer for CO_2 storage: Central Bohemian Basin, Czech Republic, International Journal of Greenhouse Gas Control, Volume 5, Issue 6, November 2011. There is currently no ongoing or CCS programme or demonstration project in the Czech Republic. On 31st March 2014 the first open call for applications to fund individual projects within the Programme CZ08 "Pilot Studies and Surveys on CCS Technology (Carbon Capture and Storage)" under the so called Norway Grants.
(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	The Czech Republic is cooperating in several bilateral development assistance projects focusing on reduction of fossil fuels dependence and development of

consumption of fossil fuels in diversifying their economies.	renewable energy sources, inter alia: - Increasing energy independence of remote regions in Georgia with solar thermal and photovoltaic systems - Construction of biomass heating plant and heat distribution network in Bosnia and Herzegovina - Development of biogas and photovoltaic energy sources in rural areas of Vietnam - Subsidizing biodigesters construction in rural areas of Cambodia to stimulate the emerging market All of the above mentioned projects are being implemented in the period 2011 – 2013.

16 Other Information

No other information submitted in 2013.

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Abbreviations

AACLC	Aggregate areas of cadastral land categories
APL	Association of Industrial Distilleries (Asociace průmyslových lihovarů)
ARR	Annual Review Report
AVNH	Association of Coatings Producers (Asociace výrobců nátěrových hmot)
AWMS	Animal Waste Management System
BOD	Biochemical Oxygen Demand
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	Czech Gas Association
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
COP	Conference of Parties
COSMC	Czech Office for Surveying, Mapping and Cadastre
COŽP UK	Centrum pro otázky životního prostředí Univerzity Karlovy
CUEC	Charles University Environment Center
CULS	Czech University of Life Sciences
CzechTerra	Czech Landscape Inventory
ČPS	Czech Gas Association (Český plynárenský svaz)
DOC	Degradable Organic Carbon
EEA	European Environmental Agency
EIG	Emission Inventory Guidebook
ERT	Expert Review Team
ETS	Emission Trading Scheme
FAO	Food and Agriculture Organization
FMI	Forest Management Institute, Brandýs nad Labem
FMP	Forest Management Plans
FOD (model)	First Order Decay (model)
GHG	Greenhouse Gas
HDV	Heavy Duty Vehicle
CHMI	Czech Hydrometeorological Institute
IEA	International Energy Agency
IFER	Institute of Forest Ecosystem Research (Ústav pro výzkum lesních ekosystémů)
IGU	International Gas Union
IPCC	Intergovernmental Panel of Climate Change
IPR	Integrated Pollution Register
ISPOP	Integrated system of mandatory reporting (Integrovaný systém plnění ohlašovacích povinností)
LDV	Light Duty Vehicle
LPG	Liquid Petroleum Gas
LTO	Landing/Taking-off
LULUCF	Land Use, Land-Use Change and Forestry
MA	Ministry of Agriculture
MCF	Methane Correction Factor
MIT	Ministry of Industry and Trade

MoE	Ministry of Environment
MSW	Municipal Solid Waste
NACE	Nomenclature Classification of Economic Activities
NIR	National Inventory System
NIS	National Inventory System (National system under Kyoto protocol, Art. 5)
OKD, a.s.	Ostrava – Karvina Mines (Ostravsko karvinské doly, a.s.)
OTE	Electricity Market Operator (Operátor trhu s elektřinou, a.s.)
PC	Passenger Car
QA/QC	Quality Assurance/Quality Control
RA	Reference Approach
REZZO	Register of Emissions and Sources of Air Pollution (Registr emisí a zdrojů znečišťování ovzduší)
SA	Sectoral Approach
SWDS	Solid Waste Disposal Sites
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nation Framework Convention on Climate Change
ÚVVP	Institute for Research and Use of Fuels (Ústav pro výzkum a využití paliv)
VŠCHT	Institute of Chemical Technology (Vysoká škola chemicko technologická)

List of figures

Annexes to the National Inventory Report

Annex 1 Key Categories

Key Categories were estimated using IPCC 2006 Gl. approach 1 including and excluding LULUCF. Tables A1-1 till A1-4 followed the approach in Tables 4.2 and 4.3 of the IPCC 2006 Gl.

Tab. A1- 1 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2013 – Level Assessment including LULUCF

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (Gg)	ABS Latest Year Emission or Removal Estimate (Gg)	LA,%	Cumulative Total (LA,%)
1.A Stationary Combustion - Solid Fuels	CO_2	60368.33	60368.33	39.53	39.53
1.A Stationary Combustion - Liquid Fuels	CO_2	18357.47	18357.47	12.02	51.56
1.A Stationary Combustion - Gaseous Fuels	CO_2	15722.85	15722.85	10.30	61.85
1.A.3.b Transport - Road Transportation	CO_2	15619.03	15619.03	10.23	72.08
4.A.1 Forest Land remaining Forest Land	CO_2	-7116.70	7116.70	4.66	76.74
2.C.1 Iron and Steel Production	CO_2	6543.14	6543.14	4.28	81.03
5.A Solid Waste Disposal on Land	CH_4	3324.45	3324.45	2.18	83.20
1.B.1.a Coal Mining and Handling	CH_4	3155.23	3155.23	2.07	85.27
2.F.1 Refrigeration and Air Conditioning Equipment (CO2 eq.)	HFC	2606.81	2606.81	1.71	86.98
3.A Enteric Fermentation	CH_4	2412.48	2412.48	1.58	88.56
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	2220.13	2220.13	1.45	90.01
2.A.1 Cement Production	CO_2	1331.79	1331.79	0.87	90.88
3.B Manure Management	N_2O	1194.62	1194.62	0.78	91.66
2.B.8 Petrochemical and carbon black production	CO_2	945.03	945.03	0.62	92.28
4.G Harvested wood products	CO_2	791.82	791.82	0.52	92.80
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	735.56	735.56	0.48	93.28
1.A Stationary Combustion - Liquid Fuels	N_2O	660.41	660.41	0.43	93.72
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	627.94	627.94	0.41	94.13
2.A.2 Lime Production	CO_2	605.53	605.53	0.40	94.52
2.B.1 Ammonia Production	CO_2	601.13	601.13	0.39	94.92
1.A.3.b Transport - Road Transportation	N_2O	599.44	599.44	0.39	95.31
5.D Wastewater treatment and discharge	CH_4	589.14	589.14	0.39	95.70
3.B Manure Management	CH_4	564.25	564.25	0.37	96.07
5.B Biological treatment of solid waste	CH_4	544.95	544.95	0.36	96.42
2.C.2 Ferroalloys Production	CH_4	423.40	423.40	0.28	96.70
1.A Stationary Combustion - Biomass	CH_4	422.31	422.31	0.28	96.98
4.A.2 Land converted to Forest Land	CO_2	-356.86	356.86	0.23	97.21
4.C.2 Land converted to Grassland	CO_2	-320.72	320.72	0.21	97.42
1.A.3.c Transport - Railways	CO_2	270.60	270.60	0.18	97.60
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	253.89	253.89	0.17	97.76
1.A Stationary Combustion - Solid Fuels	CH_4	250.88	250.88	0.16	97.93
1.A Stationary Combustion - Solid Fuels	N_2O	248.26	248.26	0.16	98.09
2.G.3 N_2O from product uses	N_2O	223.50	223.50	0.15	98.24
1.A Stationary Combustion - Other fuels - MSW	CO_2	214.21	214.21	0.14	98.38
2.B.2 Nitric Acid Production	N_2O	211.88	211.88	0.14	98.52
5.D Wastewater treatment and discharge	N_2O	203.73	203.73	0.13	98.65
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	197.42	197.42	0.13	98.78
1.B.1.a Coal Mining and Handling	CO_2	194.88	194.88	0.13	98.91
5.C Incineration and open burning of waste	CO_2	175.67	175.67	0.12	99.02
3.G Liming	CO_2	135.50	135.50	0.09	99.11
2.A.3 Glass Production	CO_2	115.76	115.76	0.08	99.19
1.A Stationary Combustion - Biomass	N_2O	113.48	113.48	0.07	99.26
2.A.4 Other process uses of carbonates	CO_2	102.93	102.93	0.07	99.33
2.D.1 Lubricant Use	CO_2	94.91	94.91	0.06	99.39
1.A.3.e Transport - Other Transportation	CO_2	92.27	92.27	0.06	99.45
4.B.2 Land converted to Cropland	CO_2	85.00	85.00	0.06	99.51
4.E.2 Land converted to Settlements	CO_2	83.16	83.16	0.05	99.56
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.05	99.61
4.A.1 Forest Land remaining Forest Land	CH_4	64.78	64.78	0.04	99.65

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (Gg)	ABS Latest Year Emission or Removal Estimate (Gg)	LA,%	Cumulative Total (LA,%)
1.A.5.b Other mobile sources not included elsewhere	CO_2	46.44	46.44	0.03	99.68
2.B.8 Petrochemical and carbon black production	CH_4	46.26	46.26	0.03	99.71
2.C.2 Ferroalloys Production	CO_2	45.60	45.60	0.03	99.74
2.F.3 Fire Protection (CO_2 eq.)	HFC	41.17	41.17	0.03	99.77
5.B Biological treatment of solid waste	N_2O	40.22	40.22	0.03	99.80
2.C.5 Lead Production	CO_2	36.05	36.05	0.02	99.82
1.A.3.c Transport - Railways	N_2O	31.12	31.12	0.02	99.84
4.D.2. Land converted to Wetlands	CO_2	29.38	29.38	0.02	99.86
1.A Stationary Combustion - Liquid Fuels	CH_4	22.83	22.83	0.01	99.87
1.A.3.b Transport - Road Transportation	CH_4	22.60	22.60	0.01	99.89
1.A Stationary Combustion - Gaseous Fuels	CH_4	21.76	21.76	0.01	99.90
4.B.1 Cropland remaining Cropland	CO_2	-15.36	15.36	0.01	99.91
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	13.13	13.13	0.01	99.92
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	12.56	12.56	0.01	99.93
2.F.4 Aerosols (CO_2 eq.)	HFC	12.03	12.03	0.01	99.94
2.C.1 Iron and Steel Production	CH_4	9.71	9.71	0.01	99.94
1.A Stationary Combustion - Gaseous Fuels	N_2O	8.47	8.47	0.01	99.95
1.A.3.a Transport - Domestic Aviation	CO_2	7.52	7.52	0.00	99.95
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	6.40	6.40	0.00	99.96
1.A.3.d Transport - Domestic navigation	CO_2	6.37	6.37	0.00	99.96
2.D.2 Paraffin Wax Use	CO_2	5.89	5.89	0.00	99.97
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	5.84	5.84	0.00	99.97
4.A.1 Forest Land remaining Forest Land	N_2O	5.31	5.31	0.00	99.97
4.B.2. Land converted to Cropland	N_2O	4.85	4.85	0.00	99.98
1.B.1.b. Solid Fuel Transformation	CH_4	4.80	4.80	0.00	99.98
2.F.5 Solvents (CO_2 eq.)	HFC	3.98	3.98	0.00	99.98
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	3.82	3.82	0.00	99.98
2.G.2 SF6 and PFC from other product use (CO_2 eq.)	SF_6	3.29	3.29	0.00	99.99
5.C Incineration and open burning of waste	N_2O	3.19	3.19	0.00	99.99
1.A Stationary Combustion - Other fuels - MSW	N_2O	2.78	2.78	0.00	99.99
2.F.2 Foam Blowing (CO_2 eq.)	HFC	2.76	2.76	0.00	99.99
1.A.3 Transport - Biomass	N_2O	2.07	2.07	0.00	99.99
1.A.5.b Other mobile sources not included elsewhere	N_2O	1.99	1.99	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	1.75	1.75	0.00	100.00
4.C.1 Grassland remaining Grassland	CO_2	-1.29	1.29	0.00	100.00
3.H Urea application	CO_2	0.81	0.81	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.69	0.69	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.55	0.55	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.48	0.48	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.38	0.38	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.37	0.37	0.00	100.00
2.C.6 Zinc Production	CO_2	0.27	0.27	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.23	0.23	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	0.06	0.06	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	0.05	0.05	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.04	0.04	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.03	0.03	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.03	0.03	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.02	0.02	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
	Total	**137079.54**	**152701.40**	**100.00**	

Tab. A1- 2 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2013 – Trend Assessment including LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	60368.33	0.09	28.40	28.40
1.A.3.b Transport - Road Transportation	CO_2	6176.54	15619.03	0.06	17.95	46.35
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	15722.85	0.04	12.47	58.82
1.B.1.a Coal Mining and Handling	CH_4	9119.12	3155.23	0.02	5.23	64.04
4.G Harvested wood products	CO_2	-1667.36	791.82	0.02	4.70	68.75
1.A Stationary Combustion - Liquid Fuels	CO_2	22214.53	18357.47	0.01	4.28	73.03
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	2606.81	0.01	4.15	77.18
5.A Solid Waste Disposal on Land	CH_4	1979.27	3324.45	0.01	3.07	80.25
3.A Enteric Fermentation	CH_4	5023.10	2412.48	0.01	1.80	82.06
4.A.1 Forest Land remaining Forest Land	CO_2	-4635.13	-7116.70	0.01	1.78	83.84
3.B Manure Management	N_2O	2981.06	1194.62	0.00	1.45	85.29
3.G Liming	CO_2	1177.82	135.50	0.00	1.11	86.39
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	250.88	0.00	0.96	87.36
5.B Biological treatment of solid waste	CH_4	0.00	544.95	0.00	0.87	88.23
2.B.2 Nitric Acid Production	N_2O	1050.29	211.88	0.00	0.84	89.07
1.A.3.b Transport - Road Transportation	N_2O	136.73	599.44	0.00	0.80	89.87
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3851.61	2220.13	0.00	0.79	90.66
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	660.41	0.00	0.76	91.42
2.A.1 Cement Production	CO_2	2489.18	1331.79	0.00	0.68	92.10
2.C.2 Ferroalloys Production	CH_4	0.01	423.40	0.00	0.67	92.77
2.B.8 Petrochemical and carbon black production	CO_2	792.47	945.03	0.00	0.62	93.39
3.B Manure Management	CH_4	1279.88	564.25	0.00	0.54	93.93
2.A.2 Lime Production	CO_2	1336.65	605.53	0.00	0.54	94.47
2.C.1 Iron and Steel Production	CO_2	9642.54	6543.14	0.00	0.41	94.88
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	253.89	0.00	0.40	95.28
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1398.25	735.56	0.00	0.40	95.68
1.A Stationary Combustion - Biomass	CH_4	265.03	422.31	0.00	0.38	96.06
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.00	197.42	0.00	0.31	96.37
1.A Stationary Combustion - Other fuels - MSW	CO_2	24.04	214.21	0.00	0.31	96.69
1.A.3.c Transport - Railways	CO_2	653.86	270.60	0.00	0.30	96.99
5.C Incineration and open burning of waste	CO_2	23.15	175.67	0.00	0.25	97.25
4.C.2 Land converted to Grassland	CO_2	-140.72	-320.72	0.00	0.22	97.47
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	627.94	0.00	0.21	97.68
1.B.1.a Coal Mining and Handling	CO_2	456.24	194.88	0.00	0.20	97.88
5.D Wastewater treatment and discharge	CH_4	982.68	589.14	0.00	0.17	98.05
2.B.1 Ammonia Production	CO_2	990.80	601.13	0.00	0.16	98.20
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	7.52	0.00	0.14	98.35
1.A.3.e Transport - Other Transportation	CO_2	5.42	92.27	0.00	0.14	98.49
2.G.3 N_2O from product uses	N_2O	206.22	223.50	0.00	0.12	98.61
3.H Urea application	CO_2	108.53	0.81	0.00	0.12	98.74
1.A Stationary Combustion - Biomass	N_2O	57.46	113.48	0.00	0.12	98.85
4.A.2 Land converted to Forest Land	CO_2	-220.80	-356.86	0.00	0.11	98.96
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	248.26	0.00	0.11	99.08
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	46.44	0.00	0.07	99.15
2.C.2 Ferroalloys Production	CO_2	0.00	45.60	0.00	0.07	99.22
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	41.17	0.00	0.07	99.29
5.B Biological treatment of solid waste	N_2O	0.00	40.22	0.00	0.06	99.35
5.D Wastewater treatment and discharge	N_2O	234.19	203.73	0.00	0.06	99.41
1.A.3.d Transport - Domestic navigation	CO_2	56.61	6.37	0.00	0.05	99.47
2.C.5 Lead Production	CO_2	10.40	36.05	0.00	0.05	99.51
2.A.3 Glass Production	CO_2	123.66	115.76	0.00	0.05	99.56
4.E.2 Land converted to Settlements	CO_2	84.38	83.16	0.00	0.04	99.60
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.00	0.03	99.63
1.A.3.c Transport - Railways	N_2O	75.21	31.12	0.00	0.03	99.67
2.B.8 Petrochemical and carbon black production	CH_4	36.17	46.26	0.00	0.03	99.70
1.A Stationary Combustion - Liquid Fuels	CH_4	60.15	22.83	0.00	0.03	99.73
4.A.1 Forest Land remaining Forest Land	CH_4	115.16	64.78	0.00	0.03	99.76
4.D.2. Land converted to Wetlands	CO_2	22.44	29.38	0.00	0.02	99.78
2.D.1 Lubricant Use	CO_2	116.13	94.91	0.00	0.02	99.80
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	21.76	0.00	0.02	99.82
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	12.56	0.00	0.02	99.84
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	12.03	0.00	0.02	99.86
4.B.1 Cropland remaining Cropland	CO_2	-18.63	-15.36	0.00	0.01	99.87
4.B.2 Land converted to Cropland	CO_2	108.61	85.00	0.00	0.01	99.89

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.40	0.00	0.01	99.90
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	5.84	0.00	0.01	99.91
4.C.1 Grassland remaining Grassland	CO_2	5.89	-1.29	0.00	0.01	99.91
2.A.4 Other process uses of carbonates	CO_2	153.37	102.93	0.00	0.01	99.92
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.80	0.00	0.01	99.93
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	8.47	0.00	0.01	99.94
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	3.98	0.00	0.01	99.94
1.A.3.b Transport - Road Transportation	CH_4	37.50	22.60	0.00	0.01	99.95
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	0.00	3.82	0.00	0.01	99.95
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.29	0.00	0.01	99.96
5.C Incineration and open burning of waste	N_2O	0.42	3.19	0.00	0.00	99.96
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.01	2.76	0.00	0.00	99.97
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.31	2.78	0.00	0.00	99.97
1.A.3 Transport - Biomass	N_2O	0.00	2.07	0.00	0.00	99.98
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	1.99	0.00	0.00	99.98
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	16.28	13.13	0.00	0.00	99.98
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.20	1.75	0.00	0.00	99.98
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	0.05	0.00	0.00	99.99
4.A.1 Forest Land remaining Forest Land	N_2O	9.44	5.31	0.00	0.00	99.99
4.B.2. Land converted to Cropland	N_2O	8.43	4.85	0.00	0.00	99.99
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	0.06	0.00	0.00	99.99
2.C.1 Iron and Steel Production	CH_4	14.84	9.71	0.00	0.00	99.99
2.D.2 Paraffin Wax Use	CO_2	9.43	5.89	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.00	0.69	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.55	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.48	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.00	0.37	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.05	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.27	0.00	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.38	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.23	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.02	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.01	0.03	0.00	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
	Total	**194301.8**	**137079.54**	**0.32289427**	**100**	

Tab. A1- 3 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2013 – Level Assessment excluding LULUCF

