

NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC

*SUBMISSION UNDER THE UNFCCC AND UNDER THE KYOTO PROTOCOL
REPORTED INVENTORIES 1990-2012*



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KONEKO, CDV, CHMI, IFER, CUEC
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Title: National Greenhouse Gas Inventory Report of the Czech Republic
(reported inventories 1990- 2012)
Contact: Ing. Ondrej Minovsky
Organization: Czech Hydrometeorological Institute
Address: Na Šabatce 17, Praha 4 – Komorany, 143 06 Czech Republic
E-mail: ondrej.minovsky@chmi.cz

Authors of individual chapters

| | | | |
|-------------------|---|---|--|
| Editors | | Ondrej Minovsky Eva Krtkova | (CHMI) (CHMI) |
| Executive Summary | | Ondrej Minovsky | (CHMI) |
| Chapter 1 | Introduction and General Issues | Ondrej Minovsky | (CHMI) |
| Chapter 2 | Trend in Total Emissions | Ondrej Minovsky | (CHMI) |
| Chapter 3 | Energy (CRF sector 1) | Vladimir Neuzil Eva Krtkova Jakub Tichy Jiri Jedlicka Miroslav Havranek | (KONEKO) (CHMI) (CDV) (CDV) (CUEC) |
| Chapter 4 | Industrial Processes (CRF sector 2) | Eva Krtkova Ondrej Minovsky | (CHMI) (CHMI) |
| Chapter 5 | Solvent and Other Product Use (CRF sector 3) | Eva Krtkova Ondrej Minovsky | (CHMI) (CHMI) |
| Chapter 6 | Agriculture (CRF sector 4) | Zuzana Exnerova | (IFER) |
| Chapter 7 | LULUCF (CRF sector 5) | Emil Cienciala | (IFER) |
| Chapter 8 | Waste (CFR sector 6) | Miroslav Havranek | (CUEC) |
| Chapter 10 | Recalculations and Improvements | Eva Krtkova | (CHMI) |
| Chapter 11 | KP LULUCF | Emil Cienciala | (IFER) |
| Chapter 12 | Information on Accounting of Kyoto units | Miroslav Rehor Michal Danhelka | (OTE) (MoE) |
| Chapter 13 | Information on Changes in National System | Ondrej Minovsky Eva Krtkova | (CHMI) (CHMI) |
| Chapter 14 | Information on Changes in National Registry | Miroslav Rehor Michal Danhelka | (OTE) (MoE) |
| Chapter 15 | Information on Minimization of Adverse Impacts | Michal Danhelka | (MoE) |
| Annexes | | Eva Krtkova Ondrej Minovsky | (CHMI) (CHMI) |

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* Provisions of chapters in bright purple have been revised. For details see page 10.

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Executive Summary

Information on UNFCCC review related resubmission

This chapter contains the announced changes in provisions of National Inventory Report issued by the potential problems identified during UNFCCC centralised review in September 2014

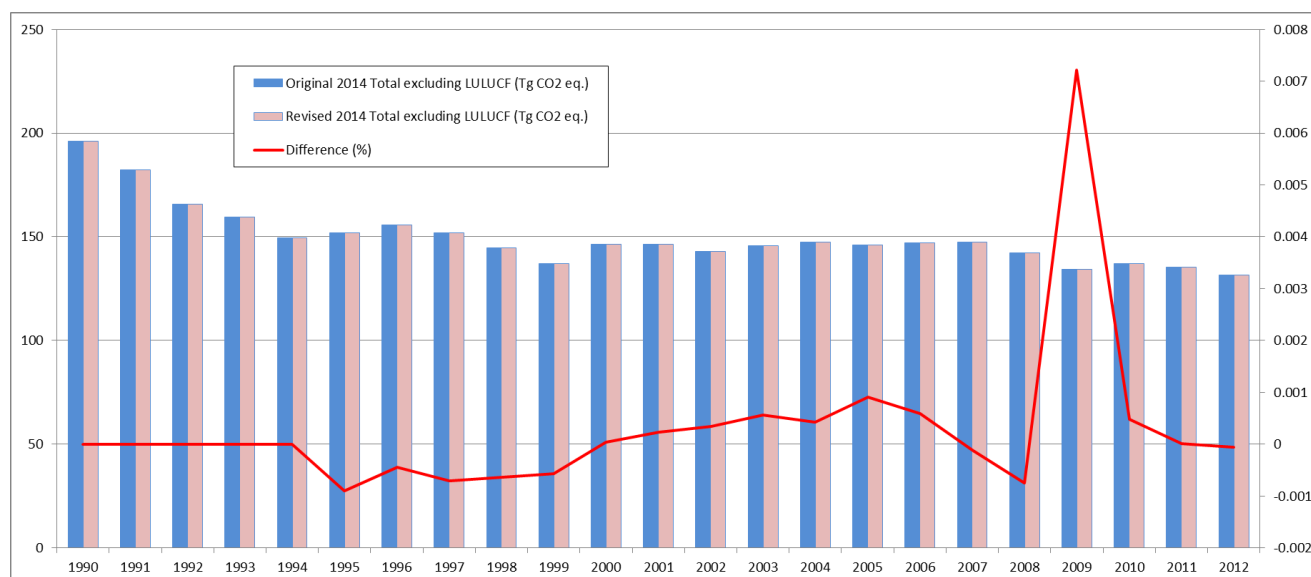
This report is the resubmitted version of National Greenhouse Gas Inventory Report of the Czech Republic. Resubmission was recommended by ERT on 26 September 2014 in Saturday paper submitted to the Czech Republic with the list of potential problems and additional questions. Czech Republic provides in this chapter additional information on the revised emissions estimates corresponding to the identified Potential Problems.

Overview of the performed recalculations

Resolving two issues in the national inventory rendered the original estimates of national total emission invalid. In case of the Czech Republic national totals (excluding LULUCF) are a base for CPR value calculation. Accordingly to the revised estimates, the CPR value has been adjusted as follows:

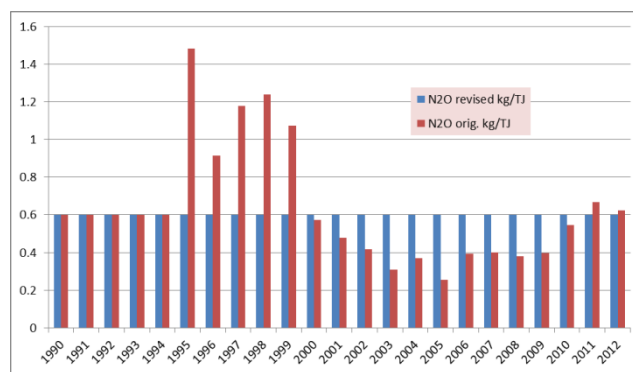
$$5 \times 131,466,030 = \mathbf{657,330,150 \text{ tonnes CO}_2 \text{ eq.}}$$

The overall change due to revised estimates discussed below proved to be rather insignificant as the difference between the original and the revised estimate does not exceed $\pm 0,007$ percent of the original estimate. For details see graph below.



Potential problem identified in Energy sector

ERT identified unusual trend in IEF time series for liquid fuels in 1.A.1.b petroleum refining which has been further identified as a data manipulation error. In the 2014 submission the recalculation of emission estimates from liquid fuels was performed since new country specific CO₂ emission factors for LPG and Refinery Gas were developed. Together with the development of CS CO₂ EF were also net calorific values updated, which affected also reporting of activity data in the categories, where LPG or Refinery Gas are used. In the 1A1b Petroleum refining is in the Czech Republic use Refinery Gas. The net calorific value for Refinery Gas was updated also in the official CzSO Questionnaires (please see Annex II of the NIR). Since activity data was updated using new net calorific value, all emission estimates were also updated. However an error appeared during the data manipulation and the emission estimates for N₂O in 1A1b Petroleum refining category were input incorrectly. The N₂O emission estimates were recalculated in the 1995 – 2011 time-series, however during the copying data from the calculation spreadsheets to the CRF Reported, data starting 1990 was copied. It means that N₂O emission estimate for 1990 was copied in 1995, N₂O emission estimate for 1991 was copied to 1996 etc. This mistake caused the unusual trend in IEF for N₂O in this category.



Comparison of the revised and original N₂O IEFs

Potential problem identified in Agriculture sector

ERT identified as a potential problem the trend of methane emission factors for manure management of non-dairy cattle, a decrease between 2009 and 2010, respectively. According to the ERT recommendation the Czech Republic provides revised estimates of CH₄ emissions for the complete time-series ensuring consistency in the time-series in accordance with chapter 7 of the IPCC good practice guidance.

The Party is convinced that the sudden update of grazing time data in 2010 is the main reason for decrease of IEF of non-dairy cattle between 2009 and 2010. The changes in grazing time are reflected in the distribution of animal waste management systems also.

The main reason why the problem was identified was an application of long-term development change in parameter (grazing time) within one year step of emission inventory. The Party recalculated a time-series data of methane emissions from Manure Management based on updating grazing time of non-dairy cattle category. Based on the background information the grazing time was updated for the recalculation in time period 2007-2011, ie. big step between 2009-2010 previously reported in CRF was redistributed to the time period 2007-2011 based on the information and data published in professional studies.

Background information

The grazing of cattle requires a transformation from extensive to intensive management of grasslands. These conditions began relevant since 2006, when setting of agro-environmental programs and subsidies, the introduction of the environmental management system on grasslands, especially in the mountain areas, selection of an appropriate option from production and sales (branded meat, yard sale, charges for bio-like quality), political support, good cooperation with authorities, professional associations, purchasers, and the support of the companies enabled active use by cattle breeders) and confirms partially this statement.

Described changes occurred in connection with the set of agro-environmental measures and paid subsidies within programme CNDP (Top-up), SAPS and LFA. For example, the sector of suckler cows is able to exploit not only the CNDP paid out directly on LU, but the SAPS payments and their development have influenced an acceleration of the sector as well as LFA payments and payments for agro-environmental measures. A sector of suckles cows is in this way supported not only through livestock units but also through area payments designated to grassland (Řezbová and Tomšík, 2012). Besides mentioned programme, other agro-environmental measures are implemented in terms of national Action Plan of Organic Farming.

To analyse such subsidies paid on per hectare basis, it is necessary to determine theoretically exploiting of pastures. Analytical studies and professional publications of Institute of Animal Science (Kvapilík and Kohoutek,

2009) determine the maximum exploitation of pastures - permanent grasslands. According to the theoretical calculations one suckler cow requires approximately 1 hectare of permanent grassland. Suckler cows sector requires much more complex approach for evaluation of impact of provided subsidies. Not only national payments for suckler cows and ruminants are to be included. It is necessary to include all other relevant payments as SAPS, LFA, agro-environmental payments as well CNDPs per hectare until 2010. The structure of payments may explain that head numbers of suckler cows are still rising, although payments per livestock unit are diminishing since 2009. Since 2012 a support of the sector is given mostly by area payments.

Recalculation of methane emissions from Manure Management (non-dairy cattle)

In line with the IPCC GPG a higher-tier method to estimate the CH₄ emissions from Manure Management (cattle only) was used. The activity data as cattle population distributed by age are obtained from the Czech statistical office (CzSO). This is a consistent time series of number of animals during entire reported period (1990-2012). Gross energy (GE) values are estimated based on the national study Kolář et al. (2004). These GE parameters are annually reported in CRF as a country-specific data for entire reported period (table 6-10 in NIR 2014). The current updated data of AWMS distribution were applied for emission estimation. Based on the Dämmgen et al. (2012), the other specific parameters for estimation of emission factors for cattle were obtained (Bo, MCF, tab 6-11 in NIR 2014). The equations for determination of emission factors and estimation of methane emissions were taken from the IPCC Guidelines (IPCC 2006). The equations for determination of emission factors and estimation of methane emissions provided by the IPCC Guidelines (IPCC 2006) were used. To estimate the methane emissions the Eq. 10.22 (IPCC 2006 Gl., p. 10.37) was used, to estimate the VS parameter the Eq. 10.24 (IPCC 2006 Gl., p. 10.42) and methane EF were calculated by Eq. 10.23 (2006 IPCC, p. 10.41).

The increase of grazing time for suckler cows and some other non-dairy cattle sub-categories during 2007-2011 is presented in the table below (Table 1). According to the information provided in NIR the number of grazing days of suckler cows changed from 40 (22 %) in 2006 to 171 (95 %) in 2011. Besides suckler cows, no significant changes of grazing time were identified for other non-dairy cattle sub-categories (see Table 1).

Results

According to ERT recommendation the methane emissions from Manure Management were recalculated for the complete time-series to ensure consistency in the entire time-series in accordance with the IPCC good practice guidance (IPCC, 2000).

The main reason for decrease of IEF of non-dairy cattle is a significant increase of grazing time for suckler cows and changes in some other non-dairy cattle sub-categories during 2007-2011 (emission inventory in period 1990-2006* and 2012* have not been recalculated). An initial data, as a grazing time, were updated. Originally mentioned sudden decrease of grazing time for suckler cows between 2009 and 2010 was distributed in accordance to implemented agro-environmental measures and the provided subsidies to time period 2007-2011. A distribution of grazing time to time period 2007-2011 is presented in the Table 1. The EF's for individual non-dairy cattle categories have been estimated based on updated data (see Table 2).

Table 1 Gradual increase of grazing time of non-dairy cattle (% of summer time)

| Cattle sub-categories | 2006* | 2007 | 2008 | 2009 | 2010 | 2011 | 2012* |
|------------------------|-------|------|------|------|------|------|-------|
| Suckler cows | 22 | 40 | 55 | 70 | 85 | 90 | 95 |
| Mature Heifers | 35 | 38 | 40 | 45 | 48 | 50 | 50 |
| Mature bulls | 40 | 37 | 34 | 30 | 27 | 25 | 25 |
| Heifers, 1 - 2 years | 40 | 42 | 45 | 48 | 50 | 50 | 50 |
| Bulls, 1 - 2 years | 40 | 37 | 34 | 30 | 27 | 25 | 25 |
| Heifers, 8m-1yr | 40 | 42 | 45 | 48 | 50 | 50 | 50 |
| Bulls, 8m-1yr | 40 | 42 | 45 | 48 | 50 | 50 | 50 |
| Calves F (0-8 months*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calves M (0-8 months*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 2 The EF's to estimate emissions from MM for individual non-dairy cattle sub-categories

| Cattle sub-categories | 2006* | 2007 | 2008 | 2009 | 2010 | 2011 | 2012* |
|------------------------|-------|-------|-------|-------|-------|-------|-------|
| Suckler cows | 16.65 | 15.12 | 13.85 | 12.58 | 11.38 | 10.96 | 10.53 |
| Mature Heifers | 8.76 | 8.61 | 8.52 | 8.28 | 8.20 | 8.10 | 8.10 |
| Mature bulls | 12.39 | 12.59 | 12.80 | 13.08 | 13.40 | 13.54 | 13.54 |
| Heifers, 1 - 2 years | 13.19 | 13.04 | 12.82 | 12.60 | 12.30 | 12.30 | 12.30 |
| Bulls, 1 - 2 years | 13.33 | 13.55 | 13.77 | 14.07 | 14.65 | 14.80 | 14.80 |
| Heifers, 8m-1yr | 9.50 | 9.40 | 9.24 | 9.08 | 9.07 | 9.07 | 9.07 |
| Bulls, 8m-1yr | 10.58 | 10.47 | 10.29 | 10.11 | 10.18 | 10.18 | 10.18 |
| Calves F (0-8 months*) | 1.04 | 1.04 | 1.04 | 1.07 | 1.08 | 1.08 | 1.08 |
| Calves M (0-8 months*) | 0.95 | 0.90 | 0.90 | 1.00 | 1.03 | 1.03 | 1.03 |

Based on individual EF's a weighted average of non-dairy cattle was estimated (Table 3). Due to the recalculation the methane emissions from Manure Management of non-dairy cattle decreased in 2007-2009 time period by about 2 to 9 %, while in 2010-2011 emissions increased about 1 to 2 %.

The new emission factors and the methane emissions, incl. differences of values, are presented in the Table 3.

Table 3 List of recalculated EF's and CH₄ emissions of non-dairy cattle from Manure Management

| Non-dairy cattle | 2006* | 2007 | 2008 | 2009 | 2010 | 2011 | 2012* |
|---------------------------------------|-------|-------|-------|-------|------|------|-------|
| EF (kg/head/year) | 10.00 | 9.78 | 9.61 | 9.34 | 8.75 | 8.73 | 8.65 |
| Emissions (Gg CH ₄) - NEW | 9.49 | 9.59 | 9.58 | 9.00 | 8.45 | 8.47 | 8.48 |
| Emissions (Gg CH ₄) - OLD | 9.49 | 9.86 | 10.11 | 9.77 | 8.32 | 8.39 | 8.48 |
| Differences in % | 0.00 | -2.77 | -5.62 | -8.60 | 1.53 | 0.89 | 0.00 |

In addition, a lack of transparency and the inconsistency of information reported in the NIR will be corrected during the next submission. The reported values of AWMS allocation (in %) in CRF Table 4.B (b) were checked and verified, those are right. The Party commits to consistently report the distribution of animal waste management systems across all emission categories in CRF tables 4.B (a) s2 and 4.B (b) in line with IPCC good practice guidance in the next submission.

Regarding to a shifting in age limit of "calves" and "young bulls and heifers", since 2009 more animals are reported in the category of "calves" and less animals are in the category of "young bulls and heifers". The shift in age structure has been correctly accounted in the background data. The weights of these cattle subcategories were increased. A text error in the animal weights reported in the NIR (tab 6-4) will be revised in the next submission.

As a result of the change of grazing time the distribution of AWMS was changed, which consequently affects the methane emissions from enteric fermentation and the nitrous oxide emissions from the soil also. To keep the completeness of the emission inventory, all consequent changes were checked, verified and inserted to the CRF tables. The maximum change of emissions in time period 2007-2011 has been recorded in 2009, an increase of total emissions about ca. 0.1 %.

Reference

Dämmgen, U., Amon, B., Hutchings, N. J., Haenel, H-D., Rösemann C. (2012). Landbauforschung – vTI. Agriculture and Forestry Research 1/2, (62)1-20.

Řezbová H. and Tomšík, K. (2012). Impact of Complementary National Direct Payments on Cattle Breeding Sector.

Kvapilík, J., Kohoutek, A. (2009). Ruminants breeding and permanent grasslands – Certified methodology, Institute of Animal Science (IAS), Czech Republic, ISBN 978-80-7403-039-0.

ES 1 Background information

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Czech Republic is required to prepare and regularly update national greenhouse gas (GHG) inventories. In addition, as a result of membership in the European Union, the Czech Republic must also fulfil its reporting requirements concerning GHG emissions and removals following from 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 2012 with specific accent on the latest year 2012 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: Revised 1996 Guidelines (IPCC, 1997) and its two extensions - Good Practice Guidance (IPCC, 2000) and Good Practice Guidance for LULUCF (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, 2006). However, Annex I Parties that are also Parties to the Kyoto Protocol are also required to report supplementary information required under Article 7.1 of the Kyoto Protocol that is specified by Decision 15/CPM.1. Thus the second part contains the Kyoto elements of the report. The both parts of the National Inventory Report, together with the data output - Common Reporting Format (CRF) Tables, are submitted annually by 15th April.

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

ES 2 Summary of national emission and removal related trends

ES 2.1 GHG inventory

In 2012, the most important GHG in the Czech Republic was CO₂ contributing 85.19 % to total national GHG emissions and removals expressed in CO₂ eq., followed by CH₄ 7.84 % and N₂O 5.88 %. PFCs, HFCs and SF₆ contributed for 1.66 % to the overall GHG emissions in the country. CO₂ net ballance from LULUCF removed 5.57 % of CO₂ from overall CO₂ emissions.

Tab. ES 1 provides data on GHG emissions in comparison of overall trend from 1990 to 2012. For overview of GHG emissions and removals by categories please see chapter ES 3 on page 15.

Tab. ES 1 GHG emission/removal overall trends

| | Base year | 2012 | Base year | 2012 | trend |
|-------------------------------|--------------------------|--------|-----------|--------|---------|
| | [Gg CO ₂ eq.] | | % | | |
| CO ₂ emissions | 164694 | 111302 | 85.41 | 89.60 | -32.42 |
| CO ₂ (LULUCF) | -3437 | -7252 | -1.78 | -5.84 | 110.97 |
| Net CO ₂ emissions | 161257 | 118554 | 83.63 | 95.44 | -26.48 |
| CH ₄ | 17985 | 10314 | 9.33 | 8.30 | -42.65 |
| N ₂ O | 13504 | 7739 | 7.00 | 6.23 | -42.69 |
| F-gases | 83 | 2181 | 0.04 | 1.76 | 2539.20 |
| Total (Net emissions) | 192829 | 124214 | 100.00 | 100.00 | -35.58 |

Over the period 1990 - 2012 CO₂ emissions and removals decreased by 29.37 %, CH₄ emissions decreased by 42.65 % during the same period mainly due to lower emissions from *1 Energy*, *4 Agriculture* and *6 Waste*; N₂O emissions decreased by 42.69 % over the same period due to emission reduction in *4 Agriculture* and despite increase from the *1A3 Transport* category. Emissions of HFCs and PFCs increased by orders of magnitude, whereas SF₆ emissions kept steady trend over the whole period, resulting the overall F-gases trend at 26.32-times increase in CO₂ eq.

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

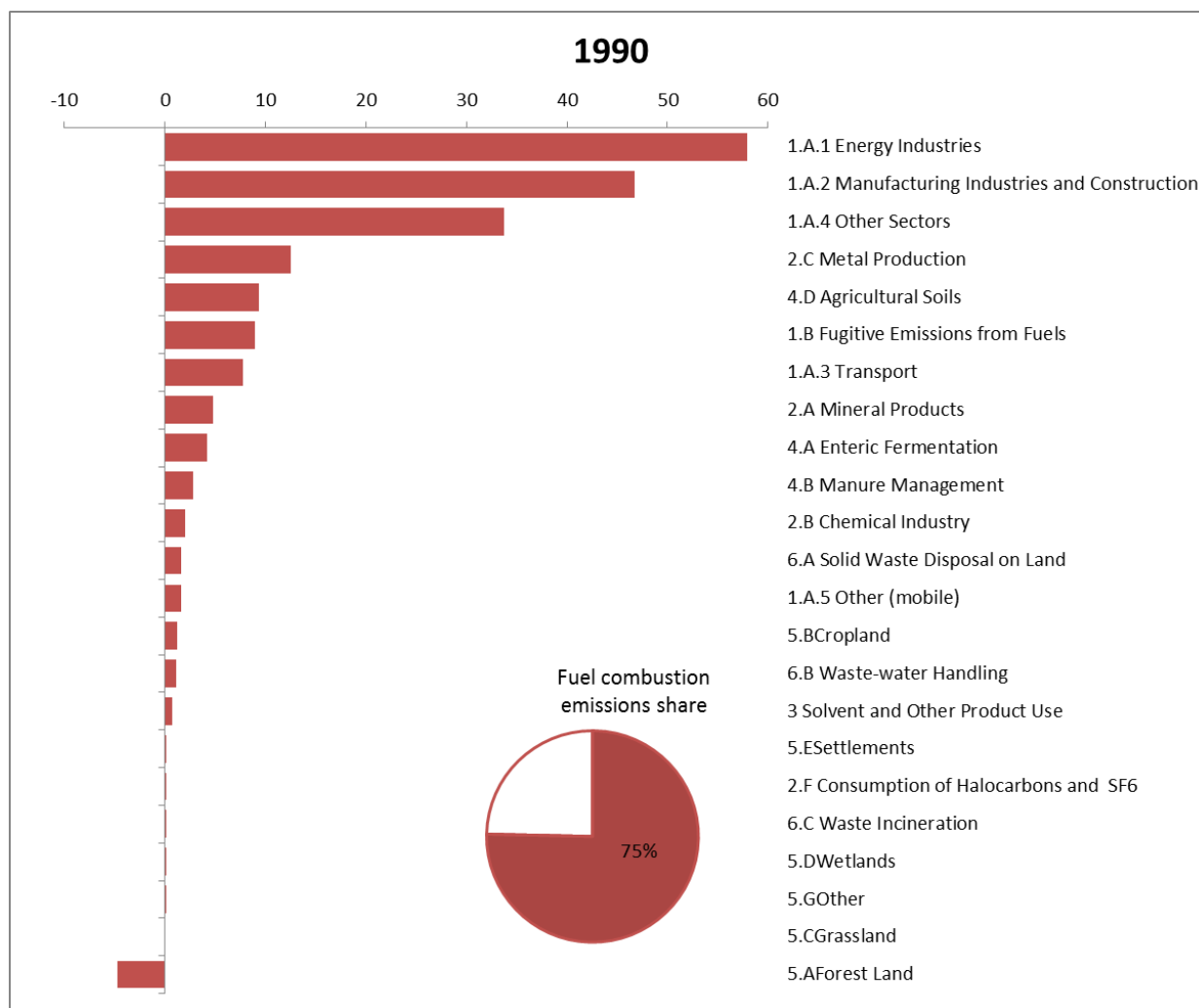


Fig. ES 1 Sources and sinks of greenhouse gases in 1990 (Tg CO₂ eq.)

ES 3.1 GHG inventory

Tab. ES 2 Overview of trends by general CRF categories (1995 as a base year for F-gases considered)

| | Base year | 2012 | Base year | 2012 | Trend |
|---------------|--------------------------|--------|-----------|-------|-------|
| | [Gg CO ₂ eq.] | | [%] | | |
| 1 Energy | 156748 | 107090 | 81.3 | 86.2 | -31.7 |
| 2 Industry | 19506 | 12095 | 10.1 | 9.7 | -38.0 |
| 3 Solvent | 765 | 456 | 0.4 | 0.4 | -40.4 |
| 4 Agriculture | 16307 | 8058 | 8.5 | 6.5 | -50.6 |
| 5 LULUCF | -3437 | -7252 | -1.8 | -5.8 | 111.0 |
| 6 Waste | 2824 | 3767 | 1.5 | 3.0 | 33.4 |
| Total | 192708 | 124214 | 100.0 | 100.0 | -35.5 |

Tab. ES 3 Overview of GHG emission/removal trends by CRF categories

| | Base year | 2012 | 2012 | 2012 | Trend |
|---|------------------------|------------------------|-----------------|--------------------|-----------------|
| | Gg CO ₂ eq. | Gg CO ₂ eq. | Total share [%] | Sectoral share [%] | % |
| 1. Energy | 156 747.78 | 107 090.15 | 86.21 | 100.00 | -31.68 |
| <i>A. Fuel Combustion (Sectoral Approach)</i> | <i>147 789.42</i> | <i>103 013.91</i> | <i>82.93</i> | <i>96.19</i> | <i>-30.30</i> |
| 1. Energy Industries | 57 936.56 | 57 413.45 | 46.22 | 53.61 | -0.90 |
| 2. Manufacturing Industries and Construction | 46 754.03 | 16 602.53 | 13.37 | 15.50 | -64.49 |
| 3. Transport | 7 755.89 | 16 908.61 | 13.61 | 15.79 | 118.01 |
| 4. Other Sectors | 33 715.39 | 10 970.03 | 8.83 | 10.24 | -67.46 |
| 5. Other | 1 627.55 | 1 119.28 | 0.90 | 1.05 | -31.23 |
| <i>B. Fugitive Emissions from Fuels</i> | <i>8 958.36</i> | <i>4 076.24</i> | <i>3.28</i> | <i>3.81</i> | <i>-54.50</i> |
| 1. Solid Fuels | 8 056.84 | 3 525.72 | 2.84 | 3.29 | -56.24 |
| 2. Oil and Natural Gas | 901.52 | 550.53 | 0.44 | 0.51 | -38.93 |
| 2. Industrial Processes | 19 502.36 | 12 095.48 | 9.74 | 100.00 | -37.98 |
| <i>A. Mineral Products</i> | <i>4 832.78</i> | <i>3 490.11</i> | <i>2.81</i> | <i>28.85</i> | <i>-27.78</i> |
| <i>B. Chemical Industry</i> | <i>2 032.51</i> | <i>1 119.67</i> | <i>0.90</i> | <i>9.26</i> | <i>-44.91</i> |
| <i>C. Metal Production</i> | <i>12 557.90</i> | <i>5 304.28</i> | <i>4.27</i> | <i>43.85</i> | <i>-57.76</i> |
| <i>F. Consumption of Halocarbons and SF₆¹</i> | <i>79.17</i> | <i>2 181.43</i> | <i>1.76</i> | <i>18.04</i> | <i>2 655.41</i> |
| 3. Solvent and Other Product Use | 764.83 | 455.57 | 0.37 | 100.00 | -40.44 |
| 4. Agriculture | 16 307.19 | 8 058.37 | 6.49 | 100.00 | -50.58 |
| <i>A. Enteric Fermentation</i> | <i>4 219.42</i> | <i>2 026.88</i> | <i>1.63</i> | <i>25.15</i> | <i>-51.96</i> |
| <i>B. Manure Management</i> | <i>2 783.51</i> | <i>1 130.54</i> | <i>0.91</i> | <i>14.03</i> | <i>-59.38</i> |
| <i>D. Agricultural Soils</i> | <i>9 304.26</i> | <i>4 900.95</i> | <i>3.95</i> | <i>60.82</i> | <i>-47.33</i> |
| 5. Land Use, Land-Use Change and Forestry² | -3 437.47 | -7 251.97 | -5.84 | 100.00 | 110.97 |
| <i>A. Forest Land</i> | <i>-4 681.95</i> | <i>-7 255.03</i> | <i>-5.84</i> | <i>100.04</i> | <i>54.96</i> |
| <i>B. Cropland</i> | <i>1 208.64</i> | <i>180.92</i> | <i>0.15</i> | <i>-2.49</i> | <i>-85.03</i> |
| <i>C. Grassland</i> | <i>-82.79</i> | <i>-301.68</i> | <i>-0.24</i> | <i>4.16</i> | <i>264.38</i> |
| <i>D. Wetlands</i> | <i>22.44</i> | <i>24.55</i> | <i>0.02</i> | <i>-0.34</i> | <i>9.40</i> |
| <i>E. Settlements</i> | <i>84.38</i> | <i>99.26</i> | <i>0.08</i> | <i>-1.37</i> | <i>17.64</i> |
| <i>G. Other</i> | <i>11.82</i> | <i>0.01</i> | <i>0.00</i> | <i>0.00</i> | <i>-99.89</i> |
| 6. Waste | 2 823.55 | 3 766.54 | 3.03 | 100.00 | 33.40 |
| <i>A. Solid Waste Disposal on Land</i> | <i>1 662.59</i> | <i>2 769.96</i> | <i>2.23</i> | <i>73.54</i> | <i>66.61</i> |
| <i>B. Waste-water Handling</i> | <i>1 137.37</i> | <i>785.81</i> | <i>0.63</i> | <i>20.86</i> | <i>-30.91</i> |
| <i>C. Waste Incineration</i> | <i>23.59</i> | <i>210.77</i> | <i>0.17</i> | <i>5.60</i> | <i>793.62</i> |
| Total CO₂ equivalent Emissions excluding LULUCF | 196 145.70 | 131 466.12 | - | - | -32.98 |
| Total CO₂ equivalent Emissions including LULUCF | 192 708.23 | 124 214.14 | 100 | 100 | -35.54 |

¹Base year 1995

²Negative numbers indicate GHG removal

NO, NA, NE sub-categories omitted

In 2012, 107 090.15 Gg CO₂ eq., that are 86.21 % of national total emissions (including 5 *Land Use, Land-Use Change and Forestry*) arose from 1 *Energy*; 96.19 % of these emissions arise from fuel combustion activities. The most important sub-category of 1 *Energy* with 53.61 % of total sectoral emissions in 2012 is 1A1 *Energy Industries*, 1A2 *Manufacturing Industries and Construction* responses for 13.37 % and 1A3 *Transport* for 13.61 % of total sectoral emissions. From 1990 to 2012 emissions from 1 *Energy* decreased by 31.68 %.

2 *Industrial Processes* is the second largest category with 9.74 % of total GHG emissions (including 5 *Land Use, Land-Use Change and Forestry*) in 2012 (1 194.40 Gg CO₂ eq.); the largest sub-category is 2C *Metal Production* with 43.85 % of sectoral share. From 1990 to 2012 emissions from 2 *Industrial Processes* decreased by 37.98 %.

In 2012, 0.37 % of total GHG emissions (including 5 *Land Use, Land-Use Change and Forestry*) in the Czech Republic (506 Gg CO₂ eq.) arose from the category 3 *Solvent and Other Product Use*. From 1990 - 2012 emissions from 3 *Solvent and Other Product Use* decreased by 40.44 %.

4 *Agriculture* is the third largest category in the Czech Republic with 6.49 % share of total GHG emissions (including 5 *Land Use, Land-Use Change and Forestry*) in 2012 (8 058.37 Gg CO₂ eq.); 60.82 % of these emissions arose from 4D *Agricultural Soils*. From 1990 to 2012 emissions from 4 *Agriculture* decreased by 50.58 %.

5 *Land Use, Land-Use Change and Forestry* is the only category where removals exceeds emissions. Net emissions/removals from this category increased from 1990 to 2012 by 110.97 % to -7 251.97 Gg CO₂ eq.

3.03 % of the national total GHG emissions (including 5 *Land Use, Land-Use Change and Forestry*) in 2012 arose from 6 *Waste*. 73.54 % share of GHG emissions arose from 6C *Solid waste disposal on land*. Emissions from 6 *Waste* increased from 1990 to 2012 by 33.40 % to 3 766.54 Gg CO₂ eq.

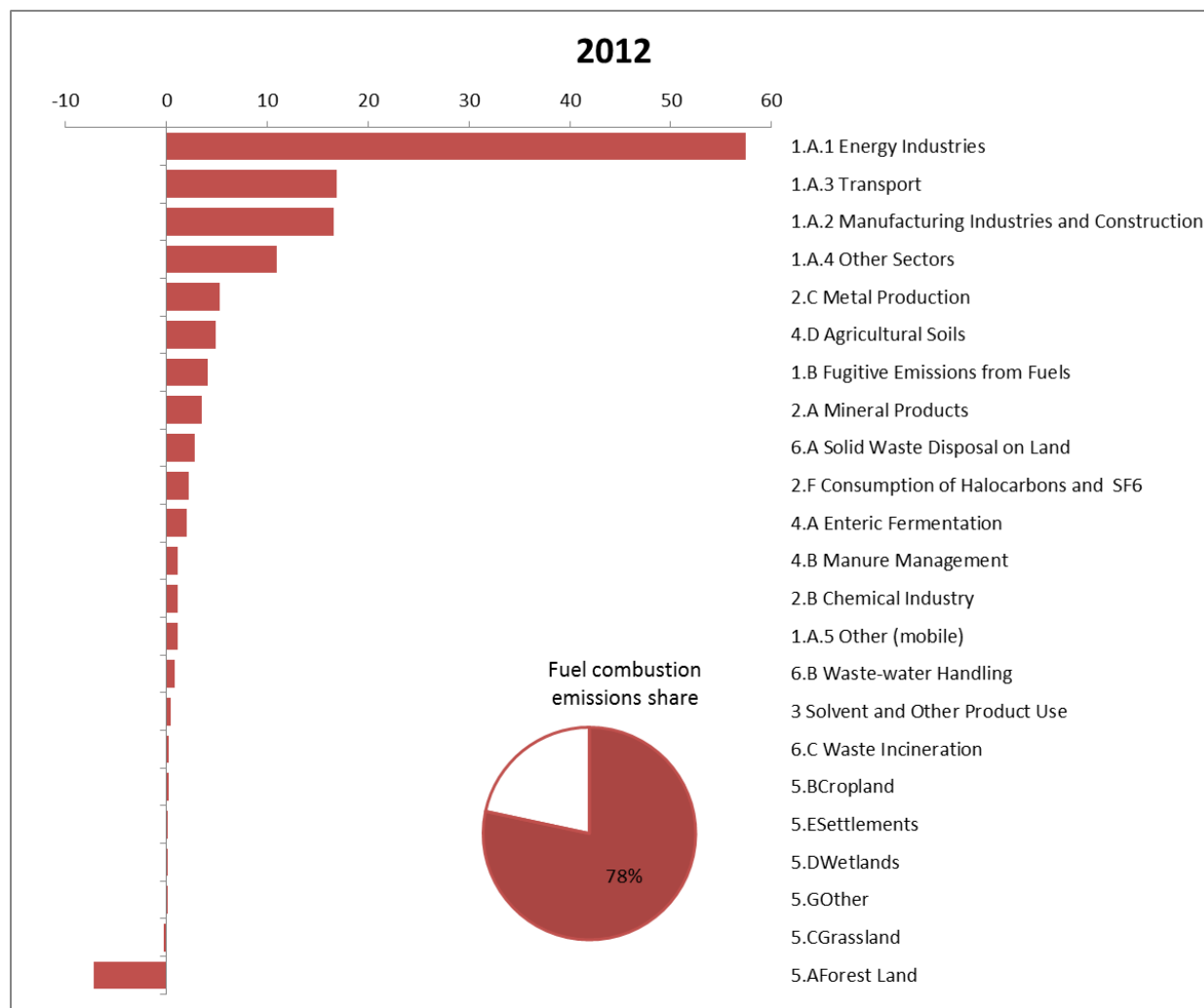


Fig. ES 2 Sources and sinks of greenhouse gases in 1990 (Tg CO₂ eq.)

ES 3.2 KP-LULUCF activities

Emission and removals estimates of GHGs for the KP LULUCF activities in the years 2008-2012 are presented in Tables ES 4 and 5.

Tab. ES 4 Overview of KP-LULUCF article 3.3 activities

| A. Article 3.3 activities | Unit | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|------------------------|---------|---------|---------|---------|---------|
| A.1. Afforestation and Reforestation | | | | | | |
| CO ₂ emissions/removals | Gg | -261.56 | -283.76 | -309.68 | -346.73 | -369.94 |
| CH ₄ | Gg | NO | NO | NO | NO | NO |
| N ₂ O | Gg | NO | NO | NO | NO | NO |
| Net CO ₂ equivalent emissions/removals | Gg CO ₂ eq. | -261.56 | -283.76 | -309.68 | -346.73 | -369.94 |
| A.2. Deforestation | | | | | | |
| CO ₂ emissions/removals | Gg | 155.83 | 165.61 | 201.68 | 159.88 | 169.44 |
| CH ₄ | Gg | NO | NO | NO | NO | NO |
| N ₂ O | Gg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Net CO ₂ equivalent emissions/removals | Gg CO ₂ eq. | 156.17 | 165.95 | 202.04 | 160.24 | 169.81 |

*0.00 represents non-zero value lower than 0.005

Tab. ES 5 Overview of KP-LULUCF article 3.4 activities

| B. Article 3.4 activities | Unit | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|------------------------|-------------|-----------|-----------|-----------|-----------|
| B.1. Forest Management | | | | | | |
| CO ₂ emissions/removals | Gg | -4 233.57 | -6 247.58 | -4 935.38 | -6 690.60 | -6 975.78 |
| CH ₄ | Gg | 6.59 | 5.57 | 5.88 | 2.60 | 2.79 |
| N ₂ O | Gg | 0.05 | 0.04 | 0.04 | 0.02 | 0.02 |
| Net CO ₂ equivalent emissions/removals | Gg CO ₂ eq. | -4 081.06 | -6 118.73 | -4 799.38 | -6 630.57 | -6 911.29 |
| B.2. Cropland Management | - | Not elected | | | | |
| B.3. Grazing Land Management | - | Not elected | | | | |
| B.4. Revegetation | - | Not elected | | | | |

ES 4 Overview of emission estimates and trends of indirect GHGs and SO₂

Emission estimates of indirect GHGs and SO₂ for the period from 1990 to 2012 are presented in Tab. ES 6.

Tab. ES 6 Indirect GHGs and SO₂ for 1990 to 2012 [Gg]

| | NO _x | CO | NMVOC | SO ₂ |
|------------------|-----------------|----------|--------|-----------------|
| 1990 | 742.34 | 1 070.29 | 311.27 | 1 875.52 |
| 1991 | 732.19 | 1 156.46 | 272.97 | 1 772.20 |
| 1992 | 708.23 | 1 161.72 | 257.47 | 1 559.14 |
| 1993 | 690.75 | 1 193.20 | 233.04 | 1 468.85 |
| 1994 | 450.84 | 1 074.41 | 255.31 | 1 290.19 |
| 1995 | 430.19 | 932.20 | 215.35 | 1 095.32 |
| 1996 | 446.69 | 964.88 | 265.16 | 934.45 |
| 1997 | 470.69 | 980.75 | 271.86 | 980.79 |
| 1998 | 414.14 | 812.22 | 267.15 | 442.22 |
| 1999 | 391.09 | 726.43 | 247.17 | 268.92 |
| 2000 | 396.70 | 680.03 | 244.31 | 264.45 |
| 2001 | 332.83 | 687.10 | 219.88 | 250.89 |
| 2002 | 319.40 | 587.53 | 202.86 | 237.39 |
| 2003 | 325.70 | 630.40 | 203.26 | 232.13 |
| 2004 | 333.56 | 622.56 | 198.46 | 227.22 |
| 2005 | 279.13 | 556.14 | 181.70 | 218.63 |
| 2006 | 283.78 | 539.89 | 178.60 | 211.23 |
| 2007 | 285.86 | 581.52 | 173.97 | 216.96 |
| 2008 | 262.75 | 496.20 | 165.66 | 174.34 |
| 2009 | 252.72 | 452.23 | 151.06 | 173.47 |
| 2010 | 240.03 | 453.61 | 150.89 | 170.32 |
| 2011 | 226.09 | 404.64 | 139.79 | 169.01 |
| 2012 | 210.77 | 366.31 | 128.56 | 157.91 |
| Trend [%] | -71.61 | -65.77 | -58.70 | -91.58 |
| NEC ¹ | 286 | - | 220 | 283 |

¹NEC - 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 2012: for NO_x by 71.61 %, for CO by 65.77 %, for NMVOC by 58.70 % and for SO₂ by 91.58 %. The most important emission source for indirect greenhouse gases and SO₂ are fuel combustion activities, for details see chapter 2.4 in Part1: Annual inventory report.

Part 1: Annual inventory submission

1 Introduction and general issues

1.1 Background information

1.1.1 Climate change

Greenhouse gases (i.e. gases that contribute to the greenhouse effect) have always been present in the atmosphere, but 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 (CO₂), methane (CH₄), nitrous oxide (N₂O) and halogenated hydrocarbons, i.e. greenhouse gases, have increased as a consequence of human activity. Greenhouse gases prevent the radiation of heat back into space and cause warming of the climate. According to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2007), the atmospheric concentrations of CO₂ have increased by 35 %, CH₄ concentrations have more than doubled and N₂O concentrations have risen by 18 %, compared with the pre-industrial era. Ground-level ozone also contributes to the greenhouse effect. The amount of ozone formed in the lower atmosphere has increased as a result of emissions of nitrogen oxides, hydrocarbons and carbon monoxide.

Relatively new, man-made greenhouse gases that are entering the atmosphere cause further intensification of the greenhouse effect. These include, in particular, a number of substances containing fluorine (F-gases), among them HFCs (hydrofluorocarbons). HFCs are used instead of ozone-layer-depleting CFCs (freons) in refrigerators and other applications, and their emissions are on rapid increase. Compared with carbon dioxide, all the other greenhouse gases occur at low (CH₄, N₂O) or very low concentrations (F-gases). On the other hand, these substances are more effective (per molecule) as greenhouse gases than carbon dioxide, which is the main greenhouse gas.

The threat of climate change is considered to be one of the most serious environmental problems faced by humankind. The average surface temperature of the earth has risen by about 0.6–0.9 °C in the past 100 years and, according to the IPCC 4AR, will rise by another 1.8–4.0 °C in the next 100 years, depending on the emission scenario. The increase of the average surface temperature of the Earth, together with the increase in the surface temperature of the oceans and the continents, will lead to changes in the hydrologic cycle and to significant changes in the atmospheric circulation, which drives rainfall, wind and temperature on a regional scale. This will increase the risk of extreme weather events, such as hurricanes, typhoons, tornadoes, severe storms, droughts and floods.

In consequence of scientific indications that human activities influence the climate and an increasing public awareness about local and global environmental issues during the middle of the 1980s, climate change became part of the political agenda. The *Intergovernmental Panel on Climate Change* (IPCC) was established in 1988 and, two years later, 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).

1.1.2 Greenhouse gas inventories

Annual monitoring of greenhouse gas emissions and removals is one of the obligations following from the *UN Framework Convention on Climate Change* and its *Kyoto Protocol*. In addition, as a result of membership in the European Union, the Czech Republic must also fulfill its reporting requirements concerning GHG emissions and removals following from Decision of the European Parliament and Council No. 280/2004/EC. This Decision also requires establishing a National Inventory System (NIS) pursuant to the *Kyoto Protocol* (Art. 5.1) from December 2005.

The *Czech Hydrometeorological Institute* (CHMI) was appointed in 1995 by the *Ministry of Environment* (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 CO₂, CH₄, N₂O, HFC, PFC, SF₆ and indirect greenhouse gases NO_x, CO, NMVOC and SO₂. 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 (O₃) 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 CO₂, N₂O, CH₄, HFCs, PFCs and SF₆ are calculated as CO₂ equivalents and added together to produce a total. Together with the direct greenhouse gases, also the emissions of NO_x, CO, NMVOC and SO₂ 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 2012. Full time series of emissions and removals from 1990 to 2012 are included in the submission.

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

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

The current data submission (2013) for UNFCCC and for the EU contains all the data sets for 1990 - 2012 in the form of the official UNFCCC software called *CRF Reporter* (version 3.6.2).

1.2 National Inventory System and institutional arrangement

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. Mr. Ondrej Minovsky is the responsible person at CHMI.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and reviewed 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 sectors 2 and 3, Industrial Processes and Solvent and Other Product Use
- Institute of Forest Ecosystem Research Ltd. (IFER), Jilove u Prahy, is responsible for compilation of the inventory in sectors 4 and 5, Agriculture and Land Use, Land Use Change and Forestry
- Charles University Environment Centre (CUEC), Prague, is responsible for compilation of the inventory in sector 6, Waste.

Official submission of the national GHG Inventory is prepared by CHMI and approved by the *Ministry of Environment*. Moreover, the 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).

1.3 Inventory preparation

1.3.1 Brief description of the inventory process

UNFCCC, the *Kyoto Protocol* and the EU greenhouse gas monitoring mechanism require the Czech Republic to annually submit a *National Inventory Report* (NIR) and *Common Reporting Format* (CRF) tables. The annual submission contains emission estimates for the second but last year, so the 2013 submission contains estimates for the calendar year of 2012. The organisation of the preparation and reporting of the Czech greenhouse gas inventory and the duties of its institutions are detailed in the previous section (1.2).

The preparation of the inventory includes the following three stages:

- 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 1.5). All data collected, together with emission estimates, are archived (see below) and documented for future reconstruction of the inventory.

In addition to the actual emission data, the background tables of the CRF are filled in by the 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 1.5).

1.3.2 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 1A *Fuel Combustion Activities* are based on the official Czech Energy Balance, compiled by the *Czech Statistical Office*. Data from the Czech Energy balance are processed both in the Reference Approach (TPES - primary sources data are used) and in the Sectoral Approach (data for fuel transformations and final consumptions). However, in the latter case, some additional data are required (e.g. data on transportation statistics).

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

The main part of this “improvement plan” consists in gradual introduction of higher tiers into the national inventory.

1.3.3 Data processing and storage

Data Sector 1A *Fuel Combustion Activities* are processed by the system of interconnected spreadsheets, compiled in MS Excel following “Worksheets” presented in IPCC *Guidelines*, Vol. 2. *Workbook*. The system is extended by incorporating sheets with modified energy balance: these sheets represent an input data system. This system was recently a bit modified to be more transparent.

Also, in the majority of other sectors, data are processed in a similar way - by using a system of joined spreadsheets taken from the *Workbook* and slightly modified in order to respect national circumstances. The following examples of such cases of processing can be mentioned: agriculture, waste, fugitive emissions. On the other hand, in some cases, e.g. for solvent use, such a system is not as efficient and thus it is substituted by spreadsheets inspired by the CORINAIR methodology. For LULUCF, a specific spreadsheet system is used, respecting the national methodology.

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.

1.3.3.1 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.

- 1) 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
- 2) 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
- 3) 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.
- 4) 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 methodology

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 existing and valid version of the IPCC methodology consists of the Revised 1996 Guidelines (IPCC, 1997), IPCC Good Practice Guidance (IPCC, 2000), IPCC Good Practice Guidance for LULUCF (IPCC, 2003) and, in well-founded cases (respecting national circumstances), also 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

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 and natural gas, while the default emission factors are employed for the other fuels. Similarly, for Industrial Processes, only the Tier 1 method is used for the production of iron and steel. In contrast, the methods of higher tiers and/or country-specific factors are employed far more frequently for other key categories. Chapter 10 describes the "Improvement Plan", which will also encompass gradual introduction of more sophisticated methods of higher tiers.

All direct GHG emissions can also be expressed in terms of total (or aggregated) values, which are calculated as a sum of the emissions of the individual gases multiplied by the Global Warming Potential values (GWP). GWP correspond to the factor by which the given gas is more effective in absorption of terrestrial radiation than CO₂ (1 for CO₂, 21 for CH₄ and 310 for N₂O). The total amount of F-gases is relatively small compared to CO₂, CH₄ and N₂O; 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 CO₂ 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 SO₂, 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).

In September of 2012, the Czech national greenhouse gas inventory was subject to "*centralised review*". The Czech national inventory team has not yet received annual inventory report (ARR) and thus was not able to take into account final comments and recommendations of the international Expert Review Team (ERT) in this submission. Therefore in most cases, the comments and recommendations will be taken into account in the 2015 submission.

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 Information on the QA/QC 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 8 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.

Last 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 the approach of estimating uncertainties. Concerning Energy sector the approaches of emissions estimating and also the issue of developing country specific emission factors were conferred. Similar bilateral meeting will be held this year (2014) in May.

1.5.1 CHMI as a coordinating institution of QA/QC activities

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

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

1.5.2 QA/QC process

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

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on the inventory principles. Quality objectives are 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.

1.5.3 Quality control procedures

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

The QC procedures used in the Czech GHG inventory comply with the *IPCC Good Practice Guidance*. General inventory QC checks (IPCC, 2000), Table 8.1 and (IPCC, 2003), Table 5.5.1 include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation

and archiving of inventory data and quality control checks. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are employed on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

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

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

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

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

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

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

1.5.4 Quality assurance procedures

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

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

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 these days 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.

1.5.5 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 (Tier 1), it is necessary to employ more demanding control procedures (Tier 2) 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.

1.6 Key source categories

The *Good Practice Guidance* (IPCC, 2000) and (IPCC, 2003) provides two tiers of determining these *key categories (key sources)*. *Key categories* by definition contribute to ninety percent of the overall uncertainty in a level (in emissions per year) or in a trend. The procedure in the Tier 2 follows from this definition, and requires thorough analysis of the uncertainty and use of sophisticated statistical procedures and evaluation of sources in terms of the appropriate characteristics. However, it is more difficult to obtain the necessary data for this approach and this information is not yet used on the national level.

Tab. 1-1 Identification of key categories by level assessment (LA) and trend assessment (TA) for 2012 evaluated with and without LULUCF (Tier 2)

| IPCC Source Categories | GHG | LA % | TA % | Cum. LA | Cum. TA | KC_L | KC_T | KC Type |
|--|------------------|--------|--------|---------|---------|------|------|---------|
| 1.A Stationary Combustion - Solid Fuels | CO ₂ | 42.784 | 20.348 | 42.784 | 20.348 | 1 | 1 | LA,TA |
| 1.A.3.b Transport - Road Transportation | CO ₂ | 10.586 | 18.140 | 53.369 | 38.487 | 2 | 2 | LA,TA |
| 1.A Stationary Combustion - Gaseous Fuels | CO ₂ | 10.057 | 10.488 | 63.426 | 48.975 | 3 | 3 | LA,TA |
| 5.A.1 Forest Land remaining Forest Land | CO ₂ | 5.298 | 6.841 | 68.725 | 62.915 | 4 | 5 | LA,TA |
| 2.C.1 Iron and Steel Production | CO ₂ | 3.787 | 5.606 | 72.511 | 68.521 | 5 | 6 | LA,TA |
| 1.A Stationary Combustion - Liquid Fuels | CO ₂ | 3.302 | 7.098 | 75.814 | 56.074 | 6 | 4 | LA,TA |
| 4.D.1 Agricultural Soils, Direct Emissions | N ₂ O | 2.775 | 2.158 | 78.589 | 82.270 | 7 | 10 | LA,TA |
| 6.A Solid Waste Disposal on Land | CH ₄ | 2.671 | 3.682 | 81.260 | 76.731 | 8 | 8 | LA,TA |
| 1.B.1.a Coal Mining and Handling | CH ₄ | 2.382 | 3.380 | 83.642 | 80.112 | 9 | 9 | LA,TA |
| 2.F.1-6 F-gases Use - ODS substitutes | F-gas | 1.927 | 4.528 | 85.569 | 73.049 | 10 | 7 | LA,TA |
| 4.D.3 Agricultural Soils, Indirect Emissions | N ₂ O | 1.786 | 1.408 | 87.354 | 88.661 | 11 | 14 | LA,TA |
| 4.A Enteric Fermentation | CH ₄ | 1.571 | 1.600 | 88.926 | 87.252 | 12 | 13 | LA,TA |
| 1.A.3.b Transport - Road Transportation | N ₂ O | 0.841 | 1.701 | 90.769 | 83.971 | 14 | 11 | LA,TA |
| 2.A.3 Limestone and Dolomite Use | CO ₂ | 0.756 | 1.028 | 92.283 | 90.804 | 16 | 16 | LA,TA |
| 4.B Manure Management | N ₂ O | 0.554 | 1.015 | 93.443 | 91.819 | 18 | 17 | LA,TA |
| 2.A.2 Lime Production | CO ₂ | 0.402 | 0.484 | 94.351 | 95.362 | 20 | 23 | LA,TA |
| 4.B Manure Management | CH ₄ | 0.394 | 0.533 | 95.145 | 94.878 | 22 | 22 | LA,TA |
| 2.A.1 Cement Production | CO ₂ | 1.003 | 0.306 | 89.928 | 97.200 | 13 | | LA |
| 1.A.5.b Mob. sources in Agriculture and Forestry | CO ₂ | 0.757 | 0.012 | 91.526 | 99.994 | 15 | | LA |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CH ₄ | 0.607 | 0.211 | 92.889 | 98.217 | 17 | | LA |
| 6.B Wastewater Handling | CH ₄ | 0.506 | 0.135 | 93.949 | 98.836 | 19 | | LA |
| 2.B.1 Ammonia Production | CO ₂ | 0.400 | 0.029 | 94.752 | 99.629 | 21 | | LA |
| 1.A Stationary Combustion - Solid Fuels | CH ₄ | 0.172 | 1.681 | 98.754 | 85.652 | | 12 | TA |
| 5.B.1 Cropland remaining Cropland | CO ₂ | 0.067 | 1.116 | 99.561 | 89.776 | | 15 | TA |
| 1.A Stationary Combustion - Biomass | CH ₄ | 0.353 | 0.741 | 95.498 | 92.560 | | 18 | TA |
| 1.A Stationary Combustion - Other fuels - MSW | CO ₂ | 0.280 | 0.610 | 97.031 | 93.170 | | 19 | TA |
| 2.B.2 Nitric Acid Production | N ₂ O | 0.317 | 0.608 | 96.148 | 93.778 | | 20 | TA |
| 1.A Stationary Combustion - Other fuels - 1A2 | CO ₂ | 0.241 | 0.567 | 97.549 | 94.345 | | 21 | TA |

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

In previous submissions, only *key sources* identification not considering the LULUCF sector based on *Good Practice Guidance* (IPCC, 2000), were performed. Starting with the 2008 submission, the *key categories* are identified according to *Good Practice Guidance for LULUCF* (IPCC, 2003), which also considers categories from LULUCF. However, for the right identification of *key categories*, also assessment without consideration of the LULUCF categories was employed. It is obvious from Tab. 1-1 that no additional *key category* was identified when the LULUCF categories were not considered.

On the whole, 25 *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 | 28 |
| KC identified by LA | 22 |
| KC identified by TA | 23 |
| KC identified by LA + TA concurrently | 17 |
| KC identified by only LA | 5 |
| KC identified by only TA | 6 |
| | |
| Key Categories (KC) without LULUCF: | 26 |
| KC identified by LA | 20 |
| KC identified by TA | 20 |
| KC identified by LA + TA concurrently | 14 |
| KC identified by only LA | 6 |
| KC identified by only TA | 6 |

Of the overall number of 28 key categories, some of them are right on the 95 % borderline and thus appear only occasionally.

1.7 Uncertainty analysis

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 methodical manuals (IPCC, 2000 and 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 uncertainty by less than 1 percent.

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 Tab. 1-3.

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 3.21 %. The corresponding uncertainty in trend is 2.20 %.

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. For detailed analysis please consult the annexed spreadsheet.