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (Gg)	ABS Latest Year Emission or Removal Estimate (Gg)	LA,%	Cumulative Total (LA)
1.A Stationary Combustion - Solid Fuels	CO_2	60368.33	60368.33	41.97	41.97
1.A Stationary Combustion - Liquid Fuels	CO_2	18357.47	18357.47	12.76	54.73
1.A Stationary Combustion - Gaseous Fuels	CO_2	15722.85	15722.85	10.93	65.67
1.A.3.b Transport - Road Transportation	CO_2	15619.03	15619.03	10.86	76.52
2.C.1 Iron and Steel Production	CO_2	6543.14	6543.14	4.55	81.07
5.A Solid Waste Disposal on Land	CH_4	3324.45	3324.45	2.31	83.39
1.B.1.a Coal Mining and Handling	CH_4	3155.23	3155.23	2.19	85.58
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	2606.81	2606.81	1.81	87.39
3.A Enteric Fermentation	CH_4	2412.48	2412.48	1.68	89.07
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	2220.13	2220.13	1.54	90.61
2.A.1 Cement Production	CO_2	1331.79	1331.79	0.93	91.54
3.B Manure Management	N_2O	1194.62	1194.62	0.83	92.37
2.B.8 Petrochemical and carbon black production	CO_2	945.03	945.03	0.66	93.03
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	735.56	735.56	0.51	93.54
1.A Stationary Combustion - Liquid Fuels	N_2O	660.41	660.41	0.46	94.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	627.94	627.94	0.44	94.43
2.A.2 Lime Production	CO_2	605.53	605.53	0.42	94.85
2.B.1 Ammonia Production	CO_2	601.13	601.13	0.42	95.27
1.A.3.b Transport - Road Transportation	N_2O	599.44	599.44	0.42	95.69
5.D Wastewater treatment and discharge	CH_4	589.14	589.14	0.41	96.10
3.B Manure Management	CH_4	564.25	564.25	0.39	96.49
5.B Biological treatment of solid waste	CH_4	544.95	544.95	0.38	96.87
2.C.2 Ferroalloys Production	CH_4	423.40	423.40	0.29	97.16
1.A Stationary Combustion - Biomass	CH_4	422.31	422.31	0.29	97.46
1.A.3.c Transport - Railways	CO_2	270.60	270.60	0.19	97.65
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	253.89	253.89	0.18	97.82
1.A Stationary Combustion - Solid Fuels	CH_4	250.88	250.88	0.17	98.00
1.A Stationary Combustion - Solid Fuels	N_2O	248.26	248.26	0.17	98.17
2.G.3 N2O from product uses	N_2O	223.50	223.50	0.16	98.32
1.A Stationary Combustion - Other fuels - MSW	CO_2	214.21	214.21	0.15	98.47
2.B.2 Nitric Acid Production	N_2O	211.88	211.88	0.15	98.62
5.D Wastewater treatment and discharge	N_2O	203.73	203.73	0.14	98.76
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	197.42	197.42	0.14	98.90
1.B.1.a Coal Mining and Handling	CO_2	194.88	194.88	0.14	99.04
5.C Incineration and open burning of waste	CO_2	175.67	175.67	0.12	99.16
3.G Liming	CO_2	135.50	135.50	0.09	99.25
2.A.3 Glass Production	CO_2	115.76	115.76	0.08	99.33
1.A Stationary Combustion - Biomass	N_2O	113.48	113.48	0.08	99.41
2.A.4 Other process uses of carbonates	CO_2	102.93	102.93	0.07	99.48
2.D.1 Lubricant Use	CO_2	94.91	94.91	0.07	99.55
1.A.3.e Transport - Other Transportation	CO_2	92.27	92.27	0.06	99.61
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.05	99.66
1.A.5.b Other mobile sources not included elsewhere	CO_2	46.44	46.44	0.03	99.70
2.B.8 Petrochemical and carbon black production	CH_4	46.26	46.26	0.03	99.73
2.C.2 Ferroalloys Production	CO_2	45.60	45.60	0.03	99.76
2.F.3 Fire Protection (CO_2 eq.)	HFC	41.17	41.17	0.03	99.79
5.B Biological treatment of solid waste	N_2O	40.22	40.22	0.03	99.82
2.C.5 Lead Production	CO_2	36.05	36.05	0.03	99.84
1.A.3.c Transport - Railways	N_2O	31.12	31.12	0.02	99.86
1.A Stationary Combustion - Liquid Fuels	CH_4	22.83	22.83	0.02	99.88
1.A.3.b Transport - Road Transportation	CH_4	22.60	22.60	0.02	99.90
1.A Stationary Combustion - Gaseous Fuels	CH_4	21.76	21.76	0.02	99.91
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	13.13	13.13	0.01	99.92
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	12.56	12.56	0.01	99.93
2.F.4 Aerosols (CO_2 eq.)	HFC	12.03	12.03	0.01	99.94
2.C.1 Iron and Steel Production	CH_4	9.71	9.71	0.01	99.94
1.A Stationary Combustion - Gaseous Fuels	N_2O	8.47	8.47	0.01	99.95
1.A.3.a Transport - Domestic Aviation	CO_2	7.52	7.52	0.01	99.95
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	6.47	6.47	0.00	99.96
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	6.40	6.40	0.00	99.96
1.A.3.d Transport - Domestic navigation	CO_2	6.37	6.37	0.00	99.97
2.D.2 Paraffin Wax Use	CO_2	5.89	5.89	0.00	99.97
2.F.1 Refrigeration and Air Conditioning Equipment	PFC	5.84	5.84	0.00	99.98

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (Gg)	ABS Latest Year Emission or Removal Estimate (Gg)	LA,%	Cumulative Total (LA)
(CO_2 eq.)					
1.B.1.b. Solid Fuel Transformation	CH_4	4.80	4.80	0.00	99.98
2.F.5 Solvents (CO_2 eq.)	HFC	3.98	3.98	0.00	99.98
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	3.82	3.82	0.00	99.98
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	3.29	3.29	0.00	99.99
5.C Incineration and open burning of waste	N_2O	3.19	3.19	0.00	99.99
1.A Stationary Combustion - Other fuels - MSW	N_2O	2.78	2.78	0.00	99.99
2.F.2 Foam Blowing (CO_2 eq.)	HFC	2.76	2.76	0.00	99.99
1.A.3 Transport - Biomass	N_2O	2.07	2.07	0.00	99.99
1.A.5.b Other mobile sources not included elsewhere	N_2O	1.99	1.99	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	1.75	1.75	0.00	100.00
3.H Urea application	CO_2	0.81	0.81	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.69	0.69	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.55	0.55	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.48	0.48	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.38	0.38	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.37	0.37	0.00	100.00
2.C.6 Zinc Production	CO_2	0.27	0.27	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.23	0.23	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	0.06	0.06	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.04	0.04	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.03	0.03	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.03	0.03	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.02	0.02	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
	Total	143832.5831	143832.58	100	

Tab. A1- 4 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2013 – Trend Assessment excluding LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	60368.33	0.10	31.98	31.98
1.A.3.b Transport - Road Transportation	CO_2	6176.54	15619.03	0.06	18.75	50.73
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	15722.85	0.04	12.90	63.63
1.B.1.a Coal Mining and Handling	CH_4	9119.12	3155.23	0.02	5.67	69.30
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	2606.81	0.01	4.37	73.66
1.A Stationary Combustion - Liquid Fuels	CO_2	22214.53	18357.47	0.01	4.08	77.74
5.A Solid Waste Disposal on Land	CH_4	1979.27	3324.45	0.01	3.19	80.93
3.A Enteric Fermentation	CH_4	5023.10	2412.48	0.01	1.99	82.92
3.B Manure Management	N_2O	2981.06	1194.62	0.00	1.58	84.50
3.G Liming	CO_2	1177.82	135.50	0.00	1.19	85.69
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	250.88	0.00	1.04	86.73
5.B Biological treatment of solid waste	CH_4	0.00	544.95	0.00	0.91	87.64
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3851.61	2220.13	0.00	0.91	88.55
2.B.2 Nitric Acid Production	N_2O	1050.29	211.88	0.00	0.91	89.46
1.A.3.b Transport - Road Transportation	N_2O	136.73	599.44	0.00	0.84	90.30
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	660.41	0.00	0.79	91.09
2.A.1 Cement Production	CO_2	2489.18	1331.79	0.00	0.76	91.85
2.C.2 Ferroalloys Production	CH_4	0.01	423.40	0.00	0.71	92.55
2.B.8 Petrochemical and carbon black production	CO_2	792.47	945.03	0.00	0.63	93.19
2.C.1 Iron and Steel Production	CO_2	9642.54	6543.14	0.00	0.62	93.81
3.B Manure Management	CH_4	1279.88	564.25	0.00	0.59	94.40
2.A.2 Lime Production	CO_2	1336.65	605.53	0.00	0.59	94.99
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1398.25	735.56	0.00	0.45	95.44
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	253.89	0.00	0.43	95.86
1.A Stationary Combustion - Biomass	CH_4	265.03	422.31	0.00	0.39	96.25
1.A.3.c Transport - Railways	CO_2	653.86	270.60	0.00	0.33	96.58
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.00	197.42	0.00	0.33	96.91
1.A Stationary Combustion - Other fuels - MSW	CO_2	24.04	214.21	0.00	0.33	97.24
5.C Incineration and open burning of waste	CO_2	23.15	175.67	0.00	0.27	97.51
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	627.94	0.00	0.25	97.76
1.B.1.a Coal Mining and Handling	CO_2	456.24	194.88	0.00	0.22	97.98
5.D Wastewater treatment and discharge	CH_4	982.68	589.14	0.00	0.19	98.17
2.B.1 Ammonia Production	CO_2	990.80	601.13	0.00	0.18	98.35
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	7.52	0.00	0.15	98.51
1.A.3.e Transport - Other Transportation	CO_2	5.42	92.27	0.00	0.15	98.66
3.H Urea application	CO_2	108.53	0.81	0.00	0.13	98.79
2.G.3 N_2O from product uses	N_2O	206.22	223.50	0.00	0.13	98.91
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	248.26	0.00	0.13	99.04
1.A Stationary Combustion - Biomass	N_2O	57.46	113.48	0.00	0.12	99.16
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	46.44	0.00	0.08	99.24
2.C.2 Ferroalloys Production	CO_2	0.00	45.60	0.00	0.08	99.31
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	41.17	0.00	0.07	99.38
5.B Biological treatment of solid waste	N_2O	0.00	40.22	0.00	0.07	99.45
5.D Wastewater treatment and discharge	N_2O	234.19	203.73	0.00	0.06	99.51
1.A.3.d Transport - Domestic navigation	CO_2	56.61	6.37	0.00	0.06	99.57
2.C.5 Lead Production	CO_2	10.40	36.05	0.00	0.05	99.62
2.A.3 Glass Production	CO_2	123.66	115.76	0.00	0.05	99.66
1.A.3.c Transport - Railways	N_2O	75.21	31.12	0.00	0.04	99.70
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.00	0.04	99.73
2.B.8 Petrochemical and carbon black production	CH_4	36.17	46.26	0.00	0.03	99.77
1.A Stationary Combustion - Liquid Fuels	CH_4	60.15	22.83	0.00	0.03	99.80
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	21.76	0.00	0.02	99.82
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	12.56	0.00	0.02	99.84
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	12.03	0.00	0.02	99.86
2.D.1 Lubricant Use	CO_2	116.13	94.91	0.00	0.02	99.88
2.A.4 Other process uses of carbonates	CO_2	153.37	102.93	0.00	0.01	99.90
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.40	0.00	0.01	99.91
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	5.84	0.00	0.01	99.92
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	6.47	0.00	0.01	99.92
1.A.3.b Transport - Road Transportation	CH_4	37.50	22.60	0.00	0.01	99.93
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.80	0.00	0.01	99.94
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	8.47	0.00	0.01	99.95

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	3.98	0.00	0.01	99.95
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	0.00	3.82	0.00	0.01	99.96
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.29	0.00	0.01	99.96
5.C Incineration and open burning of waste	N_2O	0.42	3.19	0.00	0.00	99.97
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.01	2.76	0.00	0.00	99.97
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.31	2.78	0.00	0.00	99.98
1.A.3 Transport - Biomass	N_2O	0.00	2.07	0.00	0.00	99.98
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	1.99	0.00	0.00	99.98
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.20	1.75	0.00	0.00	99.99
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	16.28	13.13	0.00	0.00	99.99
2.C.1 Iron and Steel Production	CH_4	14.84	9.71	0.00	0.00	99.99
2.D.2 Paraffin Wax Use	CO_2	9.43	5.89	0.00	0.00	99.99
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	0.06	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.00	0.69	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.55	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.48	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.00	0.37	0.00	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.38	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.05	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.27	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.23	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.02	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.01	0.03	0.00	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
	Total	**200630.1**	**143832.58**		**100**	

Tab. A1- 5 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 1990 – Level Assessment including LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	Level Assessment	Cumulative Total (LA)
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	110822.55	53.37	53.37
1.A Stationary Combustion - Liquid Fuels	CO_2	22214.53	22214.53	10.70	64.06
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	11195.61	5.39	69.45
2.C.1 Iron and Steel Production	CO_2	9642.54	9642.54	4.64	74.10
1.B.1.a Coal Mining and Handling	CH_4	9119.12	9119.12	4.39	78.49
1.A.3.b Transport - Road Transportation	CO_2	6176.54	6176.54	2.97	81.46
3.A Enteric Fermentation	CH_4	5023.10	5023.10	2.42	83.88
4.A.1 Forest Land remaining Forest Land	CO_2	-4635.13	4635.13	2.23	86.11
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3851.61	3851.61	1.85	87.97
3.B Manure Management	N_2O	2981.06	2981.06	1.44	89.40
2.A.1 Cement Production	CO_2	2489.18	2489.18	1.20	90.60
5.A Solid Waste Disposal on Land	CH_4	1979.27	1979.27	0.95	91.56
4.G Harvested wood products	CO_2	-1667.36	1667.36	0.80	92.36
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1398.25	1398.25	0.67	93.03
2.A.2 Lime Production	CO_2	1336.65	1336.65	0.64	93.68
3.B Manure Management	CH_4	1279.88	1279.88	0.62	94.29
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	1212.44	0.58	94.88
3.G Liming	CO_2	1177.82	1177.82	0.57	95.44
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	1079.91	0.52	95.96
2.B.2 Nitric Acid Production	N_2O	1050.29	1050.29	0.51	96.47
2.B.1 Ammonia Production	CO_2	990.80	990.80	0.48	96.95
5.D Wastewater treatment and discharge	CH_4	982.68	982.68	0.47	97.42
2.B.8 Petrochemical and carbon black production	CO_2	792.47	792.47	0.38	97.80
1.A.3.c Transport - Railways	CO_2	653.86	653.86	0.31	98.12
1.B.1.a Coal Mining and Handling	CO_2	456.24	456.24	0.22	98.33
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	450.92	0.22	98.55
1.A Stationary Combustion - Biomass	CH_4	265.03	265.03	0.13	98.68
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	262.57	0.13	98.81
5.D Wastewater treatment and discharge	N_2O	234.19	234.19	0.11	98.92
4.A.2 Land converted to Forest Land	CO_2	-220.80	220.80	0.11	99.03
2.G.3 N_2O from product uses	N_2O	206.22	206.22	0.10	99.12
2.A.4 Other process uses of carbonates	CO_2	153.37	153.37	0.07	99.20
4.C.2 Land converted to Grassland	CO_2	-140.72	140.72	0.07	99.27
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	139.44	0.07	99.33
1.A.3.b Transport - Road Transportation	N_2O	136.73	136.73	0.07	99.40
2.A.3 Glass Production	CO_2	123.66	123.66	0.06	99.46
2.D.1 Lubricant Use	CO_2	116.13	116.13	0.06	99.51
4.A.1 Forest Land remaining Forest Land	CH_4	115.16	115.16	0.06	99.57
4.B.2 Land converted to Cropland	CO_2	108.61	108.61	0.05	99.62
3.H Urea application	CO_2	108.53	108.53	0.05	99.67
4.E.2 Land converted to Settlements	CO_2	84.38	84.38	0.04	99.72
1.A.3.c Transport - Railways	N_2O	75.21	75.21	0.04	99.75
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.04	99.79
1.A Stationary Combustion - Liquid Fuels	CH_4	60.15	60.15	0.03	99.82
1.A Stationary Combustion - Biomass	N_2O	57.46	57.46	0.03	99.84
1.A.3.d Transport - Domestic navigation	CO_2	56.61	56.61	0.03	99.87
1.A.3.b Transport - Road Transportation	CH_4	37.50	37.50	0.02	99.89
2.B.8 Petrochemical and carbon black production	CH_4	36.17	36.17	0.02	99.91
1.A Stationary Combustion - Other fuels - MSW	CO_2	24.04	24.04	0.01	99.92
5.C Incineration and open burning of waste	CO_2	23.15	23.15	0.01	99.93
4.D.2. Land converted to Wetlands	CO_2	22.44	22.44	0.01	99.94
4.B.1 Cropland remaining Cropland	CO_2	-18.63	18.63	0.01	99.95
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	16.28	16.28	0.01	99.96
2.C.1 Iron and Steel Production	CH_4	14.84	14.84	0.01	99.96
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	12.79	0.01	99.97
2.C.5 Lead Production	CO_2	10.40	10.40	0.01	99.98
4.A.1 Forest Land remaining Forest Land	N_2O	9.44	9.44	0.00	99.98
2.D.2 Paraffin Wax Use	CO_2	9.43	9.43	0.00	99.98
4.B.2. Land converted to Cropland	N_2O	8.43	8.43	0.00	99.99
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	6.12	0.00	99.99
4.C.1 Grassland remaining Grassland	CO_2	5.89	5.89	0.00	99.99
1.A.3.e Transport - Other Transportation	CO_2	5.42	5.42	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	2.20	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	1.19	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.92	0.00	100.00
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	0.75	0.00	100.00

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	Level Assessment	Cumulative Total (LA)
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.46	0.00	100.00
5.C Incineration and open burning of waste	N_2O	0.42	0.42	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.31	0.31	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	0.21	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.20	0.20	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.13	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.02	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.01	0.01	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.01	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.01	0.01	0.00	100.00
2.C.2 Ferroalloys Production	CH_4	0.01	0.01	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.00	0.00	100.00
2.C.2 Ferroalloys Production	CO_2	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	0.00	0.00	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	CH_4	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	N_2O	0.00	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.00	0.00	100.00
1.A.3 Transport - Biomass	N_2O	0.00	0.00	0.00	100.00
	Total	**194301.77**	**207667.07**	**100.00**	