Tab. 1-3 Uncertainty analysis in level and trend assessments for 2012 (Tier 1)

| IPCC Source Category | Gas | Base year emissions abs | Latest reported year emissions abs | AD uncertainty | EF uncertainty | Combined uncertainty in % | Combined uncertainty in trend % |
|---|------------------|-------------------------|------------------------------------|----------------|----------------|---------------------------|---------------------------------|
| 1.A Stationary Combustion - Biomass | CH ₄ | 56.48 | 364.43 | 8.00 | 50.00 | 1.32E-01 | 8.29E-02 |
| 1.A Stationary Combustion - Biomass | N ₂ O | 27.24 | 132.05 | 8.00 | 60.00 | 5.73E-02 | 3.44E-02 |
| 1.A Stationary Combustion - Gaseous Fuels | CO ₂ | 12 164.90 | 15 058.27 | 3.00 | 2.50 | 4.22E-01 | 3.26E-01 |
| 1.A Stationary Combustion - Gaseous Fuels | CH ₄ | 20.59 | 25.51 | 3.00 | 50.00 | 9.16E-03 | 2.85E-03 |
| 1.A Stationary Combustion - Gaseous Fuels | N ₂ O | 6.91 | 8.51 | 3.00 | 60.00 | 3.66E-03 | 1.13E-03 |
| 1.A Stationary Combustion - Liquid Fuels | CO ₂ | 13 501.18 | 4 854.65 | 5.00 | 3.00 | 2.03E-01 | 1.82E-01 |
| 1.A Stationary Combustion - Liquid Fuels | CH ₄ | 14.30 | 3.45 | 5.00 | 50.00 | 1.24E-03 | 1.58E-03 |
| 1.A Stationary Combustion - Liquid Fuels | N ₂ O | 33.99 | 12.77 | 5.00 | 60.00 | 5.51E-03 | 3.18E-03 |
| 1.A Stationary Combustion - 1A2 | CO ₂ | 0.00 | 318.12 | 10.00 | 15.00 | 4.11E-02 | 3.24E-02 |
| 1.A Stationary Combustion - 1A2 | CH ₄ | 0.00 | 0.66 | 10.00 | 50.00 | 2.41E-04 | 1.69E-04 |
| 1.A Stationary Combustion - 1A2 | N ₂ O | 0.00 | 1.40 | 10.00 | 60.00 | 6.10E-04 | 4.26E-04 |
| 1.A Stationary Combustion - MSW | CO ₂ | 36.53 | 339.93 | 20.00 | 20.00 | 6.89E-02 | 5.67E-02 |
| 1.A Stationary Combustion - MSW | CH ₄ | 0.00 | 0.00 | 20.00 | 50.00 | 3.96E-07 | 2.74E-07 |
| 1.A Stationary Combustion - MSW | N ₂ O | 0.41 | 3.78 | 20.00 | 70.00 | 1.97E-03 | 1.32E-03 |
| 1.A Stationary Combustion - Solid Fuels | CO ₂ | 110 713.47 | 63 393.66 | 4.00 | 3.00 | 2.27E+00 | 1.78E+00 |
| 1.A Stationary Combustion - Solid Fuels | CH ₄ | 1 335.45 | 178.03 | 4.00 | 50.00 | 6.40E-02 | 1.83E-01 |
| 1.A Stationary Combustion - Solid Fuels | N ₂ O | 494.53 | 290.80 | 4.00 | 60.00 | 1.25E-01 | 1.68E-02 |
| 1.A.3.a Transport - Civil Aviation | CO ₂ | 145.90 | 7.62 | 4.00 | 3.73 | 2.99E-04 | 1.72E-03 |
| 1.A.3.a Transport - Civil Aviation | CH ₄ | 0.60 | 0.03 | 4.00 | 21.00 | 4.69E-06 | 3.97E-05 |
| 1.A.3.a Transport - Civil Aviation | N ₂ O | 6.26 | 0.33 | 4.00 | 40.00 | 9.41E-05 | 7.86E-04 |
| 1.A.3.b Transport - Road Transportation | CO ₂ | 6 238.78 | 15 863.86 | 3.00 | 2.36 | 4.34E-01 | 3.59E-01 |
| 1.A.3.b Transport - Road Transportation | CH ₄ | 26.47 | 18.85 | 3.00 | 100.00 | 1.35E-02 | 5.03E-04 |
| 1.A.3.b Transport - Road Transportation | N ₂ O | 131.76 | 653.80 | 3.00 | 100.00 | 4.69E-01 | 2.78E-01 |
| 1.A.3.c Transport - Railways | CO ₂ | 651.48 | 273.01 | 5.00 | 1.48 | 1.02E-02 | 9.62E-03 |
| 1.A.3.c Transport - Railways | CH ₄ | 0.86 | 0.36 | 5.00 | 100.00 | 2.58E-04 | 1.15E-04 |
| 1.A.3.c Transport - Railways | N ₂ O | 11.58 | 4.85 | 5.00 | 100.00 | 3.49E-03 | 1.55E-03 |
| 1.A.3.d Transport - Navigation | CO ₂ | 56.41 | 15.69 | 5.00 | 1.50 | 5.87E-04 | 5.74E-04 |
| 1.A.3.d Transport - Navigation | CH ₄ | 0.07 | 0.02 | 5.00 | 50.00 | 7.45E-06 | 7.56E-06 |
| 1.A.3.d Transport - Navigation | N ₂ O | 1.00 | 0.28 | 5.00 | 90.00 | 1.80E-04 | 1.83E-04 |
| 1.A.3.e Transport - Other Transportation | CO ₂ | 483.53 | 69.88 | 4.00 | 3.00 | 2.51E-03 | 4.36E-03 |
| 1.A.3.e Transport - Other Transportation | CH ₄ | 0.93 | 0.13 | 4.00 | 50.00 | 4.79E-05 | 1.25E-04 |
| 1.A.3.e Transport - Other Transportation | N ₂ O | 0.27 | 0.04 | 4.00 | 60.00 | 1.69E-05 | 4.44E-05 |
| 1.A.5.b Other mobile sources | CO ₂ | 1 600.90 | 1 094.81 | 7.00 | 3.00 | 5.98E-02 | 5.35E-02 |
| 1.A.5.b Other mobile sources | CH ₄ | 7.05 | 1.59 | 7.00 | 50.00 | 5.77E-04 | 8.08E-04 |
| 1.A.5.b Other mobile sources | N ₂ O | 19.59 | 22.87 | 7.00 | 60.00 | 9.91E-03 | 3.00E-03 |
| 1.B.1.a Coal Mining and Handling | CO ₂ | 456.24 | 259.41 | 4.00 | 25.00 | 4.71E-02 | 9.90E-03 |
| 1.B.1.a Coal Mining and Handling | CH ₄ | 7 599.96 | 3 262.27 | 4.00 | 13.00 | 3.18E-01 | 1.56E-01 |
| 1.B.1.b. Solid Fuel Transformation | CH ₄ | 0.63 | 4.03 | 40.00 | 50.00 | 1.85E-03 | 1.43E-03 |
| 1.B.2 Fug. Emission from Oil, Nat. Gas | CO ₂ | 4.02 | 12.14 | 7.00 | 75.00 | 6.56E-03 | 3.52E-03 |
| 1.B.2 Fug. Emission from Oil, Nat. Gas | CH ₄ | 897.48 | 538.35 | 7.00 | 75.00 | 2.91E-01 | 3.95E-02 |
| 1.B.2 Fug. Emission from Oil, Nat. Gas | N ₂ O | 0.01 | 0.04 | 7.00 | 75.00 | 1.92E-05 | 1.04E-05 |

| IPCC Source Category | Gas | Base year emissions abs | Latest reported year emissions abs | AD uncertainty | EF uncertainty | Combined uncertainty in % | Combined uncertainty in trend % |
|---|------------------|-------------------------|------------------------------------|----------------|----------------|---------------------------|---------------------------------|
| 2.A.1 Cement Production | CO ₂ | 2 489.18 | 1 517.03 | 2.00 | 2.00 | 3.08E-02 | 2.13E-02 |
| 2.A.2 Lime Production | CO ₂ | 1 336.65 | 608.57 | 2.00 | 2.00 | 1.23E-02 | 9.04E-03 |
| 2.A.3 Limestone and Dolomite Use | CO ₂ | 677.51 | 1 105.88 | 5.00 | 4.00 | 5.08E-02 | 4.06E-02 |
| 2.A.4 Soda Ash Use | CO ₂ | 0.00 | 1.09 | 5.00 | 10.00 | 8.72E-05 | 6.57E-05 |
| 2.A.7 Glass, Bricks and Ceramics | CO ₂ | 326.50 | 254.57 | 5.00 | 10.00 | 2.04E-02 | 9.01E-03 |
| 2.A.7 Glass, Bricks and Ceramics | CH ₄ | 2.94 | 2.98 | 5.00 | 50.00 | 1.07E-03 | 2.57E-04 |
| 2.B.1 Ammonia Production | CO ₂ | 806.81 | 573.45 | 5.00 | 7.00 | 3.54E-02 | 2.00E-02 |
| 2.B.2 Nitric Acid Production | N ₂ O | 1 126.69 | 427.20 | 4.00 | 15.00 | 4.76E-02 | 2.84E-02 |
| 2.B.5 Other | CH ₄ | 15.31 | 24.58 | 5.00 | 40.00 | 7.11E-03 | 2.90E-03 |
| 2.B.5 Other | N ₂ O | 83.70 | 94.43 | 20.00 | 40.00 | 3.03E-02 | 1.51E-02 |
| 2.C.1 Iron and Steel Production | CO ₂ | 12 430.71 | 5 250.45 | 7.00 | 10.00 | 4.60E-01 | 3.04E-01 |
| 2.C.1 Iron and Steel Production | CH ₄ | 127.20 | 53.83 | 7.00 | 30.00 | 1.19E-02 | 5.65E-03 |
| 2.F.1-6 F-gases Use - ODS substitutes | HFC | 3.67 | 2 086.49 | 37.00 | 23.00 | 6.52E-01 | 5.89E-01 |
| 2.F.7 F-gases Use – Semiconductor M. | PFC | 0.00 | 0.92 | 15.00 | 15.00 | 1.40E-04 | 1.18E-04 |
| 2.F.8 F-gases Use - Electrical Eq. | SF ₆ | 82.65 | 88.62 | 5.00 | 15.00 | 1.00E-02 | 3.88E-03 |
| 2.F.9 F-gases Use - Other | SF ₆ | 0.00 | 3.48 | 10.00 | 20.00 | 5.58E-04 | 4.21E-04 |
| 3 Solvents and Other Product Use | CO ₂ | 550.31 | 223.07 | 5.00 | 5.00 | 1.13E-02 | 8.68E-03 |
| 3 Solvents and Other Product Use | N ₂ O | 214.52 | 232.50 | 50.00 | 0.00 | 8.34E-02 | 8.12E-02 |
| 4.A Enteric Fermentation | CH ₄ | 4 219.42 | 2 026.88 | 5.00 | 20.00 | 3.00E-01 | 1.12E-01 |
| 4.B Manure Management | CH ₄ | 1 075.10 | 469.66 | 5.00 | 30.00 | 1.02E-01 | 4.33E-02 |
| 4.B Manure Management | N ₂ O | 1 708.42 | 660.88 | 5.00 | 30.00 | 1.44E-01 | 7.97E-02 |
| 4.D.1 Agricultural Soils, Direct Emissions | N ₂ O | 5 484.03 | 2 836.98 | 15.00 | 50.00 | 1.06E+00 | 3.77E-01 |
| 4.D.2 Pasture, Range and Paddock Manure | N ₂ O | 317.25 | 258.34 | 10.00 | 100.00 | 1.86E-01 | 2.67E-02 |
| 4.D.3 Agricultural Soils, Indirect Emissions | N ₂ O | 3 502.98 | 1 805.63 | 20.00 | 50.00 | 6.97E-01 | 2.93E-01 |
| 5.A.1 Forest Land remaining Forest Land | CO ₂ | 4 567.42 | 6 980.01 | - | 18.10 | 9.06E-01 | 3.43E-01 |
| 5.A.1 Forest Land remaining Forest Land | CH ₄ | 96.48 | 58.55 | - | 50.00 | 2.10E-02 | 1.94E-03 |
| 5.A.1 Forest Land remaining Forest Land | N ₂ O | 9.79 | 5.94 | - | 50.00 | 2.13E-03 | 1.97E-04 |
| 5.A.2 Land converted to Forest Land | CO ₂ | 220.80 | 339.52 | - | 38.78 | 9.44E-02 | 3.59E-02 |
| 5.B.1 Cropland remaining Cropland | CO ₂ | 1 089.07 | 92.99 | - | 12.47 | 8.31E-03 | 4.04E-02 |
| 5.B.2 Land converted to Cropland | CO ₂ | 108.61 | 81.53 | - | 38.54 | 2.25E-02 | 1.29E-03 |
| 5.B.2. Land converted to Cropland | N ₂ O | 10.97 | 6.40 | - | 2.83 | 1.30E-04 | 1.60E-05 |
| 5.C.1 Grassland remaining Grassland | CO ₂ | 57.93 | 4.51 | - | 9.39 | 3.04E-04 | 1.64E-03 |
| 5.C.2 Land converted to Grassland | CO ₂ | 140.72 | 306.19 | - | 18.64 | 4.09E-02 | 1.93E-02 |
| 5.D.2. Land converted to Wetlands | CO ₂ | 22.44 | 24.55 | - | 73.58 | 1.29E-02 | 3.31E-03 |
| 5.E.2 Land converted to Settlements | CO ₂ | 84.38 | 99.26 | - | 101.80 | 7.25E-02 | 2.07E-02 |
| 5G Other - Liming of Forest Land | CO ₂ | 11.82 | 0.01 | - | 15.00 | 1.42E-06 | 6.01E-04 |
| 6.A Solid Waste Disposal on Land | CH ₄ | 1 662.59 | 2 769.96 | 30.00 | 40.00 | 9.93E-01 | 6.63E-01 |
| 6.B Wastewater Handling | CH ₄ | 825.45 | 510.15 | 21.00 | 50.00 | 1.98E-01 | 7.62E-02 |
| 6.B Wastewater Handling | N ₂ O | 311.92 | 275.66 | 26.00 | 50.00 | 1.11E-01 | 5.22E-02 |
| 6.C Waste Incineration | CO ₂ | 23.15 | 206.86 | 20.00 | 5.00 | 3.06E-02 | 2.93E-02 |
| 6.C Waste Incineration | CH ₄ | 0.00 | 0.00 | 20.00 | 50.00 | 5.72E-07 | 3.96E-07 |
| 6.C Waste Incineration | N ₂ O | 0.44 | 3.91 | 20.00 | 70.00 | 2.04E-03 | 1.36E-03 |
| Combined overall "Tier 1" uncertainty in percent | | | | | | 3.21 | 2.20 |

1.8 General assessment of the completeness

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

1.8.1 Notation keys

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

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

IE (included elsewhere):

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

NE (not estimated):

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

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

2 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.

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emissions

Tab. 2-1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2012. For CO₂, CH₄ and N₂O the base year is 1990; for F-gases the base year is 1995.

Tab. 2-1 GHG emissions from 1990-2012 excl. bunkers [Gg CO₂ eq.]

| | CO ₂ ¹ | CH ₄ ³ | N ₂ O ³ | HFCs | PFCs | SF ₆ | Total emissions | |
|----------------|------------------------------|------------------------------|-------------------------------|----------|--------|-----------------|-----------------|--------------|
| | | | | | | | incl. LULUCF | excl. LULUCF |
| 1990 | 161 139.45 | 17 985.37 | 13 504.25 | NE | | 79.17 | 192 708.23 | 196 145.70 |
| 1991 | 145 215.14 | 16 335.50 | 11 687.98 | | | 78.85 | 173 317.46 | 182 192.75 |
| 1992 | 129 126.47 | 15 391.08 | 10 430.08 | | | 79.91 | 155 027.54 | 165 624.18 |
| 1993 | 126 513.65 | 14 460.24 | 9 266.94 | | | 80.90 | 150 321.73 | 159 466.81 |
| 1994 | 119 758.96 | 13 607.84 | 9 098.71 | | | 81.80 | 142 547.30 | 149 435.24 |
| 1995 | 121 868.26 | 13 492.81 | 9 389.69 | 0.21 | 0.01 | 82.65 | 144 833.64 | 151 773.53 |
| 1996 | 125 737.22 | 13 316.23 | 8 992.68 | 31.45 | 0.38 | 92.28 | 148 170.24 | 155 539.54 |
| 1997 | 123 125.90 | 12 997.94 | 9 064.90 | 88.07 | 1.24 | 88.69 | 145 366.75 | 151 816.23 |
| 1998 | 116 258.91 | 12 547.83 | 8 879.40 | 118.76 | 1.21 | 85.67 | 137 891.79 | 144 667.47 |
| 1999 | 109 245.73 | 12 014.55 | 8 699.94 | 129.47 | 0.66 | 96.14 | 130 186.47 | 137 106.75 |
| 2000 | 118 745.21 | 11 229.06 | 8 783.61 | 178.36 | 3.12 | 110.82 | 139 050.18 | 146 330.13 |
| 2001 | 118 372.26 | 10 975.77 | 8 958.32 | 270.18 | 6.49 | 111.35 | 138 694.37 | 146 326.41 |
| 2002 | 115 698.55 | 10 653.12 | 8 644.35 | 351.50 | 11.69 | 128.36 | 135 487.56 | 142 844.95 |
| 2003 | 121 019.01 | 10 629.78 | 8 138.10 | 446.50 | 5.67 | 150.91 | 140 389.96 | 145 827.26 |
| 2004 | 121 516.65 | 10 338.16 | 8 837.57 | 529.96 | 8.46 | 121.15 | 141 351.95 | 147 274.23 |
| 2005 | 119 606.28 | 10 655.71 | 8 539.53 | 617.02 | 9.77 | 113.19 | 139 541.51 | 145 965.05 |
| 2006 | 123 580.92 | 10 923.69 | 8 349.06 | 820.64 | 22.18 | 102.08 | 143 798.56 | 147 021.15 |
| 2007 | 126 582.52 | 10 591.31 | 8 390.59 | 1 116.45 | 20.57 | 88.71 | 146 790.15 | 147 245.85 |
| 2008 | 117 136.37 | 10 661.78 | 8 512.38 | 1 314.12 | 28.23 | 95.19 | 137 748.08 | 142 184.64 |
| 2009 | 107 809.00 | 10 325.31 | 7 980.87 | 1 423.87 | 33.13 | 105.45 | 127 677.64 | 134 205.66 |
| 2010 | 111 816.47 | 10 492.54 | 7 719.34 | 1 688.82 | 36.66 | 71.45 | 131 825.28 | 137 007.81 |
| 2011 | 107 991.12 | 10 384.00 | 7 872.32 | 1 924.52 | 9.07 | 83.67 | 128 264.70 | 135 276.54 |
| 2012 | 103 979.00 | 10 314.32 | 7 739.40 | 2 082.75 | 6.57 | 92.11 | 124 214.14 | 131 466.12 |
| % ² | -35.47 | -42.65 | -42.69 | 100.00 | 100.00 | 16.34 | -35.54 | -32.98 |

Note: Global warming potentials (GWPs) used (100 years time horizon): CO₂ = 1; CH₄ = 21; N₂O = 310; SF₆ = 23 900; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

¹GHG emissions excluding emissions/removals from LULUCF

²relative to base year

³incl. 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 140 000 Gg CO₂ eq. and continues fluctuating ever since (see Fig. 2-1). From 2010 to 2012 the total GHG emissions (incl. LULUCF) decreased by 4.85 % or 6397.82 Gg CO₂ eq. resulting in total emissions of 124 214.28 Gg CO₂ eq. The decrease was caused by CO₂, CH₄, HFC emissions (decreased by 3.14 %; 1.19 %; 22.99 %) despite increase in N₂O and SF₆ emissions (raised by 1.88 % and 112.99 % respectively) compared to previous year. The total GHG emissions and removals in 2012 were -35.54 % below the base year level including LULUCF and -32.98 %, when excluding LULUCF.

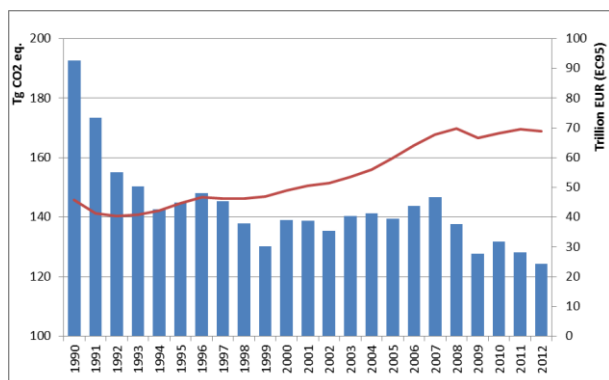


Fig. 2-1 Total GHG emissions (incl. LULUCF) and GDP in 1995 constant prices (1990-2012) [Tg CO₂ eq.]

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 2012 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 gas

The major greenhouse gas in the Czech Republic is CO₂, which represents 84.62 % of total GHG emissions and removals in 2012, compared to 83.31 % in the base year. It is followed by CH₄ (7.84 % in 2012, 9.51 % in the base year), N₂O (8.88 % in 2012, 7.14 % in the base year) and F-gases (1.66 % in 2012, 0.04 % 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 CO₂, CH₄ and N₂O emissions 1990 - 2012 in index form (base year = 100 %) and Trend in HFCs, PFCs (1995 - 2012) and SF₆ (1990 - 2012) actual emissions in index form (base year = 100 %)

CO₂

CO₂ emissions have been rapidly decreasing in early 90's, after 1994 the emissions have kept at approx. 70-75 % of the amount produced in 1990. Between 2007 and 2009 emissions of CO₂ dropped to its lowest value among the whole reported period. Inter-annual increase in CO₂ emissions (excl. LULUCF) from 2010 to 2012 by 3.14 % results the total decrease to 30.65 % from 1990 to 2012 (34.02 % decrease incl. LULUCF). Quoting in absolute figures, CO₂ emissions and removals decreased from 164 812.75 to 114 296.49 Gg CO₂ eq. in the period from 1990 to 2012, mainly due to lower emissions from the *1 Energy* category (mainly *1A2 Manufacturing Industries & Construction*, *1A4a Commercial / Institutional and 1A4b Residential*).

The main source of CO₂ emissions is fossil fuel combustion; within the *1A Fuel Combustion* category, *1A1 Energy Industry* and *1A2 Manufacturing Industries & Construction* sub-categories are the most important. CO₂ emissions increased remarkably between 1990 and 2012 from the *1A3 Transport* category from 7 576 to 16 564 Gg CO₂.

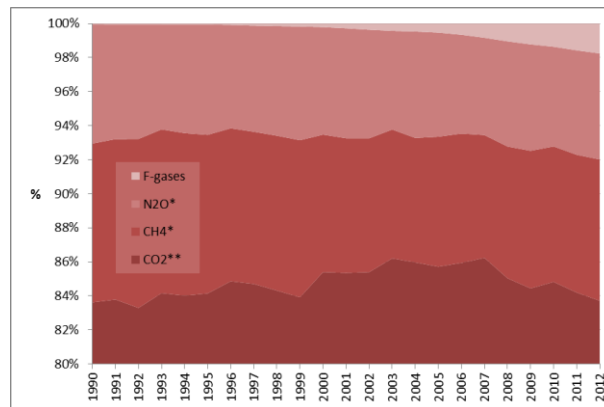


Fig. 2-3 Percentual share of GHGs (Y-axis begins at 80% - part of CO₂ share is hidden)

CH₄

CH₄ emissions share decreased almost steadily during the period from 1990 to 2004, from 2004 methane fluctuated around 58 % of its base year emissions. In 2012 CH₄ emissions were 42.57 % below the base year level, mainly due to lower contribution of *1B Fugitive Emissions from Fuels* and emissions from *4 Agriculture* and despite increase from the *6 Waste* category. The main sources of CH₄ emissions are *1B Fugitive Emissions from Fuels* (solid fuel), *4 Agriculture* (*4A Enteric Fermentation* and *4B Manure Management*) and *6 Waste* (*6A Solid Waste Disposal on Land* and *6B Waste-water Handling*).

N₂O

N₂O emissions strongly decreased from 1990 to 1994 by 34 % over this period and then shows slow decreasing trend with inter-annual fluctuation. N₂O emissions decreased between 1990 and 2012 from 13 365 to 7 783 Gg CO₂ eq. In 2012 N₂O emissions were 41.77 % below the base year level, mainly due to lower emissions from *4 Agriculture* and *2B Chemical Industry* and despite increase from the *1A3 Transport* category.

The main source of N₂O emission is category *4D Agricultural Soils* (others less important sources are *1A Fossil Fuel Combustion* and *2 Industrial Processes - 2B Chemical Industry*).

HFCs

HFCs actual emissions increased remarkably between 1995 and 2012 from 0.73 to 1 130.4 Gg CO₂ eq. Emissions of HFCs have been rapidly increasing since the base year 1995, when they were started to use. HFC seems to have decreasing trend due economic recession which started after 2007. In 2012, HFCs emissions were more than 2000-times higher than in the base year 1995.

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

PFCs

PFCs actual emissions show very similar trend as HFCs emissions but on much lower scale. They increased between 1995 and 2012 from 0.12 to 29.43 Gg CO₂ eq. In 2012, 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*.

SF₆

SF₆ actual emissions in 1995 accounted for 75.2 Gg CO₂ eq. Between 1995 and 2012 they inter-annually fluctuated with maximum of 168.7 Gg CO₂ eq. in 2001 and minimum of 16.22 Gg CO₂ eq. in 2010. In 2012 SF₆ reached amount of 34.55 Gg, the level was 55.52 % below the base year.

The main sources of SF₆ emissions are *Electrical Equipment; Semiconductor Manufacture and Filling of Insulate Glasses*.

2.3 Description and interpretation of emission trends by category

Tab. 2-2 presents a summary of GHG emissions by categories for the period from 1990 to 2012:

- Category 1 Energy
- Category 2 Industrial Processes
- Category 3 Solvent and Other Product Use
- Category 4 Agriculture
- Category 5 LULUCF
- Category 6 Waste

The dominant category is the *1 Energy* category, which caused for 86.21 % of total GHG emissions in 2012 (81.7 % in 1990) excluding LULUCF, followed by the categories *2 Industrial Processes* and *4 Agriculture*, which caused for 9.74 % and 6.49 % of total GHG emissions in 2012 (10.2 % and 8.2 % in 1990, resp.), *6 Waste* category covered 3.03 %, *3 Solvent and Other Product Use* 0.4 % and *5 LULUCF* category removed 7 959.22 Gg CO₂ eq. which represents share of 5.84 % of all GHG emissions.

The trend of GHG emissions by categories is presented in Fig. 2-5 (indexed relative to the base year), see also the percentual share of individual sectors (Fig. 2-6).

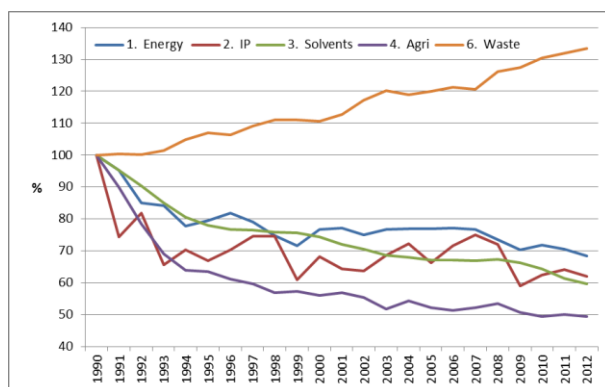


Fig. 2-4 Emission trends in 1990-2012 by categories in index form (base year = 100)

Tab. 2-2 Summary of GHG emissions by category 1990-2012 [Gg CO₂ eq.]

| | 1 Energy | 2 IP | 3 Solvents | 4 Agriculture | 5 LULUCF | 6 Waste |
|----------------|-----------|-----------|------------|---------------|------------|----------|
| 1990 | 156747.78 | 19 602.83 | 764.83 | 16 233.28 | -3 617.94 | 2 673.17 |
| 1991 | 149444.48 | 14 619.03 | 728.05 | 14 611.72 | -9 037.27 | 2 722.88 |
| 1992 | 133370.08 | 16 069.16 | 690.99 | 12 731.33 | -10 786.93 | 2 733.48 |
| 1993 | 131889.58 | 12 922.95 | 650.54 | 11 204.85 | -9 432.86 | 2 749.91 |
| 1994 | 121734.12 | 13 855.70 | 616.05 | 10 372.50 | -7 141.07 | 2 859.32 |
| 1995 | 124729.60 | 13 188.23 | 596.31 | 10 331.98 | -7 210.11 | 2 907.58 |
| 1996 | 128299.91 | 13 893.50 | 586.63 | 9 966.29 | -7 620.64 | 2 882.31 |
| 1997 | 123894.00 | 14 847.10 | 584.76 | 9 758.20 | -6 660.85 | 2 967.44 |
| 1998 | 117162.02 | 14 850.27 | 580.41 | 9 284.71 | -6 997.96 | 3 011.85 |
| 1999 | 112180.52 | 12 102.86 | 578.49 | 9 350.12 | -7 155.04 | 3 029.28 |
| 2000 | 120218.17 | 13 561.11 | 568.56 | 9 094.86 | -7 524.24 | 3 058.11 |
| 2001 | 120759.35 | 12 885.78 | 549.96 | 9 220.88 | -7 877.91 | 3 113.32 |
| 2002 | 117532.32 | 12 546.46 | 539.65 | 8 955.86 | -7 632.54 | 3 242.00 |
| 2003 | 120110.20 | 13 656.01 | 525.16 | 8 314.94 | -5 742.66 | 3 328.53 |
| 2004 | 120469.05 | 14 239.70 | 519.28 | 8 750.49 | -6 182.96 | 3 277.31 |
| 2005 | 120666.15 | 12 979.24 | 513.77 | 8 385.03 | -6 685.51 | 3 297.01 |
| 2006 | 120743.70 | 14 156.44 | 512.93 | 8 249.77 | -3 464.66 | 3 351.23 |
| 2007 | 120171.19 | 15 264.70 | 512.17 | 8 403.04 | -726.83 | 3 332.89 |
| 2008 | 115347.59 | 14 085.39 | 515.27 | 8 583.06 | -4 772.86 | 3 491.67 |
| 2009 | 110332.87 | 11 153.29 | 506.15 | 8 134.29 | -6 863.11 | 3 528.62 |
| 2010 | 112583.82 | 12 025.82 | 492.05 | 7 964.57 | -5 488.45 | 3 611.79 |
| 2011 | 110424.40 | 11 790.63 | 469.42 | 8 064.84 | -7 959.22 | 3 656.03 |
| 2012 | 107090.15 | 12 095.48 | 455.57 | 8 058.37 | -7 251.97 | 3 766.54 |
| % ¹ | -3.02 | -3.19 | -2.95 | -1.28 | 3.42 | 1.07 |
| % ² | -31.68 | -37.98 | -40.44 | -50.58 | 110.97 | 33.40 |

¹ Difference relative to previous year

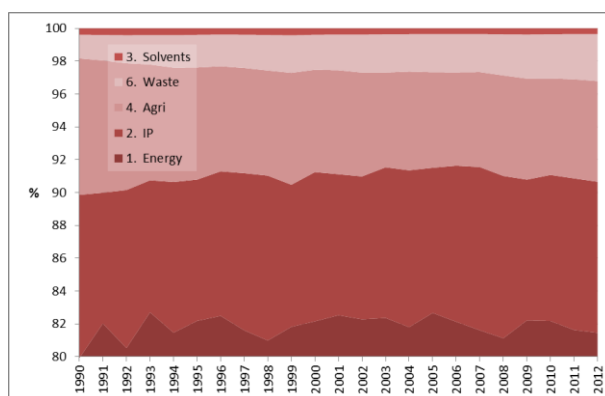
² Difference relative to base year


Fig. 2-5 Percentual share of GHG emissions by categories (y-axis begins at 80% - part of energy share is hidden)

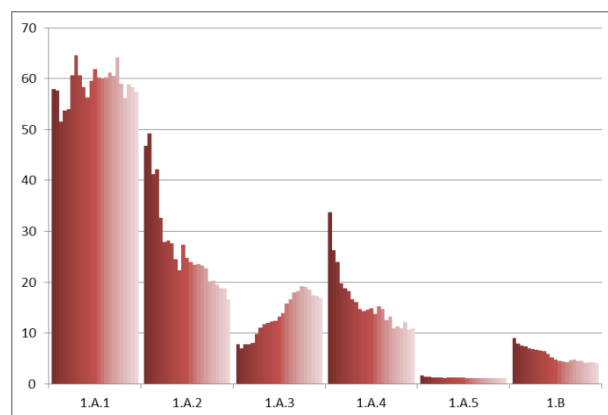
Tab. 2-3 Overview of recent emission trend development (Gg CO₂ eq.)

| GREENHOUSE GAS CATEGORIES | 1990 | ... | 2008 | 2009 | 2010 | 2011 | 2012 |
|--|---------|-----|---------|---------|---------|---------|---------|
| 1. Energy | 156 748 | | 115 348 | 110 333 | 112 584 | 110 424 | 107 090 |
| A. Fuel Combustion (Sectoral Approach) | 147 789 | | 110 875 | 106 185 | 108 329 | 106 207 | 103 014 |
| 1. Energy Industries | 57 937 | | 59 019 | 56 152 | 58 855 | 58 393 | 57 413 |
| 2. Manufacturing Industries and Construction | 46 754 | | 20 302 | 19 455 | 18 836 | 18 834 | 16 603 |
| 3. Transport | 7 756 | | 19 076 | 18 510 | 17 434 | 17 263 | 16 909 |
| 4. Other Sectors | 33 715 | | 11 319 | 10 924 | 12 096 | 10 602 | 10 970 |
| 5. Other (mobile) | 1 628 | | 1 159 | 1 143 | 1 108 | 1 116 | 1 119 |
| B. Fugitive Emissions from Fuels | 8 958 | | 4 473 | 4 148 | 4 255 | 4 217 | 4 076 |
| 1. Solid Fuels | 8 057 | | 3 818 | 3 454 | 3 529 | 3 538 | 3 526 |
| 2. Oil and Natural Gas | 902 | | 655 | 695 | 726 | 679 | 551 |
| 2. Industrial Processes | 19 502 | | 14 054 | 11 512 | 12 191 | 12 493 | 12 095 |
| A. Mineral Products | 4 833 | | 4 135 | 3 453 | 3 429 | 3 827 | 3 490 |
| B. Chemical Industry | 2 033 | | 1 396 | 1 257 | 1 111 | 1 090 | 1 120 |
| C. Metal Production | 12 558 | | 7 085 | 5 239 | 5 855 | 5 559 | 5 304 |
| F. Consumption of Halocarbons and SF ₆ | 79 | | 1 438 | 1 562 | 1 797 | 2 017 | 2 181 |
| 3. Solvent and Other Product Use | 765 | | 515 | 506 | 492 | 469 | 456 |
| 4. Agriculture | 16 307 | | 8 707 | 8 255 | 8 058 | 8 162 | 8 058 |
| A. Enteric Fermentation | 4 219 | | 2 103 | 2 047 | 1 999 | 2 003 | 2 027 |
| B. Manure Management | 2 784 | | 1 303 | 1 228 | 1 173 | 1 140 | 1 131 |
| D. Agricultural Soils | 9 304 | | 5 301 | 4 980 | 4 886 | 5 019 | 4 901 |
| 5. Land Use, Land-Use Change and Forestry | -3 437 | | -4 437 | -6 528 | -5 183 | -7 012 | -7 252 |
| A. Forest Land | -4 682 | | -4 349 | -6 403 | -5 104 | -6 956 | -7 255 |
| B. Cropland | 1 209 | | 165 | 116 | 136 | 152 | 181 |
| C. Grassland | -83 | | -373 | -362 | -366 | -325 | -302 |
| D. Wetlands | 22 | | 22 | 20 | 34 | 31 | 25 |
| E. Settlements | 84 | | 93 | 101 | 115 | 86 | 99 |
| G. Other | 12 | | 5 | 0 | 2 | 0 | 0 |
| 6. Waste | 2 824 | | 3 561 | 3 599 | 3 683 | 3 727 | 3 767 |
| A. Solid Waste Disposal on Land | 1 663 | | 2 528 | 2 614 | 2 708 | 2 745 | 2 770 |
| B. Waste-water Handling | 1 137 | | 788 | 783 | 791 | 791 | 786 |
| C. Waste Incineration | 24 | | 245 | 203 | 183 | 191 | 211 |
| International Bunkers | 568 | | 1 215 | 1 110 | 1 040 | 1 031 | 960 |
| Aviation | 568 | | 1 215 | 1 110 | 1 040 | 1 031 | 960 |
| CO ₂ Emissions from Biomass | 2 368 | | 8 886 | 9 464 | 10 692 | 11 259 | 12 238 |
| Total CO ₂ eq. Emissions without LULUCF | 196 146 | | 142 185 | 134 206 | 137 008 | 135 277 | 131 466 |
| Total CO ₂ eq. Emissions with LULUCF | 192 708 | | 137 748 | 127 678 | 131 825 | 128 265 | 124 214 |

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 CO₂ eq. Total decrease between 1990 and 2012 is 31.68 %. Between 2011 to 2012 emissions from category *1 Energy* slightly decreased by 3.02 %.

From the total 107090.29 Gg CO₂ eq. in 2012 96.19 % comes from *1A Fuel Combustion*, the rest are *1B Fugitive Emissions from Fuels* (mainly Solid Fuels). *1B Fugitive Emissions from Fuels* is the largest source for CH₄, which represented 36.89 % of all CH₄ emissions in 2012. 42.64 %


Fig. 2-6 Trends in Energy by categories 1990 (dark)-2012 (light) in Tg CO₂ eq.

of all CH₄ emissions in 2012 originated from *Energy* category.

CO₂ emissions from fossil fuels combustion (category 1 *Energy*) are the main source in Czech Republic's inventory with a share of 91.00 % in national CO₂ emissions (excl. LULUCF). CO₂ from category 1 *Energy* contributes for 81.76 % to total GHG emissions, CH₄ for 3.54 % and N₂O for 0.91 % in 2012.

Industrial Processes (IPCC Category 2)

GHG emissions from the 2 *Industrial Processes* category fluctuated with decreasing trend during the whole period 1990 to 2012. 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 2012 emissions from this category decreased by 37.98 %. In 2012 emissions amounted for 12 095.48 Gg CO₂ eq.

The main categories in the 2 *Industrial Processes* category are 2C *Metal Production* (43.85 %), 2A *Mineral Products* (28.85 %), 2B *Chemical Industry* (9.26 %) and 2F *Consumption of Halocarbons and SF₆* (18.04 %) of the sectoral emissions in 2012.

The most important GHG of the 2 *Industrial Processes* category was CO₂ with 76.98 % of sectoral emissions, followed by F-gases (18.04 %).

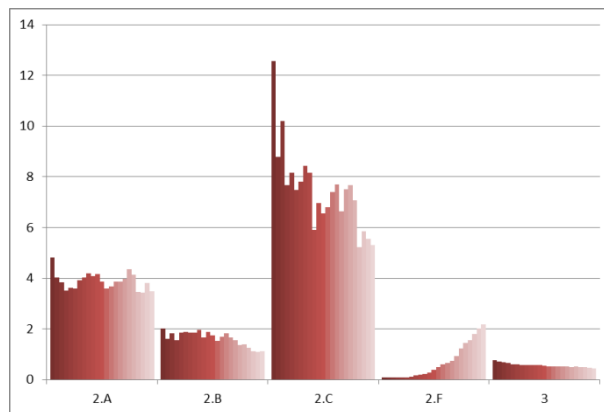


Fig. 2-7 Trends in IP and Solvents by categories 1990 (dark)-2012 (light) in Tg CO₂ eq.

Solvent and Other Product Use (IPCC Category 3)

In 2012, 0.37 % of total GHG emissions (455,57 Gg CO₂ eq.) arose from the 3 *Solvent and Other Product Use* category. Emissions in this category generally decreases steadily in the period from 1990 to 2012, but has steadily kept its aprox. 0.4 % share over all the years. In 2012 GHG emissions from 3 *Solvent and Other Product Use* were 40.44 % below the base year. 50.47 % of these emissions were CO₂, N₂O emissions contributed by 51,03 %.

Agriculture (IPCC Category 4)

GHG emissions from the category 4 *Agriculture* decreased relatively steadily over the period from 1990 to 2003 and then fluctuated. In 2012 emissions reached minimum level which is 50.58 % below the base year level.

Agriculture amounted 8 058.37 Gg CO₂ eq. in 2012 which corresponds to 6.49 % of national total emissions (excluding LULUCF). The most important sub-category agricultural soils (N₂O emissions) contributed by 60.82 % to sectoral total in 2012, followed by the enteric fermentation (CH₄ emissions, 25.15 %).

4 *Agriculture* is the largest source for N₂O and second largest source for CH₄ emissions. However it's emission trend steadily decreases over the whole observed period.

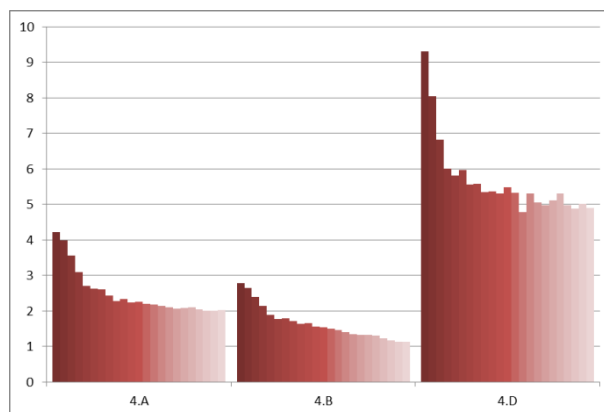


Fig. 2-8 Trends in Agriculture by categories 1990 (dark)-2012 (light) in Tg CO₂ eq.

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

Net GHG emissions/removals from the 5 *Land Use, Land-Use Change and Forestry* category vary through the whole time series with minimum of -455.70 Gg CO₂ eq. in 2007 and maximum -10 596.64 CO₂ eq. in 1992. In 2012 removals were by 110.97 % above the base year level.

Emissions and removals amounted to -7 251.97 Gg CO₂ eq. in 2012, which corresponds to 5.84 % 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 CO₂. CO₂ removals for this category amounted to 7 322.87 Gg CO₂ eq. in 2012. CH₄ emissions amounted to 58.55 Gg CO₂ eq., N₂O to 12.35 Gg CO₂ eq.

Waste (IPCC Category 6)

GHG emissions from category 6 *Waste* substantially increased during the whole period. In 2012 emissions amounted for 3 766.54 Gg CO₂ eq., which is 33.40 % above the base year level. The increase of emissions is mainly due to higher emissions of CH₄ from 6A *Solid Waste Disposal on Land* (and partly due to increase of N₂O emissions from 6B *Waste-water Handling*), which are the most important categories. As a result of CH₄ recovery systems installed in 6B *Wastewater Handling* emissions decreased in this category by aprox. 35 % compared to

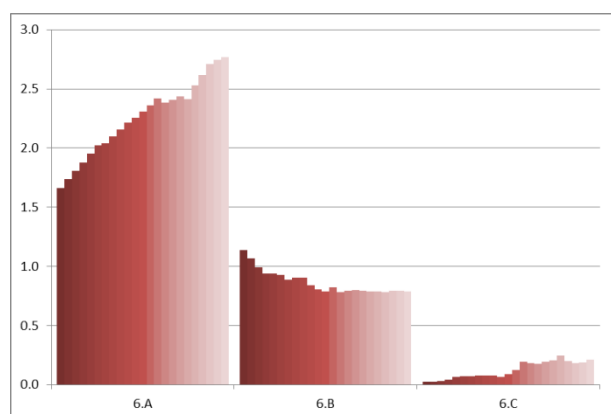


Fig. 2-10 Trends in Waste by categories 1990 (dark)-2012 (light) in Tg CO₂ eq.

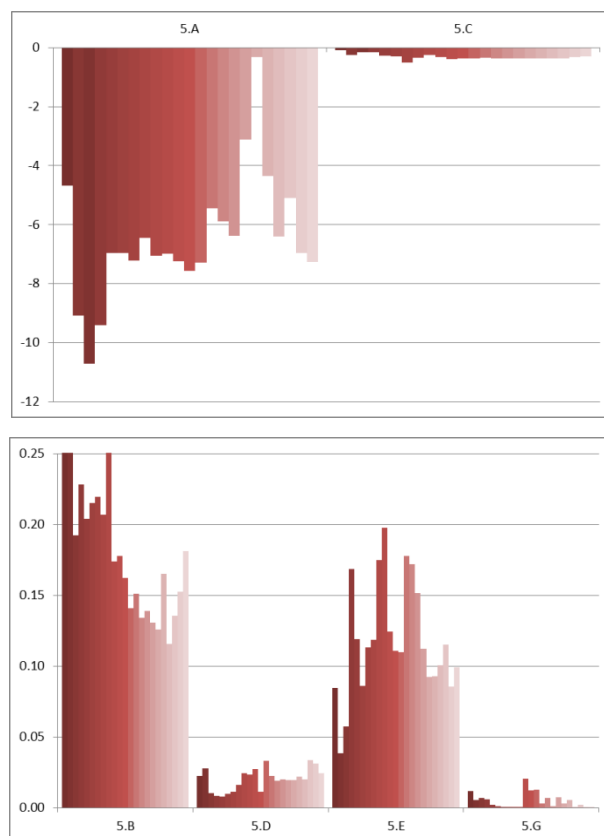


Fig. 2-9 Trends in LULUCF by separate source and sink categories 1990 (dark)-2012 (light) in Tg CO₂ eq.

the base year. The share of category 6 *Waste* in total emissions was 3.03 % in 2012.

The main source is solid 6A *Solid Waste Disposal on Land*, which accounted for 84.45 % of sectoral CH₄ emissions in 2012, followed by 6B *Wastewater Handling* (CH₄ - 26.86 % and N₂O - 3.56 %) and 6C *Waste Incineration* (CO₂ - 100.0 % and N₂O - 1.70 %).

87.09 % of all emissions from *Waste* category are CH₄ emissions; CO₂ contributes by 5.49 % and N₂O by 7.42 %.

2.4 Description and interpretation of emission trends of indirect greenhouse gases and SO₂

Emission estimates for NO_x, CO, NMVOC and SO₂ are also reported in the CRF. The following chapter summarizes the trends for these gases.

A detailed description of the methodology used to estimate these emissions should be available in *Czech Informative Inventory Report (IIR)*, *Submission under the UNECE / CLRTAP Convention*. Indirect greenhouse gases totals correspond under both submissions, the differences between reporting formats (NFR-CRF) are taken into account. Tab.2-4 presents a summary of emission estimates for indirect GHGs and SO₂ for the period from 1990 to 2012 and the National Emission Ceilings (NEC) as set out in the 1999 *Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone*. These reduction targets should have been 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 2012 (NMVOC by 58.70 %, CO by 65.77 % and NO_x by 71.61 %). SO₂ emissions decreased by 91.58 % compared to 1990 level.

Tab. 2-4 Emissions of indirect GHGs and SO₂ 1990-2012 [Gg]

| | NO _x | CO | NMVOC | SO ₂ |
|------------------|-----------------|----------|--------|-----------------|
| 1990 | 742.34 | 1 070.29 | 311.27 | 1 875.52 |
| 1991 | 732.19 | 1 156.46 | 272.97 | 1 772.20 |
| 1992 | 708.23 | 1 161.72 | 257.47 | 1 559.14 |
| 1993 | 690.75 | 1 193.20 | 233.04 | 1 468.85 |
| 1994 | 450.84 | 1 074.41 | 255.31 | 1 290.19 |
| 1995 | 430.19 | 932.20 | 215.35 | 1 095.32 |
| 1996 | 446.69 | 964.88 | 265.16 | 934.45 |
| 1997 | 470.69 | 980.75 | 271.86 | 980.79 |
| 1998 | 414.14 | 812.22 | 267.15 | 442.22 |
| 1999 | 391.09 | 726.43 | 247.17 | 268.92 |
| 2000 | 396.70 | 680.03 | 244.31 | 264.45 |
| 2001 | 332.83 | 687.10 | 219.88 | 250.89 |
| 2002 | 319.40 | 587.53 | 202.86 | 237.39 |
| 2003 | 325.70 | 630.40 | 203.26 | 232.13 |
| 2004 | 333.56 | 622.56 | 198.46 | 227.22 |
| 2005 | 279.13 | 556.14 | 181.70 | 218.63 |
| 2006 | 283.78 | 539.89 | 178.60 | 211.23 |
| 2007 | 285.86 | 581.52 | 173.97 | 216.96 |
| 2008 | 262.75 | 496.20 | 165.66 | 174.34 |
| 2009 | 252.72 | 452.23 | 151.06 | 173.47 |
| 2010 | 240.03 | 453.61 | 150.89 | 170.32 |
| 2011 | 226.09 | 404.64 | 139.79 | 169.01 |
| 2012 | 210.77 | 366.31 | 128.56 | 157.91 |
| Trend [%] | -71.61 | -65.77 | -58.70 | -91.58 |
| NEC ¹ | 286 | - | 220 | 283 |

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

NO_x

NO_x emissions decreased from 742 to 210.77 Gg during the period from 1990 to 2012. In 2012 NO_x emissions were 71.61 % below the 1990 level. Almost 99 % of NO_x emissions originate from *1 Energy*, - mainly subsectors *1A1 Energy Industries* 34.46 %, *1A3 Transport* 29.12 %, *1A2 Manufacturing Industries and Construction* 12.24 % and *1A5 Other* 16.93 %.

CO

CO emissions decreased from 1,071 to 366.31 Gg during the period from 1990 to 2012. In 2012 CO emissions were 65.77 % below the 1990 level. In 2012, approximately 87 % of total CO emissions originated from *1 Energy*; subsectors *1A3 Transport* (32.02 %), *1A2 Manufacturing Industries and Construction* (28.42 %), and *1A4 Other Sectors* (17.55 %), followed by *Industrial Processes* (6.69 %) and *LULUCF* (6.66 %).

NMVOC

NMVOC emissions decreased from 311 to 128.56 during the period from 1990 to 2012. In 2012 NMVOC emissions were 58.70 % below the 1990 level. There are two main emission source categories, first is *3 Solvent and Other Product Use* (55.21 % of the national total) and second is *1A1 Energy industries* (43.12 %) and *1A3 Transport* (22.27 %), and *1A4 Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fisheries)* 12.19 %).

SO₂

SO₂ emissions decreased from 1 876 to 157.91 Gg during the period from 1990 to 2012. In 2012 SO₂ emissions were 91.58 % below the 1990 level. In 2012, over 99 % of total SO₂ emissions originated from *1 Energy*; mainly subsectors *1A1 Energy Industries* (62.08 %), *1A4 Other Sectors* (16.43 %) and *1A2 Manufacturing Industries and Construction* (13.23 %).

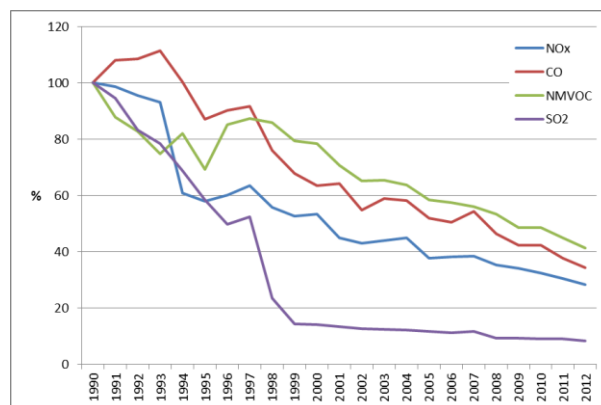


Fig. 2-11 Indexed emissions of indirect GHGs and SO2 1990 – 2012 (1990=100 %)

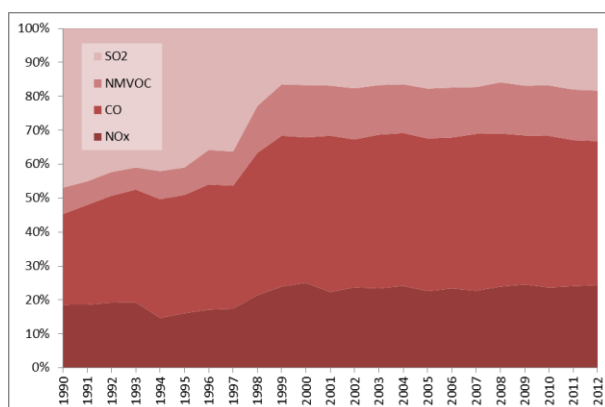


Fig. 2-12 Overall trend in percentual share of indirect GHG

Tab. 2-5 Indirect GHG emissions in sectors of origin 2012 (Gg)

| Indirect Greenhouse gas sources | NO _x | CO | NM VOC | SO ₂ |
|---|-----------------|--------|--------|-----------------|
| | Gg | Gg | Gg | Gg |
| Total National Emissions and Removals | 210.77 | 366.31 | 128.56 | 157.91 |
| 1. Energy | 207.62 | 317.41 | 55.44 | 156.44 |
| A. Fuel Combustion | 207.20 | 317.08 | 54.58 | 145.58 |
| 1. Energy Industries | 72.64 | 9.81 | 5.59 | 98.03 |
| 2. Manufacturing Industries and Construction | 25.80 | 104.10 | 1.87 | 20.89 |
| 3. Transport | 61.37 | 117.31 | 28.63 | 0.55 |
| 4. Other Sectors | 11.71 | 64.28 | 15.67 | 25.94 |
| 5. Other | 35.68 | 21.58 | 2.83 | 0.18 |
| B. Fugitive Emissions from Fuels | 0.42 | 0.32 | 0.85 | 10.86 |
| 1. Solid Fuels | 0.03 | 0.05 | 0.14 | 0.04 |
| 2. Oil and Natural Gas | 0.40 | 0.28 | 0.71 | 10.82 |
| 2. Industrial Processes | 2.33 | 24.49 | 2.10 | 1.46 |
| 3. Solvent and Other Product Use | - | - | 70.98 | - |
| 4. Agriculture | - | - | - | - |
| 5. Land Use, Land-Use Change and Forestry | 0.69 | 24.40 | - | - |
| 6. Waste | 0.12 | 0.02 | 0.04 | 0.01 |

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

Sinks from Forest Management dominate the emissions and removals estimates of the KP LULUCF activities (see Tab. 2-5). They were positively affected by the absence of disturbances requiring sanitary logging, which significantly reduced sinks in 2007 and partly also in 2008.

Tab. 2-5 Summary of GHG emissions and removals for KP LULUCF activities [Gg CO₂ eq.]

| Year | Article 3.3 activities | | Article 3.4 activities | | | |
|----------------|---------------------------------|---------------|------------------------|---------------------|-------------------------|--------------|
| | Afforestation and Reforestation | Deforestation | Forest Management* | Cropland Management | Grazing Land Management | Revegetation |
| 2008 | -261.56 | 156.17 | -4 081.06 | NA | NA | NA |
| 2009 | -283.76 | 165.95 | -6 118.73 | NA | NA | NA |
| 2010 | -309.68 | 202.04 | -4 799.38 | NA | NA | NA |
| 2011 | -346.73 | 160.24 | -6 630.57 | NA | NA | NA |
| 2012 | -369.94 | 169.81 | -6 911.29 | NA | NA | NA |
| Total** | -1 571.67 | 854.21 | -28 541.03 | NA | NA | NA |

*) Net emissions or removals / accounting quantity

**) Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

* Provisions of this chapter have been changed due to findings during UNFCCC expert review. Body of the chapter remained unchanged, for detailed information on the changes see page 10.

3 Energy (CRF Sector 1)

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 *1A Fuel Combustion* and *1B Fugitive Emissions from Fuels*.

Activity data are based on the energy balance of the Czech Republic prepared by the *Czech Statistical Office*. Data from the energy balance form the basic framework for processing greenhouse gas emissions from combustion in stationary and mobile sources. Greenhouse gas emissions from stationary sources are calculated from the activity data and the emission factors. CO₂ emissions from mobile sources are calculated from the emission factors, while data on CH₄ and N₂O emissions are calculated using the special model developed by Transport research centre (CDV).

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.

Inventories of CO₂, CH₄ and N₂O emissions are performed using a different procedure in subsector 1A3 Transport and in the other subsectors: combustion of fuels in stationary sources (1A1, 1A2, 1A4) and other mobile sources (1A5). The CDV model is used for mobile sources in subsector 1A3 Transport. A calculation procedure based on the activity data and on the country-specific or default emission factors are used for the other subsectors. Another procedure is used for category 1A1a – Other Fuels, which contains Waste Incineration for energy purposes.

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

3.1 Overview of sector 1A

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

On the whole, 12 key sources have been identified in sector 1A, the most important of which are the first 3 given in Tab. 3-1. This group of sources contributes 72.38 % 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 1A were appropriately completed for the entire required time interval of 1990 to 2012.

Tab. 3-1 Overview of key categories in Sector 1A (2012)

| Category | Character of category | Gas | % of total GHG* |
|--|-----------------------|------------------|-----------------|
| 1.A Stationary Combustion - Solid Fuels | LA,TA | CO ₂ | 42.784 |
| 1.A.3.b Transport - Road Transportation | LA,TA | CO ₂ | 10.586 |
| 1.A Stationary Combustion - Gaseous Fuels | LA,TA | CO ₂ | 10.057 |
| 1.A Stationary Combustion - Liquid Fuels | LA,TA | CO ₂ | 3.302 |
| 1.B.1.a Coal Mining and Handling | LA,TA | CH ₄ | 2.382 |
| 1.A.3.b Transport - Road Transportation | LA,TA | N ₂ O | 0.841 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | LA | CO ₂ | 0.757 |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | LA | CH ₄ | 0.607 |
| 1.A Stationary Combustion - Biomass | TA | CH ₄ | 0.353 |
| 1.A Stationary Combustion - Other fuels - MSW | TA | CO ₂ | 0.280 |
| 1.A Stationary Combustion - Other fuels - 1A2 | TA | CO ₂ | 0.241 |
| 1.A Stationary Combustion - Solid Fuels | TA | CH ₄ | 0.172 |

* 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.

The CzSO Questionnaires (IEA/OECD, Eurostat, UN Questionnaires) represent the official reports of the Czech Republic, for international purposes, on the consumption of the individual kinds of fuel. They consist in a set of data on Liquid, Solid and Gaseous Fuels in independent datasets. They contain source and consumption parts of the energy balance in a structure that permits processing of activity data in the CRF structure. The use of these reports is advantageous especially because they provide a very similar data structure to CRF. The transition from the final CzSO balance to the use of these reports does not affect the consistency of the time series, as the same data are involved. Each year a number of meetings were held with CzSO, where current problematic issues were resolved. These meetings were just on at the KONEKO - CzSO level, but they contributed positively to the preparation of this submission. The overall energy balance for 2012 is given in Annex 4 in Tables A4-5 – A4-12.

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

Since 2003, the balance of fuel consumption has been supplemented by consumption of Other Fuels and the corresponding greenhouse gas emissions. As this consists exclusively of consumption in cement-plant furnaces, this consumption and emissions were included in category 1A2f.

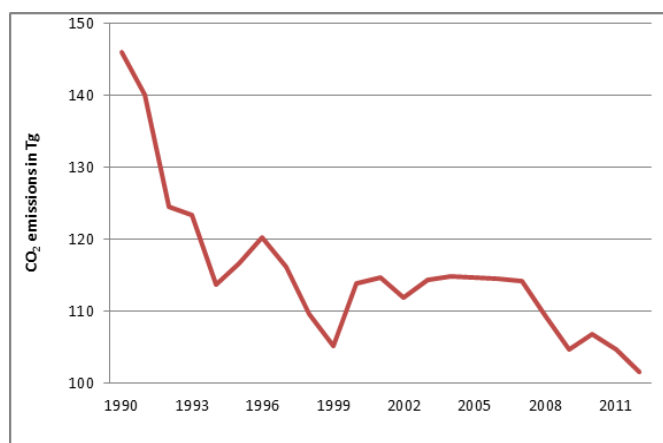


Fig. 3-1 Trend total CO₂ (Sectoral Approach) in period 1990 – 2012

Emissions Trends

CO₂ emissions from the 1A sector decreased by 30.5 % from 146 Tg CO₂ in 1990 to 102 Tg CO₂ in 2012. Fig. 3-1 indicates overall trend in CO₂ emissions in the whole time series.

Tab. 3-2 Emissions of greenhouse gases and their trend from 1990 - 2012 from IPCC Category 1A Energy

| | CO ₂ [Gg] | CH ₄ [Gg] | N ₂ O [Gg] |
|-------|----------------------|----------------------|-----------------------|
| 1990 | 146 053 | 474 | 2.366 |
| 1991 | 140 148 | 410 | 2.247 |
| 1992 | 124 543 | 389 | 2.111 |
| 1993 | 123 437 | 371 | 2.128 |
| 1994 | 113 750 | 349 | 2.089 |
| 1995 | 116 713 | 347 | 2.325 |
| 1996 | 120 363 | 342 | 2.447 |
| 1997 | 116 134 | 333 | 2.474 |
| 1998 | 109 688 | 319 | 2.521 |
| 1999 | 105 285 | 291 | 2.565 |
| 2000 | 113 920 | 258 | 2.855 |
| 2001 | 114 720 | 243 | 3.025 |
| 2002 | 111 855 | 224 | 3.126 |
| 2003 | 114 392 | 222 | 3.426 |
| 2004 | 114 875 | 213 | 3.593 |
| 2005 | 114 657 | 231 | 3.741 |
| 2006 | 114 487 | 242 | 3.769 |
| 2007 | 114 226 | 225 | 3.929 |
| 2008 | 109 443 | 225 | 3.838 |
| 2009 | 104 725 | 211 | 3.781 |
| 2010 | 106 858 | 218 | 3.717 |
| 2011 | 104 765 | 215 | 3.720 |
| 2012 | 101 564 | 209 | 3.650 |
| Trend | -30 % | -56 % | 54 % |

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 CO₂ emissions and the share of CO₂ emissions in different subsectors in 2012.