Tab. A1- 6 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 1990 – Level Assessment excluding LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	LA,%	Cumulative Total (LA)
3.B Manure Management	N_2O	110822.55	110822.55	55.24	55.24
5.C Incineration and open burning of waste	CH_4	22214.53	22214.53	11.07	66.31
5.D Wastewater treatment and discharge	N_2O	11195.61	11195.61	5.58	71.89
1.B.1.a Coal Mining and Handling	CH_4	9642.54	9642.54	4.81	76.70
2.C.1 Iron and Steel Production	CO_2	9119.12	9119.12	4.55	81.24
2.F.5 Solvents (CO_2 eq.)	PFC	6176.54	6176.54	3.08	84.32
1.A Stationary Combustion - Solid Fuels	N_2O	5023.10	5023.10	2.50	86.82
1.A Stationary Combustion - Other fuels - MSW	N_2O	3851.61	3851.61	1.92	88.74
1.A Stationary Combustion - Solid Fuels	CO_2	2981.06	2981.06	1.49	90.23
2.B.1 Ammonia Production	CO_2	2489.18	2489.18	1.24	91.47
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	1979.27	1979.27	0.99	92.46
1.A Stationary Combustion - Other fuels - MSW	CH_4	1398.25	1398.25	0.70	93.15
2.A.4 Other process uses of carbonates	CO_2	1336.65	1336.65	0.67	93.82
1.A Stationary Combustion - Solid Fuels	CH_4	1279.88	1279.88	0.64	94.46
3.B Manure Management	CH_4	1212.44	1212.44	0.60	95.06
1.A Stationary Combustion - Other fuels - MSW	CO_2	1177.82	1177.82	0.59	95.65
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	1079.91	1079.91	0.54	96.19
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	1050.29	1050.29	0.52	96.71
2.A.1 Cement Production	CO_2	990.80	990.80	0.49	97.20
1.A Stationary Combustion - Gaseous Fuels	CH_4	982.68	982.68	0.49	97.69
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	792.47	792.47	0.39	98.09
2.F.4 Aerosols (CO_2 eq.)	HFC	653.86	653.86	0.33	98.42
2.C.1 Iron and Steel Production	CH_4	456.24	456.24	0.23	98.64
3.A Enteric Fermentation	CH_4	450.92	450.92	0.22	12.04
1.A.3 Transport - Biomass	N_2O	265.03	265.03	0.13	0.13
5.B Biological treatment of solid waste	N_2O	262.57	262.57	0.13	2.42
1.A Stationary Combustion - Gaseous Fuels	CO_2	234.19	234.19	0.12	99.25
1.A.3.a Transport - Domestic Aviation	CO_2	206.22	206.22	0.10	99.35
2.A.2 Lime Production	CO_2	153.37	153.37	0.08	99.43
2.G.3 N2O from product uses	N_2O	139.44	139.44	0.07	6.34
2.F.4 Aerosols (CO_2 eq.)	PFC	136.73	136.73	0.07	10.82
2.A.3 Glass Production	CO_2	123.66	123.66	0.06	99.63
1.A.5.b Other mobile sources not included elsewhere	CH_4	116.13	116.13	0.06	99.68
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	108.53	108.53	0.05	99.74
2.F.3 Fire Protection (CO_2 eq.)	HFC	75.21	75.21	0.04	9.55
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	74.50	74.50	0.04	99.81
5.C Incineration and open burning of waste	CO_2	60.15	60.15	0.03	0.35
1.A.3 Transport - Biomass	CH_4	57.46	57.46	0.03	0.06
2.F.2 Foam Blowing (CO_2 eq.)	PFC	56.61	56.61	0.03	99.90
2.F.5 Solvents (CO_2 eq.)	HFC	37.50	37.50	0.02	3.21
1.B.1.b. Solid Fuel Transformation	CH_4	36.17	36.17	0.02	99.94
3.G Liming	CO_2	24.04	24.04	0.01	0.45
1.A Stationary Combustion - Liquid Fuels	CH_4	23.15	23.15	0.01	99.96
1.A.3.a Transport - Domestic Aviation	N_2O	16.28	16.28	0.01	99.97
1.B.1.a Coal Mining and Handling	CO_2	14.84	14.84	0.01	99.97
5.D Wastewater treatment and discharge	CH_4	12.79	12.79	0.01	0.03
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	10.40	10.40	0.01	99.99
1.A.5.b Other mobile sources not included elsewhere	CO_2	9.43	9.43	0.00	99.99
5.C Incineration and open burning of waste	N_2O	6.12	6.12	0.00	0.03
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	5.42	5.42	0.00	100.00
2.B.8 Petrochemical and carbon black production	CO_2	2.20	2.20	0.00	100.00
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	1.19	1.19	0.00	0.37
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.92	0.92	0.00	0.65
2.B.8 Petrochemical and carbon black production	CH_4	0.75	0.75	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.46	0.46	0.00	100.00
1.A Stationary Combustion - Gaseous Fuels	N_2O	0.42	0.42	0.00	100.00
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	0.31	0.31	0.00	0.04
1.A.3.e Transport - Other Transportation	CO_2	0.21	0.21	0.00	100.00
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	0.20	0.20	0.00	0.02
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.13	0.13	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.02	0.02	0.00	0.05
1.A.3.d Transport - Domestic navigation	CH_4	0.01	0.01	0.00	100.00
2.B.2 Nitric Acid Production	N_2O	0.01	0.01	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.01	0.01	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.01	0.01	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	LA,%	Cumulative Total (LA)
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	NF_3	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Liquid Fuels	CO_2	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	CH_4	0.00	0.00	0.00	0.00
5.A Solid Waste Disposal on Land	CH_4	0.00	0.00	0.00	0.00
3.H Urea application	CO_2	0.00	0.00	0.00	0.00
2.D.2 Paraffin Wax Use	CO_2	0.00	0.00	0.00	100.00
2.D.1 Lubricant Use	CO_2	0.00	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.00	0.00	100.00
2.C.5 Lead Production	CO_2	0.00	0.00	0.00	100.00
2.C.2 Ferroalloys Production	CH_4	0.00	0.00	0.00	100.00
2.C.2 Ferroalloys Production	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.00	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	CO_2	0.00	0.00	0.00	100.00
1.A.3.c Transport - Railways	N_2O	0.00	0.00	0.00	100.00
1.A.3.c Transport - Railways	CO_2	0.00	0.00	0.00	100.00
1.A.3.b Transport - Road Transportation	N_2O	0.00	0.00	0.00	100.00
1.A.3.b Transport - Road Transportation	CH_4	0.00	0.00	0.00	100.00
1.A.3.b Transport - Road Transportation	CO_2	0.00	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Liquid Fuels	N_2O	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Biomass	N_2O	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Biomass	CH_4	0.00	0.00	0.00	100.00
	Total	**200630.08**	**200630.08**	**100.00**	

Annex 2 Assessment of uncertainty

Tab A2- 1 Uncertainty analysis (Tier 1), first part of Table 3.3 of IPCC 2006 Gl.

Input DATA					
IPCC Source Category	Gas	Base year emissions (1990) abs	Year t emissions (2013) abs	Activity data uncertainty	Emission factor uncertainty
1.A Stationary Combustion - Biomass	CH_4	265.03	422.31	8	50
1.A Stationary Combustion - Biomass	N_2O	57.46	113.48	8	60
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	15722.85	3	3
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	21.76	3	50
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	8.47	3	60
1.A Stationary Combustion - Liquid Fuels	CO_2	22214.53	18357.47	5	3
1.A Stationary Combustion - Liquid Fuels	CH_4	60.15	22.83	5	50
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	660.41	5	60
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.00	197.42	10	15
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.00	0.37	10	50
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.00	0.69	10	60
1.A Stationary Combustion - Other fuels - MSW	CO_2	24.04	214.21	20	20
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.20	1.75	20	50
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.31	2.78	20	70
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	60368.33	4	3
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	250.88	4	50
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	248.26	4	60
1.A.3.a Transport - Civil Aviation	CO_2	139.44	7.52	4	4
1.A.3.a Transport - Civil Aviation	CH_4	0.02	0.00	4	21
1.A.3.a Transport - Civil Aviation	N_2O	1.19	0.06	4	40
1.A.3.b Transport - Road Transportation	CO_2	6176.54	15619.03	3	2
1.A.3.b Transport - Road Transportation	CH_4	37.50	22.60	3	100
1.A.3.b Transport - Road Transportation	N_2O	136.73	599.44	3	100
1.A.3.c Transport - Railways	CO_2	653.86	270.60	5	1
1.A.3.c Transport - Railways	CH_4	0.92	0.38	5	100
1.A.3.c Transport - Railways	N_2O	75.21	31.12	5	100
1.A.3.d Transport - Navigation	CO_2	56.61	6.37	5	2
1.A.3.d Transport - Navigation	CH_4	0.13	0.02	5	50
1.A.3.d Transport - Navigation	N_2O	0.46	0.05	5	90
1.A.3.e Transport - Other Transportation	CO_2	5.42	92.27	4	3
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	4	50
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	4	60
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	46.44	7	3
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.23	7	50
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	1.99	7	60
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	253.89	7	3
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.48	7	50
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.40	7	60
1.B.1.a Coal Mining and Handling	CO_2	456.24	194.88	4	25
1.B.1.a Coal Mining and Handling	CH_4	9119.12	3155.23	4	13
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.80	40	50
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	0.05	7	75
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	627.94	7	75
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	7	75
2.A.1 Cement Production	CO_2	2489.18	1331.79	2	2
2.A.2 Lime Production	CO_2	1336.65	605.53	2	2
2.A.3 Glass Production	CO_2	123.66	115.76	5	10
2.A.4 Other process uses of carbonates	CO_2	153.37	102.93	5	10
2.B.1 Ammonia Production	CO_2	990.80	601.13	5	7
2.B.2 Nitric Acid Production	N_2O	1050.29	211.88	4	15
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	5	40

Input DATA					
IPCC Source Category	**Gas**	**Base year emissions (1990) abs**	**Year t emissions (2013) abs**	**Activity data uncertainty**	**Emission factor uncertainty**
2.B.8 Petrochemical and carbon black production	CH_4	792.47	945.03	5	40
2.B.8 Petrochemical and carbon black production	CO_2	36.17	46.26	5	40
2.C.1 Iron and Steel Production	CH_4	9642.54	6543.14	7	10
2.C.1 Iron and Steel Production	CO_2	14.84	9.71	7	30
2.C.2 Ferroalloys Production	CH_4	0.00	45.60	5	25
2.C.2 Ferroalloys Production	CO_2	0.01	423.40	5	25
2.C.5 Lead Production	CH_4	10.40	36.05	10	50
2.C.6 Zinc Production	CO_2	0.00	0.27	10	50
2.D.1 Lubricant Use	CO_2	116.13	94.91	5	50
2.D.2 Paraffin Wax Use	CO_2	9.43	5.89	5	50
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	0.00	12.56	15	15
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	0.00	3.82	15	15
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	0.21	2606.81	37	23
2.F.1 Refrigeration and Air Conditioning Equipment (CO2 eq.)	HFC	0.00	5.84	37	23
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.01	2.76	37	23
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	0.00	37	23
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	41.17	37	23
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.01	0.03	37	23
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	12.03	37	23
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	0.00	37	23
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	3.98	37	23
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	0.00	37	23
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	16.28	13.13	5	15
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.29	10	20
2.G.3 N_2O from product uses	SF_6	206.22	223.50	5	40
3.A Enteric Fermentation	N_2O	5023.10	2412.48	5	20
3.B Manure Management	CH_4	1279.88	564.25	5	30
3.B Manure Management	CH_4	2981.06	1194.62	5	30
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3851.61	2220.13	15	50
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1398.25	735.56	20	50
3.G Liming	N_2O	1177.82	135.50	20	50
3.H Urea application	CO_2	108.53	0.81	20	50
4.A.1 Forest Land remaining Forest Land	CO_2	-4635.13	-7116.70	0	18
4.A.1 Forest Land remaining Forest Land	CO_2	115.16	64.78	0	50
4.A.1 Forest Land remaining Forest Land	CH_4	9.44	5.31	0	50
4.A.2 Land converted to Forest Land	N_2O	-220.80	-356.86	0	39
4.B.1 Cropland remaining Cropland	CO_2	-18.63	-15.36	0	12
4.B.2 Land converted to Cropland	CO_2	108.61	85.00	0	39
4.B.2. Land converted to Cropland	CO_2	8.43	4.85	0	3
4.C.1 Grassland remaining Grassland	N_2O	5.89	-1.29	0	9
4.C.2 Land converted to Grassland	CO_2	-140.72	-320.72	0	19
4.D.2. Land converted to Wetlands	CO_2	22.44	29.38	0	74
4.E.2 Land converted to Settlements	CO_2	84.38	83.16	0	102
4.G Harvested wood products	CO_2	-1667.36	791.82	0	20
5.A Solid Waste Disposal on Land	CO_2	1979.27	3324.45	30	40
5.B Biological treatment of solid waste	CH_4	0.00	544.95	20	10
5.B Biological treatment of solid waste	CH_4	0.00	40.22	20	1
5.C Incineration and open burning of waste	N_2O	23.15	175.67	20	5
5.C Incineration and open burning of waste	CO_2	0.00	0.00	20	50
5.C Incineration and open burning of waste	CH_4	0.42	3.19	20	70
5.D Wastewater treatment and discharge	N_2O	982.68	589.14	21	50
5.D Wastewater treatment and discharge	CH_4	234.19	203.73	26	50
1.A.3 Transport - Biomass	N_2O	0.00	0.55	8	50
1.A.3 Transport - Biomass	CH_4	0.00	2.07	8	60
	Total	**194301.77**	**137079.54**		

Tab A2- 2 Uncertainty analysis (Tier 1), second part of Table 3.3 of IPCC 2006 Gl.

Uncertainty of Emissions				
IPCC Source Category	**Gas**	**Combined uncertainty**	**Uncertain amount**	**Combined uncertainty as% of total national emissions in year t**
1.A Stationary Combustion - Biomass	CH_4	50.64	213.84	0.1560
1.A Stationary Combustion - Biomass	N_2O	60.53	68.69	0.0501
1.A Stationary Combustion - Gaseous Fuels	CO_2	3.91	614.00	0.4479
1.A Stationary Combustion - Gaseous Fuels	CH_4	50.09	10.90	0.0080
1.A Stationary Combustion - Gaseous Fuels	N_2O	60.07	5.09	0.0037
1.A Stationary Combustion - Liquid Fuels	CO_2	5.83	1070.42	0.7809
1.A Stationary Combustion - Liquid Fuels	CH_4	50.25	11.47	0.0084
1.A Stationary Combustion - Liquid Fuels	N_2O	60.21	397.62	0.2901
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	18.03	35.59	0.0260
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	50.99	0.19	0.0001
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	60.83	0.42	0.0003
1.A Stationary Combustion - Other fuels - MSW	CO_2	28.28	60.59	0.0442
1.A Stationary Combustion - Other fuels - MSW	CH_4	53.85	0.94	0.0007
1.A Stationary Combustion - Other fuels - MSW	N_2O	72.80	2.03	0.0015
1.A Stationary Combustion - Solid Fuels	CO_2	5.00	3018.42	2.2019
1.A Stationary Combustion - Solid Fuels	CH_4	50.16	125.84	0.0918
1.A Stationary Combustion - Solid Fuels	N_2O	60.13	149.29	0.1089
1.A.3.a Transport - Civil Aviation	CO_2	5.47	0.41	0.0003
1.A.3.a Transport - Civil Aviation	CH_4	21.38	0.00	0.0000
1.A.3.a Transport - Civil Aviation	N_2O	40.20	0.03	0.0000
1.A.3.b Transport - Road Transportation	CO_2	3.82	596.18	0.4349
1.A.3.b Transport - Road Transportation	CH_4	100.04	22.61	0.0165
1.A.3.b Transport - Road Transportation	N_2O	100.04	599.71	0.4375
1.A.3.c Transport - Railways	CO_2	5.21	14.11	0.0103
1.A.3.c Transport - Railways	CH_4	100.12	0.38	0.0003
1.A.3.c Transport - Railways	N_2O	100.12	31.16	0.0227
1.A.3.d Transport - Navigation	CO_2	5.22	0.33	0.0002
1.A.3.d Transport - Navigation	CH_4	50.25	0.01	0.0000
1.A.3.d Transport - Navigation	N_2O	90.14	0.05	0.0000
1.A.3.e Transport - Other Transportation	CO_2	5.00	4.61	0.0034
1.A.3.e Transport - Other Transportation	CH_4	50.16	0.02	0.0000
1.A.3.e Transport - Other Transportation	N_2O	60.13	0.03	0.0000
1.A.5.b Other mobile sources not included elsewhere	CO_2	7.62	3.54	0.0026
1.A.5.b Other mobile sources not included elsewhere	CH_4	50.49	0.12	0.0001
1.A.5.b Other mobile sources not included elsewhere	N_2O	60.41	1.20	0.0009
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	7.62	19.34	0.0141
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	50.49	0.24	0.0002
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	60.41	3.86	0.0028
1.B.1.a Coal Mining and Handling	CO_2	25.32	49.34	0.0360
1.B.1.a Coal Mining and Handling	CH_4	13.60	429.16	0.3131
1.B.1.b. Solid Fuel Transformation	CH_4	64.03	3.07	0.0022
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	75.33	0.04	0.0000
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	75.33	473.00	0.3451
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	75.33	0.02	0.0000
2.A.1 Cement Production	CO_2	2.83	37.67	0.0275
2.A.2 Lime Production	CO_2	2.83	17.13	0.0125
2.A.3 Glass Production	CO_2	11.18	12.94	0.0094
2.A.4 Other process uses of carbonates	CO_2	11.18	11.51	0.0084
2.B.1 Ammonia Production	CO_2	8.60	51.71	0.0377
2.B.2 Nitric Acid Production	N_2O	15.52	32.89	0.0240
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	40.31	30.03	0.0219
2.B.8 Petrochemical and carbon black production	CH_4	40.31	380.95	0.2779
2.B.8 Petrochemical and carbon black production	CO_2	40.31	18.65	0.0136
2.C.1 Iron and Steel Production	CH_4	12.21	798.69	0.5826
2.C.1 Iron and Steel Production	CO_2	30.81	2.99	0.0022
2.C.2 Ferroalloys Production	CH_4	25.50	11.63	0.0085
2.C.2 Ferroalloys Production	CO_2	25.50	107.94	0.0787
2.C.5 Lead Production	CH_4	50.99	18.38	0.0134
2.C.6 Zinc Production	CO_2	50.99	0.14	0.0001
2.D.1 Lubricant Use	CO_2	50.25	47.69	0.0348
2.D.2 Paraffin Wax Use	CO_2	50.25	2.96	0.0022
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	21.21	2.66	0.0019

Uncertainty of Emissions				
IPCC Source Category	**Gas**	**Combined uncertainty**	**Uncertain amount**	**Combined uncertainty as% of total national emissions in year t**
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	21.21	0.81	0.0006
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	43.57	1135.68	0.8285
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	43.57	2.54	0.0019
2.F.2 Foam Blowing (CO_2 eq.)	PFC	43.57	1.20	0.0009
2.F.2 Foam Blowing (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.F.3 Fire Protection (CO_2 eq.)	PFC	43.57	17.93	0.0131
2.F.3 Fire Protection (CO_2 eq.)	HFC	43.57	0.02	0.0000
2.F.4 Aerosols (CO_2 eq.)	PFC	43.57	5.24	0.0038
2.F.4 Aerosols (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.F.5 Solvents (CO_2 eq.)	PFC	43.57	1.73	0.0013
2.F.5 Solvents (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	15.81	2.08	0.0015
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	22.36	0.74	0.0005
2.G.3 N_2O from product uses	SF_6	40.31	90.10	0.0657
3.A Enteric Fermentation	N_2O	20.62	497.34	0.3628
3.B Manure Management	CH_4	30.41	171.61	0.1252
3.B Manure Management	CH_4	30.41	363.33	0.2650
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	52.20	1158.94	0.8455
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	53.85	396.11	0.2890
3.G Liming	N_2O	53.85	72.97	0.0532
3.H Urea application	CO_2	53.85	0.43	0.0003
4.A.1 Forest Land remaining Forest Land	CO_2	18.10	-1288.12	-0.9397
4.A.1 Forest Land remaining Forest Land	CO_2	50.00	32.39	0.0236
4.A.1 Forest Land remaining Forest Land	CH_4	50.00	2.65	0.0019
4.A.2 Land converted to Forest Land	N_2O	38.78	-138.39	-0.1010
4.B.1 Cropland remaining Cropland	CO_2	12.47	-1.91	-0.0014
4.B.2 Land converted to Cropland	CO_2	38.54	32.76	0.0239
4.B.2. Land converted to Cropland	CO_2	2.83	0.14	0.0001
4.C.1 Grassland remaining Grassland	N_2O	9.39	-0.12	-0.0001
4.C.2 Land converted to Grassland	CO_2	18.64	-59.78	-0.0436
4.D.2. Land converted to Wetlands	CO_2	73.58	21.62	0.0158
4.E.2 Land converted to Settlements	CO_2	101.80	84.65	0.0618
4.G Harvested wood products	CO_2	20.00	158.36	0.1155
5.A Solid Waste Disposal on Land	CO_2	50.00	1662.23	1.2126
5.B Biological treatment of solid waste	CH_4	22.36	121.85	0.0889
5.B Biological treatment of solid waste	CH_4	20.01	8.05	0.0059
5.C Incineration and open burning of waste	N_2O	20.62	36.21	0.0264
5.C Incineration and open burning of waste	CO_2	53.85	0.00	0.0000
5.C Incineration and open burning of waste	CH_4	72.80	2.32	0.0017
5.D Wastewater treatment and discharge	N_2O	54.23	319.49	0.2331
5.D Wastewater treatment and discharge	CH_4	56.36	114.81	0.0838
1.A.3 Transport - Biomass	N_2O	50.64	0.28	0.0002
1.A.3 Transport - Biomass	CH_4	60.53	1.26	0.0009
		Level uncertainty =	**14654.02**	**3.31**

Tab A2- 3 Uncertainty analysis (Tier 1), third part of Table 3.3 of IPCC 2006 Gl.