The greatest increase in emissions was recorded in subsector 1A3 Transport between 1990 and 2007, when emissions increased by 145 %. In absolute values, this corresponded to an increase from 7.5 Tg CO₂ in 1990 to 18.5 Tg in 2007. A slight decrease has been apparent since 2008, by 2.1 Tg in 2012. Emissions from subsector 1A1 Energy Industries are almost constant with slight fluctuations over the entire period; the greatest reduction occurred in subsectors 1A2 and 1A4 from 46.5 and 32.3 Tg CO₂ in 1990 to 16.2 and 10.3 Tg CO₂ in 2012, respectively.

Tab. 3-3 gives the trends in GHG emissions in CO₂ eq. in the individual subcategories of the Energy sector. It is apparent from the table that there was a considerable increase

in the area of transport and a substantial reduction in the manufacturing industry and in households, as well as the areas of commercial and institutional and agriculture, forestry and fishing.

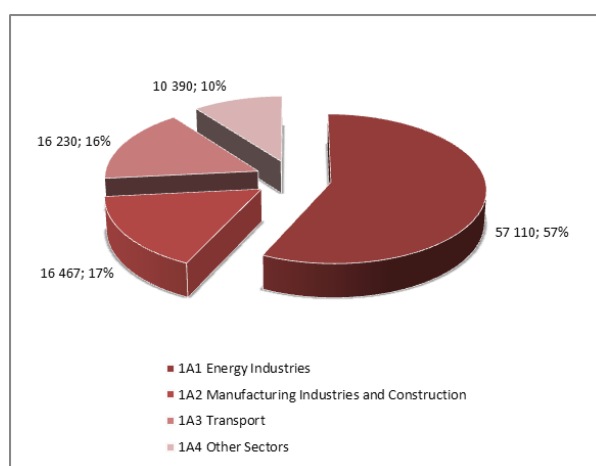
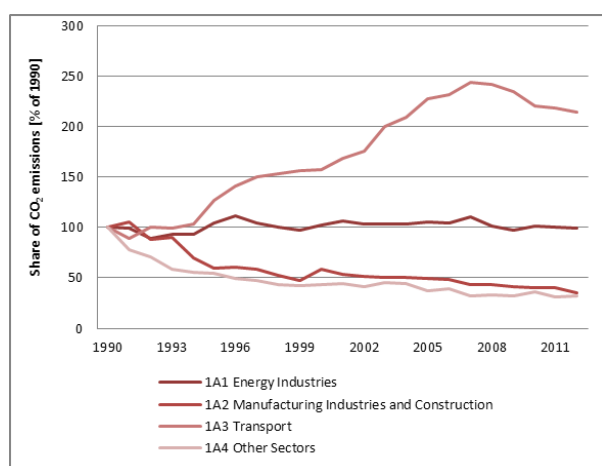


Fig. 3-2 Share and development of CO₂ emissions from 1990 - 2012 in individual sub-sectors; share of CO₂ emissions in individual subsectors in 2012 [Gg]

Tab. 3-3 Total GHG emissions in [Gg CO₂ equivalent] from 1990 – 2012 by sub categories of Energy

| | 1 | 1A | 1A1 | 1A2 | 1A3 | 1A4 | 1A5 | 1B | 1B1 | 1B2 |
|--|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1990 | 156 748 | 145 593 | 57 937 | 46 754 | 7 756 | 33 715 | 1 628 | 8 958 | 8 057 | 902 |
| 1991 | 149 444 | 139 748 | 57 627 | 49 297 | 6 938 | 26 242 | 1 432 | 7 907 | 7 136 | 770 |
| 1992 | 133 370 | 124 144 | 51 489 | 41 218 | 7 808 | 23 984 | 1 342 | 7 529 | 6 819 | 710 |
| 1993 | 131 890 | 123 055 | 53 739 | 42 102 | 7 737 | 19 690 | 1 297 | 7 325 | 6 632 | 693 |
| 1994 | 121 734 | 113 377 | 53 932 | 32 704 | 8 091 | 18 736 | 1 306 | 6 964 | 6 285 | 679 |
| 1995 | 124 730 | 116 346 | 60 668 | 27 875 | 9 895 | 18 235 | 1 211 | 6 846 | 6 166 | 681 |
| 1996 | 128 300 | 120 008 | 64 605 | 28 115 | 11 021 | 16 681 | 1 159 | 6 719 | 5 982 | 737 |
| 1997 | 123 894 | 115 784 | 60 614 | 27 620 | 11 745 | 16 111 | 1 209 | 6 596 | 5 871 | 725 |
| 1998 | 117 162 | 109 342 | 58 284 | 24 520 | 12 000 | 14 658 | 1 290 | 6 410 | 5 648 | 762 |
| 1999 | 112 181 | 104 964 | 56 240 | 22 320 | 12 223 | 14 262 | 1 273 | 5 862 | 5 116 | 746 |
| 2000 | 120 218 | 113 591 | 59 522 | 27 290 | 12 388 | 14 590 | 1 262 | 5 166 | 4 457 | 709 |
| 2001 | 120 759 | 114 382 | 61 804 | 24 801 | 13 280 | 14 806 | 1 220 | 4 848 | 4 181 | 667 |
| 2002 | 117 532 | 111 511 | 60 204 | 23 965 | 13 893 | 13 795 | 1 166 | 4 510 | 3 818 | 693 |
| 2003 | 120 110 | 114 058 | 60 151 | 23 449 | 15 767 | 15 255 | 1 084 | 4 403 | 3 767 | 637 |
| 2004 | 120 469 | 114 550 | 60 179 | 23 601 | 16 572 | 14 775 | 1 132 | 4 210 | 3 618 | 592 |
| 2005 | 120 666 | 114 333 | 61 123 | 23 311 | 17 951 | 12 546 | 1 119 | 4 616 | 3 912 | 704 |
| 2006 | 120 744 | 114 142 | 60 572 | 22 700 | 18 280 | 13 267 | 1 098 | 4 826 | 4 111 | 715 |
| 2007 | 120 171 | 113 914 | 64 191 | 20 184 | 19 237 | 10 979 | 1 110 | 4 470 | 3 755 | 715 |
| 2008 | 115 348 | 109 137 | 59 019 | 20 302 | 19 076 | 11 319 | 1 159 | 4 473 | 3 818 | 655 |
| 2009 | 110 333 | 104 458 | 56 152 | 19 455 | 18 511 | 10 924 | 1 143 | 4 148 | 3 454 | 695 |
| 2010 | 112 584 | 106 585 | 58 855 | 18 836 | 17 434 | 12 096 | 1 108 | 4 255 | 3 529 | 726 |
| 2011 | 110 425 | 104 497 | 58 393 | 18 834 | 17 263 | 10 602 | 1 116 | 4 217 | 3 538 | 679 |
| 2012 | 107 093 | 101 293 | 57 413 | 16 606 | 16 909 | 10 970 | 1 119 | 4 076 | 3 526 | 551 |
| Total Trend 1990 - 2012 | -32 % | -30 % | 0.9 % | -64 % | 118 % | -67 % | -31 % | -54 % | -56 % | -39 % |

3.2 Fuel combustion (1A)

Combustion of fuels is in CRF divided into the individual subsectors prescribed by the IPCC methodology. The fuel consumption in the individual subsectors yields the activity data for subsequent calculation of greenhouse gas emissions. The fuel consumption is taken from the energy balance of the Czech Republic and is transformed to the IPCC structure. Transformation of data is described in chapter 3.3 under the descriptions of the individual subsectors. Consumption of the other kinds of fuels (Other fuels) was taken from the national ETS system (ETS, 2013, <http://www.svcement.cz/>).

According to IPCC methodology (IPCC, 1997), carbon dioxide emissions are calculated in two ways: Sectoral and Reference Approach.

3.2.1 Sectoral Approach

The **Sectoral Approach**. This method is considerably more demanding than Reference Approach in relation to input data and requires information on fuel consumption according to type of fuel in the individual consumer sectors. It has an advantage in the possibility of analysing the structure of the origin of emissions. Since the emission factors employed are specific for each kind of fuel burned, calculations using this method should be more exact.

In Sectoral Approach are CO₂ emissions calculated in sectors

- 1A1 Energy industries
- 1A2 Manufacturing Industries and Construction
- 1A3 Transport
- 1A4 Other sectors – excl. mobile sources in the Agriculture/Forestry/Fishing sector
- 1A5 Other – other mobile sources not included elsewhere

In the Sectoral Approach, CO₂ emissions are derived from the consumption of the individual kinds of fuel in the individual subcategories using emission and oxidation factors.

3.2.2 Reference Approach

The Reference Approach is calculated on the basis of total domestic consumption of the individual fuels. This relatively simple method is based on the assumption that almost all the fuel consumed is burned in combustion processes in energy production. It does not require a large amount of input activity data and the basic values of the sources included in the national energy balance and some supplementary data are sufficient. It provides information only on total emissions without any further classification in the consumer sector. The emission factors are related to those kinds of fuel that enter domestic consumption at the level of sources, without regard to specific kinds of fuel burned in the consumer part of the energy balance. Thus, for Liquid Fuels, this means that the emissions are determined in fact only on the basis of domestic petroleum (Crude Oil) consumption.

3.2.3 Comparison of the Sectoral and Reference Approach

The resulting emissions are determined by the Sectoral Approach (SA), while the Reference Approach (RA) is used for control. Comparison of both approaches is given in the Annex 4. It follows from the analysis provided in Annex 4 that the differences in the overall results from these two approaches are insignificant.

3.2.4 International bunkers 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, 2013). Tab. 3-4 gives the amount of stored Kerosene Jet Fuel.

Tab. 3-4 Kerosene Jet Fuel in international bunkers

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|-----------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| [TJ/year] | 7 325 | 6 020 | 6 967 | 5 792 | 7 208 | 7 805 | 5 866 | 6 759 | 7 991 | 7 520 | 8 234 | 8 750 |
| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | |
| [TJ/year] | 7 556 | 10 163 | 13 062 | 13 573 | 14 070 | 14 763 | 15 646 | 14 290 | 13 387 | 13 272 | 12 368 | |

3.2.5 Feedstocks and non-energy use of fuels

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

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

The classification in the energy balance in the Transformation sector is dependent on the kind of fuel.

Tab. 3-5 provides those items of the Transformation sector section that correspond to raw material inputs into the improvement processes.

Tab. 3-5 Transformation sector for Solid and Liquid Fuels

| Solid Fuels | Liquid Fuels |
|---|--|
| Transformation Sector | Transformation Sector |
| Patent Fuel Plants (Transformation) | Gas Works (Transformation) |
| Coke Ovens (Transformation) | Natural gas blending plants |
| BKB Plants (Transformation) | Coke ovens (Transformation) |
| Gas Works (Transformation) | Blast furnaces (Transformation) |
| Blast Furnaces (Transformation) | Patent fuel plants (Transformation) |
| Coal Liquefaction Plants (Transformation) | Not elsewhere specified (Transformation) |

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

Biofuels are not used in transformation processes.

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

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

Naphtha - another part of fossil carbon is used as raw material for the manufacture of plastics. Plastics end up in waste incineration plants or in landfills. In incineration plants, the carbon in the plastics is converted to CO₂. In managed landfills, plastics very slowly decompose through biochemical processes. For detailed explanations please see relevant chapter for Other Fuels (1A1a).

However, part of plastics stores carbon from petrochemical raw materials for a long time. At the beginning of the monitored period, the fraction of carbon stored for naphtha was estimated at 50 %. This value was obtained by expert estimate of a sectoral expert.

The remaining 50 % of carbon was considered to oxidize to CO₂. Recently, plastics have been increasingly recycled. The recycled material obtained is used to manufacture products with considerably long lifetimes. In 2004 was decided to increase the fraction of carbon stored 50 % to the value given in IPCC methodology (IPCC, 1997). The fraction of stored carbon has been gradually increased from a value of 50 % to a value of 80 %. The value of 80 % is default level of carbon stored provided by Revised 1996 Guidelines (IPCC, 1997). Tab. 3-6 depicts the gradual increase.

Tab. 3-6 Naphtha - fraction of stored carbon

| 1990 - 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|-------------|------|------|------|------|------|------|------|------|------|
| 0.5 | 0.6 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

Starting in 2007, a constant value of 80 % is used in subsequent years.

Lubricating oils and other lubricants are not produced primarily as energy production materials. However, part of the oils is returned to the energy system after the end of their lifetimes as lubricants. They are then converted to alternative fuels and burned. The CRF structure specifies 50 % recovery as fuels over the entire time series from 1990. Value of 50 % is given in Revised 1996 methodology (IPCC, 1997).

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

Coal Tars are utilized primarily as a raw material for the production of soot as the filler for rubber for production of tires. Part of the Tars is used as additive fuel in energy-production installations for production of electricity and heat. This part has been reported separately in the energy balance since 2003. This permits estimation of the ratio between Tar for energy-production and other uses. Up until 2002, the fraction of Tars for non-energy use was estimated at 75 %; since 2003, the fraction has been determined on the basis of information from the CzSO – EUROSTAT – IEA questionnaires (CzSO, 2013) in the following way:

Tab. 3-7 Coal Tars - fraction of stored carbon [%]

| 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|------|------|------|------|------|------|------|------|------|------|
| 71.8 | 74.1 | 69.2 | 85.7 | 85.2 | 82.9 | 74.2 | 73.0 | 73.5 | 76.1 |

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

3.2.6 CO₂ capture from flue gases and subsequent CO₂ storage

Not performed in the Czech Republic.

3.2.7 Country-specific issues

The country-specific conditions in the Czech Republic are determined primarily by the specific properties of the Solid Fuels mined in this country. Specific CO₂ emission factors are determined for these kinds of Solid Fuels. Tab. 3-8 provides emission factors, incl. NCV and oxidation factors.

Tab. 3-8 Average Net calorific values (NCV), country specific CO₂ emission factors and oxidation factors (default) used in the Czech GHG inventory - 2012

| Fuel (Revised 1996 Guidelines definitions) | NCV ^{c)} | CO ₂ EF ^{a)} | Oxidation factor | CO ₂ EF ^{b)} |
|--|-------------------|----------------------------------|------------------|----------------------------------|
| | [TJ/Gg] | [t CO ₂ /TJ] | | [t CO ₂ /TJ] |
| Coking Coal | 29.2 | 93.24 | 0.98 | 91.38 |
| Other Bituminous Coal | 22.7 | 93.24 | 0.98 | 91.38 |
| Lignite (Brown Coal) | 12.2 | 99.99 | 0.98 | 97.99 |

a) Emission factor without oxidation factor

b) Resulting emission factor with oxidation factor

c) relevant NCV for 2012

Since last submission, the country-specific CO₂ emission factor is also used for Natural Gas combustion. Description of the research is given in Annex 2. Tab. A2- 6 lists the emission factors used in the entire time series. Evaluation of the emission factors depends on the net calorific value; in 2012 the net calorific value equalled 34.23 MJ/m³ and the emission factor is then equal to 15.04. Please see the relevant equation in Annex 2.

In this submission the country-specific CO₂ emission factors for LPG and Refinery Gas are used for emission estimates. The detailed approach of evaluation of these emission factors is described in Annex 2.

Other country-specific conditions are employed in sector 1B, where the country-specific emission factors are used in the calculation of CH₄ and CO₂ emissions from underground mining. In addition, methane emissions in the Natural Gas sector are calculated according to the country-specific approach.

More details are given in chapter 3.9 Fugitive emissions.

All CO₂ emissions from metallurgical coke used in blast furnaces are reported under the Industrial processes sector and estimated according to the amount of carbon in the coke (see Chapter 4.4). Most of the blast furnace gas is combusted in the three metallurgical plants and is not used elsewhere. From this reason we consider this method to be right.

In a similar way part of Liquid Fuels are reallocated into 2 Industrial Processes where it is used for production of hydrogen which is used for ammonia production (see Chapter 4.3).

3.3 Source category description

3.3.1 Energy Industries (1A1)

The fraction of CO₂ emissions from sector 1A1 equalled 56% in 2012 in the whole Energy sector.

3.3.1.1 Public Electricity and Heat Production (1A1a)

Under source category 1A1a 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 CO₂ emissions in subsector 1A1a in CO₂ emissions in sector 1A1 equalled 95 % in 2012. It contributed 53 % to CO₂ emissions in the whole Energy sector.

In the final energy balance of CzSO (CzSO, 2013), 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)

CO₂ 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 forces for emissions in this source category. Brown Coal + Lignite are most important, with average consumption of 451 PJ, corresponding to 44 300 kt CO₂/year on an average for the whole 1990 – 2012 period. The second largest consumption is indicated for Other Bituminous Coal with an average consumption value of 78 PJ, corresponding to 7 143 kt CO₂/year on an average for the whole 1990 – 2012 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 CO₂ emissions. 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 III.

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

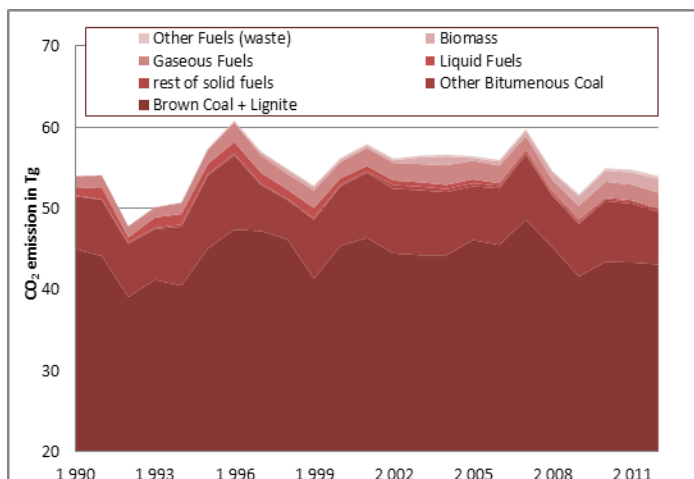


Fig. 3-3 Development of CO₂ emissions in 1A1a category

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. Since last submission new country-specific emission factor is used for CO₂ emissions. Detailed explanation of development of this EF is given in Annex 2.

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

Other Fuels (1A1a): 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 6 C waste incineration however based on the suggestion of ERT in 2011 it was reallocated under the energy sector since last submission. This chapter is still prepared by CUEC (Charles University Environment Center) – the organization responsible for the waste sector.

This category consists of emissions of CO₂ from incinerated fossil carbon in MSW and emissions of methane and N₂O 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 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. 3-9 Capacity of municipal waste incineration plants in the Czech Republic, 2012

| Incinerator (city) | Capacity (Gg) |
|-----------------------------|---------------|
| 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 6C.

All the parameters and calculations are shown in Tab. 3-10.

The table gives the total amount of incinerated waste, energy content of the waste and all the parameters used in the equation. The lower part of the table gives the results for separate gases. The activity data comes from two sources- ISOH (waste management information system) and the Ministry of Trade and Industry (MTI) - renewable energy statistics. MTI data are used as category data, ISOH data are used as control data for the QA/QC procedure. The data is also checked with the reporting of the incineration companies.

Tab. 3-10 Parameters and emissions from waste incineration 1990 - 2012

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| MSW incinerated (Gg MSW) | 66 | 58 | 82 | 102 | 156 | 163 | 171 | 174 | 245 | 285 | 334 | 382 | 411 | 408 | 409 | 388 | 392 | 392 | 376 | 360 | 467 | 586 | 610 |
| MSW incinerated (TJ) NCV | 656 | 577 | 822 | 1018 | 1564 | 1631 | 1710 | 1741 | 2332 | 2686 | 3190 | 3701 | 3987 | 3749 | 4231 | 3957 | 3779 | 4157 | 4052 | 3744 | 4900 | 5574 | 5840 |
| 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 | 9.7 | 9.2 | 10.3 | 10.2 | 9.6 | 10.6 | 10.8 | 10.4 | 10.5 | 9.5 | 9.6 |
| Biogenic (TJ) | 393 | 346 | 493 | 611 | 939 | 979 | 1026 | 1045 | 1399 | 1612 | 1914 | 2221 | 2392 | 2250 | 2539 | 2374 | 2268 | 2494 | 2431 | 2247 | 2940 | 3345 | 3504 |
| Fossil (TJ) | 262 | 231 | 329 | 407 | 626 | 652 | 684 | 697 | 933 | 1074 | 1276 | 1480 | 1595 | 1500 | 1692 | 1583 | 1512 | 1663 | 1621 | 1498 | 1960 | 2230 | 2336 |
| Amount of carbon fraction | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Fossil carbon fraction | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Combust efficiency fraction | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C-CO ₂ ratio | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| Avg. Emission factor Gg CH ₄ /Gg | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 |
| Avg. Emission factor Gg N ₂ O/Gg | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 |
| 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 | 228.8 | 227.3 | 228.1 | 216.4 | 218.4 | 218.3 | 209.8 | 200.9 | 260.3 | 326.5 | 339.9 |
| 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 | 343.2 | 340.9 | 342.2 | 324.6 | 327.7 | 327.4 | 314.7 | 301.3 | 390.4 | 489.7 | 509.9 |
| Total CH ₄ emissions (Gg CH ₄) Fossil | 5E-06 | 5E-06 | 7E-06 | 8E-06 | 1E-05 | 1E-05 | 1E-05 | 1E-05 | 2E-05 | 2E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 4E-05 | 5E-05 | 5E-05 |
| Total CH ₄ emissions (Gg CH ₄) Biogenic | 8E-06 | 7E-06 | 1E-05 | 1E-05 | 2E-05 | 2E-05 | 2E-05 | 2E-05 | 3E-05 | 3E-05 | 4E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 4E-05 | 6E-05 | 7E-05 | 7E-05 |
| Total N ₂ O emissions (Gg N ₂ O) Fossil | 0.001 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.005 | 0.006 | 0.007 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 | 0.009 | 0.012 | 0.012 |
| Total N ₂ O emissions (Gg N ₂ O) Biogenic | 0.002 | 0.002 | 0.002 | 0.003 | 0.005 | 0.005 | 0.005 | 0.005 | 0.007 | 0.009 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.011 | 0.011 | 0.014 | 0.018 | 0.018 |
| Total CO ₂ emissions (Gg CO ₂ eq) | 36.5 | 32.2 | 45.8 | 56.7 | 87.2 | 90.9 | 95.3 | 97.0 | 136.3 | 158.6 | 185.9 | 212.9 | 228.8 | 227.3 | 228.1 | 216.4 | 218.4 | 218.3 | 209.8 | 200.9 | 260.3 | 326.5 | 339.9 |
| Total CH ₄ emissions (Gg CO ₂ eq) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total N ₂ O emissions (Gg CO ₂ eq) | 1.0 | 0.9 | 1.3 | 1.6 | 2.4 | 2.5 | 2.7 | 2.7 | 3.8 | 4.4 | 5.2 | 5.9 | 6.4 | 6.3 | 6.3 | 6.0 | 6.1 | 6.1 | 5.8 | 5.6 | 7.2 | 9.1 | 9.5 |

3.3.1.2 Petroleum Refining (1A1b)

This category includes all facilities that process raw petroleum imported into this country as their primary raw material. Domestic petroleum constitutes approximately 3.5 % of the total amount. All fuels used in the internal refinery processes, internal consumption (reported by companies as “own use”) for production of electricity and heat and heat supplied to the public mains are included in emission calculations in this subcategory. This corresponds primarily to the Česká rafinářská Inc. company in the Czech Republic. Fugitive CH₄ emissions are included in category 1B2 *Fugitive Emissions from Fuels - Oil*.

The fraction of CO₂ emissions in subsector 1A1b in CO₂ emissions in sector 1A1 equalled 2 % in 2012. It contributed 1 % to CO₂ emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2013), 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 2 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 Tab 3-11 – Tab. 3-13.

No consumption of Solid Fuels occurred in this category. On the other hand Liquid Fuels are of the greatest importance and exhibit a decreasing trend at the beginning and increasing trend at the end of the period. The fluctuations that have occurred over the years can be explained as resulting from differences in production quantities. The maximum production equal to 927 kt CO₂ occurred in 2008, followed by a value of 893 kt CO₂ in 1990. Thereafter, production decreased to the resulting level of 803 kt CO₂ in 2012.

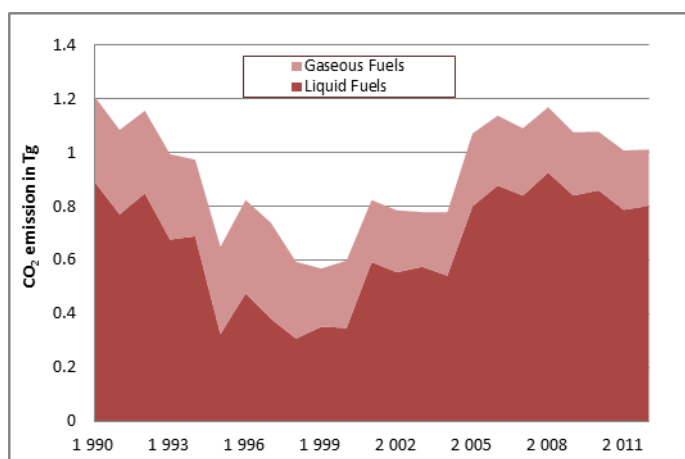


Fig. 3-1 Development of CO₂ emissions in 1A1b category

The second greatest role is played by Natural

Gas, with emissions in the range between 203 kt CO₂ in 2003 and 357 kt CO₂ in 1997 and resulting with 210 kt CO₂ in 2012.

3.3.1.3 Manufacture of Solid Fuels and Other Energy Industries (1A1c)

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 interest in the Czech Republic.

The fraction of CO₂ emissions in subsector 1A1c in CO₂ emissions in sector 1A1 equalled 7 % in 2012. It contributed only 4 % to CO₂ emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2013), 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)

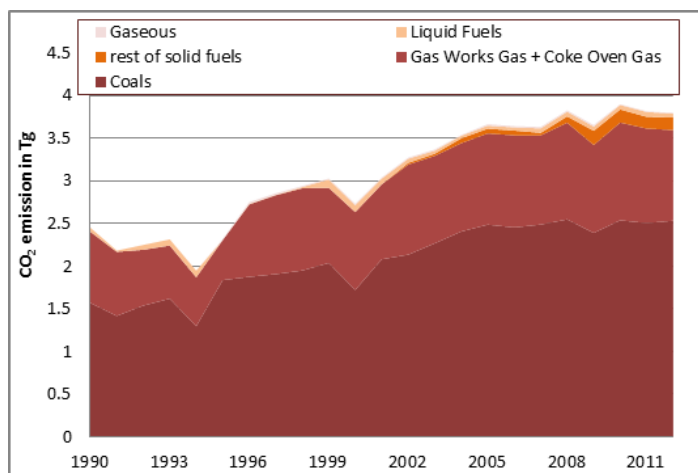


Fig. 3-2 Development of CO₂ emissions in 1A1c category

Figure 3-5 clearly shows the increase in emissions in 1995 – 2012 period in category 1A1c. 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>).

Coke Oven Gas is produced in the Ostrava area where the Coke Plants operating.

3.3.2 Manufacturing Industries and Construction (1A2)

The fraction of CO₂ emissions in sector 1A2 in CO₂ emissions in the Energy sector equalled 19 % in 2012.

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

Transition to the new format of source data (CzSO, 2013) permitted utilization of the data for more detailed classification in this subcategory.

- 1A2a Iron and steel
- 1A2b Non-ferrous metals
- 1A2c Chemicals
- 1A2d Pulp, paper and print
- 1A2e Food processing, beverages and tobacco
- 1A2f Other

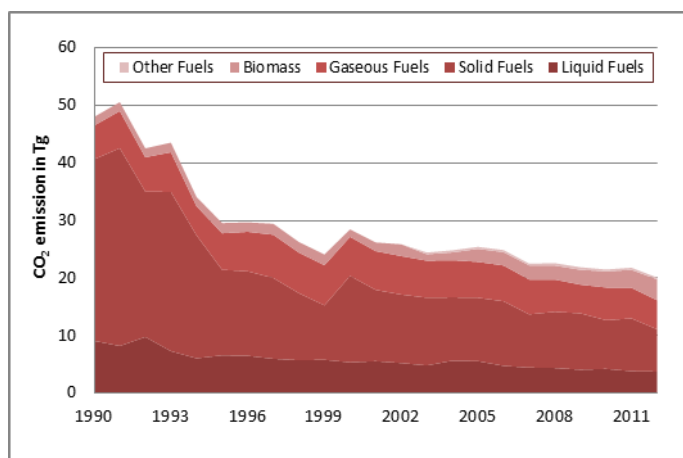


Fig. 3-3 Development of CO₂ emissions in 1A2 category

It is clearly visible on the figure that Solid Fuels played the main role in emissions at the beginning of the period; however, the importance of Solid Fuels decreased over time. Currently, they are still of the greatest importance, but do not play such a dominant role in comparison with other fuels. Liquid Fuels indicate steady

trend over the whole period – there is only a slight decrease at the beginning of the period. Natural Gas is also an important fuel in category 1A2.

3.3.2.1 Iron and Steel (1A2a)

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, 2013), 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.

Important facility belongs to this category is ArcelorMittal Ostrava, a.s. The fraction of CO₂ emissions in subsector 1A2a in CO₂ emissions in sector 1A2 equalled 16 % in 2012. It contributed only 3 % to CO₂ emissions in the whole Energy sector.

3.3.2.2 Non-Ferrous Metals (1A2b)

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, 2013), 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 CO₂ emissions in subsector 1A2b in CO₂ emissions in sector 1A2 equalled 0.4 % in 2012. It contributed only 0.1 % to CO₂ emissions in the whole Energy sector.

3.3.2.3 Chemicals (1A2c)

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

In the CzSO Questionnaire (CzSO, 2013), 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 CO₂ emissions in subsector 1A2c in CO₂ emissions in sector 1A2 equalled 33 % in 2012. It contributed 6 % to CO₂ emissions in the whole Energy sector.

3.3.2.4 Pulp, Paper and Print (1A2d)

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

In the CzSO Questionnaire (CzSO, 2013), 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 CO₂ emissions in subsector 1A2d in CO₂ emissions in sector 1A2 equalled 12 % in 2012. It contributed 2 % to CO₂ emissions in the whole Energy sector.

3.3.2.5 Food Processing, Beverages and Tobacco (1A2e)

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.

In the CzSO Questionnaire (CzSO, 2013), 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 CO₂ emissions in subsector 1A2e in CO₂ emissions in sector 1A2 equalled 8 % in 2012. It contributed 2 % to CO₂ emissions in the whole Energy sector.

3.3.2.6 1A2f Other

This subcategory includes the remaining enterprises in the processing industry not included in subcategories 1A2a to 1A2e. This is an energy-demanding branch with high fuel consumption, such as the cement industry, lime production, the glass industry, production of ceramic materials, the textile and leather industry, wood processing and subsequent production processes, the entire machine industry, incl. production of means of transport and the construction industry.

In the CzSO Questionnaire (CzSO, 2013), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

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

There are embodied the fuels of economic part according to NACE Rev. 2 Other: NACE Divisions 05 – 09, 13 – 16, 21 – 23, 25 – 33 and 41 – 43.

In this year's submission, this subcategory also includes the combustion of other kinds of fuel (Other Fuels). Activity data and data on CO₂ production were taken from the national ETS system (ETS, 2013), while CH₄ and N₂O emissions were calculated using the default emission factors for Solid and Liquid Fuels. The fraction of CO₂ emissions in subsector 1A2f in CO₂ emissions in sector 1A2 equalled 31 % in 2012. It contributed 6 % to CO₂ 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 2012. Liquid fuels also constantly decrease since 1990. Natural Gas has also apparent importance in this category.

3.3.3 1A3 Mobile Combustion

Source category description

The categories of means of transport for the purposes of calculations of greenhouse gas emissions did not change compared to 2008. The criteria for inclusion of a certain means of transport in a particular category consist in the kind of transport, the fuel employed and the type of emission standard that the particular vehicle must meet (in road transport). The categories of vehicles are not as detailed for non-road transport.

The categories of mobile sources are following:

3.3.3.1 1A3a Civil Aviation

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

3.3.3.2 1A3b Road Transportation

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

3.3.3.3 1A3c Railways

- diesel locomotives

3.3.3.4 1A3d Navigation

- ships with diesel engines

3.3.3.5 1A3e Other Transportation

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, 2013) 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.

3.3.4 1A4 Other Sectors

This category includes emissions which are not included in the 1A1 and 1A2 categories. They can be generally defined as heat production processes for internal consumption.

The fraction of CO₂ emissions in sector 1A4 in CO₂ emissions in the Energy sector equalled 16 % in 2012.

The main driving force for CO₂ emissions in category 1A4 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 CO₂ 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 CO₂ emissions (emission factors). The importance of Solid Fuels at the beginning of the period, which constantly decreases in time, is apparent in the figure. 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.

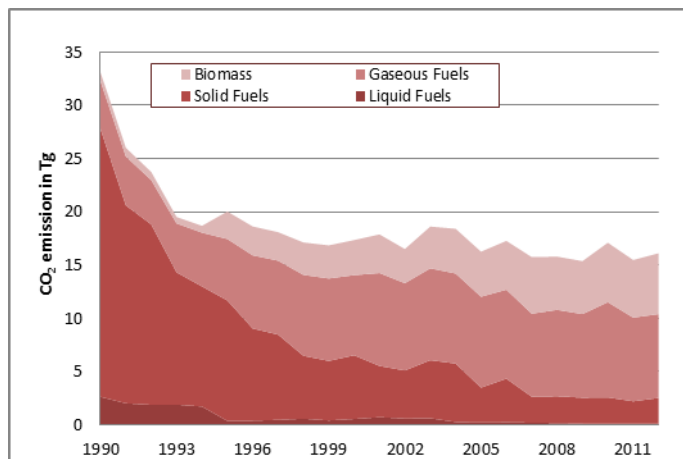


Fig. 3-4 Development of CO₂ emissions in 1A4 category

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 and institutions using biomass for heating (biomass boilers) in the Czech Republic has increased in the last few years. This trend is also apparent in the figure.

The winter of 2006 was colder than in other years, which also affected the consumption of fuels. Higher consumption of fuels for heating in households and institutions is apparent in this year. Significantly lower temperatures were recorded in the winter months in 2006 than in other years. The same trend is apparent in 2012.

3.3.4.1 1A4a Commercial/Institutional

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

In the CzSO Questionnaire (CzSO, 2013), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Commercial and Public Services

Where fuel consumption is reported here under the item:

- Non-specified (Other)

It is included under 1A4a Commercial/Institutional on the basis of an agreement with CzSO. There are embodied the fuels of economic part according to NACE Rev. 2 Commercial/Institutional: NACE Divisions 35 excluding 1A1a and 1A3e, 36 – 39, 45 – 99 excluding 1A3e and 1A5a.

The fraction of CO₂ emissions in subsector 1A4a in CO₂ emissions in sector 1A4 equalled 21 % in 2012. It contributed 3 % to CO₂ emissions in the whole Energy sector.

3.3.4.2 1A4b Residential

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

In the CzSO Questionnaire (CzSO, 2013), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Residential

The fraction of CO₂ emissions in subsector 1A4b in CO₂ emissions in sector 1A4 equalled 75 % in 2012. It contributed 12 % to CO₂ emissions in the whole Energy sector.

3.3.4.3 1A4c Agriculture/Forestry/Fisheries

This subcategory contains combustion sources at stationary facilities for heating buildings, breeding and other operational facilities. The subcategory does not include fuel consumption for powering off-road means of transport and machinery. They are reported in category 1A5b Mobile - Agriculture, Forestry and Fishing.

In the CzSO Questionnaire (CzSO, 2013), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Agriculture/Forestry
- Fishing

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

The fraction of CO₂ emissions in subsector 1A4c in CO₂ emissions in sector 1A4 equalled 4 % in 2012. It contributed 0.6 % to CO₂ emissions in the whole Energy sector.

3.3.5 1A5 Other

The fraction of CO₂ emissions in sector 1A5 in CO₂ emissions in the Energy sector equalled 1 % in 2012.

3.3.5.1 1A5b Other – mobile sources

In this subcategory are reported emissions from consumption of motor fuels, that are not reported in sector 1A3 Transport and could not be reported in the other sectors as consumption of fuels in stationary sources.

3.4 Methodological issues

3.4.1 Stationary combustion

The original data on the final national energy balance from CzSO (series of data in the 1990 – 1995 time series) were taken for the CRF structure directly in TJ. The time series from 1995 was constructed on the basis of data from the CzSO Questionnaire (CzSO, 2013), where the data on fuel consumption are given in various ways. Data are available for Solid and Liquid Fuels in mass units (kt p.a.), where the net caloric values of these fuels are also tabulated. The consumption of gaseous fuels derived from fossil fuels is given in TJ p.a. Natural Gas is given in thousand m³ 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 (2012) is given in Annex 4, Tables A4-5 – A4-12.

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. There are two updated net calorific values in this submission – for refinery gas and for LPG. Detail please see in the chapter 3.7.

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

Collection of activity data

In collection of activity data, all the background data are stored at the workplace of the sector 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 A4-5 – A4-12; 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.

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.

The Title page shall contain particularly the following information:

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

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

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

The conversion shall be performed in two separate sets for the Sectoral Approach (SA) and Reference Approach (RA). If the data conversion requires recalculation from natural units to energy units (i.e. for Solid and Liquid Fuels), the calorific values of the individual kinds of fuels used is included in the calculation. Used calorific values are stored.

Calculations of emissions

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

Original activity data are given in kilotons. It means that it is necessary to convert these values to energy units – terajoules. For this conversion are used calorific values. Tab. 3-11 gives the calorific values used for calculations of the 2012 emissions.

Tab. 3-11 Net calorific values used in the Czech GHG inventory – 2012

| NCV [TJ/Gg] | 1A1a | 1A1b | 1A1c | 1A2 | 1A4a | 1A4b | 1A4c | 1A5 |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| LPG | | | | 45.95 | 45.95 | 45.95 | 45.95 | |
| Naphtha | | | | 43.99 | | | | |
| Gasoline | | | | | | 43.40 | | 43.40 |
| Kerosene Jet Fuel | | | | 43.30 | 43.30 | | | 43.30 |
| Other kerosene | | | | | 42.80 | | | |
| Diesel Oil | | | 42.60 | 42.60 | | | | 42.60 |
| Heating and Other Gasoil | | | 42.60 | 42.60 | 42.60 | | 42.60 | |
| Fuel Oil - Low Sulphur | 39.44 | 39.44 | | 39.44 | 39.44 | | 39.44 | |
| Fuel Oil - High Sulphur | 39.58 | 39.58 | | 39.58 | | | | |
| Lubricants | | | | 40.19 | | | | |
| Other Oil | | 40.35 | | 40.35 | | | | |
| Anthracite | | | | 28.17 | | | | |
| Coking Coal | | | | | | | | |
| Other Bituminous Coal | 23.34 | | | 22.97 | 27.27 | 27.27 | 27.27 | |
| Brown Coal + Lignite | 12.30 | | 12.21 | 12.60 | 12.98 | 12.98 | 12.98 | |
| Coke | 22.33 | | | 28.41 | 28.53 | | 28.53 | |
| Coal Tars | 37.00 | | 37.30 | 37.30 | | 37.30 | | |
| Brown Coal Briquettes | | | | | | | | |
| Charcoal | | | | | | 30.00 | | |

Coke Oven Gas, Gas Works Gas and biofuels are given directly in terajoules in the CzSO Questionnaires (CzSO, 2013), 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, 2013) in thousand m³ and in TJ; however, the data in TJ is determined using the gross caloric value. The values were then divided by a coefficient of 1.11 for recalculation from the gross caloric value to the net caloric value. Volume reported by CzSO in thousand m³ is related to the „trade conditions“, i.e. temperature 15°C and pressure 101,3 kPa.

Information on the average values of the gross caloric value and the net caloric value of Natural Gas are given in Tab. 3-12.

Recalculation of volume units to mass units for Natural Gas was performed using the density 0.69 kg/m³ (t = 15 °C, p = 101.3 kPa).

Tab. 3-12 Average values of the gross caloric value and the net caloric value of Natural Gas – Questionnaire IEA – CzSO (CzSO, 2013), 2012

| [MJ/m ³] | GCV | NCV | GCV/NCV |
|--|-------|-------|---------|
| Indigenous Production | 35.67 | 32.10 | 1.11 |
| Associated Gas | 35.01 | 31.51 | 1.11 |
| Non-Associated Gas | 36.35 | 32.72 | 1.11 |
| Total Imports (Balance) | 37.80 | 34.02 | 1.11 |
| Total Exports (Balance) | 37.88 | 34.10 | 1.11 |
| Stock Changes (National Territory) | 37.99 | 34.19 | 1.11 |
| Inland Consumption (Calculated) | 37.75 | 33.98 | 1.11 |
| Inland Consumption (Observed) | 37.75 | 33.98 | 1.11 |
| Opening Stock Level (National Territory) | 37.83 | 34.05 | 1.11 |
| Closing Stock Level (National Territory) | 37.83 | 34.04 | 1.11 |

Tab. 3-13 Net calorific values (NCV), CO₂ emission factors and oxidation factors used in the Czech GHG inventory – 2012

| Fuel (IPCC 1996 Guidelines definitions) | NCV [TJ/Gg] | CO ₂ EF ^{a)} [t CO ₂ /TJ] | Oxidation factor | CO ₂ EF ^{b)} [t CO ₂ /TJ] |
|--|---------------------|---|---------------------|---|
| Crude Oil | 42.39 | 73.33 | 0.99 | 72.60 |
| Gas / Diesel Oil | 42.60 | 74.07 | 0.99 | 73.33 |
| Residual Fuel Oil | 39.51 | 77.37 | 0.99 | 76.59 |
| LPG ^{d)} | 45.95 | 65.90 | 0.995 | 65.57 |
| Naphtha | 43.99 | 73.33 | 0.99 | 72.60 |
| Bitumen | 40.19 | 80.67 | 0.99 | 79.86 |
| Lubricants | 40.19 | 73.33 | 0.99 | 72.60 |
| Petroleum Coke | 38.5 | 100.83 | 0.98 | 98.82 |
| Other Oil | 40.35 | 73.33 | 0.99 | 72.60 |
| Coking Coal ^{d)} | 29.26 | 93.24 | 0.98 | 91.38 |
| Other Bituminous Coal ^{d)} | 24.53 | 93.24 | 0.98 | 91.38 |
| Lignite (Brown Coal) ^{d)} | 12.62 | 99.99 | 0.98 | 97.99 |
| Brown Coal Briquettes | 21.93 | 94.60 | 0.98 | 92.71 |
| Coke Oven Coke | 28.41 | 108.17 | 0.98 | 106.00 |
| Coke Oven Gas (TJ/mill. m ³) | 15.62 ^{c)} | 47.67 | 0.995 | 47.43 |
| Natural Gas (TJ/Gg) ^{d)} | 57.05 | 55.15 | 0.995 | 54.87 |
| Natural Gas (TJ/mill. m ³) ^{d)} | 34.23 ^{c)} | 55.15 | 0.995 | 54.87 |

a) Emission factor without oxidation factor

b) Resulting emission factor with oxidation factor

c) TJ/mill. m³, t = 15°C, p = 101.3 kPa

d) Country specific values of CO₂ EFs

e) Oxidation factors values used for national inventory of greenhouse gases are 0.995 for Gaseous Fuels, 0.99 for Liquid Fuels and 0.98 for Solid Fuels

The greenhouse gas emissions were calculated as the product of the activity data and the relevant emission factor. A survey of the emission factors employed for CO₂ is given in Tab. 3-13. The experimentally determined country-specific values of the emission factors were used for Coal and Lignite (Fott, 1999), for Natural Gas (please see Annex 2) and since this submission also for Refinery Gas and LPG (please see Annex 2); for the rest of fuels, the default emission factors from the IPCC methodology (IPCC, 1997) were used. Oxidation factors used in the national inventory are the default values taken from the IPCC methodology (IPCC, 1997).

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

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

- coal-type Solid Fuels
- Gaseous Fuels
- Liquid Fuels
- wood fuel (biomass)
- other biomass.

Tab. 3-14 provides CH₄ emission factors used for computation of CH₄ emissions.

Tab. 3-14 CH₄ emission factors in the individual sectors used in the Czech GHG inventory (1990 – 2012)

| [kg CH ₄ /TJ] | 1A1 | 1A2 ^{*)} | 1A3e | 1A4a | 1A4b | 1A4c |
|--------------------------|-----|-------------------|------|------|------|------|
| Liquid Fuels | 3 | 2 | | 10 | 10 | 10 |
| Solid Fuels | 1 | 10 | | 10 | 300 | 300 |
| Gaseous Fuels | 1 | 5 | 5 | 5 | 5 | 5 |
| Biomass | 30 | 30 | | 300 | 300 | 300 |
| Charcoal | 200 | 200 | | 200 | 200 | 200 |

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

N₂O emissions from stationary sources do not belong amongst key sources in the CR. Tab. 3-15 provides N₂O emission factors (used uniformly for the entire sector of stationary combustion sources).

Tab. 3-15 N₂O emission factors in the individual sectors used in the Czech GHG inventory (1990 – 2012)

| | |
|-----------------------|----------------------------|
| Liquid Fuels | 0.6 kg N ₂ O/TJ |
| Solid Fuels | 1.4 kg N ₂ O/TJ |
| Gaseous Fuels | 0.1 kg N ₂ O/TJ |
| Biomass | 4.0 kg N ₂ O/TJ |
| Charcoal (1A4) | 1.0 kg N ₂ O/TJ |

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

In this context, emphasis is placed on the correct determination of the fraction of stored (fixed) carbon in the non-energy use of fossil fuels. Calculation of its amount is based on the assumption that a certain amount of the carbon contained non-energy raw materials remains fixed in the long term and is not released as CO₂. In the energy balance CzSO (CzSO, 2013), this consists in:

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

Part of the intermediate products from pyrolysis of petrochemical raw materials is used directly as heating gases and oils, part of the final products (plastic materials) are also burned after use in municipal waste incinerators, but part ends up in land-fills. Thus, a considerable part of the input carbon remains bonded for a longer time in plastic materials. As plastic materials are being increasingly recycled, the fraction of carbon stored in plastics has been gradually increased from 50 % to 80 % between 2003 and 2006 (in period 1990 - 2002 this fraction was considered constant, 50 %).

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

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

Practically one hundred percent fixation is assumed for asphalt.

Allocation of emissions from coke and oil between 1A2 and 2B, 2C is explained above (Chapter 3.2.7).

Data on the consumption of Other Fuels are used in the Czech greenhouse gas inventory. Information on the consumption of Other Fuels was taken from the national ETS database (ETS, 2013) and is related only to the use of these fuels in cement production. Data on consumption of Other Fuels (1A2f) were employed as provided by the Czech Cement Association (Czech Cement Association, 2013). The database contains detailed information on consumption of the individual kinds of alternative fuels, their calorific values and emission factors. The same data source was also employed for processing data for 2012 (Czech Cement Association, 2013). The default emission factors were employed for calculation of the CH₄ and N₂O emissions according to the character of the relevant fuel.

Tab. 3-16 Consumption and EF – Other Fuels in the cement industry (1A2f) in 2012

| Kind of Fuel | Consumption [TJ/year] | EF | | |
|---------------------|------------------------------|------------------------------|-------------------------------|-------------------------------|
| | | [t CO₂/TJ] | [kg CH₄/TJ] | [kg N₂O/TJ] |
| Solid | 3 054.6 | 74.16 | 10 | 1.4 |
| Liquid | 394.1 | 63.97 | 2 | 0.6 |

Tab. 3-17 CO₂, CH₄ and N₂O emissions from use of Other Fuels in the cement industry (1A2f) in 2012

| Kind of Fuel | Emission [kt/year] | | |
|-----------------|--------------------|-----------------|------------------|
| | CO ₂ | CH ₄ | N ₂ O |
| Solid | 226.5 | 0.0305 | 0.00428 |
| Liquid | 25.2 | 0.0008 | 0.00024 |
| Total | 251.7 | 0.0313 | 0.00451 |

Other Fuels (1A1a)

This category follows Tier 1 methodology for emissions from waste incineration. Consistent with the Revised 1996 Guidelines (IPCC, 1997), only CO₂ emissions resulting from oxidation, during incineration and open burning of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered in the net emissions and are included in the national CO₂ emissions estimate.

Estimation of CO₂ emissions from waste incineration is based on the Tier 1 approach (IPCC, 2000). It assumes that total fossil carbon dioxide emissions are dependent on the amount of carbon in waste, on the fraction of fossil carbon and on the combustion efficiency of the waste incineration. As no country-specific data were available for the necessary parameters, the default data for the calculation were taken from the Good Practice Guidance (IPCC, 2000). All parameters and calculations are shown in Tab. 3-10.

1A3e Other Transportation

Country specific CO₂ emission factor is used since this submission. For detailed information please see Annex 2.

Default emission factors are used for CH₄ and N₂O in the entire time series.

3.4.2 1A3 - Mobile Combustion

CO₂ 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 CO₂ 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 LPG, CNG and biofuels (separately).

The share of transport in total CO₂ 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, emissions of carbon dioxide from transport recorded a decrease, which started a downward trend continuing until 2012 (Jedlicka et al, 2013). The reduction in carbon dioxide emissions was 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 is a decrease of gasoline consumption in 2012 continuing the downward trend from previous four years. However, the persistent downward trend may no longer be a consequence of the economic crisis. A slight increase in diesel oil was recorded in 2012 and this trend continues in 2012. This phenomenon indicates a return to the theoretical expectations of development in the consumption of conventional fuels. The fuel

consumption in 2012 may be affected by a cross boarder purchase of gasoline and especially diesel oil. The price of gasoline and 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 1569 tons in 2012. This decline is caused especially by a downward trend of fuel consumption of 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 CO₂ 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 CO₂ 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 CO₂ 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. 3-18 CO₂ emissions calculation from mobile sources in 1990 – 2012 [Gg CO₂]

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|------|----------------------------------|------------------------|----------|------------|---|--------------------------------------|-----------|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| 1990 | 145.9 | 6 239 | 651.5 | 56.4 | 435.2 | 1 601 | 9 188 |
| 1991 | 40 | 5 616 | 580.2 | 56 | 441.5 | 1 409 | 8 203 |
| 1992 | 40.7 | 6 494 | 492.4 | 54.6 | 482.0 | 1 321 | 8 950 |
| 1993 | 24.8 | 6 610 | 413.6 | 54.1 | 389.8 | 1 276 | 8 821 |
| 1994 | 22.9 | 7 147 | 333.4 | 53.3 | 275.2 | 1 285 | 9 154 |
| 1995 | 14 | 9 180 | 332.7 | 55 | 35.8 | 1 191 | 10 809 |
| 1996 | 15.9 | 10 227 | 328 | 45.8 | 87.0 | 1 141 | 11 847 |
| 1997 | 10.4 | 10 997 | 282.1 | 38.4 | 74.7 | 1 189 | 12 593 |
| 1998 | 10.2 | 11 167 | 354.6 | 37.7 | 57.8 | 1 264 | 12 892 |
| 1999 | 13.2 | 11 391 | 329.5 | 22 | 61.8 | 1 245 | 13 064 |
| 2000 | 11.3 | 11 521 | 326.4 | 15.7 | 57.6 | 1 235 | 13 168 |
| 2001 | 8.2 | 12 375 | 304.4 | 25.1 | 58.9 | 1 194 | 13 967 |
| 2002 | 11.1 | 12 966 | 295 | 12.6 | 61.1 | 1 140 | 14 487 |
| 2003 | 11.4 | 14 759 | 288.7 | 12.6 | 57.7 | 1 061 | 16 192 |
| 2004 | 12.3 | 15 520 | 285.6 | 18.8 | 55.6 | 1 107 | 17 000 |
| 2005 | 9.2 | 16 840 | 288.7 | 15.7 | 68.0 | 1 094 | 18 317 |
| 2006 | 9.8 | 17 146 | 301.2 | 18.8 | 72.9 | 1 074 | 18 624 |
| 2007 | 9.8 | 18 029 | 298.1 | 15.7 | 118.1 | 1 085 | 19 558 |
| 2008 | 8.6 | 17 826 | 329.5 | 12.6 | 145.0 | 1 133 | 19 457 |
| 2009 | 9.6 | 17 290 | 298.1 | 15.7 | 150.7 | 1 117 | 18 882 |
| 2010 | 9.1 | 16 268 | 288.7 | 12.6 | 150.4 | 1083 | 17 814 |
| 2011 | 4.8 | 16 120 | 282.4 | 9.4 | 144.4 | 1091 | 17 656 |
| 2012 | 7.6 | 15 864 | 273.0 | 15.7 | 69.9 | 1095 | 17 325 |

CH₄ emissions

For road transportation, the method of methane emission calculation corresponds to the Tier 2 level, because different road vehicles produce different amounts of methane. It can be stated that methane emissions from road transportation exhibit the same differences as total hydrocarbons. Mobile emission sources were divided up into several categories according to the fuel used, the transport mode and the emission limit that a particular vehicle must meet. This division is more detailed because there are larger differences in methane production by individual vehicles. These categories are described in detail in Chapter 3.3.3 1A3 Mobile Combustion.

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 2005. The emission factors were the IPCC default values and, from 2004, the country-specific values as CDV became part of the emission inventory team.

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

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

Emissions of CH₄ from mobile sources are given in Tab. 3-19.

Tab. 3-19 CH₄ emissions calculation from mobile sources in 1990 – 2012 [Mg CH₄]

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|------|----------------------------------|------------------------|----------|------------|---|--------------------------------------|-----------|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| 1990 | 28.58 | 1 260 | 40.86 | 3.54 | 44.29 | 335.7 | 1 712.98 |
| 1991 | 7.8 | 1 098 | 36.39 | 3.51 | 44.92 | 291.9 | 1 482.55 |
| 1992 | 7.92 | 1 318 | 30.89 | 3.43 | 49.04 | 270.1 | 1 679.33 |
| 1993 | 4.79 | 1 336 | 25.95 | 3.39 | 39.65 | 262.0 | 1 671.79 |
| 1994 | 4.38 | 1 449 | 20.91 | 3.34 | 28.00 | 264.0 | 1 769.58 |
| 1995 | 2.71 | 1 638 | 20.87 | 3.45 | 3.27 | 242.8 | 1 911.08 |
| 1996 | 3.2 | 1 798 | 20.57 | 2.87 | 7.96 | 221.0 | 2 053.61 |
| 1997 | 1.92 | 1 883 | 17.69 | 2.41 | 6.83 | 191.0 | 2 102.86 |
| 1998 | 1.88 | 1 851 | 22.24 | 2.36 | 5.28 | 144.7 | 2 027.48 |
| 1999 | 2.48 | 1 839 | 20.67 | 1.38 | 5.65 | 98.6 | 1 967.75 |
| 2000 | 2.16 | 1 633 | 20.47 | 0.98 | 5.27 | 84.6 | 1 829.47 |
| 2001 | 1.55 | 1 648 | 19.9 | 1.57 | 5.38 | 82.0 | 1 849.37 |
| 2002 | 2.13 | 1 570 | 18.5 | 0.79 | 5.58 | 81.3 | 1 738.33 |
| 2003 | 2.18 | 1 633 | 18.11 | 0.79 | 5.27 | 74.1 | 1 781.43 |
| 2004 | 2.32 | 1 577 | 17.91 | 1.18 | 5.09 | 78.3 | 1 702.81 |
| 2005 | 1.72 | 1 541 | 18.11 | 0.98 | 6.22 | 77.9 | 1 714.94 |
| 2006 | 1.82 | 1 451 | 18.9 | 1.18 | 6.65 | 75.0 | 1 620.56 |
| 2007 | 1.82 | 1 416 | 18.7 | 0.98 | 10.77 | 78.3 | 1 627.53 |
| 2008 | 1.61 | 1 320 | 20.67 | 0.79 | 13.22 | 81.4 | 1 579.65 |
| 2009 | 1.78 | 1 198 | 18.7 | 0.98 | 13.72 | 81.2 | 1 509.10 |

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|------|----------------------------------|------------------------|----------|------------|---|--------------------------------------|-----------|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| 2010 | 1.7 | 1 040 | 18.11 | 0.79 | 13.68 | 76.4 | 1 334.71 |
| 2011 | 0.89 | 971 | 17.71 | 0.59 | 13.14 | 76.4 | 1 276.75 |
| 2012 | 1.46 | 898 | 17.12 | 0.98 | 6.34 | 75.9 | 999.83 |

N₂O 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 N₂O emissions. However, this effect is suppressed in new vehicles as a consequence of lower fuel consumption. Between 2008 and 2012, N₂O emissions still continued to decrease, similar to carbon dioxide emissions.

Road transport was identified as a key source of N₂O emissions over the past 4 years, as the share of vehicles with high N₂O emissions has been increasing over this time. Consequently, N₂O emissions from mobile sources represent a somewhat more important contribution than CH₄ emissions. In calculation of N₂O 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 N₂O measurement results and values recommended in IPCC methodology, the special verification including the statistical evaluation has been performed. The resulted values of N₂O emission factors from mobile sources are approaching to recommended IPCC values. The emissions factors for N₂O for vehicles with diesel motors and for vehicles with gasoline motors without catalysts are not very high and were taken in the standard manner from the methodical instructions (IPCC default values). The situation is more complex for vehicles with gasoline motors equipped with three-way catalysts. The IPCC methodology (IPCC, 1997) gives three pairs of emission factors for passenger cars with catalysts (for new and deactivated catalysts). The value for a deactivated catalyst is approximately three times that for a new catalyst. The pair of values recommended on the basis of Canadian research was selected because of the lack of domestic data; in addition, American and French coefficients are presented in the *IPCC Reference Manual*, Box 3 (IPCC, 1997). The arithmetic mean of the values for new and older used catalysts was taken as the final emission factor for passenger cars with catalysts.

A partial increase in N₂O 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 N₂O 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 N₂O 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 IPCC 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 N₂O 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 N₂O are given in Tab. 3-20.