Uncertainty of Trend						
IPCC Source Category	Gas	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
1.A Stationary Combustion - Biomass	CH_4	0.0012	0.0022	0.0606	0.0246	0.0654
1.A Stationary Combustion - Biomass	N_2O	0.0004	0.0006	0.0225	0.0066	0.0235
1.A Stationary Combustion - Gaseous Fuels	CO_2	0.0402	0.0809	0.1006	0.3433	0.3578
1.A Stationary Combustion - Gaseous Fuels	CH_4	0.0001	0.0001	0.0033	0.0005	0.0033
1.A Stationary Combustion - Gaseous Fuels	N_2O	0.0000	0.0000	0.0013	0.0002	0.0013
1.A Stationary Combustion - Liquid Fuels	CO_2	0.0138	0.0945	0.0414	0.6681	0.6694
1.A Stationary Combustion - Liquid Fuels	CH_4	-0.0001	0.0001	-0.0050	0.0008	0.0051
1.A Stationary Combustion - Liquid Fuels	N_2O	0.0024	0.0034	0.1467	0.0240	0.1487
1.A Stationary Combustion - Other fuels – 1.A.2	CO_2	0.0010	0.0010	0.0152	0.0144	0.0209
1.A Stationary Combustion - Other fuels – 1.A.2	CH_4	0.0000	0.0000	0.0001	0.0000	0.0001
1.A Stationary Combustion - Other fuels – 1.A.2	N_2O	0.0000	0.0000	0.0002	0.0000	0.0002
1.A Stationary Combustion - Other fuels - MSW	CO_2	0.0010	0.0011	0.0203	0.0312	0.0372
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.0000	0.0000	0.0004	0.0003	0.0005
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.0000	0.0000	0.0009	0.0004	0.0010
1.A Stationary Combustion - Solid Fuels	CO_2	-0.0912	0.3107	-0.2735	1.7575	1.7787
1.A Stationary Combustion - Solid Fuels	CH_4	-0.0031	0.0013	-0.1555	0.0073	0.1557
1.A Stationary Combustion - Solid Fuels	N_2O	-0.0004	0.0013	-0.0216	0.0072	0.0228
1.A.3.a Transport - Civil Aviation	CO_2	-0.0005	0.0000	-0.0017	0.0002	0.0018
1.A.3.a Transport - Civil Aviation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.a Transport - Civil Aviation	N_2O	0.0000	0.0000	-0.0002	0.0000	0.0002
1.A.3.b Transport - Road Transportation	CO_2	0.0579	0.0804	0.1367	0.3410	0.3674
1.A.3.b Transport - Road Transportation	CH_4	0.0000	0.0001	-0.0020	0.0005	0.0020
1.A.3.b Transport - Road Transportation	N_2O	0.0026	0.0031	0.2589	0.0131	0.2592
1.A.3.c Transport - Railways	CO_2	-0.0010	0.0014	-0.0015	0.0098	0.0100
1.A.3.c Transport - Railways	CH_4	0.0000	0.0000	-0.0001	0.0000	0.0001
1.A.3.c Transport - Railways	N_2O	-0.0001	0.0002	-0.0113	0.0011	0.0113
1.A.3.d Transport - Navigation	CO_2	-0.0002	0.0000	-0.0003	0.0002	0.0003
1.A.3.d Transport - Navigation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.d Transport - Navigation	N_2O	0.0000	0.0000	-0.0001	0.0000	0.0001
1.A.3.e Transport - Other Transportation	CO_2	0.0005	0.0005	0.0014	0.0027	0.0030
1.A.3.e Transport - Other Transportation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.e Transport - Other Transportation	N_2O	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.0002	0.0002	0.0007	0.0024	0.0025
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.0000	0.0000	0.0006	0.0001	0.0006
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.0013	0.0013	0.0039	0.0129	0.0135
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.0000	0.0000	0.0020	0.0003	0.0020
1.B.1.a Coal Mining and Handling	CO_2	-0.0007	0.0010	-0.0163	0.0057	0.0173
1.B.1.a Coal Mining and Handling	CH_4	-0.0169	0.0162	-0.2192	0.0919	0.2377
1.B.1.b. Solid Fuel Transformation	CH_4	0.0000	0.0000	0.0011	0.0014	0.0018
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	0.0000	0.0000	-0.0006	0.0000	0.0006
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	-0.0007	0.0032	-0.0517	0.0320	0.0608
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.0000	0.0000	0.0000	0.0000	0.0000
2.A.1 Cement Production	CO_2	-0.0022	0.0069	-0.0044	0.0194	0.0199
2.A.2 Lime Production	CO_2	-0.0017	0.0031	-0.0035	0.0088	0.0095
2.A.3 Glass Production	CO_2	0.0001	0.0006	0.0015	0.0042	0.0045
2.A.4 Other process uses of carbonates	CO_2	0.0000	0.0005	-0.0003	0.0037	0.0038
2.B.1 Ammonia Production	CO_2	-0.0005	0.0031	-0.0035	0.0219	0.0222
2.B.2 Nitric Acid Production	N_2O	-0.0027	0.0011	-0.0408	0.0062	0.0413
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	0.0001	0.0004	0.0045	0.0027	0.0053
2.B.8 Petrochemical and carbon black production	CH_4	0.0020	0.0049	0.0795	0.0344	0.0866
2.B.8 Petrochemical and carbon black production	CO_2	0.0001	0.0002	0.0043	0.0017	0.0046
2.C.1 Iron and Steel Production	CH_4	-0.0013	0.0337	-0.0134	0.3334	0.3336

Uncertainty of Trend						
IPCC Source Category	**Gas**	**Type A sensitivity**	**Type B sensitivity**	**Uncertainty in trend in national emissions introduced by EF uncertainty**	**Uncertainty in trend in national emissions introduced by AD uncertainty**	**Uncertainty introduced into the trend in total national emissions**
2.C.1 Iron and Steel Production	CO_2	0.0000	0.0000	-0.0001	0.0005	0.0005
2.C.2 Ferroalloys Production	CH_4	0.0002	0.0002	0.0059	0.0017	0.0061
2.C.2 Ferroalloys Production	CO_2	0.0022	0.0022	0.0545	0.0154	0.0566
2.C.5 Lead Production	CH_4	0.0001	0.0002	0.0074	0.0026	0.0078
2.C.6 Zinc Production	CO_2	0.0000	0.0000	0.0001	0.0000	0.0001
2.D.1 Lubricant Use	CO_2	0.0001	0.0005	0.0033	0.0035	0.0048
2.D.2 Paraffin Wax Use	CO_2	0.0000	0.0000	-0.0002	0.0002	0.0003
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	0.0001	0.0001	0.0010	0.0014	0.0017
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	0.0000	0.0000	0.0003	0.0004	0.0005
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	0.0134	0.0134	0.3086	0.7020	0.7668
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.0000	0.0000	0.0007	0.0016	0.0017
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.0000	0.0000	0.0003	0.0007	0.0008
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.0002	0.0002	0.0049	0.0111	0.0121
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.4 Aerosols (CO_2 eq.)	PFC	0.0001	0.0001	0.0014	0.0032	0.0035
2.F.4 Aerosols (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.5 Solvents (CO_2 eq.)	PFC	0.0000	0.0000	0.0005	0.0011	0.0012
2.F.5 Solvents (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	0.0000	0.0001	0.0001	0.0005	0.0005
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.0000	0.0000	0.0003	0.0002	0.0004
2.G.3 N_2O from product uses	SF_6	0.0004	0.0012	0.0161	0.0081	0.0180
3.A Enteric Fermentation	N_2O	-0.0058	0.0124	-0.1164	0.0878	0.1458
3.B Manure Management	CH_4	-0.0017	0.0029	-0.0523	0.0205	0.0562
3.B Manure Management	CH_4	-0.0047	0.0061	-0.1403	0.0435	0.1468
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	-0.0026	0.0114	-0.1279	0.2424	0.2741
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	-0.0013	0.0038	-0.0646	0.1071	0.1250
3.G Liming	N_2O	-0.0036	0.0007	-0.1790	0.0197	0.1800
3.H Urea application	CO_2	-0.0004	0.0000	-0.0195	0.0001	0.0195
4.A.1 Forest Land remaining Forest Land	CO_2	-0.0198	-0.0366	-0.3584	0.0000	0.3584
4.A.1 Forest Land remaining Forest Land	CO_2	-0.0001	0.0003	-0.0042	0.0000	0.0042
4.A.1 Forest Land remaining Forest Land	CH_4	0.0000	0.0000	-0.0003	0.0000	0.0003
4.A.2 Land converted to Forest Land	N_2O	-0.0010	-0.0018	-0.0401	0.0000	0.0401
4.B.1 Cropland remaining Cropland	CO_2	0.0000	-0.0001	-0.0001	0.0000	0.0001
4.B.2 Land converted to Cropland	CO_2	0.0000	0.0004	0.0017	0.0000	0.0017
4.B.2. Land converted to Cropland	CO_2	0.0000	0.0000	0.0000	0.0000	0.0000
4.C.1 Grassland remaining Grassland	N_2O	0.0000	0.0000	-0.0003	0.0000	0.0003
4.C.2 Land converted to Grassland	CO_2	-0.0011	-0.0017	-0.0212	0.0000	0.0212
4.D.2. Land converted to Wetlands	CO_2	0.0001	0.0002	0.0051	0.0000	0.0051
4.E.2 Land converted to Settlements	CO_2	0.0001	0.0004	0.0124	0.0000	0.0124
4.G Harvested wood products	CO_2	0.0101	0.0041	0.2026	0.0000	0.2026
5.A Solid Waste Disposal on Land	CO_2	0.0099	0.0171	0.3969	0.7259	0.8273
5.B Biological treatment of solid waste	CH_4	0.0028	0.0028	0.0280	0.0793	0.0841
5.B Biological treatment of solid waste	CH_4	0.0002	0.0002	0.0001	0.0059	0.0059
5.C Incineration and open burning of waste	N_2O	0.0008	0.0009	0.0041	0.0256	0.0259
5.C Incineration and open burning of waste	CO_2	0.0000	0.0000	0.0000	0.0000	0.0000
5.C Incineration and open burning of waste	CH_4	0.0000	0.0000	0.0010	0.0005	0.0011
5.D Wastewater treatment and discharge	N_2O	-0.0005	0.0030	-0.0268	0.0900	0.0940
5.D Wastewater treatment and discharge	CH_4	0.0002	0.0010	0.0099	0.0386	0.0398
1.A.3 Transport - Biomass	N_2O	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.3 Transport - Biomass	CH_4	0.0000	0.0000	0.0006	0.0001	0.0007
					Trend uncertainty =	**2.41**

Annex 3 Detailed methodological descriptions for individual sources or sink categories

A3. 1 Updates of the country specific emission and oxidation factors for determination of CO_2 emissions from combustion of bituminous coal and lignite (brown coal) in the Czech Republic

1. Introduction

Emissions of CO_2, produced during the combustion of solid fuels, have in the Czech Republic a very significant contribution to the overall emissions of greenhouse gases. Emissions of CO_2 are according to the IPCC methodology determined as a product of the consumption of fuels, expressed as amount of energy contained in the fuels determined on the basis of net calorific value (TJ), emission factor for CO_2 (t CO_2/TJ) and oxidation factor. In the methodology for GHG inventory, IPCC provides default emission factors for CO_2, for the individual types of fuels (IPCC,1997 and 2006).

The default emission factors, tabulated in IPCC methodology were determined as middle values on the basis of many calorimetric and analytical tests of individual types of fuels. It is necessary to remember that the used data for determination of this emission factors has predominantly American origin and further comes from the 80s. For the needs of current national inventory, where the nature of the various types of fuels may be different, the default emission factors are not necessary sufficiently satisfactory.

Hence, the new versions of the IPCC methodology (IPCC, 2000 and 2006) recommends to all countries, where emissions of CO_2 from combustion of solid fuels is a so called key category, to check and update the emission factors of CO_2 for calculation of emissions of CO_2 on the basis of national data. In the Czech Republic, where the main part of the CO_2 emissions from solid fuels comes from the combustion of lignite (brown coal) and bituminous coal, it is significant to determine country specific emission factors for these two types of fuels.

The default emission factors for lignite (brown coal) and bituminous coal, provided in the older and newer version of the IPCC methodology, practically do not differ. In the recommended values for oxidation factor, however a substantial change appeared: while the older version (IPCC, 1997) reported default value of oxidation factor 0.98, new version (IPCC, 2006) provides default value of 1, which is the maximum possible and considering the solid fuels, in practice unreachable. In the IPCC methodology this change was introduced, because the authors of the new version were aware that these values are for solid fuels so geographically and technologically specific, that it could be difficult to generalize them. Default value of 1 was chosen as a conservative estimate, preventing possible underestimation of emission determination. Therefore a country, which wants to prevent possible overestimation of the emissions of CO_2 from combustion of solid fuels, has to determine representative country specific values of oxidation factor for individual types of solid fuels, on the basis of local data.

For determination of the country specific emission factors it is necessary to obtain data about the carbon content in given type of fuel and its net calorific value.

The factor for the carbon content (CC) is for the individual types of solid fuels defined as the ratio of weight of the carbon and the amount of energy in this fuel of the mass m

$CC = m \bullet w_C/m \bullet Q_i = w_C/Q_i$ (A3-1)

where wc is the fraction of mass of carbon in the fuel and Q_i is its net calorific value. It is important to notice, that all variables in the equation (A3-1) are related to the fuel (carbon) with its current water content in the supplied fuel, i.e. in the state, when it is determined the quantity (i.e. mass): raw - index ^{r} .

As the calorific value is expressed in MJ/kg (=TJ/kt), carbon content in% mass ($C^r = 100*w_C$) and CC in t C/TJ, it is possible to rewrite the previous equation to:

$CC\ [t\ C/TJ] = 10 \bullet C^r\ [\%]/Q_i^r\ [MJ/kg]$ (A3-2)

The emission factor for CO_2 (t CO_2/TJ) is obtained by multiplying by the ratio of the molar weight of carbon dioxide and carbon

$EF(CO_2) = CC \bullet 3.664$ (A3-3)

IPCC methodology provides the following default factors for carbon content CC:

Lignite (brown coal): 27.6 (t C/TJ)

Bituminous coal: 25.8 (t C/TJ)

In the Czech national inventory these emission factors were used until 2006. On the basis of the recommendation of international expert review team (ERT) of UNFCCC, during the review conducted in February 2007, it was decided to use for lignite (brown coal) and bituminous coal factors for CC values 25.43 and 27.27 (t C/TJ), which can be found in the national study from 1999 (Fott, 1999) and are pertaining to the state of the coal in the Czech Republic in the 90s. For determination of the oxidation factor the necessary data was not available, therefore for all solid fuels was used the default value of 0.98 from 1996 Guidelines, for the whole time series from 1990 to 2012 (2006 Guidelines come into force from the current year 2013).

In the last years related to the implementation of the emission trading within EU ETS, the operators of the bigger plants combusting coal began to systematically address the laboratory determined emission factors for different types of coal, combusted in these plants according to the prescribed requirements of the European Directive 82/2003 EC including the relevant guidelines, regarding the methodology of monitoring. Some operators gradually extended this assessment also by the determination of oxidation factors, whose values depend not only on the type of coal, but also on the nature of the combustion source.

Data from the coal analysis from 1999 naturally was not so extensive. Further the coal base in the beginning of the 90s in the Czech Republic largely changed - production in less efficient mines have been gradually phased out and the in the existing mines now often is extracted on different places for example, in deeper coal layers. For these reasons, the research team of the Czech national inventory decided in the frame of its improvement plan to revise the emission factors, used until now and to determine new oxidation factors. Detailed description of the used approach, input data and discussion of the reached results, can be found in the study of authors E. Krtková, P. Fott and V. Neužil, prepared for publication in scientific journal. In the further text of this Annex clarification of the principle of the used method is reported and the reached results from the above mentioned paper are presented.

2. Revision and updating of nationally specific emission factors

In the last years, lignite (brown coal) is extracted mostly in the North Bohemia (Mostecko), where is the most significant brown coal area in the Czech Republic, and to a lesser extent in the West Bohemian region (Sokolovsko). Bituminous coal is currently quarried only in Ostrava-Karvina district, in the large coalfield, whose greater part is situated in the neighboring country Poland. Lignite (brown coal) is in the Czech Republic extracted from the surface mines, while bituminous coal is extracted from the underground mines.

Overview of data sets for updating emission factors

<u>Set “ČEZ“</u>

The most extensive collection of data with the results of chemical analyzes, including calorific values, gained the national inventory team from the company ČEZ, which operates most of the coal-fired power plants in CR, burning in particular energy (pulverized) lignite (brown coal). The set contains 29 samples of bituminous energy (pulverized) coal and 146 samples of lignite (brown coal), mainly energy one and to a lesser extent also sorted one - 25 samples and this is mostly from North Bohemian region, and in to a lesser extent from West Bohemian region.

<u>Set “Dalkia”</u>

Except from the company ČEZ, the research team received extended set of relevant coal data from the company Dalkia, which operates particularly power and heat plants, combusting mostly bituminous energy coal in the east part of the Czech Republic and with a lesser extent lignite (brown coal). The set “Dalkia” contains analyzes mostly of bituminous coal (143 samples) and 36 samples of lignite (brown coal).

<u>Combined set of aggregated data</u>

In order to evaluate the parameters, required for determining of country specific emission factors, the primary data was aggregated as it follows: aggregated items from the above mentioned sets (“ČEZ” and “Dalkia”) were acquired as average of calorific value and the percentage of carbon content from six to twelve analyzed samples (i.e. analysis of monthly collected samples).

Combined set was extended by 3 aggregated items (yearly average for 2012) by lignite (brown coal) from West Bohemian region (Sokolovská uhelná).

The combined set included three major operators of combustion sources in the Czech Republic and contains of 37 aggregated items altogether, from which 19 from the set “ČEZ”, 15 from set “Dalkia”, three were obtained as described in the previous paragraph. This set contains 23 aggregated items of lignite (brown coal) (from which 4 from set “Dalkia”) and 14 for bituminous coal (3 items come from the set “ČEZ”, the rest 11 items are from the set “Dalkia”). 18 aggregated items for lignite (brown coal) come from a larger North Bohemian region, 5 items of lignite (brown coal) – from smaller West Bohemian region.

The range of the net calorific value for lignite (brown coal) is, from this set, between 9.9 and 18.5 MJ/kg, while the range of the net calorific value for black coal is between (16.2 and 26.4 MJ/kg).

<u>Set “ETS”</u>

The set contains data from the ETS database created in CHMI, to which have been saved certified forms, filled by the operators of energy installations in the Czech Republic under the ETS. These forms, containing data for 2011, were provided to CHMI from the Ministry of Environment. For the processing there were taken into account only those installations whose annual emissions exceeded 50 kt CO_2 and which, in accordance with monitoring guidelines of EU, determined emission factors from the laboratory data. In this way there were processed 34 sources, combusting lignite (brown coal) and 13 – combusting bituminous coal.

The range of net calorific value for lignite (brown coal) was in this case between 10.4 and 18.8 MJ/kg, while for bituminous coal - was between 17.1 and 26.8 MJ/kg.

The procedure for evaluating of the emission factors

In the above mentioned article from 1999 (Fott, 1999) it was demonstrated linear correlation between the carbon content C^r [%] in the coal and its calorific value Q_i^r [MJ/kg].

$$C^r = a \bullet Q_i^r + b \qquad \text{(A3-4)}$$

with a correlation coefficient r^2 higher than 0.99. This correlation equation fits for bituminous and lignite (brown coal), therefore both types of coal can be described by one equation (i.e. a single pair of parameters a, b).

Taking into account the equation (A3-2), dependence between the carbon content CC (t C/TJ) and the calorific value Q_i^r [MJ/kg] is obtained.

$$CC = 10 \bullet (a + b/ Q_i^r) \qquad \text{(A3-5)}$$

In this way a country specific parameters a, b were evaluated in equation (A3-4), (A3-5) instead of two separate values of country specific factor for lignite (brown coal) and for bituminous coal.

This procedure was applied also on current data. For the process there were used the two most representative sets: combined set of aggregated data, hereinafter referred as “Comb” and “ETS”.

On Fig. A3 1 it can be seen, that for the combined data set “Comb” a correlation between carbon content and net calorific value can be described for both types of coal with a regression line (see equation (A3-4)) with parameters a = 2.4142 and b = 4.0291, while the correlation coefficient value r^2 = 0.997 is close to one.