Tab. 3-20 N₂O emissions calculation from mobile sources in 1990 – 2012 [Mg N₂O]

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|------|----------------------------------|------------------------|----------|------------|---|--------------------------------------|-----------|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| 1990 | 20.19 | 425 | 37.37 | 3.24 | 0.89 | 63.2 | 549.89 |
| 1991 | 5.53 | 377.5 | 33.28 | 3.21 | 0.90 | 55.0 | 475.45 |
| 1992 | 5.63 | 479.9 | 28.25 | 3.13 | 0.98 | 51.1 | 568.99 |
| 1993 | 3.43 | 522.9 | 23.73 | 3.1 | 0.79 | 50.0 | 603.96 |
| 1994 | 3.17 | 610.3 | 19.12 | 3.6 | 0.56 | 49.7 | 686.44 |
| 1995 | 1.93 | 759.1 | 19.9 | 3.16 | 0.07 | 46.3 | 830.49 |
| 1996 | 2.19 | 875.5 | 18.81 | 2.63 | 0.16 | 44.9 | 944.17 |
| 1997 | 1.44 | 954.4 | 16.18 | 2.2 | 0.14 | 53.7 | 1028.02 |
| 1998 | 1.41 | 1049.8 | 20.34 | 2.16 | 0.11 | 75.6 | 1149.38 |
| 1999 | 1.83 | 1161.9 | 18.9 | 1.26 | 0.11 | 81.0 | 1265.05 |
| 2000 | 1.56 | 1 336.80 | 18.72 | 0.9 | 0.11 | 82.6 | 1440.71 |
| 2001 | 1.14 | 1 506.90 | 17.46 | 1.44 | 0.11 | 80.0 | 1607.03 |
| 2002 | 1.53 | 1 639.70 | 16.92 | 0.72 | 0.11 | 78.2 | 1737.13 |
| 2003 | 1.58 | 1 927.30 | 16.56 | 0.72 | 0.11 | 71.8 | 2018.05 |
| 2004 | 1.7 | 2 067.00 | 16.38 | 1.08 | 0.10 | 75.5 | 2161.75 |
| 2005 | 1.27 | 2 231.30 | 16.56 | 0.9 | 0.12 | 74.9 | 2325.07 |
| 2006 | 1.36 | 2 238.00 | 17.28 | 1.08 | 0.13 | 72.7 | 2330.54 |
| 2007 | 1.36 | 2 354.60 | 17.1 | 0.9 | 0.22 | 74.9 | 2449.04 |
| 2008 | 1.18 | 2 322.40 | 18.9 | 0.72 | 0.26 | 78.0 | 2421.43 |
| 2009 | 1.32 | 2 306.80 | 17.1 | 0.9 | 0.27 | 77.4 | 2403.61 |
| 2010 | 1.25 | 2 182.50 | 16.56 | 0.72 | 0.27 | 73.7 | 2275.06 |
| 2011 | 0.66 | 2 176.40 | 16.2 | 0.54 | 0.26 | 74.1 | 2268.13 |
| 2012 | 1.05 | 2 109.00 | 15.66 | 0.9 | 0.13 | 73.8 | 2200.53 |

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 as to vehicle category, fuel used and EURO standard. The second table contains information about the emission factors of non-road transportation, particularly railways, navigation and civil aviation. Civil 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 emission factors taken from the IPCC and EIG databases (CO₂ and N₂O), and also those that have country-specific character (CH₄). The last missing emission factors for nitrous oxide for LPG and CNG (IPCC, 2006) were added in 2010 and 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. 3-21 Emission factors of CO₂, N₂O and CH₄ from road transport in 2012 [g/kg fuel]

| Vehicle type | Fuel type | European emission standard | EF CO ₂ | EF N ₂ O | EF CH ₄ |
|--------------|------------|----------------------------|--------------------|---------------------|--------------------|
| | | | g/kg fuel | g/kg fuel | g/kg fuel |
| Motorcycles | Gasoline | PRE-EURO and higher | 3 183 | 0.06 | 4.10 |
| PC+LDV | Gasoline | PRE-EURO | 3 183 | 0.31 | 0.90 |
| PC+LDV | Gasoline | EURO I and EURO II | 3 183 | 0.70 | 0.40 |
| PC+LDV | Gasoline | EURO III and higher | 3 183 | 0.90 | 0.10 |
| PC+LDV | Diesel Oil | PRE-EURO | 3 138 | 0.10 | 0.08 |
| PC+LDV | Diesel Oil | EURO I and EURO II | 3 138 | 0.20 | 0.08 |
| PC+LDV | Diesel Oil | EURO III and higher | 3 138 | 0.25 | 0.08 |
| PC+LDV | LPG | PRE-EURO and higher | 3 030 | 0.01 | 1.02 |
| PC+LDV | CNG | PRE-EURO and higher | 2 697 | 0.15 | 0.20 |
| PC+LDV | Biomass | PRE-EURO and higher | 3 021 | 0.36 | 0.06 |
| HDV | Diesel Oil | PRE-EURO | 3 138 | 0.10 | 0.60 |

| Vehicle type | Fuel type | European emission standard | EF CO ₂ | EF N ₂ O | EF CH ₄ |
|--------------|------------|----------------------------|--------------------|---------------------|--------------------|
| | | | g/kg fuel | g/kg fuel | g/kg fuel |
| HDV | Diesel Oil | EURO I and EURO II | 3 138 | 0.20 | 0.20 |
| HDV | Diesel Oil | EURO III and higher | 3 138 | 0.25 | 0.15 |
| HDV | CNG | PRE-EURO and higher | 2 697 | 0.15 | 0.20 |
| HDV | Biomass | PRE-EURO and higher | 3 021 | 0.36 | 0.06 |
| Bus | Diesel Oil | EURO II and older | 3 138 | 0.18 | 0.60 |
| Bus | Diesel Oil | EURO III and higher | 3 138 | 0.10 | 0.15 |
| Bus | CNG | PRE-EURO and higher | 2 697 | 0.15 | 0.20 |
| Bus | Biomass | PRE-EURO and higher | 3 021 | 0.36 | 0.06 |

Tab. 3-22 Emission factors of CO₂, N₂O and CH₄ from non-road transport in 2012 [g/kg fuel]

| Transport type | Fuel type | EF CO ₂ | EF N ₂ O | EF CH ₄ |
|-------------------------|-------------------|--------------------|---------------------|--------------------|
| | | g/kg fuel | g/kg fuel | g/kg fuel |
| Railways | Diesel Oil | 3 138 | 0.18 | 0.20 |
| Navigation | Diesel Oil | 3 138 | 0.18 | 0.20 |
| Civil Aviation - LTO | Aviation Gasoline | 3 211 | 0.44 | 0.63 |
| Civil Aviation - Cruise | Aviation Gasoline | 3 211 | 0.44 | 0.63 |
| Civil Aviation - LTO | Kerosene | 3 230 | 0.44 | 0.53 |
| Civil Aviation - Cruise | Kerosene | 3 211 | 0.44 | 0.53 |

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.

These types of data 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 experienced 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 (Civil Aviation, Aviation 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 1A3 (or International Bunkers 1C1), but in sectors 1A5bi, 1A2f and 1A4a respectively. Other two categories (Civil Aviation 1A3a and Aviation Bunkers 1C1a) 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). 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 Civil Aviation also Kerosene consumption from categories Army, Industry, Commercial and Public Services and that is not used for aviation or transport at all. The following table 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. 3-23 Distribution of Jet Kerosene consumption in CRF Reporter and IEA data in 2012

| CRF Reporter | | | |
|---------------------------------------|-------|------|--------|
| | | [kt] | [TJ] |
| Total | | 303 | 13 120 |
| Civil Aviation | 1A3a | 0.50 | 16.1 |
| Aviation Bunkers | 1C1a | 286 | 12368 |
| Army | 1A5bi | 12 | 520 |
| Industry | 1A2f | 2 | 87 |
| Commercial and Public Services | 1A4a | 3 | 130 |
| IEA data | | | |
| | | [kt] | [TJ] |
| Total | | 303 | 13 120 |
| Domestic Aviation | | 19 | 823 |
| International Aviation | | 284 | 12 297 |

3.5 Uncertainties and time-series consistency

3.5.1 Stationary combustion

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 1.7, Tables 1-3, 1-4 and 1-5. Tab. 3-24 furthermore lists source of expert judgement provided for uncertainty analysis for each category.

Activity data

Information on fuel consumption is taken from CzSO (CzSO, 2013).

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 calculations 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. 3-24. 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. 3-24 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 | 1A Stationary combustion – Solid Fuels | 4 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A Stationary combustion – Gaseous Fuels | 3 | 2.5 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A Stationary combustion – Liquid Fuels | 5 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A Stationary combustion – Other Fuels – 1A2 | 10 | 15 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A3e Other Transportation | 4 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A5b Mobile sources in agriculture and forestry | 7 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A Stationary combustion – Solid Fuels | 5 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A Stationary combustion – Gaseous Fuels | 4 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A Stationary combustion – Liquid Fuels | 5 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A Stationary combustion – Biomass | 8 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A5b Mobile sources in agriculture and forestry | 7 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A3e Other Transportation | 4 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A Stationary combustion – Solid Fuels | 5 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A Stationary combustion – Gaseous Fuels | 4 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A Stationary combustion – Liquid Fuels | 5 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A Stationary combustion – Biomass | 8 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A Stationary combustion – Other Fuels – 1A2 | 10 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A3e Other Transportation | 4 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A5b 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 1A2c subsector. The energy production is split off to independent entity B, whose main activity is production and supply of heat. In the final analysis, the reported fuel consumption is shifted from 1A2c to 1A1a.

In the Czech Republic, the 1990's and beginning of the 20th century were a period when a route to rational utilization of means of production was sought and changes in the ownership structure of energy-production facilities were quite frequent. Consequently, consistency of the time series is interrupted in some subcategories. Justification for the exact causes of each such change lies outside the current capabilities of the sector 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 (1A1a) - Uncertainties and time-series consistency

The time series is consistent, as it comes from a single data source – time-series produced by MTI. There are no country-specific uncertainties yet, as all the factors but activity data used in the equations are default IPCC factors. In upcoming inventories, we plan to have the uncertainty in the activity data checked by expert questionnaires.

3.5.2 1A3 Mobile Combustion – Uncertainties and time – series consistency

In spite of the fact that verification has been performed, the N₂O 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. 3-25 lists source of expert judgement provided for uncertainty analysis for each category in mobile combustion.

Tab. 3-25 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 | 1A3a Civil Aviation | 4 | 3.73 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A3b Road Transportation | 3 | 2.36 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A3c Railways | 5 | 1.48 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CO ₂ | 1A3d Navigation | 5 | 1.5 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A3a Civil Aviation | 4 | 21.5 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A3b Road Transportation | 3 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A3c Railways | 5 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1A3d Navigation | 5 | 50 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A3a Civil Aviation | 4 | 40 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A3b Road Transportation | 3 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A3c Railways | 5 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| N ₂ O | 1A3d Navigation | 5 | 90 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |

3.6 Source-specific QA/QC and verification

3.6.1 Stationary combustion

The general QA/QC plan was formulated since the last submission and is presented in the Chapter 1.5. 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 mechanisms and procedures to ensure data quality.

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

- processes and updates the sectoral QA/QC plan
- organizes QC procedure (Tier 1)
- ensures QC procedure (Tier 2) 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

- is responsible for the compliance of all QA/QC procedures with the IPCC Good Practice Guidance (GPG) and QA/QC plan.
- ensures data input in the CRF Reporter
- carries out auto-control (1st step of QC procedure, Tier 1)
- ensures and is responsible for the storing of documents

The QC procedures at the Tier 1 are related to the processing, manipulation, documentation, storing and transmission of information. The first step of the control (auto-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 (other colleague who is familiar with problematic). At this control level (Tier 1) individual steps are controlled according to the table 8.1 (IPCC, 2000).

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.

QC procedures at the Tier 2 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.

Also external employees of KONEKO familiar with the assessed topic participate in the QC procedures (Tier 2). 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.

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.

Fig. 3-8 shows the correlation of fuel consumption in category 1A1a and total electricity production. Electricity production should have a similar trend to consumption in category 1A1a. Very good correlation can be seen at the end of the period, where the same change is apparent since 2005. Overall, the correlation after 2000 can be considered as very good agreement. Some changes are apparent in the previous period, however the trend is also considered to be similar.

It also indicates the correlation of CO₂ emissions in category 1A1b and CO₂ emissions from Crude Oil in the Reference Approach. These two features should have same trend and this is visible in the figure. The same trend is apparent in both categories at the end of the period; there is a peak in 2008 and the same shape of the curves between 2004 and 2006. At the beginning of nineties there were a great many technical innovations provided in refineries. The older technological facilities from the previous period were reconstructed, resulting in a decrease of energy intensity. This decrease in the energy intensity is connected with lower consumption of fuels even when the amount of processed oil was increasing.

Fig. 3-8 shows also the correlation of fuel consumption in category 1A2a Iron and Steel and production of pig iron (*source: hz.cz*). Obviously these two features should correlate. A dissimilar trend is apparent at the beginning of the period, probably caused by inaccuracy in the activity data. In the next submission, we will exert an effort to improve these data. On the other hand, is apparent that the curve has the same shape in 1999, indicating good correlation.

The correlation of fuel consumption in category 1A2c Chemicals and production of chemicals – *source DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO PRODUCT* provided by CzSO. These two features should be correlated. There are also some dissimilarity in the trends, which we will try to correct in future submissions. The figure shows good agreement of both features after 2002. The last two pictures in the Fig. 3-8 indicate correlations for 1A2e and 1A2f. Correlation of fuel consumption in category 1A2e Food processing, beverages and tobacco and production of food and beverages – *source DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO*

PRODUCT provided by CzSO. These two quantities apparently exhibit similar development over the whole time series. Correlation of fuel consumption in 1A2f with production of cement and lime shows the correlation of fuel consumption in category 1A2f with production of cement and lime - source *DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO PRODUCT* provided by CzSO.

Attention was also focused on checking sources from inter-sector boundaries (Energy, Industrial Processes) that they are neither omitted nor counted twice. Therefore CO₂ 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 experts from CHMI, who are responsible for the Industrial Processes sector. Identical control was carried out for CO₂ emissions from coke used in blast furnaces, which is not considered in Energy sector.

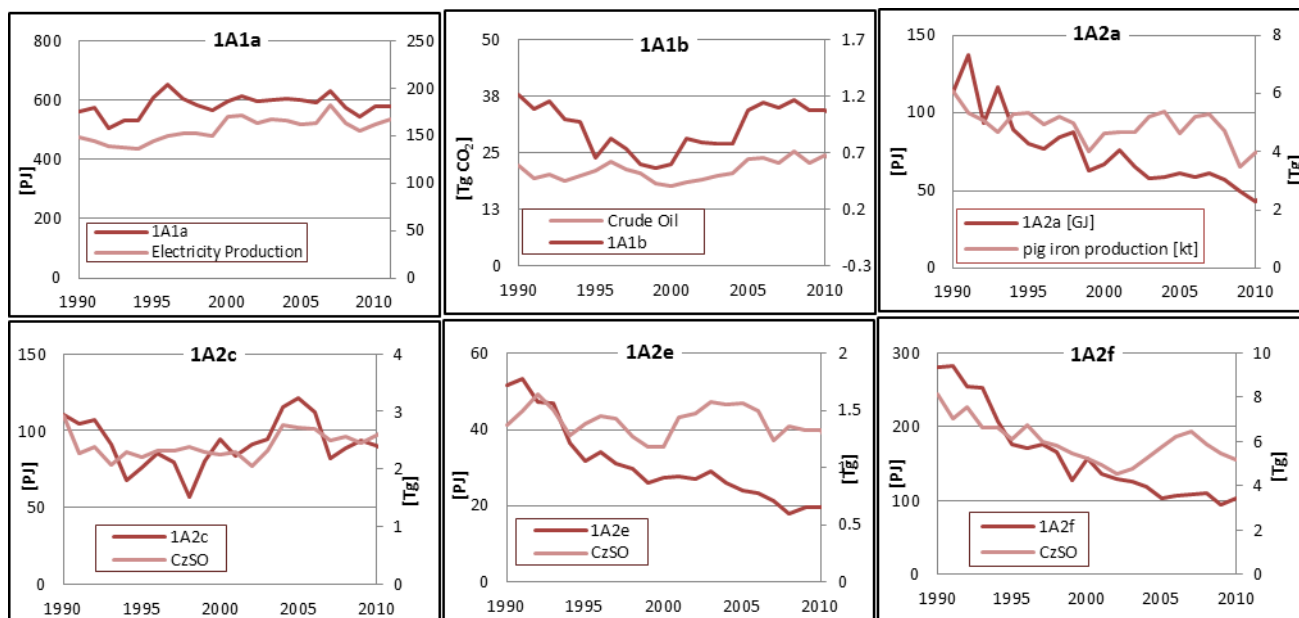


Fig. 3-5 Comparison of trends of indicators of different categories

Other Fuels (1A1a) - QA/QC and verification

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.

3.6.2 1A3 Mobile Combustion - 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 Good Practice Guidance (IPCC, 2000),
- 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 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 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.

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

3.7.1 Stationary combustion

Recalculation of 1A Energy – country specific CO₂ emission factor for LPG and Refinery Gas

Extensive research was performed last year with aim to develop country-specific emission factors for Liquid Fuels combustion. New country-specific emission factors were developed for Liquefied Petroleum Gas and for Refinery Gas. These emission factors are used starting with this submission. The recalculation was performed for the whole time series. During the research were also net calorific values of these two fuels updated.

Annex 2 provides a detailed description of the research. Tab. 3-26 indicates comparison of emission estimates using default emission factors and updated country specific emission factors. It is apparent that the default emission factor slightly overestimates the emissions.

Tab. 3-26 Comparison of emission estimates using default and country specific emission factors for LPG and Refinery Gas

| year | Gg CO ₂ using default emission factors | Gg CO ₂ using country specific emission factors |
|------|---|--|
| 1990 | 15 121 | 15 102 |
| 1991 | 13 960 | 13 940 |
| 1992 | 14 490 | 14 475 |
| 1993 | 12 533 | 12 513 |
| 1994 | 11 155 | 11 142 |
| 1995 | 9 734 | 9 730 |
| 1996 | 9 957 | 9 950 |
| 1997 | 9 384 | 9 374 |
| 1998 | 9 004 | 9 003 |
| 1999 | 9 192 | 9 187 |
| 2000 | 8 412 | 8 412 |
| 2001 | 8 801 | 8 811 |
| 2002 | 8 160 | 8 159 |
| 2003 | 7 654 | 7 648 |
| 2004 | 8 124 | 8 118 |
| 2005 | 8 226 | 8 212 |
| 2006 | 7 382 | 7 352 |
| 2007 | 6 987 | 6 957 |
| 2008 | 7 057 | 7 024 |
| 2009 | 6 572 | 6 537 |
| 2010 | 6 588 | 6 542 |
| 2011 | 6 056 | 6 029 |

Recalculation due to changes in activity data

Few recalculations were also performed in this submission due to changes in primary activity data. It is mainly applied to solid fuels in category 1A4b Residential and to Natural Gas in 1A2f, 1A4a and 1A4c categories.

3.7.2 Other Fuels (1A1a) – Recalculations

No recalculations were performed this year.

3.7.3 1A3 Mobile Combustion - Source-specific recalculations

There is a recalculation of activity data in road transport sector in 2013 for the 2000 – 2012 time period. On the basis of QA/QC was found two public website sources of activity data for number of vehicles powered by CNG. The first source of information is Czech source administrated by Czech Gas Association and the second one is Natural & bio Gas Vehicle Association Europe. These two sources have influenced the ratio of CNG consumption among transport categories (passenger cars, light duty vehicle, heavy duty vehicle, bus) back to 2004.

In second step of QA/QC was used activity data concerning number of diesel oil passenger cars from Transport Yearbook (source of data is Central Vehicle Register) managed by the Ministry of Transport (MoT, 2011; MoT, 2013). This fact influenced the ratio of diesel oil consumption among transport categories (PC+LDV, HDV) back to 2006. The last and the most important update is related to many years of research, which is linked to dynamic structure of the vehicles fleet on roads in Czech Republic. Within this update (back to 2000) are taken account 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 most complicated transport category due to small representation in the total vehicle fleet is clearly the category of buses and therefore is monitored in more detail directly on CDV.

It should be noted, that the total consumption of any fuel type in road transport sector remains unchanged, only CH₄ a N₂O emissions reach different values after recalculation than before. The vehicle fleet in Czech Republic seems to be relatively old before recalculation, especially in case of heavy duty vehicles and buses.

3.8 Source-specific planned improvements

3.8.1 Stationary combustion

The planned improvement consists primarily in a further increase in cooperation with CzSO. As mentioned in the introduction, a new addendum was created for the agreement between the Ministry of the Environment and CzSO. In the framework of this addendum, the parties agreed to hold regular meetings at least 3x annually to deal with coordination of work on the national energy balance, so that this is in accordance with the requirements on processing of activity data for greenhouse gas emission inventories.

Attention is constantly devoted to obtaining data from the ETS national database for use in performing QA/QC procedures. At the present time, the creation of this database is included in the plan of the Ministry of the Environment. As a certain part of the reports on the individual enterprises are currently available only in printed form, the data cannot be converted as distortion could occur.

It is assumed, that following systematic comparison of activity data obtained in various ways, it will be possible to refine the national GHG inventories in the ENERGY sector using “bottom-up” data, or at least to use this data for the QA/QC procedures.

Another improvement is planned for QA procedures. QA should be performed by an independent expert who does not participate in processing the National Inventory of Greenhouse Gases. It is intended to establish a “working group”, which will consist of independent experts from different branches of industry and energy production. Members of the group should be officially named by a letter of appointment from CHMI as the coordination workplace.

Important issue for improvement is development of new country specific emission factors for fuels. The effort is put on the updating of country specific emission factors for Lignite, Other Bituminous Coal and Coking Coal, as well as on development of country specific emission factors for liquid fuels.

In the next submission will be new – IPCC 2006 Gl. – methodology used. For Energy sector it considers more detailed division of categories, for instance category 1A1c will be specified in 1A1c i, 1A1c ii. More detailed will be also categories for reporting emissions from Manufacturing industries (1A2). Furthermore implementation of IPCC 2006 Gl. will bring more crosscutting issues with the Industrial Processes sector.

3.8.2 1A3 Mobile Combustion

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 CO₂ and N₂O emission calculation and refinement of methodologies for each category of transport.

3.9 Fugitive emissions from Solid Fuels and Oil and Natural Gas (1B)

Mining, treatment and all handling of fossil fuels are sources of fugitive emissions. In the Czech Republic, CH₄ emissions from underground mining of Hard Coal are significant, while emissions from surface mining of Brown Coal, Oil and Gas production, distribution, storage and distribution are less important.

The current inventory includes CH₄ emissions for the following categories:

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

In *1B Fugitive Emissions from Fuels* category, especially *1B1a Coal Mining and Handling* was evaluated as a *key category* (Tab. 3-27). Category 1B2 also was identified as a *key category* by the latest assessment, but only in one from the four tests (LA). Moreover, identifiers placed this category just over the borderline between *key* and *non-key categories*.

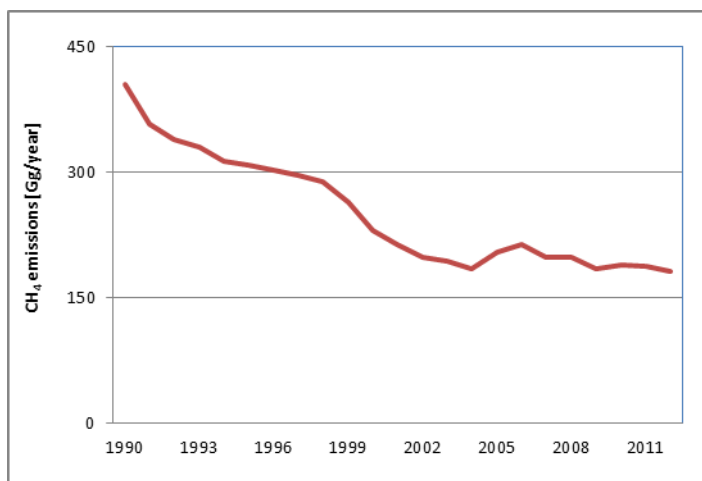


Fig. 3-6 Methane emissions trends from the sector Fugitive Emissions from Fuels [Gg CH₄]

Tab. 3-27 Overview of significant categories of sources in this sector (2012)

| Category | Character of category | Gas | % of total GHG* |
|---|-----------------------|-----------------|-----------------|
| 1B1a Fugitive Emissions from Coal Mining and Handling | KC (LA, TA) | CH ₄ | 2.40 |
| 1B2 Fugitive Emissions from Oil & Gas operations | KC (LA) | CH ₄ | 0.61 |

* assessed without considering LULUCF (without * means considering LULUCF); KC: key category, LA: identified by level assessment, TA: identified by trend assessment

3.9.1 Solid Fuels (1B1)

The source category *1B1 Solid Fuels* consists of three sub – source categories: source category *1B1a Coal mining and Handling*, source category *1B1b Coal transformation* and source category *1B1c Other*. The main process that emits more than 80 % of methane emissions from the category *1B1 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

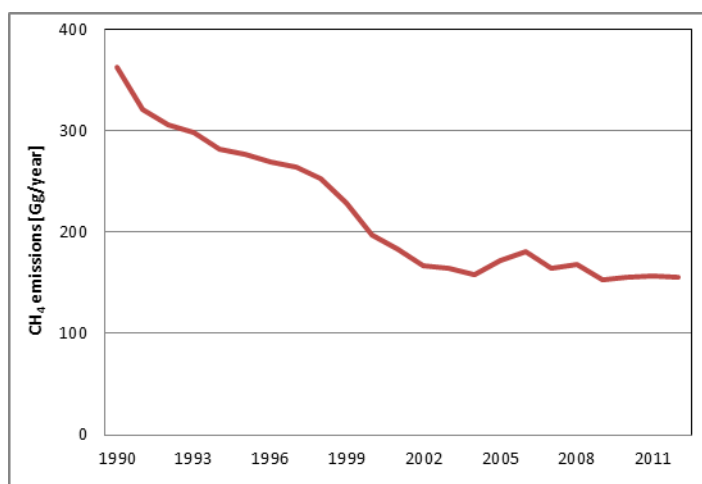


Fig. 3-7 Methane emissions trends from the sector Fugitive Emissions from Solid Fuels [Gg CH₄]

to the coal mass or is present as the free gas in pores and cracks in the coal and in the surrounding rocks.

Abandoned mines

In the Czech Republic there are also abandoned mines occurring. All of them have CH₄ 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/>).

3.9.1.1 Source category description

Coal Mining and Handling (1B1a)

In underground Hard Coal mining, CH₄ 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 Mines (1B1a1)

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 *1B1a2 Surface Mines*.

Mining Activities (1B1a11)

The data of CzSO in the report CZECH_COAL.xls (CzSO, 2013) can be used for control purposes.

Hard-coal mining is the principal source of fugitive emissions of CH₄. 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 (1B1a12)

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

Surface Mines (1B1a2)

Mining Activities (1B1a21)

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

Post-Mining Activities (1B1a22)

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

Solid Fuel Transformation (1B1b)

Production of Coke from Coking Coal

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

Production of briquettes from Brown Coal

Fugitive methane emissions from coal treatment prior to the actual briquetting process are listed under *1B1a22 Post-Mining Activities*. CO₂ emissions from the actual production of briquettes are included in subcategory 1A2f.

Production of charcoal

CH₄ emissions from charcoal production were estimated by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); the value of 1000 kg/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 CH₄ emissions please see in the Tab. 3-28.

Tab. 3-28 CH₄ emissions from charcoal production

| 1B1b Solid Fuel Transformation | | | |
|---------------------------------------|-------------------|-------------------|---------------------------------|
| | Production | Production | CH₄ 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 |

Fugitive CO₂ emissions are not estimated or are negligible and no known method is available for their determination in this category (notation key NE). Fugitive N₂O emissions are not estimated because, according to the current state of knowledge, these emissions cannot occur (notation key NA) and also Revised 1996 Guidelines (IPCC, 1997) do not provide default emission factor.

Other (1B1c)

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

3.9.1.2 Methodological issues

Underground Mines (1B1a1)

Mining Activities (1B1a11)

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. 3-29, see (Takla and Nováček, 1997).

Tab. 3-29 Coal mining and CH₄ emissions in the Ostrava - Karvina coal-mining area

| | Coal mining | CH ₄ emissions | Emission factors |
|----------------|-----------------|------------------------------|----------------------|
| | [mil. t / year] | [mil. m ³ / year] | [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 | 20.6 | 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 m³/t was recalculated to **12.261 kg/t** using a density of methane of 0.67 m³/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 deep mines in other areas. This is valid for coal with minimum coal gas capacity (coal from the Kladno area to 2002 and coal from the Žacléř area from 1998).

The emission factors given in Tab. 3-31 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.

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.

Tab. 3-30 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 information was used to calculate the emission factors and to determine the average emission factor, which is used for the period after 2000-2008.

Tab. 3-31 Calculation of emission factors from OKD mines for period 2000 onwards

| year | OKD mining | CH ₄ emissions | EF |
|-------------|------------|---------------------------|--------|
| | [kt/year] | [t/year] | [t/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. 3-31 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 III – 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 CO₂ emission factor for underground hard coal mining. Monthly data on the concentrations and amounts of CO₂ 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/kt of mined coal and this emission factor is country specific – Tier III 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/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 CO₂ emissions for underground hard coal mining; the values are given in the Tab. 3-32.

Tab. 3-32 Emission factors and emissions from deep mining of hard coal

| year | production OKD | emission factor | emission of CO ₂ |
|------|-------------------|--------------------|--------------------------------|
| | [kt/year] | [t/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 |

Post-Mining Activities (1B1a12)

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 CH₄/t coal; the activity data are employed at the same level as in subcategory 1B1a11 Mining Activities.

Tab. 3-33 contains a summary of fugitive methane emissions during the actual underground mining of Hard Coal and during post-mining operations.

Tab. 3-33 Used emissions factors and calculation of CH₄ emissions from underground coal mining in 2012

| | Amount of Coal Produced [million t] | Emission Factor [kg CH ₄ /t] | Methane Emissions [Gg CH ₄] |
|-------------------------------|---|---|---|
| OKR ^{*)} (tier III) | 11.400 | 8.8 | 100.1 |
| Other - tier I | 0.000 | 6.7 | 0.0 |
| Mining (tier III) | 11.400 | 8.8 | 100.1 |
| OKR ^{*)} (tier I) | 11.400 | 1.6 | 18.8 |
| Other - tier I | 0.000 | 0.6 | 0.0 |
| Post-Mining (tier I) | 11.400 | 1.6 | 18.8 |
| Total sub-sector 1B1a1 | 11.400 | 10.4 | 118.9 |

* Ostrava-Karviná coal-mining area

Surface Mines (1B1a2)

Mining Activities (1B1a2)

Data from the source part of the questionnaire completed in the CzSO Questionnaire (CzSO, 2013), 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).

Tab. 3-34 illustrates the calculation of fugitive emissions of methane from surface coal mining activities.