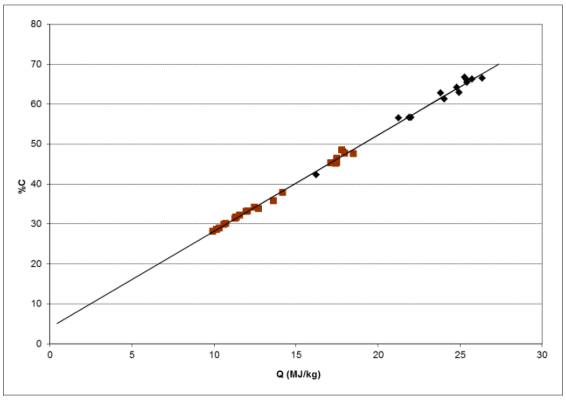

Fig. A3 1 Combined set of aggregated data “Comb”. Correlation between carbon content (%C) and net calorific value for lignite (brown coal) (indicated with brown squares) and bituminous coal (indicated with black squares)

In terms of the uncertainty of emission determination, it is necessary to assess the extent to which the carbon content factor values differ from the values determined by the curve (5). This is graphically illustrated on Fig. A3 2. Numerically, the difference between the individual points from the calculated curve can be characterized with the mean relative error, which is 1.14% for lignite (brown coal) and 1.30% for bituminous coal. Nevertheless, the mean relative error of any kind of coal does not exceed 3%. Therefore, the uncertainty of the carbon content factors and thus the uncertainty of CO_2 emission factors can be considered as acceptable.

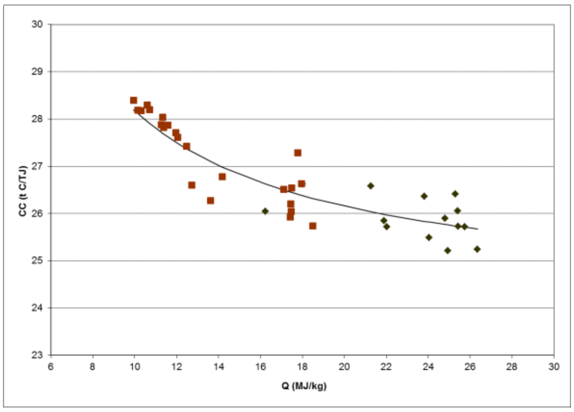

Fig. A3 2 Combined set of aggregated data "Comb". Correlation between the factor of carbon content CC and net calorific value for brown coal (indicated as brown squares) and black coal (indicated as black squares), found through the eq. A3-5.

In the set "ETS" values Q_i^r and factors for CC were available, but the carbon content in percentages was not given. Therefore the parameters a, b were assessed with non-liner regression, using the equation (A3-5). In this way the parameters a = 2.4211 and b = 3.9539 were determined. In this case the mean relative error for lignite (brown coal) was equal to 1.59% and for bituminous coal was equal to 1.73%.

The parameters a, b, evaluated from the both sets are very similar. However, statistical indicators characterizing uncertainty are in the case of set "ETS" somewhat higher, than for the combined set.

3. Determination of country specific oxidation factors

Formula for calculation of oxidation factor from analytical data

Oxidation factor from analytical data is calculated using the following formula.

$$OF = 1 – A/[C\bullet (1/C_{,out} – 1)] = 1 – A \bullet C_{,out}/[C \bullet (1 – C_{,out})]$$

where OF is oxidation factor (with value somewhat lower than 1), A is the mass fraction of ash, C is the mass fraction of carbon and C,out is the mass fraction of carbon on the exit of the combustion device (the mass fractions are values in the interval between 0 and 1, e.g. 40% corresponds to mass fraction of 0.4). In case, that on the exit both forms of ash are present (slag and dry ash), C,out is calculated as weighted average of the fraction of non-combusted carbon in both forms of ash.

Sets of data used for determination of oxidation factors and their processing

Set "ČEZ"

This is the set "ČEZ", which is described above, containing 146 samples of lignite (brown coal) and 29 samples of bituminous coal. This set contains also all data occurring in the resulting equation (A3-6), used for the calculation of oxidation factor.

Results from the processed data from the set "ČEZ" are these values of oxidation factors:

OF for lignite (brown coal): 0.9857

OF for bituminous coal: 0.9696

Set "Dalkia"

As a matter of fact the set "Dalkia" is that described above. The set contains analysis of mostly bituminous coal (143 samples). Representative value in case of the bituminous coal from the set "Dalkia" is 0.9719.

OF for lignite (brown coal) was possible to be obtained from the set "Dalkia", using only the part of the samples, combusted at not so important combustion installations (i.e. with relatively low emissions). From these was calculated average (0.979) considered only as approximate value for comparison purposes.

Set "ETS"

The set contains data from the ETS database, created in CHMI (see above), into which have been saved proven forms, provided by the energy operators, falling under ETS. For processing there were taken into account only these plants (installations), whose emissions exceeded 50 kt and where the indicated oxidation factors were identified based on chemical analysis. In this way were processed 10 sources combusting bituminous coal and 18 sources, combusting lignite (brown coal). From the set "ETS" were calculated the following representative values of OF for bituminous and lignite (brown coal).

Resulting values of OF from set "ETS" are:

OF for lignite (brown coal): 0.9835

OF for bituminous coal: 0.9708

For lignite (brown coal) was taken as the most representative current country value for OF, the value of **OF = 0.9846** determined as average of the two average values from sets "ČEZ" and "ETS": OF = (0.9857 + 0.9835)/2 = 0.9846

For bituminous coal was taken as the most representative current country value for OF, the value of **OF = 0.9707** determined as average of the three average values from sets "ČEZ", "Dalkia" and "ETS": OF = (0.9696 + 0.9719 + 0.9708)/3 = 0.9707.

4. The method of determining carbon dioxide emissions, using country specific parameters

Carbon dioxide emissions for specific category sources is determined as a product of consumed fuel, expressed as the amount of energy contained in the fuel defined on the basis of calorific value (TJ), emission factor for CO_2 (t CO_2/TJ) and oxidation factor. CzSO provides annual fuel consumption for each category of sources, both in weight units and in energy units determined using the net calorific value. The national inventory research team uses this data as an input activity data.

For determination of the CO_2 emission factor it is necessary to define appropriate emission and oxidation factor for individual categories and for the whole time series. Regarding the updating of the country specific emission factors, the research team decided to determine them as an average of two values: emission factor, calculated using the eq. A3-5, using the parameters **a = 2.4142** and **b = 4.0291**, determined from the combined file "Comb" and emission factor calculated using the parameters **a =2.4211** and **b = 3.9539**, calculated from the file "ETS". The reason for this decision is the very good correspondence of the relevant curves calculated from equation (A3-5) of these two representative sets.

In the case of the oxidation factors the research team decided to use till 2010 so far used oxidation factor of 0.98 and from year 2011 the newly determined country specific oxidation factor presented in section 3. The reason for this decision is the fact that the current values were determined, based on data recorded between 2011 and 2012, while the data for the previous years was not available. However, the newly established oxidation factors suggest that so far used value 0.98 corresponds better to reality than the default value of 1 pursuant to 2006 Guidelines.

Examples of setting of CO_2 emission factors, 2013

a) Lignite (brown coal)

In tab. 3-11, chapter "Energy" is provided average calorific value of 13.409 MJ/kg, CC factor is calculated as: [10 • (2.4142+4.0291/13.409)+10 • (2.4211+3.9539 /13.409)]/2

= (27.147+27.160) /2 = 27.153 t C/TJ. To this corresponds emission factor for CO_2 27.153 • 3.664= 99.489 t CO_2/TJ. Resultant emission factor for CO_2 including the oxidation factor has a value of 99.489 • 0.9846= 97.957 t CO_2/TJ.

b) Bituminous coal

In tab. 3-11, chapter "Energy" is provided average calorific value of 25.502 MJ/kg, CC factor is calculated as: [10 • (2.4142+4.0291/ 25.502)+10 • (2.4211 + 3.9539/ 25.502)]/2 = (25.722+25.761) /2 = 25.742 t C/TJ. To this corresponds emission factor for CO_2 25.742 • 3.664= 94.317 t CO_2/TJ. Resultant emission factor for CO_2 including the oxidation factor has a value of 94.317 • 0.9707=91.554 t CO_2/TJ

A3. 2 Country specific CO_2 emission factor for LPG

In order to enhance the accuracy of emission estimates from Energy sector the research with aim to develop country specific emission factor for LPG was carried out last year. LPG is the mixture of propane and butane and other C2 – C5 hydrocarbons and is available in two versions – summer and winter mixture. The basic qualitative parameters are available in the official Czech Standard ČSN EN ISO 4256. These parameters are given in Tab. A3 - 1.

Tab. A3 - 1 Qualitative parameters of LPG – summer and winter mixture

PARAMETER*)	summer mixture	winter mixture
C2-hydrocarbons and inerts -%, max.	7	7
C3- hydrocarbons -%, min.	30	55
C4- hydrocarbons -%	30 - 60	15 - 40
C5-and higher hydrocarbons -%, max.	3	2
Unsaturated hydrocarbons -%, max.	60	65
Hydrogen sulfide - $mg.kg^{-1}$, max.	0.2	0.2
Content of sulphur - $mg.kg^{-1}$, max.	200	200

**)% in the table mean mass percents*

For the determination of country specific emission factor is necessary to obtain data about composition of LPG, which is distributed in the territory of the Czech Republic. These data were obtained from the Česká rafinérská, a.s., which is the major distributor of the LPG in the CR. The quality of distributed LPG is based on the above mentioned official standard (ČSN EN ISO 4256) and so also the data provided by Česká rafinérská, a.s. are in line with this standard. The specific composition is listed in Tab. A3 - 3.

Tab. A3 - 2 Composition of LPG distributed in the Czech Republic (in mass percents)

Composition	summer mixture	winter mixture
C2+inerts	0.2	0.1
propane	38.5	58.7
propylene	7.2	4.5
iso-butane	25.6	27.9
n-butane	15.7	5.9
sum of butens	12.2	2.8
C5 and higher	0.6	0.1
Ratio of the production of summer : winter mixture = circa 1 : 1.1		

This elementary composition of LPG (given in Tab. A2-2) was used for the calculations of country specific emission factor (based on the carbon content in each component). At first carbon emission factors related to the mass of LPG (kg C/kg LPG) were computed. For the summer mixture is the carbon emission factor equal to 0.8287 kg C/kg; for winter mixture 0.8232 kg C/kg. Final value computed using weighted average taking in consideration the summer : winter mixture ratio is equal to 0.8258 kg C/kg.

The net calorific value related to the mass (MJ/kg) was computed using equation A2-2. For the summer mixture is net calorific value equal to 45.853 MJ/kg; for the winter mixture to 46.029 MJ/kg. Final value computed using weighted average taking in consideration the summer : winter mixture ratio is equal to 45.945 MJ/kg. This net calorific value was also used for the conversion of activity data from kilotons to TJ.

Final emission factor was determined using equation A3-7

$$1000 \bullet 0.8258/45.945 = 17.974 \text{ t C/TJ} \qquad \text{(A3-7)}$$

This value is in very good agreement with the value 17.9 t C/TJ determined in Harmelen and Koch (2002); corresponded net calorific value is 45.5 MJ/kg (Harmelen and Koch, 2002), which is also in a good agreement with the value determined as Czech country specific.

Tab. A3 – 3 indicates comparison of the newly developed country specific CO_2 emission factor and the default one provided either in Revised 1996 Guidelines (IPCC, 1997) or in 2006 Guidelines (IPCC, 2006). It is necessary to keep in mind, that 2006 Guidelines states the range of default emission factors, which for LPG is 16.8 – 17.9 t C/TJ. It is apparent that default emission factors slightly underestimate the emission estimates. The country specific emission factor does not fit into the default interval, which also supports this conclusion. Since country specific emission factor was evaluated based on the specific composition of LPG distributed in the Czech Republic, the newly developed emission factor will evaluate the emission estimates more accurate than the default emission factor.

Tab. A3 - 3 Comparison of country specific CO_2 and default emission factors for LPG

	[t C/TJ]	[t CO_2/TJ]
Revised 1996 Guidelines	17.2	63.07
2006 Guidelines	17.2	63.1
CO_2 country specific emission factor for CR	17.97	65.90

Based on the composition of LPG was also net calorific value computed, which agreed better to the specific conditions of CR then the net calorific value presented in CzSO questionnaire. The updated net calorific value was used for the computation of fuel consumption in TJ; the value 45 945 kJ/kg was used (conversion from kt to TJ).

A3. 3 Country specific CO_2 emission factor for Refinery Gas

Another improvement concerning emission factor from combustion of Refinery Gas was accomplished in 2013. Refinery gas is defined as non-condensable gas obtained during distillation of crude oil or treatment id oil products in refineries. It consists mainly of hydrogen, methane, ethane and olefins (IPCC, 2006).

Refinery Gas in CR is also used mainly by Česká rafinérská, a.s. This company is also included in the EU ETS and in terms of this obligation also carries out the analyses of molar composition of Refinery Gas. These analyses were provided to the inventory team for the purposes of the development of country specific CO_2 emission factor from combustion of Refinery Gas. These analyses obtain the information about content of hydrogen, content of CO_2, content of CO, content of methane, ethane, propane, iso-butane, n-butane, butenes, iso-pentanes, n-pentanes, ethylene, propylene, C6 and higher hydrocarbons, content of oxygen, nitrogen, hydrogen sulphide and water in the Refinery Gas. The analyses are available for the 2008 – 2012 in the time step 3 – 4 days.

It is apparent that the available analyses are sufficiently detailed, so it allowed the inventory to team to develop country specific emission factor for the Czech Republic. The approach of ‘carbon content in the fuel’, which was fully attested in case of determination of country specific emission factor from combustion of Natural Gas (Krtková et al., 2014), was also used for determination of Refinery Gas emission factor. Based on the molar composition of the gas mixture the country specific emission factors for years 2008 – 2012 were determined. For the years before the average value of the 2008 – 2012 values was used. The table below shows the used values.

Tab. A3 - 4 Country specific carbon emission factors from combustion of Refinery Gas (t C/TJ)

1990 - 2007	2008	2009	2010	2011	2012
15.03	15.06	14.93	14.58	15.24	15.34

All values in the table lies within the default range 13.1 – 18.8 t C/TJ specified in the 2006 Guidelines and further more are close to the default value 15.7 t C/TJ (IPCC, 2006). However, the previously used default value provided by the 1996 Guidelines (IPCC, 1997) was somewhat higher, 18. 2 t C/TJ.

Also net calorific value of Refinery Gas was computed based on the available analyses of the molar composition. CzSO has updated this value based on the request of the inventory team. The updated value is 46.023 MJ/kg. This value was used for the whole time series.

A3. 4 Country specific CO_2 emission factor for Natural Gas combustion

Extensive research was carried out in 2012 with aim to develop the country-specific emission factor for Natural Gas combustion (CHMI, 2012b). This research was part of a project of The Technical Assistance of the Green Savings programme. Final evaluation of the CO_2 emission factor for Natural Gas combustion is based on its correlation with the net calorific value. Detailed description of the research is given in the following paragraphs.

Complete description of this research will be published in Greenhouse Gas Measurement & Management journal, the manuscript is entitled Carbon dioxide emissions from natural gas combustion – country specific emission factors for the Czech Republic (Krtková et al., 2014).

The net calorific value of Natural Gas can be computed on the basis of the molar composition according to:

$$Qm = \sum wi \bullet Qmi \quad \text{(A3-8)}$$

$$Qv = Qm \bullet d \quad \text{(A3-9)}$$

where Q_m [MJ/kg] is the net calorific value of Natural Gas related to its mass, w [kg/kg] is the mass fraction, Q_{mi} [MJ/kg] is the net calorific value of different components of Natural Gas related to their mass, Q_v [MJ/m^3] is the net calorific values of Natural Gas related to its volume and d [kg/m^3] is its density.

Tab. A3 - 5 lists the net calorific values of the basic components of Natural Gas.

Tab. A3 - 5 Net calorific values of the basic components of Natural Gas (ČSN EN ISO 6976, 2006)

Net calorific values of basic components of Natural Gas [MJ/kg]	
methane	50.035
ethane	47.52
propane	46.34
iso-butane	45.57
n-butane	45.72
iso-pentane	45.25
n-pentane	45.35
sum C>6 (like heptane)	44.93

The carbon emission factor for Natural Gas related to its energy content (CEF_{TJ} [t C/TJ]) is computed according to

$$CEFTJ = CEF_m/Q_m \quad \text{(A3-10)}$$

where CEF_m is carbon emission factor related to the mass.

Carbon dioxide emission factor (EF (CO_2) [t CO_2/TJ]) is then calculated

$$EF\ (CO_2) = CEFTJ \bullet M_{CO2}/M_C \quad \text{(A3-11)}$$

where M_{CO2} and M_C are the molecular weight of carbon dioxide and atomic weight of carbon, respectively.

A similar method (to the one described here) of computing EF (CO_2) and Q_v for 10 characteristic samples of Natural Gas was used in the article (Čapla and Havlát, 2006). Samples 1 – 4 were chosen based on their place of origin: sample 1 – Natural Gas from Russian gas fields distributed in Czech Republic in 2001; sample 2 – Natural Gas from Norwegian gas fields in the North Sea; sample 3 – Natural Gas coming from Dutch gas fields; sample 4 – Natural Gas mined in Southern Moravia. Samples 5 – 10 represented the composition of the Natural Gas distributed in the Czech Republic in 2005 – 2006.

This rather representative dataset was used to determine the regression curve, which was similar to the line

$$EF\ (CO_2) = 0.269 \bullet (Qv/3.6)^2 - 2.988 \bullet (Qv/3.6) + 59.212 \qquad (A3\text{-}12)$$

which was tightly fit to all 10 points (correlation coefficient $R^2 = 0.999$). In this correlation expression Q_v represents the net calorific value related to the volume under "trade conditions" (101.3 kPa, 15° C).

The calculations of the regression curve for the samples 5 – 10 indicated in particularly close range of Qv: 34.11 – 34.27 MJ/m^3. The lowest net calorific value (31.31 MJ/m^3) was determined for sample number 3 (Dutch field) and the highest (38.28 MJ/m^3) for Norwegian gas type. The low net calorific value of Dutch Natural Gas is caused by relatively high content of nitrogen; the high net calorific value of the Norwegian Natural Gas is a result of the higher content of C2, C3 and C4 hydrocarbons (especially ethane).

The above-described methodology was tested on a relatively small dataset. To obtain sufficiently reliable correlation, this methodology had to be tested on a dataset which would provide composition of Natural Gas in sufficient time series. In cooperation with CzSO a dataset comprising analyses of Natural Gas composition was obtained. These analyses are continuously evaluated in the laboratory of NET4GAS, Ltd. Daily average values on the Natural Gas composition from the first day in the month were available for evaluation of the CO_2 emission factor. The dataset of these analyses began on 1st January 2007 and the last data are from 1st September 2011. Furthermore data for 1st February 2012 were also available. The report on each analysis contains data on the molar composition of the Natural Gas, physical characteristics and conditions during which the analysis was performed. Overall, 58 analyses were available. Fig. A2- 1 depicts the trend of net calorific values in time.

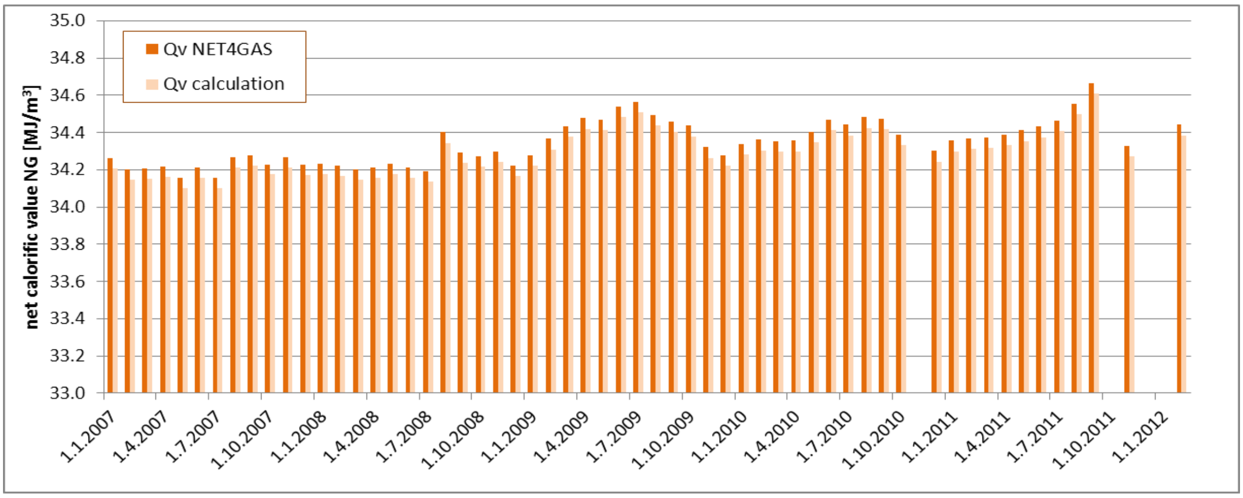

Fig. A3 3 Net calorific values given in NET4GAS Ltd. reports and net calorific values calculated on the basis of composition of Natural Gas in 1.1.2007 – 1.2.2012 (both values are given at 15°C)

The figure indicates a good match between the two depicted values; the deviation is almost constant and reaches an average value of 0.16%. The deviation is probably caused by the fact that the measured values correspond to the non-state gas behaviour; however the calculation is based on the assumption of ideal gas behaviour. For this reason, the net calorific values from the NET4GAS Ltd. reports were used for calculation of the emission factor. The reports contain data related to the reference temperature 20° C; thus, it was necessary to recalculate net calorific values and densities for 15° C.

The results of the calculations are depicted in Fig.A2- 2. This figure also contains computation of the correlation

$$EF\ (CO_2) = 0.787 \bullet Qv + 28.21 \qquad (A3\text{-}13)$$

where Q_v [MJ/m^3] is the net calorific value of Natural Gas at “trade conditions”: temperature 15°C and pressure of 101.3 kPa.

These findings were compared with the results obtained during preparation of this research. First, the data about analyses of Natural Gas obtained from RWE Transgas were used for comparison. This dataset contains data from 2003, 2004 and 2009 and evaluation of these data resulted in the correlation

$$EF\ (CO_2) = 0.6876 \bullet Qv + 31.619 \qquad (A3\text{-}14)$$

The second source for comparison is the paper of Čapla and Havlát (2006), where the correlation resulted in equation (A3-13).

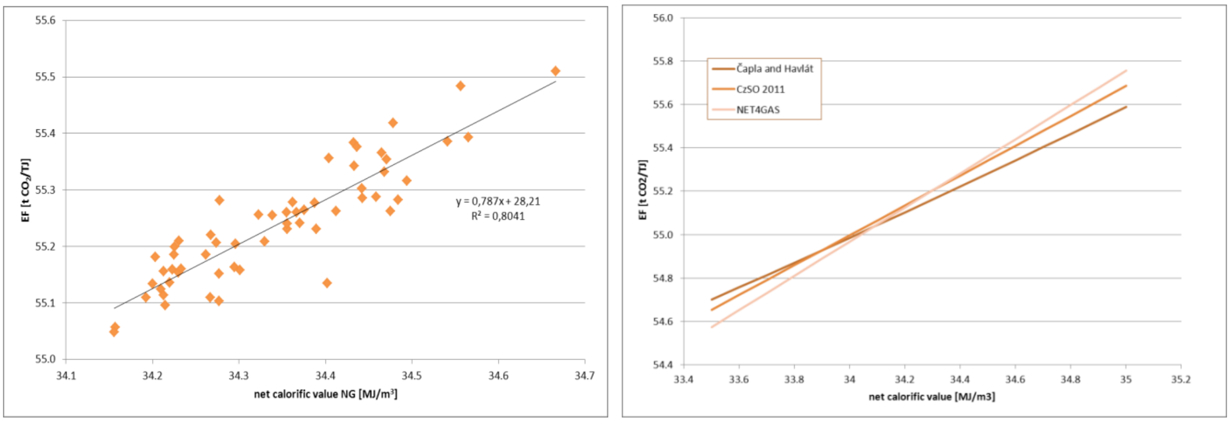

Fig. A3 4 Correlation of EF [t CO_2/TJ] and net calorific value of Natural Gas and Comparison of three approaches used for calculation

Fig. A3- 3 indicates good correlation between all three approaches in the region of 34.1 – 34.3 MJ/m^3, where the deviation between the results is 0.3% in maximum.

Each year in its energy balance, the Czech Statistical Office reports the average value of net calorific value of Natural Gas. Fig. A3- 4 indicates the trend of these calorific values. It is apparent that NCV is continuously slightly increasing.

The dark line in Fig. A2- 4 indicates the lowest net calorific value determined in the dataset provided by NET4GAS Ltd in 2007 - 2012. For the period of 2007 towards all the net calorific values are lower than 34.1 MJ/m^3. For this reason, it is more accurate to use the correlation obtained from the dataset representing the data before this year, i.e. the correlation evaluated by Čapla and Havlát (2006).

Fig. A3- 5 depicts the correlation curve combined on the basis of both correlations. It is given for the whole range of net calorific values, which was identified in Natural Gas in the Czech Republic in the 1990 - 2010 period. The value 34.1 MJ/m^3 is depicted by the dashed line.

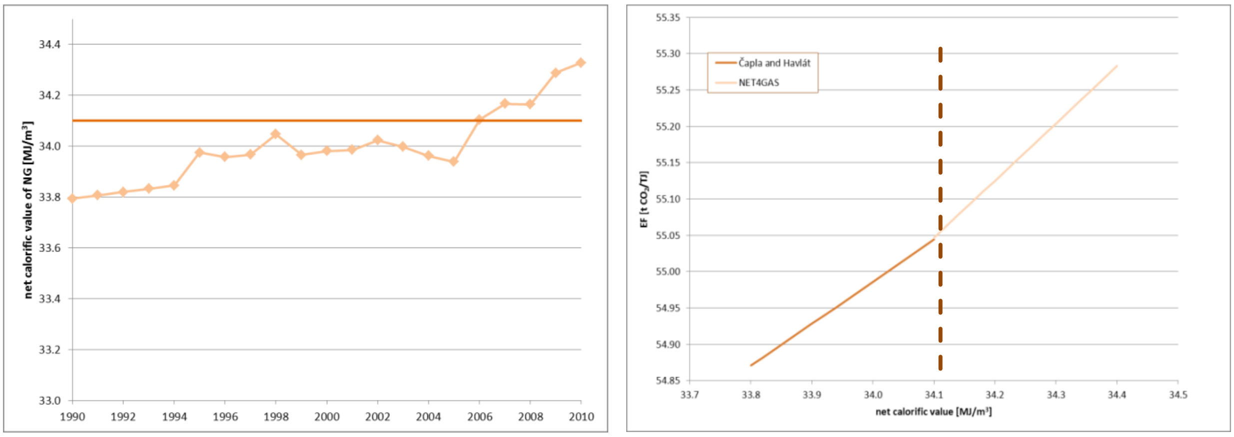

Fig. A3 5 Trend in Natural Gas NCV 1990 – 2010 and Correlation between NCV and EF combined from two approaches – Čapla and Havlát (NCV lower than 34.1 MJ/m^3) and computed correlation on the basis of NET4GAS dataset (NCV higher than 34.1 MJ/m^3)

Evaluation of CO_2 emission factors for Natural Gas combustion is based on the computational approach described above. There are two correlation relations; each of them is used for a different range of net calorific values. As depicted in Fig. A2- 5, both correlations follow each other closely. Tab A3 - 6 lists all the calculated emission factors for both correlations; the recommended values are in bold.

Tab. A3 - 6 Comparison of both recommended correlations

year	Average net calorific value of NG reported by CzSO	EF CO_2 calculated on the basis of Čapla and Havlát correlation (eq. A2-5)	EF CO_2 calculated on the basis of NET4GAS, Ltd. dataset correlation (eq. A2-6)
	[MJ/m^3]	[t CO_2/TJ]	[t CO_2/TJ]
1990	33.794	**54.87**	*54.81*
1991	33.807	**54.87**	*54.82*
1992	33.820	**54.88**	*54.83*
1993	33.832	**54.89**	*54.84*
1994	33.845	**54.90**	*54.85*
1995	33.975	**54.97**	*54.95*
1996	33.957	**54.96**	*54.93*
1997	33.966	**54.97**	*54.94*
1998	34.046	**55.01**	*55.00*
1999	33.965	**54.97**	*54.94*
2000	33.980	**54.97**	*54.95*
2001	33.986	**54.98**	*54.96*
2002	34.023	**55.00**	*54.99*
2003	33.997	**54.98**	*54.97*
2004	33.962	**54.96**	*54.94*
2005	33.938	**54.95**	*54.92*
2006	34.105	*55.05*	**55.05**
2007	34.167	*55.08*	**55.10**
2008	34.164	*55.08*	**55.10**
2009	34.288	*55.16*	**55.19**
2010	34.328	*55.18*	**55.23**

The deviations between the two calculations are less than 0.15%. The values written in bold were used for recalculation of CO_2 emissions from Natural Gas combustion for the 1990 – 2010 time series (held in 2013 submission). Former submissions employed the default emission factor 56.1 t CO_2/TJ, which overestimated the CO_2 emissions from Natural Gas combustion, especially at the beginning of the nineteen nineties (about 2.4% in 1990).

For years 2011 and 2012 the correlation relation based on the NET4GAS, Ltd. dataset was used (eq. A3-13):

$$EF(CO_2) = 0.787 \bullet Qv + 28.21 \quad \text{(A3-15)}$$

The availability of analyses of the Natural Gas composition should be ensured in the coming years. The validity of equation (A2-7) will be continuously tested using new data, and if necessary, the correlation equation will be modified to fit the new data as best as possible.

Starting with submission 2013 updated emission factors are be used for all categories in 1A Energy for the whole time series.

For other detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion please see the discussion of methodology in Chapter 3.4 and in the Annex 4.

A3. 5 Methodology for Road Transport (1.A.3.b)

The Methodology of determination of air polluting emissions from transport in the Czech Republic is used for transport emission calculations on a national and regional level. The results are reported not only to UNFCCC, but also to CLRTAP and other international bodies. The methodology was adopted by the Ministry of Transport, Ministry of Environment and Czech Hydrometeorological Institute in 2002 and was updated in 2006. The methodology includes only emissions from transport and does not include emissions from electricity production used by electric vehicles. It also does not include emissions from the engines of off-road machines and vehicles used, for example, in agriculture, the building industry, the army or households.

The underlying principles of the methodology are:

- categorization of vehicles
- measured emission factors
- distribution of fuel consumption between individual transport modes
- annual mileages in selected vehicle categories

The methodology is based on the classification of vehicles in 23 categories using the following criteria: transport mode, fuel type, weight of vehicles (in road freight traffic) and equipment with effective catalytic converter systems (cars). Every category has associated emission factors for CO_2, CO, NO_X, N_2O, CH_4, NMVOC, SO_2, Pb and PM, based on the available measurements. Emission factors are expressed in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

Two parallel approaches are used for classification of fuel consumption. The first one is "top - down", i.e. allocating total fuel consumption according to transport performances and numbers of vehicles, and the second one is "bottom - up", i.e. from annual mileages and average consumption in $1.100km^{-1}$. This consumption is classified in 5 categories (motorcycles, gasoline passenger cars with or without catalytic converter systems, diesel light duty vehicles, diesel heavy duty vehicles), taken from the 23 categories mentioned above, which exhibit the largest differences in annual mileages ($km.year^{-1}$).

Mileages are reported in a manner such that the sum of the fuel consumptions in the first three categories (motorcycles, gasoline passenger cars with or without catalytic convert systems) calculated using the "bottom - up" method is identical with the fuel consumption in the individual transport categories calculated using the "top - down" method. A similar approach is employed for road freight transport. The relationship of the mileages employed must be in line with the relationships of the above mentioned categories in real situations. These are derived from the transport census. This is based on the total fuel consumption in the appropriate transport modes. Transport performances are used to derive the relative fuel consumption for the individual transport modes.

The categorization of vehicles enables separate calculation of the N_2O production from the total amount of NO_X. VOCs are separated into CH_4 (which contributes to the greenhouse effect) and nonmethane VOCs. Every category has associated emission factors according to the available measurements in the Czech Republic and the recommended values from international statistics (IPCC, Emission Inventory Guidebook). Emission factors are given in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

Reference:

DUFEK, J., HUZLÍK, J., ADAMEC, V. Methodology of determination of air pollution emissions from transport in the Czech Republic. Brno: CDV, 2006, 26 s.(in Czech). http://www.cdv.cz/metodiky/

A3. 6 Country specific CO_2 emission factor for Lime Production

Emissions of GHG from lime production are classified into two different categories. The first category relates to the combustion processes, ongoing in the production of lime, and emissions from it are reported in sector "Energy" in the Czech National Inventory Report. In the second category are included emissions from decomposition of carbonates, of decomposition of organic carbon, contained in the raw material, used for the production of lime. These emissions are described in sector "Industrial processes", in subsector 'Mineral industry'. The following calculations apply only to the second category of emissions.

Production of lime is based on heating limestone, during which decomposition (calcination) of carbonates, contained in limestone, occurs and carbon dioxide is released. In limestone mainly calcium carbonate and magnesium carbonate mixture is present in range of 75.0 to 98.5% of weight, of which the magnesium carbonate is 0.5 to 15.0% of weight. Detailed chemical composition and the division into classes of limestone, according to the national standards are shown in Tab. A3 - 7 (ČSN, 1992).

Tab. A3 - 7 Division of limestone, according to chemical composition

Chemical composition in% weight		Quality class							
		I	II	III	IV	V	VI	VII	VIII
$CaCO_3 + MgCO_3$	min	98.5	97.5	96.0	95.0	93.0	85.0	80.0	75.0
from which $MgCO_3$	min	0.5	0.8	2.0	4.0	6.0	10.0	15.0	
SiO_2	max	0.3	0.8	1.5	3.0	4.5	6.0	8.0	18.0
$Al_2O_3 + Fe_2O_3$	max	0.2	0.4	0.8	2.0	3.5	5.0	6.0	6.0
from which Fe_2O_3	max	0.03	0.1	0.03	1.0	2.0	2.5	2.5	
MnO	max	0.01	0.03	0.03	0.03				
SO_3	max	0.08	0.1	0.2	0.2	0.3	0.5	0.5	2.0

The composition of limestone is closely associated with the emission factor. As calcium carbonate and magnesium carbonate have a different emission factors, the ratio between the two emission factors is reflected in the resulting emission factor. Emission factor derived from $CaCO_3$ or $MgCO_3$ is defined as emission factor of method A. This method is based on the input materials in the process of lime production. Further emission factor can be determined for outgoing materials or for CaO and MgO in lime. This procedure is called method B. Emission factors from method A and B are described in Tab. A3-8 (Commission Regulation (EU) № 601/2012).

Tab. A3 - 8 Emission factors for method A and B

Method	Material	EF [t CO_2/ t material]
A (input)	$CaCO_3$	0.440
	$MgCO_3$	0.522
B (output)	CaO	0.785
	MgO	1.092

Additional ingredients (other carbonates and organic carbon), which occur in limestone in very small quantities, may also be a source of emissions. These small amounts will affect to a minor extent the total emission factor; therefore for the inventory of GHG can be considered as negligible.

Thus the most significant impact on the emission factor has the composition of the input material, which subsequently is reflected in the composition of lime. Therefore we can affirm that, it is inessential, if we calculate from the composition of the input material (Method A) or the composition of the output material (Method B), both ways would lead to the same emission factor for the given process.

The best way to do that is to observe the relation between the emission factor and mass in% of $MgCO_3$ in the input material (Method A). This dependence can be observed on Fig. A3-4.

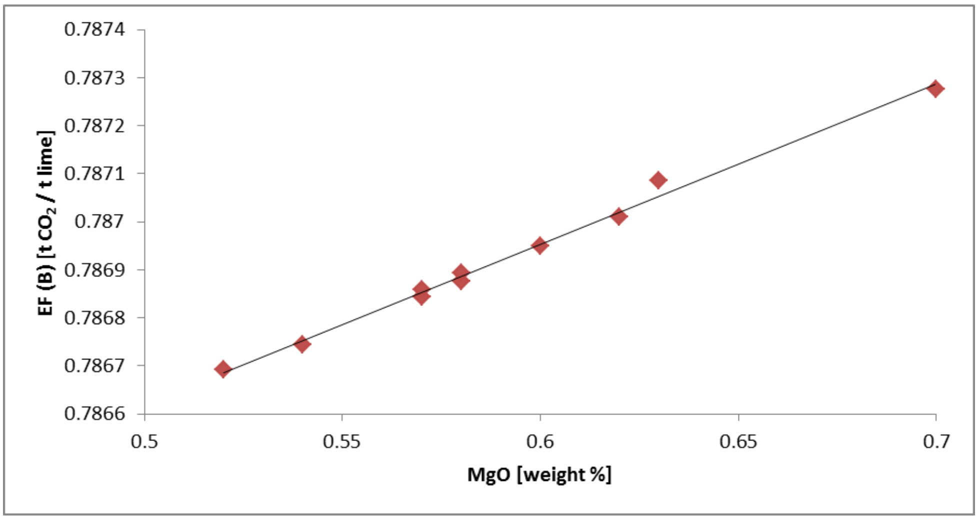

Fig. A3 6 Correlation between emission factor and mass representation of $MgCO_3$ in input material

Dependence between emission factor and output material (weight% MgO) occurs naturally, even when using method B, as you can see on Fig. A3 - 5.

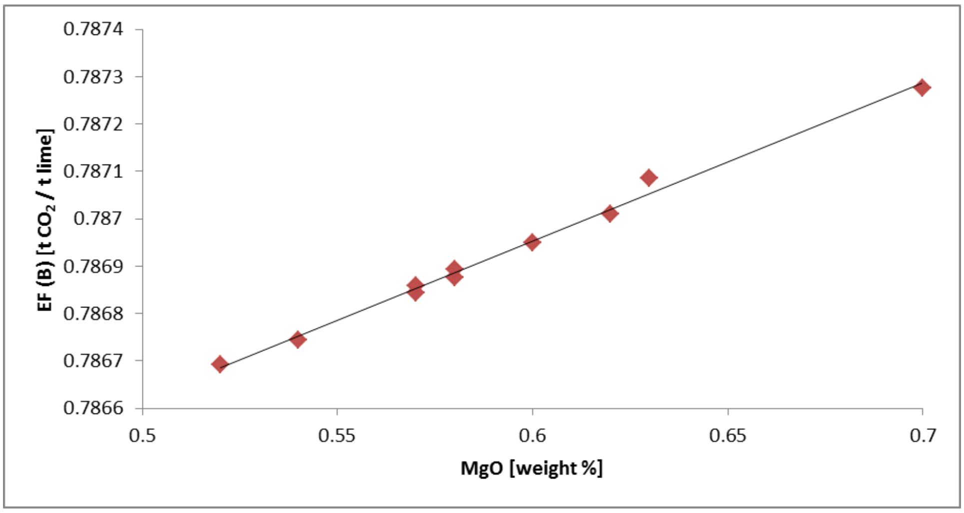

Fig. A3 7 Correlation of emission factor in mass representation of MgO in output material

As Fig. A3 -4 and A3 - 5 shows, the emission factor varies with the amount of MgCO3 or MgO only very slightly. Limestone, which is processed in the Czech Republic, is supplied to the lime plants from the same source and the composition of it for the individual sources does not change much with time. These facts reveal that, similarly, the emission factor for lime production will move only within a narrow range, which will have a small impact on the calculation of the emissions. As it is evident from Fig. A3 – 6 the emissions calculated, using Tier 1 approach, which adopts country specific emission factor (Vacha, 2004), are only very slightly overestimated compared to emissions from the ETS, which are obtained by measuring or Tier 3 approach.

Fig. A3 8 Development of emissions of CO_2 from production of lime in CR for period 1990 – 2014

Figure A3 - 7 shows oscillating weighted total emission factor derived from the ETS which fluctuates near the country specific emission factor values. From figure 4 it is observed that there could be a slight decrease in the emission factor since 2009, but it will be rather an incidental drop. For the period 1990 - 2004, for which ETS data are not available, the emission factors could be calculated as the average of the available data from the ETS. The average of these values is 0.7885 t CO_2/t lime and it differs from the country specific emission factor only by one ten-thousandth. For this reason, for this time period it is considered to keep the country specific emission factor.

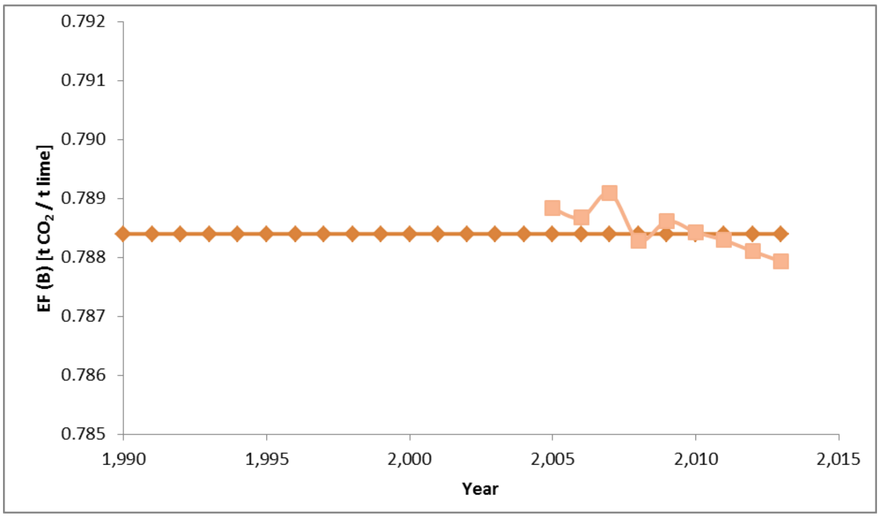

Fig. A3 9 Development of EF for production of lime in CR for period 1990 - 2014 (method B)

Since the composition of limestone from 1990 to the present has not changed significantly, the emission factor does not undergo any major change. Therefore for the period 1990 - 2004 the country specific emission factor (0.7884 t CO2/t lime; Vacha, 2004) can be used and for the remaining period will be applied emission factors derived from the ETS.

Due to the very small variation of $MgCO_3$ content in limestone, the emission factor changes slightly over time. We can use as an emission factor for the period 1990-2004 the proposed country specific, which is equal to 0.7884 t CO_2/t lime (Method B) and activity data for emission calculations utilize the Czech Statistical Office and Czech Lime Association. Since 2005 it is possible to use ETS data that have greater accuracy than the country specific EF together with data from the CSO and CLA.

Annex 4 The national energy balance for the most recent inventory year

Following tables present energy balance for the Czech Republic for 2013.

Tab. A4 - 1 Energy balance for solid fuels 2013

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	4 559	4 035	40 385	2 489	193
Total Imports (Balance)	1 006	807	312	429	304
Total Exports (Balance)	2 230	2 581	1 111	457	9
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	-40	1 200	-650	-11	3
Inland Consumption (Calculated)	3 295	3 611	38 936	2 450	491
Statistical Differences	87	-209	-343	0	0
Transformation Sector	3 208	3 349	35 953	1 993	7
Main Activity Producer Electricity Plants	0	960	21 801	0	0
Main Activity Producer CHP Plants	0	2 178	10 224	0	4
Main Activity Producer Heat Plants	0	9	173	0	0
Autoproducer Electricity Plants	0	0	438	0	0
Autoproducer CHP Plants	0	201	1 933	0	0
Autoproducer Heat Plants	0	1	30	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0
Coke Ovens (Transformation)	3 208	0	0	93	0
BKB Plants (Transformation)	0	0	0	0	0
Gas Works (Transformation)	0	0	1 354	0	0
Blast Furnaces (Transformation)	0	0	0	1 900	3
Coal Liquefaction Plants (Transformation)	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0
Energy Sector	0	0	794	0	89
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	0	794	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	89
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	0	0	0	0
Total Final Consumption	0	471	2 532	457	395
Total Non-Energy Use	0	0	0	0	356
Final Energy Consumption	0	471	2 532	457	39
Industry Sector	0	367	902	426	39
Iron and Steel	0	107	23	384	7
Chemical (including Petrochemical)	0	65	564	0	12
Non-Ferrous Metals	0	0	0	5	0
Non-Metallic Minerals	0	168	33	21	20
Transport Equipment	0	0	26	0	0
Machinery	0	1	31	9	0
Mining and Quarrying	0	2	3	0	0
Food, Beverages and Tobacco	0	14	93	7	0
Paper, Pulp and Printing	0	10	101	0	0
Wood and Wood Products	0	0	2	0	0
Construction	0	0	8	0	0
Textiles and Leather	0	0	11	0	0
Non-specified (Industry)	0	0	7	0	0
Transport Sector	0	0	1	0	0
Other Sectors	0	104	1 629	31	0
Commercial and Public Services	0	5	66	10	0
Residential	0	97	1 530	20	0
Agriculture/Forestry	0	2	24	1	0
Fishing	0	0	0	0	0
Non-specified (Other)	0	0	9	0	0

Tab. A4 - 2 Energy balance for solid fuels 2013

SOLID FUELS	BKB-PB [kt/year]	Gas Works Gas [TJ/year]	Coke Oven Gas [TJ/year]	Blast Furnace Gas [TJ/year]	Other Recovered Gases [TJ/year]
Indigenous Production	0	16 396	20 550	20 513	1 813
Total Imports (Balance)	159	0	0	0	0
Total Exports (Balance)	18	0	0	0	0
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	0	0	0	0	0
Inland Consumption (Calculated)	141	16 396	20 550	20 513	1 813
Statistical Differences	0	0	0	0	0
Transformation Sector	0	16 269	6 371	8 585	637
Main Activity Producer Electricity Plants	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	6 371	8 585	637
Main Activity Producer Heat Plants	0	0	0	0	0
Autoproducer Electricity Plants	0	21	0	0	0
Autoproducer CHP Plants	0	16 248	0	0	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	127	8 862	3 187	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	127	0	0	0
Patent Fuel Plants (Energy)	0	0	0	0	0
Coke Ovens (Energy)	0	0	8 862	1 532	0
BKB Plants (Energy)	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	1 655	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	266	0	0
Total Final Consumption	141	0	5 051	8 741	1 176
Total Non-Energy Use	0	0	0	0	0
Final Energy Consumption	141	0	5 051	8 741	1 176
Industry Sector	0	0	5 051	8 741	1 176
Iron and Steel	0	0	4 896	8 695	1 123
Chemical (including Petrochemical)	0	0	0	0	0
Non-Ferrous Metals	0	0	0	0	0
Non-Metallic Minerals	0	0	50	1	53
Transport Equipment	0	0	0	0	0
Machinery	0	0	105	45	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	141	0	0	0	0
Commercial and Public Services	0	0	0	0	0
Residential	141	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

Tab. A4 - 3 Energy balance for Crude Oil, Refinery Gas and Additives/Oxygenates for 2013

LIQUID FUELS	Crude Oil [kt/year]	Refinery Feedstocks [kt/year]	Additives Oxygenates [kt/year]
Indigenous Production	154	0	106
From Other Sources	0	0	319
From Other Sources - Solid fuels	0	0	0
From Other Sources - Natural Gas	0	0	0
From Other Sources - Renewables	0	0	319
Backflows	0	73	0
Primary Product Receipts	0	0	0
Refinery Gross Output	0	0	0
Inputs of Recycled Products	0	0	0
Refinery Fuel	0	0	0
Total Imports (Balance)	6 552	18	18
Total Exports (Balance)	25	0	0
International Marine Bunkers	0	0	0
Interproduct Transfers	0	0	0
Products Transferred	0	123	0
Direct Use	0	0	197
Stock Changes (National Territory)	-17	-4	6
Refinery Intake (Calculated)	6 664	210	252
Gross Inland Deliveries (Calculated)	0	0	0
Statistical Differences	0	0	0
Gross Inland Deliveries (Observed)	0	0	0
Refinery Intake (Observed)	6 664	210	252

Tab. A4 - 4 Energy balance for liquid fuels 2013

LIQUID FUELS	Refinery Gas [kt/year]		LPG [kt/year]		Naphtha [kt/year]		Motor Gasoline [kt/year]		Biogasoline [kt/year]		Aviation Gasoline [kt/year]	
Refinery Gross Output	134		180		737		1,252		39		0	
Refinery Fuel	118		0		0		0		0		0	
Total Imports (Balance)	0		107		141		556		3		2	
Total Exports (Balance)	0		90		2		320		12		0	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	0		0		-2		-5		5		0	
Gross Inland Deliveries (Calculated)	16		234		874		1,483		87		2	
Statistical Differences	0		0		0		-4		4		0	
Gross Inland Deliveries (Observed)	16		234		874		1,487		83		2	
Refinery Intake (Observed)	0		0		0		0		0		0	
Non-energy use in Petrochemical industry	16		120		874		0		0		0	
	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use
Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	0	16	114	120	0	874	1 487	0	83	0	2	0
Transport Sector	0	0	69	0	0	0	1 487	0	83	0	2	0
International Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	0	0	0	0	0	2	0
Road	0	0	69	0	0	0	1 487	0	83	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Navigation	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	16	34	120	0	874	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (including Petrochemical)	0	16	0	120	0	874	0	0	0	0	0	0
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	1	0	0	0	0	0	0	0	0	0
Transport Equipment	0	0	1	0	0	0	0	0	0	0	0	0
Machinery	0	0	5	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	1	0	0	0	0	0	0	0	0	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	1	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	0	25	0	0	0	0	0	0	0	0	0
Other Sectors	0	0	11	0	0	0	0	0	0	0	0	0
Commercial and Public Services	0	0	1	0	0	0	0	0	0	0	0	0
Residential	0	0	4	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	4	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	2	0	0	0	0	0	0	0	0	0

Tab. A4 - 5 Energy balance for liquid fuels 2013

LIQUID FUELS	Kerosene Type Jet Fuel [kt/year]		Other Kerosene [kt/year]		Transport Diesel [kt/year]		Biodiesel [kt/year]		Heating and Other Gasoil [kt/year]		Residual Fuel Oil [kt/year]	
Refinery Gross Output	111		0		2 865		86		117		148	
Refinery Fuel	0		0		0		0		0		0	
Total Imports (Balance)	171		2		1 696		46		14		13	
Total Exports (Balance)	0		0		664		24		26		120	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	9		0		19		0		0		57	
Gross Inland Deliveries (Calculated)	291		2		4 053		253		110		108	
Statistical Differences	0		0		0		0		0		32	
Gross Inland Deliveries (Observed)	291		2		4 053		253		110		76	
Refinery Intake (Observed)	0		0		0		0		0		0	
Non-energy use in Petrochemical industry	0		0		0		0		6		0	
	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use
Transformation Sector	0	0	0	0	1	0	0	0	2	0	27	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	7	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	1	0	5	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	8	0
Main Activity Producer Heat Plants	0	0	0	0	1	0	0	0	1	0	5	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	2	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	16	0	0	0	1	0	0	0
Coal Mines	0	0	0	0	16	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	1	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	291	0	2	0	4 036	0	253	0	101	6	49	6
Transport Sector	291	0	0	0	3 661	0	253	0	85	0	0	0
International Aviation	274	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	17	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	3 659	0	253	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	85	0	0	0
Domestic Navigation	0	0	0	0	2	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	0	0	0	43	0	0	0	9	6	42	6
Iron and Steel	0	0	0	0	0	0	0	0	0	0	5	0
Chemical (including Petrochemical)	0	0	0	0	0	0	0	0	0	6	1	6
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	0	0	0	0	0	0	0	0	7	0
Transport Equipment	0	0	0	0	0	0	0	0	1	0	0	0
Machinery	0	0	0	0	0	0	0	0	2	0	2	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	1	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	1	0	1	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	4	0
Wood and Wood Products	0	0	0	0	0	0	0	0	1	0	3	0
Construction	0	0	0	0	41	0	0	0	3	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	0	0	0	2	0	0	0	1	0	18	0
Other Sectors	0	0	2	0	332	0	0	0	7	0	7	0
Commercial and Public Services	0	0	0	0	5	0	0	0	2	0	3	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	0	0	319	0	0	0	4	0	2	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	2	0	8	0	0	0	1	0	2	0

Tab. A4 - 6 Energy balance for liquid fuels 2013

LIQUID FUELS	White Spirit SBP [kt/year]		Lubricants [kt/year]		Bitumen [kt/year]		Paraffin Wax [kt/year]		Petroleum Coke [kt/year]		Other Products [kt/year]	
Refinery Gross Output	0		100		477		9		0		925	
Refinery Fuel	0		0		0		0		0		65	
Total Imports (Balance)	13		130		272		7		10		166	
Total Exports (Balance)	0		69		347		5		2		102	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	-1		-1		3		-1		0		-21	
Gross Inland Deliveries (Calculated)	12		161		402		10		8		750	
Statistical Differences	0		0		0		0		0		0	
Gross Inland Deliveries (Observed)	12		161		402		10		8		750	
Refinery Intake (Observed)	0		0		0		0		0			
Non-energy use in Petrochemical industry	0		0		0		0		0		514	
	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use
Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	73
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	73
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	0	12	0	161	2	400	0	10	0	8	111	566
Transport Sector	0	0	0	137	0	0	0	0	0	0	0	0
International Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	130	0	0	0	0	0	0	0	0
Rail	0	0	0	7	0	0	0	0	0	0	0	0
Domestic Navigation	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	12	0	24	0	400	0	10	0	8	111	566
Iron and Steel	0	0	0	0	0	0	0	0	0	4	0	0
Chemical (including Petrochemical)	0	1	0	0	0	0	0	0	0	0	0	514
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	0	0	0	0	0	0	0	0	5	0
Transport Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	2	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	1	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	400	0	0	0	0	1	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	11	0	24	0	0	0	10	0	2	104	52
Other Sectors	0	0	0	0	2	0	0	0	0	0	0	0
Commercial and Public Services	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	0	0	2	0	0	0	0	0	0	0

Tab. A4 - 7 Energy balance for Natural Gas 2013 [TJ] in GCV

Indigenous Production	9 579
Associated Gas	5 730
Non-Associated Gas	
Colliery Gas	3 849
From Other Sources	0
Total Imports (Balance)	324 154
Total Exports (Balance)	310
International Marine Bunkers	0
Stock Changes (National Territory)	-10 276
Inland Consumption (Calculated)	323 147
Statistical Differences	0
Inland Consumption (Observed)	323 147
Recoverable Gas	
Opening Stock Level (National Territory)	73 543
Closing Stock Level (National Territory)	83 819
Opening stock level (Held abroad)	13 173
Closing stock level (Held abroad)	14 203
Memo:	
Gas Vented	0
Gas Flared	0
Memo: Cushion Gas	
Cushion Gas Closing Stock Level	40 768
Memo: From other sources	
From Other Sources - Oil	0
From Other Sources - Coal	0
From Other Sources - Renewables	0

Transformation Sector	45 116
Main Activity Producer Electricity Plants	252
Autoproducer Electricity Plants	0
Main Activity Producer CHP Plants	17 197
Autoproducer CHP Plants	4 061
Main Activity Producer Heat Plants	20 921
Autoproducer Heat Plants	2 685
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	4 388
Coal Mines	0
Oil and Gas Extraction	152
Petroleum Refineries	4 236
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	5 418
Transport Sector	2 482
Road	632
of which Biogas	0
Pipeline Transport	1 850
Non-specified (Transport)	0
Industry Sector	98 240
Iron and Steel	10 171
Chemical (including Petrochemical)	12 264
Non-Ferrous Metals	1 860
Non-Metallic Minerals	21 888
Transport Equipment	7 842
Machinery	12 562
Mining and Quarrying	2 020
Food, Beverages and Tobacco	13 845
Paper, Pulp and Printing	4 802
Wood and Wood Products	1 472
Construction	3 676
Textiles and Leather	2 278
Non-specified (Industry)	3 560
Other Sectors	162 433
Commercial and Public Services	62 170
Residential	94 433
Agriculture/Forestry	2 980
Fishing	0
Non-specified (Other)	2 850

Annex 5 Any additional information, as applicable

Information provided in A5.1 – A5.2 are related to emission estimation in Energy sector.

A5.1 Improved ratio NCV/GCV for Natural Gas

Default ratio NCV/GCV for natural gas according to the IPCC methodology (IPCC 2006) is equal to 0.9

For more accurate determination of the ratio, data set NET4GAS was used. This data set contains, among other values, NCV and GCV in MJ/m^3 for reference temperature of 20˚C, for each month and for the time period of 5 years (1997 to 2011). All monthly values for NCV and GCV were recalculated for temperature of 15 ˚C (i.e. trading conditions), and further it was determined annual average of the monthly values for NCV and GCV and their ratio NCV/GCV, see Tab. A5-1

Tab. A5 1 Annual average NCV, GCV and their ratio (determined and calculated using correlation)

MJ/m^3	2007	2008	2009	2010	2011	Average	Standard deviation	%Standard deviation
NCV, 15 ˚C	34.2236	34.2498	34.4267	34.3921	34.4469	34.3478	0.0927	0.27%
GCV, 15 ˚C	37.9572	37.9841	38.1724	38.1363	38.1942	38.0888	0.0986	0.26%
Ratio NCV/GCV	0.90164	0.90169	0.90187	0.90182	0.90189	0.90178	0.0001	0.01%
0.001011*GCV + 0.863274 [a)]	0.90165	0.90168	0.90187	0.90183	0.90189			

[a)] *Precise calculation of the ratio NCV/GCV*

As CzSO reports mainly yearly gross calorific values for natural gas (GCV), while data expressing net calorific value (NCV) is needed, correlation for the calculation of NCV from known values for GCV, reported every year from CzSO, was determined by linear regression, see. Fig. A5-1

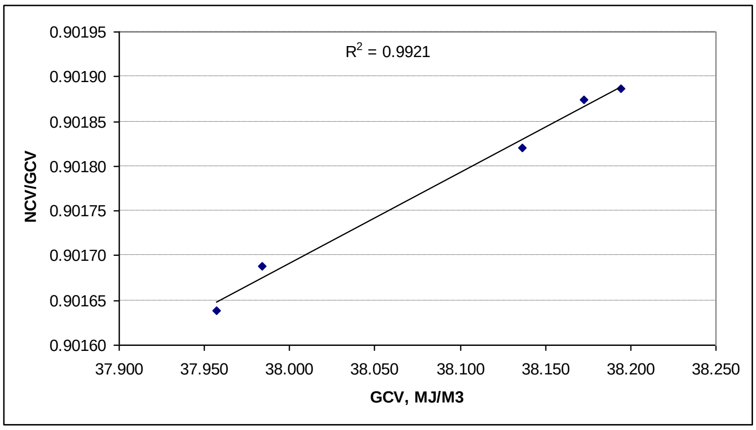

Fig. A5 1 Regression line corresponds with the data shown in Tab. A5-1.

The resulting equation for exact calculation of NCV from known values for GCV is:

NCV = (0.001011 * GCV + 0.863274) * GCV (A5 – 1)

where NCV and GCV are expressed in MJ/m^3 in the reference temperatures of 15 ˚C (i.e. trading conditions)

A5.2 Improved ratio NCV/GCV for coke oven gas

Recommended ratio NCV/GCV for coke oven gas according to the CzSO is equal to 0.9

For more accurate determination of the ratio, the data set obtained from the one of the significant coke producer in the Czech Republic, was mostly used. This data set uses calculation sheets developed by CHMI for determination of emission factors for CO_2, density and NCV for gaseous fuels, calculated from its composition, etc.

This calculation sheet uses for calculation of NCV and GCV for fuels in gaseous state, calorific value and GCV, based on the weight of the individual components that are listed in regulation ČSN 38 5509 (DIN 1872), so it enables also the calculation of the ratio NCV/GCV.

Unlike in natural gas, in industrially produced fuels NCV and GCV are usually provided in reference temperature of 0˚C (273.15 K), i.e. in "normal conditions". The same is used in the above mentioned data set. Default ratio NCV/GCV does not depend on the reference temperature, because recalculation coefficients for different reference temperatures in the ratio NCV/GCV are canceled out. The ratio NCV/GCV is calculated for each month in 2010, i.e. 12 times, from which the ratio, standard deviation and its relative value are calculated.

Results are presented in Tab. A5-2.

Tab. A5 2 Annual averages of NCV, GCV under normal condition (i.e. 0˚C) and their ratio

Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
NCV. MJ/Nm^3	16.935	17.108	16.847	16.040	16.459	17.210	17.162	
GCV, MJ/NM^3	19.053	19.251	18.953	18.059	18.530	19.342	19.270	
NCV/GCV	0.8888	0.8886	0.8889	0.8882	0.8883	0.8898	0.8906	
Month	**8**	**9**	**10**	**11**	**12**	**Average**	**Standard deviation**	**%**
NVC. MJ/Nm^3	17.177	16.832	17.056	17.218	17.312	16.946	0.353	2.1%
GCV, MJ/NM^3	19.309	18.925	19.183	19.357	19.443	19.056	0.386	2.0%
NCV/GCV	0.8896	0.8894	0.8891	0.8895	0.8904	0.8893	0.0007	0.1%

Average value of the ratio NCV/GCV is **0.8893** (precisely 0.88926).

In addition to this, a control calculation was conducted, based on the data obtained from another significant coke producer. Due to the incompleteness of the data in comparison with the dataset mentioned above, the ratio NCV/GCV was determined from the average of 4 values (January, April, July, October) and the value is 0.8861, which is relatively close to the more precisely identified value above.

A5.3 Net calorific values of individual types of fuels in the period 1990-2013

Net Calorific Values (NCV) of each individual fossil fuel in the period 1990-2013 used in the Energy sector were taken from the standard CzSO Questionnaires (IEA/OECD, Eurostat, UN Questionnaires). For liquid fuels, CzSO provides for each year one net calorific value for all sectors, while for solid fuels, generally indicates three values: for 1A1, 1A2 and 1A4 which were used in the sectoral approach. In Table A5- 3 are shown for clarity aggregated values, calculated as a weighted average of these three values.

In case of solid and liquid fuels are calorific values expressed in kJ/kg. For natural gas CzSO presents primarily Gross Calorific Values (GCV) in kJ/m3 (volume related to the trading conditions: 15 ° C and 101.3 kPa). Conversion GCV to NCV, derived in the Czech Hydrometeorological Institute in cooperation with KONEKO, is shown in this Annex above. For the COG (Coke Oven Gas) CzSO presents activity data directly in energy units TJ related to GCV (marked as TJ_{Gross}), but without GCV values for individual years. Conversion to TJ related to NCV (marked as TJ_{Net}), which is required for the calculation of emissions with respect to the definition of emission factors, also appears in this Annex. It is visible that the ratio NCV/GCV = 0.8893 is equal to the ratio $TJ_{Net}/TJ_{Gross.}$

In Table A5-3 are shown the net calorific values of solid and liquid fuels in the period 1990 - 2013. The symbol "NO" means, as in CRF, that the fuel was not used, “NE” symbol indicates that the value of NCV has not been estimated. Table A5-3 provides definitions of fuels used by CzSO. In most cases, these definitions of fuel are identical to the definitions of IPCC (IPCC, 2006). It is noted, however, that fuels marked as "Fuel oil - high sulfur" and "Fuel oil - low sulfur" in the table, according to the terminology of CzSO, fall according to the IPCC under "Residual Fuel Oil". Similarly fuels marked as "Road diesel" and "Heating and other gas oil" are covered by the IPCC under " Gas/Diesel Oil ".

Tab. A5 3a Net calorific values for fossil fuels

NCV [kJ/kg]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bituminous Coal	19.411	19.229	21.420	21.655	21.724	21.907	22.046	22.233	23.838	24.072	21.710
Coking Coal	28.413	27.178	28.419	28.467	28.467	28.466	28.464	28.608	28.608	28.537	28.392
Lignite	12.076	12.062	12.046	12.075	12.211	12.496	12.614	12.112	12.114	12.824	12.481
Coke Oven Coke	27.167	27.177	27.426	27.375	27.215	27.216	27.218	28.225	28.230	28.688	28.013
Coal Tar	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
BKB	22.868	23.058	21.854	22.922	23.136	22.941	22.918	22.924	24.080	24.620	24.912
Crude oil	41.646	41.646	41.650	41.652	41.652	41.652	41.650	41.650	41.622	41.628	41.543
Refinery gas	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023
LPG	46.050	46.050	46.050	46.050	46.050	46.045	46.000	46.000	46.000	46.000	46.000
Naphtha	43.300	43.300	43.300	43.300	43.300	43.352	43.416	43.391	43.709	43.686	43.669
Motor gasoline	43.340	43.332	43.342	43.340	43.308	43.320	43.320	43.300	43.300	43.300	43.300
Aviation gasoline	43.836	43.836	43.836	43.836	43.836	43.836	43.836	43.800	43.800	43.800	43.800
Biogasoline	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000
Kerosene Jet Fuel	43.454	43.454	43.454	43.454	43.454	43.445	43.433	43.116	43.000	43.000	43.000
Other kerosene	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800
Road diesel	42.503	42.492	42.505	42.513	42.513	42.497	42.506	42.500	42.505	42.622	42.571
Heating and other gas oil	42.300	42.300	42.300	42.300	42.300	42.279	42.310	42.300	42.300	42.412	42.461
Biodiesel	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000
Fuel oil - low sulphur	38.850	38.850	38.850	38.850	38.850	38.825	37.041	38.784	38.890	39.639	39.694
Fuel oil - high sulphur	40.700	40.700	40.700	40.700	40.700	40.863	40.804	40.783	40.775	40.917	40.893
Residential Fuel Oil	40.576	40.589	40.619	40.626	40.635	40.738	40.258	40.595	40.538	40.544	40.659
Petroleum coke	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500
Other products*)	40.193	40.193	40.193	40.193	40.193	41.530	39.373	39.392	38.387	39.290	39.398

**) The same values of NCV as for Other products are reported by CzSO also for White spirit and SPB, Paraffin waxes, Lubricants and Bitumen*

Tab. A5 3b Net calorific values for fossil fuels

NCV [kJ/kg]	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Anthracite	NO	32.000	32.000	32.000	32.000	30.941	30.000	30.000	30.000	30.000	29.809	28.170	28.944
Bituminous Coal	22.205	23.119	23.436	23.292	22.333	22.390	23.389	23.418	22.642	22.706	22.975	23.443	23.305
Coking Coal	28.596	28.752	28.971	28.745	28.818	29.148	29.279	29.326	29.381	29.385	29.207	29.373	29.244
Lignite	12.443	12.441	12.418	12.605	12.687	12.793	12.451	12.609	12.470	12.519	12.204	12.327	12.591
Coke Oven Coke	28.502	28.542	28.562	28.024	27.880	28.631	28.312	28.344	28.588	27.892	27.833	28.209	28.465
Coal Tar	NE	37.148	36.944	36.686	37.336	36.301	37.000	37.000	37.161	36.936	36.995	37.716	37.756
BKB	24.243	23.803	25.505	24.025	22.948	23.638	23.525	22.098	22.253	20.772	21.437	21.933	20.809
Crude oil	41.889	41.483	41.991	41.980	41.980	41.986	42.259	42.357	42.353	42.400	42.370	42.392	42.400
Refinery gas	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023	46.023
LPG	44.321	44.340	44.368	44.337	44.337	45.803	45.803	43.826	43.817	43.822	43.814	43.800	43.800
Naphtha	42.837	42.858	42.940	42.841	42.841	42.841	43.935	43.951	43.947	43.961	43.971	43.993	43.600
Motor gasoline	43.300	43.300	43.300	43.300	43.300	43.817	43.800	43.839	44.165	44.235	44.308	44.302	44.315
Aviation gasoline	43.800	43.800	43.793	43.790	43.790	43.790	43.790	43.790	43.790	43.790	43.790	43.790	43.790
Biogasoline	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000
Kerosene Jet Fuel	42.800	42.800	42.800	42.800	42.800	43.300	43.300	43.300	43.300	43.300	43.300	43.300	43.300
Other kerosene	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800	42.800
Road diesel	41.850	41.832	41.833	41.839	41.827	42.760	42.706	42.760	42.762	42.753	42.594	42.599	42.600
Heating and other gas oil	41.764	41.748	41.711	41.718	41.800	42.600	42.600	42.600	42.600	42.600	42.600	42.600	42.600
Biodiesel	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000	37.000
Fuel oil - low sulphur	39.286	39.313	40.000	39.584	39.538	39.599	41.484	39.718	39.700	39.696	39.522	39.436	39.439
Fuel oil - high sulphur	39.636	40.316	40.371	40.519	39.869	39.663	39.758	39.700	39.695	39.489	39.427	39.581	39.500
Residential Fuel Oil	39.511	39.670	40.182	39.997	39.686	39.628	40.594	39.710	39.698	39.603	39.482	39.509	39.475
Petroleum coke	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	37.500	38.500	38.500
Other products*)	40.754	40.711	40.660	40.820	40.894	39.300	39.300	40.000	40.074	39.821	40.189	40.354	40.179

**) The same values of NCV as for Other products are reported by CzSO also for White spirit and SPB, Paraffin waxes, Lubricants and Bitumen*

Tab. A5 4a Net calorific values for Natural Gas

NCV [kJ/m³]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Natural Gas**)	33.428	33.428	33.428	33.859	33.910	33.975	33.957	33.966	34.046	33.965	33.980

***) 15 °C, 101.3 kPa*

Tab. A5 4b Net calorific values for Natural Gas

NCV [kJ/m³]	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Natural Gas**)	33.986	34.023	33.997	33.962	33.975	34.105	34.246	34.164	34.285	34.328	34.619	34.230	34.353

***) 15 °C, 101.3 kPa*

A5. 4 General quality control protocol used in NIS

The following table shows general QC form, which is used for QC procedures in each specific sector.

QC form for general technical control
QC (Tier 1)

Source category/ removals: (e.g. 2A Mineral Products)

Reviewed documents: (e.g. CRF Reporter, computational spreadsheet for 2A, relevant chapter in NIR)

Responsible compiler of reviewed category: …

Persons, who carried out the controls: autocontrol – …, control – …

Date of finalization of control:

Instructions for filling

This form should be fulfilled for each source category or removals and provides the record of controls which were carried out and possible consequent corrections. This form should be fulfilled in line with QA/QC plan. In case when it is not clear how to solve founded discrepancies the worker responsible for control should problematic issues discuss with the sector compiler and if needed with other relevant experts.

First part of the form summarizes results of the control and highlights all significant findings. Second part should be fulfilled according to each listed item. For particular categories are usually not applicable all these items - these items are then noted as not relevant (n.r.). On other hand in the form can be added additional issues which are characteristic for the relevant category.

Summary of control results

Overview of findings and corrections:

description of findings

Suggested corrections, which should be realised in the next submission:

description of suggested corrections

Issues remaining after the corrections:

description of remaining issues

QC form for general and technical control (QC, Tier 1)

	Auto-control / control realisation			Correction realisation	
Description of controls	**Date year 12/13**	**Controlled by**	**Finding YES- NO**	**Date year 12/13**	**Corrected by**
Qualitative check of input data					
1. Check for transcription errors in data input (mistakes made on the way from input data to the computational spreadsheet)					
2. Check of the computational spreadsheets and comparison of data recorded in them and in the CRF (and if needed in NIR)					
3. Identification of possible changes in input documents and check of their relevance and correctness					
4. Another check of input data (specification needed)					
Quantitative check of data documentation (Data + NIR)					
5. Check of data file from the view of completeness					
6. Check of the references on sources of input data in the spreadsheets					
7. Check that all references in spreadsheets are documented					
8. Check of completeness of references on the sources of input data in the computational spreadsheets					
9. Random check of correctness of references on the data sources (NIR)					
10. Check, that new references (in this submission) are in line with the list of references (NIR)					
11. Random check of referred materials, if they really contains referred data					
12.Check that assumptions and criteria for the selection of activity data, emission factors and other parameters are documented (data + NIR)					
13. Check, that the changes in data or methodology (i.e. recalculations) are documented (data + NIR)					
14. Check, that quotes are realised uniformly (NIR)					
15a. Another check of data documentation (specification needed) – e.g. data archiving					
15b. Another check of data documentation (specification needed) – e.g. transparency of sectoral chapter in NIR					
Check of correctness of computations of emissions and removals					
16. Check, that all realised computations are included					

17. Check of the units, parameters and conversion factors					
18. Check of correct significations and units used during the whole computation					
19. Check of correct use of conversion factors					
20. Check of correct use of factors describing seasonal fluctuations and spatial orientation					
21. Check of correctness of relationships and equations used in computations					
22. Check that in the spreadsheet is apparent which data are input data and which are calculated (i.e. output data)					
23. On the representative sample confirm the way of computation by independent calculation (i.e. out of the particular computational spreadsheet)					
24. Comparison of some computations with the simplified approaches					
25. Check of correctness of data aggregation in terms of relevant category					
26. Check of time-series consistency in case of methodology changes or data changes (corrections)					
27. Comparison of results of actual year with the previous year and check of unexpected differences					
28. Check of implied emission factors, check possible outliers and explanations					
29. Check of every unexpected and unexplainable trends of input data and computational sources					
30. Check of methodology in terms of consistency with IPCC methodology and its Good Practice Guidance (data + NIR)					

General notes to controls

description

Notes for each parts and founded issues

notes which are needed to add in order to finish adequate control

A5. 5 Completeness check form used for controlling of data in CRF Reporter

Following table is presenting example of form used for completeness evaluation for all sectors. The table contain also comments by expert in case the completeness function is not working properly. Following shortcuts have been used:

COMPLETED	C
PARTLY COMPLETED	P
INCOMPLETE	I
MISSING	M

Tab. A5 – 5 Completeness check for Waste sector (2013)

Waste		15 May check	19 October check	Comment by expert
5	Waste	i	p	complete
5.A	Solid waste disposal	c	p	complete
5.A.1	Managed waste disposal sites	c	p	complete
5.A.1.a	Anaerobic	c	p	complete
5.A.1.b	Semi-aerobic	c	c	
5.A.2	Unmanaged waste disposal sites	c	c	
5.A.3	Uncategorised waste disposal sites	c	c	
5.B	Biological treatment of solid waste	c	p	complete
5.B.1	Composting	c	p	complete
5.B.1.a	Municipal solid waste	c	c	
5.B.1.b	Other	c	i	complete
5.B.2	Anaerobic digestion at biogas facilities	c	p	complete
5.B.2.a	Municipal solid waste	c	p	complete
5.B.2.b	Other	c	i	complete
5.C	Incineration and open burning of waste	c	p	complete
5.C.1	Waste incineration	c	p	complete
5.C.1.1	Biogenic	c	p	complete
5.C.1.1.a	Municipal solid waste	c	p	complete
5.C.1.1.b	Other	c	i	complete
5.C.1.2	Non-biogenic	c	p	complete
5.C.1.2.a	Municipal solid waste	c	p	complete
5.C.1.2.b	Other	c	c	
	Hazardous waste		c	
5.C.2	Open burning of waste	c	c	
5.C.2.1	Biogenic	c	c	
5.C.2.1.a	Municipal solid waste	c	c	
5.C.2.1.b	Other	c	i	complete
5.C.2.2	Non-biogenic	c	c	
5.C.2.2.a	Municipal solid waste	c	c	
5.C.2.2.b	Other	c	i	complete
5.D	Wastewater treatment and discharge	i	p	complete
5.D.1	Domestic wastewater treatment and discharge	c	c	
5.D.2	Industrial waste water and discharge	c	p	complete
5.D.3	Other	i	i	complete
5.E	Other	c	i	complete
5.F	Memo Items	c	p	complete
5.F.1	Long-term Storage of C in Waste Disposal Sites	c	c	
5.F.2	Annual Change in Total Long-term C Storage	c	c	
5.F.3	Annual Change in Total Long-term C Storage in HWP Waste	c	p	complete

The following tables shows categories that are not estimated (NE) including relevant explanations of the reasons. Categories that are included elsewhere (IE) are shown in similar way.

A5. 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

Standard electronic format (SEF) tables

SEF Table 1

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year						
Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	348,528,647	NO	NO	12,738	NO	NO
Entity holding accounts	NO	18,747	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation account	NO	NO	NO	NO		
Other cancellation accounts	27	NO	NO	1,935	NO	NO
Retirement account	334,650,295	18,735,943	NO	19,874,444	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	683,178,969	18,754,690	NO	19,889,117	NO	NO

SEF Table 2A

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 2a. Annual internal transactions												
	Additions						Subtractions					
Transaction type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Art6 issuance and conversion												
Party verified projects		NO					NO		NO			
Independently verified projects		NO					NO		NO			
Art3.3 and 3.4 issuance or cancellation												
3.3 Afforestation reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Art 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	6,222	NO	NO
Subtotal		NO	NO				NO	NO	NO	6,222	NO	NO

Transaction type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	NO	NO	NO	NO	NO	NO

SEF Table 2BC

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 2b. Annual external transactions

	Additions						Subtractions					
Transfers and acquisitions	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
EU	7,616	14,006	NO	11,393	NO	NO	NO	18,747	NO	12,159	NO	NO
Subtotal	7,616	14,006	NO	11,393	NO	NO	NO	18,747	NO	12,159	NO	NO

Additional Information

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Independently verified ERU								NO				

Table 2c. Total annual transactions

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Total (Sum of table 2(a) and 2(b))	7,616	14,006	NO	11,393	NO	NO	NO	18,747	NO	18,381	NO	NO

SEF Table 3

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 3. Expiry, cancellation and replacement

	Expiry, cancellation and requirement to replace		Replacement					
Transaction or event type	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERs)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

SEF Table 4

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type: AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	348,536,263	14,006	NO	5,750	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation account	NO	NO	NO	NO		
Other cancellation accounts	27	NO	NO	8,157	NO	NO
Retirement account	334,650,295	18,735,943	NO	19,874,444	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	683,186,585	18,749,949	NO	19,888,351	NO	NO

SEF Table 5ABC

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 5 a. Summary information on additions and subtractions

	Additions: AAUs	ERUs	RMUs	CERs	tCERs	lCERs	Subtractions: AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Starting Values												
Issuance pursuant to Article 3.7 and 3.8	893,541,801											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Subtotal	893,541,801	NO		NO			NO	NO	NO	NO		
Annual Transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	6,423,610	NO	NO	5,052,040	NO	NO	35,377,857	NO	NO	722,906	NO	NO
Year 2 (2009)	59,665,197	428,939	NO	7,722,832	NO	NO	109,090,556	330,302	NO	6,123,076	NO	NO
Year 3 (2010)	40,059,068	2,539,673	NO	6,751,365	NO	NO	75,690,649	2,136,642	NO	2,853,506	NO	NO
Year 4 (2011)	19,017,124	3,617,809	NO	6,025,303	NO	NO	32,202,279	2,306,359	NO	3,810,407	NO	NO
Year 5 (2012)	5,332,856	4,183,302	NO	1,967,087	NO	NO	23,922,224	1,933,342	NO	525,679	NO	NO
Year 6 (2013)	2	15,003,411	NO	7,418,048	NO	NO	64,577,151	311,799	NO	1,013,919	NO	NO
Year 7 (2014)	7,616	14,006	NO	11,393	NO	NO	NO	18,747	NO	18,381	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Subtotal	130,505,473	25,787,140	NO	34,948,068	NO	NO	340,860,716	7,037,191	NO	15,067,874	NO	NO
Total	1,024,047,274	25,787,140	NO	34,948,068	NO	NO	340,860,716	7,037,191	NO	15,067,874	NO	NO

Table 5 b. Summary information on replacement

	Expiry, cancellation and requirement to replace: tCERs	lCERs	Replacement: AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 c. Summary information on retirement

Year	Retirement: AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	219,835,850	754,388	NO	9,382,544	NO	NO
Year 5 (2012)	67,795,483	3,085,075	NO	3,112,580	NO	NO
Year 6 (2013)	47,018,962	14,896,480	NO	7,379,320	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	334,650,295	18,735,943	NO	19,874,444	NO	NO

SEF Table 6ABC

Party	CZ
Submission Year	2015
Reported Year	2014
Commitment Period	1

Table 6 a. Memo item: corrective transactions relating to additions and subtractions

Additions: AAUs	ERUs	RMUs	CERs	tCERs	lCERs	Subtractions: AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 b. Memo item: corrective transactions relating to replacement

Expiry, cancellation and requirement to replace: tCERs	lCERs	Replacement: AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 c. Memo item: corrective transactions relating to retirement

Retirement: AAUs	ERUs	RMUs	CERs	tCERs	lCERs