Tab. 3-34 Emission factors employed and calculation of CH₄ emissions from surface coal mining in 2012

| | Amount of Coal Produced [million t] | Emission Factor [kg CH ₄ /t] | Methane Emissions [Gg CH ₄] |
|------------------------|--|--|--|
| Mining (tier I) | 43.533 | 0.77 | 33.5 |
| Post-Mining (tier I) | 43.533 | 0.07 | 2.9 |
| Total sub-sector 1B2a1 | 43.533 | 0.84 | 36.5 |

3.9.1.3 Uncertainty and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2012. 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 deep 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 CO₂ emission factor is considered to be at the level of 25 %.

Summary of uncertainty estimates provides Tab. 3-35.

Tab. 3-35 Uncertainty estimates for fugitive emissions from Solid Fuels

| Gas | Source category | AD uncertainty [%] | EF uncertainty [%] | Origin of actual level of uncertainty |
|-----------------|-------------------------------|--------------------|--------------------|---|
| CO ₂ | 1B1a Coal Mining and Handling | 4 | 25 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |
| CH ₄ | 1B1a Coal Mining and Handling | 4 | 13 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |

3.9.1.4 Source specific QA/QC and verification

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

QC activities at the level of Tier 1 were performed according to the QA/QC plan by the 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.

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.

3.9.1.5 Source-specific recalculations

No recalculations were performed in this submission.

3.9.1.6 Source-specific planned improvements

No improvements are planned at the present.

3.9.2 Oil and Natural Gas (1B2)

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

Approximately 10 % of emissions are formed in the Czech Republic from gas industry in extraction, storage, transport and distribution of Natural Gas and in its final use. Crude Oil extraction and refining processes are less important.

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

Methane emissions from the gas industry were determined using national emission factors based on the specific emission factors for the individual parts of the gas industry system (Alfeld, 1998).

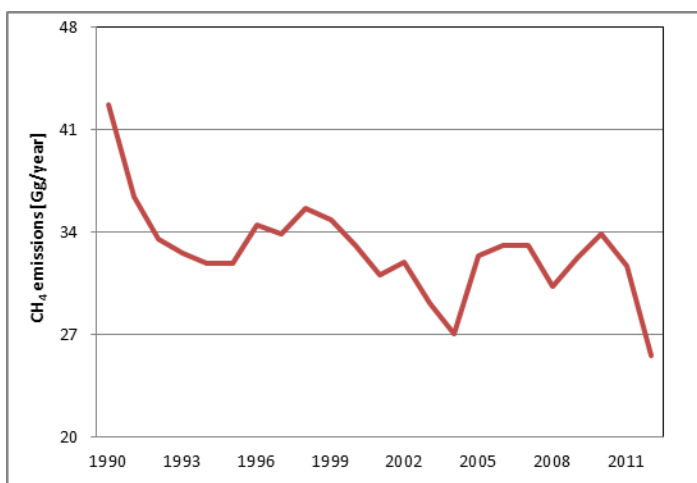


Fig. 3-8 Methane emissions trends from the sector Fugitive Emissions from Oil and Natural Gas [Gg CH₄]

3.9.2.1 Source category description

Oil (1B2a)

CH₄ 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. CO₂ emissions from the refinery resulting from combustion processes (including flaring) are included in *1A1b Crude Oil Refining*.

1B2a1 Exploration

Exploration is not systematically performed in the Czech Republic.

1B2a2 Production

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

Tab. 3-36 Crude Oil mining in the CR in 2000 – 2012

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| [kt/year] | 175 | 183 | 265 | 317 | 306 | 313 | 265 | 246 | 242 | 222 | 176 | 165 | 156 |

1B2a3 Transport

Transport of Crude Oil in the territory of the Czech Republic is performed only in closed systems (pipeline transport). So far, emissions from this subsector have not been evaluated. In the context of internal control procedures, this fact was identified as an inadequacy and thus default emission factors were used to calculate fugitive CH₄ and CO₂ emissions in this subsector.

1B2a4 Refining / Storage

Crude Oil is processed in the territory of the Czech Republic in two main refinery facilities. Tab. 3-37 gives the total volume of Crude Oil processed in the Czech Republic.

Tab. 3-37 Total Crude Oil input to refineries in CR in 2000 – 2012 [kt/year]

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Refinery Intake | 5 871 | 6 072 | 6 238 | 6 573 | 6 704 | 7 746 | 7 866 | 7 394 | 8 249 | 7 376 | 7 901 | 7 098 | 7 247 |

1B2a5 Distribution of oil products

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

1B2a6 Other

No other operations are considered.

Tab. 3-38 Summarizes the activity data and emission factors used, including calculation of total methane emissions in this subcategory

| Category | Tier | A | B | C | D |
|-------------------------|-------|-----------------|------------------------|--|--|
| | | Activity | Emission Factors | CH ₄ Emissions (kg CH ₄) | Emissions CH ₄ (Gg CH ₄) |
| | | | | C = (A x B) | D = (C/10 ⁶) |
| Production - OIL | | PJ oil produced | kg CH ₄ /PJ | | |
| domestic production | 3 | 6.61 | 5 288 | 34 974 | 0.035 |
| Transport | | PJ oil refined | kg CH ₄ /PJ | | |
| transport of Crude oil | | 307.2 | 146 | 44 884 | 0.045 |
| Refining | | PJ oil refined | kg CH ₄ /PJ | | |
| processing of Crude oil | 1 - 2 | 307.2 | 1 150 | 353 297 | 0.353 |
| | | | | CH ₄ from Oil | 0.433 |

1B2b Natural Gas

1B2b1 Exploration

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

1B2b2 Production

Natural Gas is extracted in the Czech Republic in the area of Southern Moravia, accompanying extraction of Crude Oil, and in Northern Moravia, where it is derived from degassing of hard coal deposits. The following Tab. 3-39 gives the amount of extracted Natural Gas in the territory of the Czech Republic.

Tab. 3-39 Extraction of Natural Gas in the CR in 2000 - 2012

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| [mill. m ³ /year] | 219 | 160 | 153 | 168 | 215 | 201 | 194 | 201 | 199 | 178 | 203 | 184 | 263 |

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

1B2b3 Transmission

A transit gas pipeline runs through the territory of the Czech Republic, transporting Natural Gas from Russia to the countries of Western Europe, with a length of 2,455 km. In addition to this central gas pipeline, a system of high-pressure gas pipelines is in operation in the territory of the Czech Republic, providing supplies of Natural Gas from the transit gas pipeline and underground gas storage tanks to centres of consumption. In 2012, the high-pressure gas pipelines had an overall length of 13 065 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.

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

1B2b4 Distribution

Emissions from distribution gas pipelines, with an overall length in 2012 of 48 253 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.

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

Emissions from storage (injection and mining) of Natural Gas in the territory of the Czech Republic are reported in this subcategory. The total turnover (injection and mining) of Natural Gas in underground storage areas corresponded to 3 450 mil. m³ in 2012.

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

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

Activity data, emission factors and the resultant emission data are given in Tab. 3-40 for the entire *1B2b Natural Gas* sector.

Tab. 3-40 Calculation of CH₄ emissions from Gas in 2012 in structure IPCC

| Category | Tier | A | B | C | D |
|---|------|--------------------------------------|-----------------------------|--------------------------------------|---|
| | | Activity | Emission Factors | CH ₄ Emissions | CH ₄ Emissions |
| | | | | (kg CH ₄) C = (A x B) | (Gg CH ₄) D = (C/10 ⁶) |
| GAS | | | | | |
| Production/Processing | | <i>PJ gas produced</i> | <i>kg CH₄/PJ</i> | | |
| <i>(domestic production NG)</i> | 3 | 8.96 | 38 649 | 346 108 | 0.346 |
| Transmission and Distribution | | <i>PJ gas transported</i> | <i>kg CH₄/PJ</i> | | |
| <i>(transit transport and high pressure pipeline)</i> | 2 | 1 134.8 | 6 720 | 7 626 240 | 7.63 |
| Distribution | | <i>PJ gas distributed</i> | <i>kg CH₄/PJ</i> | | |
| <i>(low pressure pipeline)</i> | | 143.4 | 113 216 | 16 237 554 | 16.24 |
| Other Leakage | | <i>PJ gas stored</i> | <i>kg CH₄/PJ</i> | | |
| <i>(underground storage)</i> | 3 | 117.47 | 7 768 | 912 472 | 0.91 |
| | | TOTAL CH₄ from Gas | | | 25.12 |

1B2c Venting and Flaring

In this category the default EFs from the Good Practice Guidance (IPCC, 2000) (table 2.16, pages 2.86-2.87) were used. The EF value of 2.7 E-04 Gg per 103 m³ was used for conventional oil production, which was taken from the "Oil Production, Conventional Oil, Fugitives" part of table. Owing to the fact that activity data are required in kg/PJ, the value was converted to 7 327.9 kg/PJ by using the typical value of density for crude oil of 880 kg/t and NCV = 41.87 MJ/kg (this value was calculated as the weighted average for the 1990 – 2008 period from the CzSO questionnaires for IEA).

In addition, the estimations of CO₂, CH₄ and N₂O emissions from venting and flaring in the course of oil production were obtained by using the default EFs provided by the Good Practice Guidance (IPCC, 2000)(see table 2.16, page 2.86). In this case the following EFs were taken (from the part of the table for "Oil Production, Conventional Oil, Venting and Oil Production, Conventional Oil, Flaring"):

1. B. 2. c. Venting

CH₄: 6.2E-05 to 270E-05 Gg per 103 m³ conventional oil production

CO₂: 1.2E-05 Gg per 103 m³ conventional oil production

1. B. 2. c. Flaring

CH₄: 0.5E-05 to 27E-05 Gg per 103 m³ conventional oil production

CO₂: 6.7E-02 Gg per 103 m³ conventional oil production

N₂O: 6.4E-07 Gg per 103 m³ conventional oil production

Like in the previous case (1.B.2.a.ii), the EFs were converted to kg/PJ by using the same values for the oil density and NCV.

For CH₄, only the minimum and maximum values of the EF range are given. Taking into account that the range is rather wide, we assumed lognormal distribution; see 2006 Guidelines (IPCC, 2006), Vol. 1: General Guidance and Reporting, Chapter 3.2.2.4 Good Practice Guidance (IPCC, 2000) for selecting probability density functions, p. 3.23. Therefore, the average of the logarithms was used for evaluation of the EFs for venting and flaring:

1. B. 2. c. Venting

CH₄: 11 104 kg/PJ

CO₂: 325.7 kg/PJ

1. B. 2. c. Flaring

CH₄: 997.2 kg/PJ

CO₂: 1 818 399 kg/PJ

N₂O: 17.4 kg/PJ

Tab. 3-41 gives the CH₄ and CO₂ emissions from Venting for domestic extraction of petroleum; N₂O emissions are not included in this subcategory since no emission factor is available for their calculation. Tab. 3-41 further contains CH₄, CO₂ and N₂O emissions from Flaring in domestic extraction of petroleum.

Tab. 3-41 Emissions of CH₄, CO₂ and N₂O from Venting and Flaring in 1990 – 2012

| | Venting - emissions [t/year] | | Flaring - emissions [t/year] | | |
|------|------------------------------|-----------------|------------------------------|-----------------|------------------|
| | CH ₄ | CO ₂ | CH ₄ | CO ₂ | N ₂ O |
| 1990 | 23.4 | 0.688 | 2.1 | 3 839 | 0.037 |
| 1991 | 31.5 | 0.924 | 2.8 | 5 162 | 0.049 |
| 1992 | 37.7 | 1.107 | 3.4 | 6 180 | 0.059 |
| 1993 | 51.0 | 1.495 | 4.6 | 8 346 | 0.080 |
| 1994 | 59.4 | 1.744 | 5.3 | 9 735 | 0.093 |
| 1995 | 67.5 | 1.974 | 6.1 | 11 022 | 0.105 |
| 1996 | 70.3 | 2.055 | 6.3 | 11 476 | 0.110 |
| 1997 | 75.4 | 2.204 | 6.8 | 12 306 | 0.118 |
| 1998 | 82.7 | 2.419 | 7.4 | 13 505 | 0.129 |
| 1999 | 85.2 | 2.490 | 7.6 | 13 904 | 0.133 |
| 2000 | 81.6 | 2.385 | 7.3 | 13 317 | 0.127 |
| 2001 | 85.2 | 2.492 | 7.7 | 13 911 | 0.133 |
| 2002 | 123.6 | 3.614 | 11.1 | 20 176 | 0.193 |
| 2003 | 147.6 | 4.316 | 13.3 | 24 099 | 0.230 |
| 2004 | 142.2 | 4.159 | 12.8 | 23 220 | 0.222 |
| 2005 | 145.5 | 4.254 | 13.1 | 23 751 | 0.227 |
| 2006 | 123.5 | 3.612 | 11.1 | 20 168 | 0.193 |
| 2007 | 114.9 | 3.361 | 10.3 | 18 764 | 0.179 |
| 2008 | 112.9 | 3.300 | 10.1 | 18 425 | 0.176 |
| 2009 | 103.5 | 3.037 | 9.3 | 16 902 | 0.161 |
| 2010 | 82.9 | 2.430 | 7.4 | 13 570 | 0.130 |
| 2011 | 77.7 | 2.278 | 7.0 | 12 682 | 0.121 |
| 2012 | 73.4 | 2.154 | 6.6 | 11 990 | 0.115 |

3.9.2.2 Methodological issues

1B2a Oil

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.

1B2a1 Exploration

Activity data: number of mined boreholes – notation key NO, default emission factors have not been published for CO₂ and CH₄ – notation key NO. N₂O emissions: notation key NA: N₂O emissions are practically not formed in exploratory work.

1B2a2 Production

Activity data for determining CH₄ emissions are taken from the CzSO – IEA questionnaires and controlled using data from the Mining Yearbook. CH₄ emissions are determined as the product of annual Crude Oil mining and the emission factor. The emission factor has a value of 5,287 kg/PJ and was determined on the basis of published data in (Zanat et al., 1997). The emission factor was determined as the sum of the individual emission factors from pumping of raw Crude Oil and from storage of raw Crude Oil. These data were obtained by direct measurement. The resultant emission factor was increased by an estimate of fugitive emissions at mining boreholes (probes).

1B2a3 Transport

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 Good Practice Guidance (IPCC, 2000) Table 2.16, page 2.87 are employed to calculate the CH₄ and CO₂ emissions.

EF CH₄ – 0.00015 kt/PJ, EF CO₂ – 0.00001 kt/PJ. These emission factors were used to calculate fugitive emissions for the years since 1990.

1B2a4 Refining / Storage

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 1,150 kg/PJ.

The IPCC method does not give any EF for CO₂ or N₂O. Consequently, the notation key NE is used in CRF.

1B2a5 Distribution of oil products

The available IPCC methodology does not provide any EF for CO₂, CH₄ or N₂O – notation key – NE. The products which originate during oil processing cannot contain CO₂ or CH₄. There isn't known process by which could arise fugitive CO₂ or CH₄ emissions during the distribution of oil products.

1B2a6 Other

Activity data: notation key: NO; CH₄ and CO₂ emissions – notation key NO.

1B2b Natural Gas

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

As a method was developed in the last few years for determining methane emissions in the gas industry using specific emission factors, this sophisticated method of calculation continues to be used, although, from the standpoint of ref. (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 (Alfeld, 1998). The total emission value given corresponds to about 0.3 % of the total consumption of Natural Gas in the Czech Republic. The detailed calculation given corresponds to Tier 2.

In general, it can be stated that the determined methane emissions in category 1B2 Gas are basically formed in several ways:

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

1B2b1 Exploration

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

1B2b2 Production

1B2b3 Transmission

1B2b4 Distribution

1B2b5 Other Leakage – 1B2b51 storage of Natural Gas

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

Tab. 3-42 Model calculation of CH₄ emissions in the Natural Gas sector (2012)

| | EF | | Activity data | | Emissions |
|-------------------------|---|--------------------------|---------------|---------------------|--------------------------|
| | value | units | value | units | mil.m ³ /year |
| production | 0.20 | % vol. | 263.0 | mil. m ³ | 0.526 |
| high pressure pipelines | 600 | m ³ /km.year | 13 065 | km | 7.839 |
| compressors | | | | | 4.339 |
| storage | 0.075 | % vol. | 3 450 | mil. m ³ | 2.587 |
| regulation stations | 1 000 | m ³ /station | 4 465 | pcs | 4.465 |
| distribution network | 300 | m ³ /km.year | 48 253 | km | 14.476 |
| final consumption | 2 | m ³ /consumer | 2 868 083 | pcs | 5.736 |
| Total | | | | | 41.786 |
| | Emissions in Gg (0.67 kg/m ³) | | | | 27.997 |

Emissions calculated in this model are then transformed to the structure of the sectors and subsectors according to the IPCC methodology.

3.9.2.3 Uncertainty and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 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 1B2 Oil and Natural Gas is estimated to equal 75 %.

Summary of uncertainty values provides Tab. 3-43.

Tab. 3-43 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 | 1B2 Oil and Natural Gas | 7 | 75 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| CH ₄ | 1B2 Oil and Natural Gas | 7 | 75 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |

3.9.2.4 Source specific QA/QC and verification

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

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, 2012) 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.

3.9.2.5 Source-specific recalculations

No recalculations were performed in this submission.

3.9.2.6 Source-specific planned improvements

Specific attention will be paid to uncertainty determination and assessment.

4 Industrial Processes (CRF Sector 2)

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 CO₂ emissions from the decomposition of limestone) and not from fuel used to heat the rotary kiln (considered in category 1A2f). However, the situation in iron and steel production is more complicated. Evaluation of the CO₂ 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 2012, the total aggregate GHG emissions from industrial processes were 11 887.95 Gg of CO₂ equivalents, which represent decrease of 2 % compared to the previous year. Emissions decreased by 39 % compared to the reference year 1990.

4.1 Overview of sector

4.1.1 General description and key categories identification

The major share of CO₂ emissions in this sector comes from sub-source categories 2C1 Iron and Steel Production and 2A Mineral Products.

N₂O emissions coming from 2B Chemical Industry and F-gas emissions and consumption are less significant. Iron and steel, Cement production, F-gases Use, Limestone and Dolomite Use, Lime production and Nitric acid production can be considered to be *key categories* (KC) according to Good Practice Guidance (IPCC, 2000, IPCC, 2003). Tab. 4-1 gives a summary of the main sources of direct greenhouse gases in this sector, shows share of national emissions in 2012 and lists type of key category analysis for key categories.

Tab. 4-1 Overview of key categories in sector Industrial Processes (2012)

| Category | Character of category | Gas | % of total GHG* |
|---------------------------------------|-----------------------|------------------|-----------------|
| 2.C.1 Iron and Steel Production | LA,TA | CO ₂ | 3.787 |
| 2.F.1-6 F-gases Use - ODS substitutes | LA,TA | HFC,PFC | 1.927 |
| 2.A.1 Cement Production | LA | CO ₂ | 1.003 |
| 2.A.3 Limestone and Dolomite Use | LA,TA | CO ₂ | 0.756 |
| 2.A.2 Lime Production | LA,TA | CO ₂ | 0.402 |
| 2.B.1 Ammonia Production | LA | CO ₂ | 0.400 |
| 2.B.2 Nitric Acid Production | TA | N ₂ O | 0.317 |

* 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.

Category 2A Mineral Products includes practically only emissions of CO₂ as well as category 2C Metal Production. CO₂ emissions from the 2B Chemical Industry comes from 2B1 Ammonia Production, while N₂O emissions originate from 2B2 Nitric Acid Production. Industrial CH₄ emissions are insignificant.

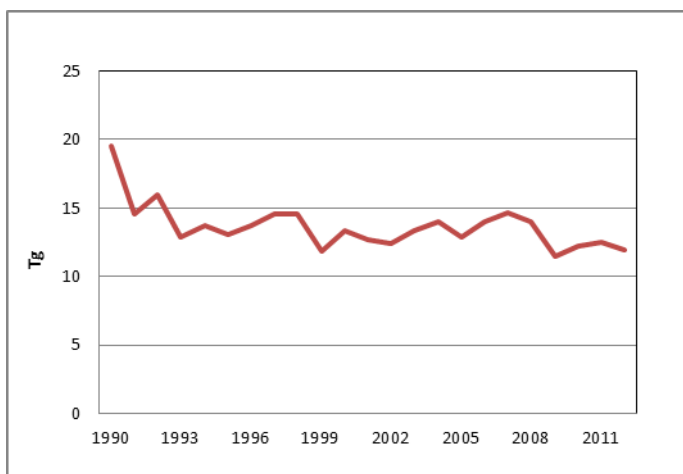


Fig. 4-1 GHG emissions trend from Industrial Processes, 1990 – 2012 [Tg CO₂ eq.]

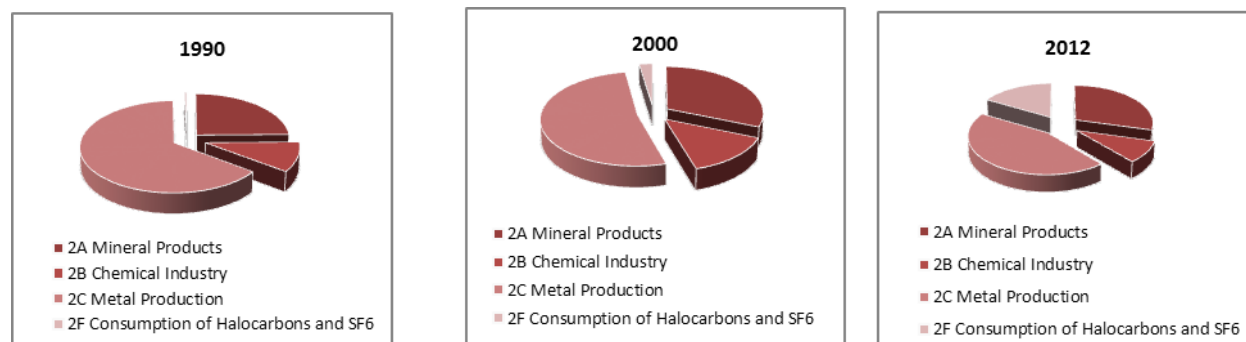


Fig. 4-2 Share of GHG emissions from individual subcategories on the whole sector of Industrial Processes in 1990, 2000, 2012 [Gg CO₂ eq.]

4.2 Mineral Products (2A)

This category describes GHG emissions from the non-combustion processes from the following categories: 2A1 Cement Production, 2A2 Lime Production, 2A3 Limestone and Dolomite Use, 2A4 Soda Ash Production and Use and 2A7 Other.

Fig. 4-3 depicts the share of CO₂ emissions in this category. The major share (44 %) belongs to 2A1 Cement Production, 32 % belongs to 2A3 Limestone and Dolomite Use production and 17 % to 2A2 Lime Production. Tab. 4-2 lists the CO₂ emissions in the individual subcategories in 2A Mineral Products in 2012.

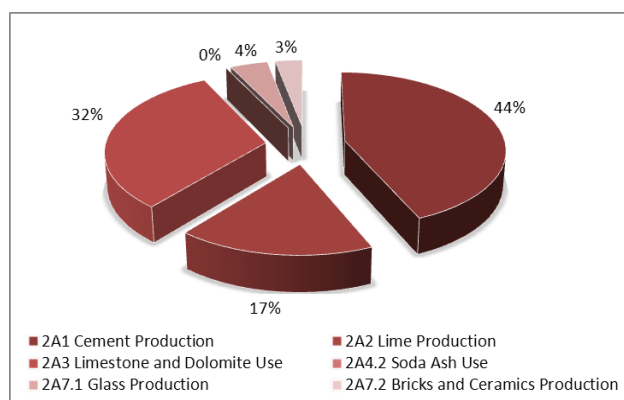


Fig. 4-3 The share of individual categories in CO₂ emissions from category 2A Mineral Products in 2012 [Gg CO₂]

Tab. 4-2 CO₂ emissions in individual subcategories in 2A Mineral Products category in 1990 – 2012

| | Category 2A - CO ₂ emissions [Gg] | | | | | |
|------|--|---------------------|--------------------------------|--------------------|------------------------|--------------------------------------|
| | 2A1 Cement Production | 2A2 Lime Production | 2A3 Limestone and Dolomite Use | 2A4.2 Soda Ash Use | 2A7.1 Glass Production | 2A7.2 Bricks and Ceramics Production |
| 1990 | 2 489.18 | 1 336.65 | 677.51 | NO | 173.12 | 153.37 |
| 1991 | 2 308.92 | 844.66 | 605.37 | NO | 148.43 | 127.93 |
| 1992 | 2 468.42 | 831.46 | 282.51 | NO | 146.46 | 123.12 |
| 1993 | 2 194.55 | 778.67 | 251.37 | NO | 142.06 | 147.18 |
| 1994 | 2 208.38 | 806.53 | 290.97 | NO | 153.60 | 150.98 |
| 1995 | 2 005.01 | 817.53 | 519.03 | NO | 116.48 | 144.39 |
| 1996 | 2 116.49 | 830.73 | 662.96 | NO | 122.50 | 175.76 |
| 1997 | 2 083.36 | 852.73 | 750.60 | NO | 135.80 | 213.49 |
| 1998 | 2 067.65 | 797.00 | 909.35 | NO | 141.68 | 271.46 |
| 1999 | 1 962.91 | 787.47 | 975.24 | NO | 145.88 | 210.67 |
| 2000 | 1 936.86 | 828.53 | 1 007.85 | NO | 167.58 | 225.50 |
| 2001 | 1 628.84 | 827.06 | 1 033.10 | 0.1031 | 168.42 | 201.58 |
| 2002 | 1 403.48 | 815.33 | 1 043.28 | 0.2098 | 188.86 | 151.81 |
| 2003 | 1 484.85 | 808.00 | 1 032.65 | 0.3266 | 198.24 | 161.55 |
| 2004 | 1 626.76 | 808.73 | 1 044.81 | 0.4359 | 232.68 | 160.78 |
| 2005 | 1 624.53 | 762.82 | 1 055.00 | 0.4682 | 231.56 | 181.00 |
| 2006 | 1 748.45 | 758.02 | 1 069.05 | 0.3458 | 245.00 | 153.92 |
| 2007 | 2 043.08 | 794.07 | 1 105.73 | 0.5016 | 236.32 | 184.36 |
| 2008 | 1 996.15 | 742.01 | 1 017.32 | 0.5597 | 212.69 | 161.32 |
| 2009 | 1 566.08 | 625.43 | 944.84 | 0.4129 | 186.10 | 126.25 |
| 2010 | 1 469.27 | 670.89 | 1 021.32 | 0.8604 | 143.15 | 119.73 |
| 2011 | 1 664.53 | 691.42 | 1 151.23 | 1.0620 | 193.31 | 122.14 |
| 2012 | 1 517.03 | 608.57 | 1 105.88 | 1.0875 | 148.18 | 106.38 |

Tab. 4-3 gives an overview of the emission factors used for computations of emissions in category 2A Mineral Products in 2012.

Tab. 4-3 CO₂ emission factors used for computations of 2012 emissions in category 2A

| | Emission factor CO ₂ | unit | Source or type of EF |
|--|---------------------------------|---|----------------------|
| 2A1 Cement Production | 0.5346 | t CO ₂ / t sinter | EU ETS |
| 2A2 Lime Production | 0.7884 | t CO ₂ / t CaO | CS |
| 2A3 Limestone and Dolomite Use from use in sintering plants | 0.08 | t CO ₂ / t sinter | EU ETS |
| 2A4 Soda Ash Use | 0.415 | t CO ₂ / t soda ash | IEF |
| 2A7.1 Glass Production | 0.14 | t CO ₂ / t glass | EMEP/CORINAIR |
| 2A7.2 Bricks and Ceramics Production | 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 |

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 (2A1)

CO₂ emissions from cement production have decreased since 1990 by 33 %. 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 CO₂ is emitted during transformation of raw materials (mainly decarbonization of limestone). Process-related CO₂ is emitted during the production of clinker (calcination process) when calcium carbonate (CaCO₃) 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. CO₂ emissions from combustion processes taking place in the cement industry (especially heating of rotary kilns) have been reported in IPCC category 1A2f. Limestone (and dolomite) contains also small amount of magnesium carbonate (MgCO₃) and fossil carbon (C), which will also calcinate or oxidize in the process causing CO₂ emissions.

4.2.1.2 Methodological issues

CO₂ emissions from *2A1 Cement production* can be calculated according to the 2000 GPG (IPCC, 2000) from the production of cement (Tier 1) or clinker (Tier 2). The Tier 1 approach was employed towards 2006 submission. The cement production statistic was available and default emission factor from the Revised 1996 Guidelines (IPCC, 1997), i.e. 0.4985 t CO₂/t cement, was used for estimating of CO₂ emissions from cement production throughout the nineties.

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. CO₂ 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 - 2012. 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 CO₂ emissions and, therefore, substantial attention is devoted to their determination.

The methodology used for CO₂ emissions must be in accordance with national legislation (Vyhláška 12/2009 o stanovení postupu zjišťování, vykazování a ověřování množství emisí skleníkových plynů / Decree 12/2009 establishing a procedure for identifying, reporting and verifying emissions of greenhouse gases) 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, 2012), 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 CO₂ emissions and clinker production, varies from 0.5267 to 0.5534 t CO₂ / t clinker.

Tab. 4-4 introduces the activity data for clinker production, emission factor and CO₂ emissions for the whole time series.

Tab. 4-4 Activity data, CO₂ emission factor and CO₂ emissions in 2A1 Cement Production category in 1990 - 2012

| | 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 |
|---------------------------|------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 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 |
| 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 |
| Emissions CO ₂ | Gg | 1 403 | 1 485 | 1 627 | 1 625 | 1 748 | 2 043 | 1 996 | 1 566 | 1 469 | 1 665 | 1 517 |

4.2.1.3 Uncertainty and time-series consistency

In 2012 the research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are based on the 2006 Guidelines (IPCC, 2006). Since the Tier 3 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 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

4.2.1.4 Source-specific QA/QC and verification

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 8.

4.2.1.5 Source-specific recalculations

No recalculations were performed in this submission.

4.2.1.6 Source-specific planned improvements

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

4.2.2 Lime Production (2A2)

CO₂ 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.

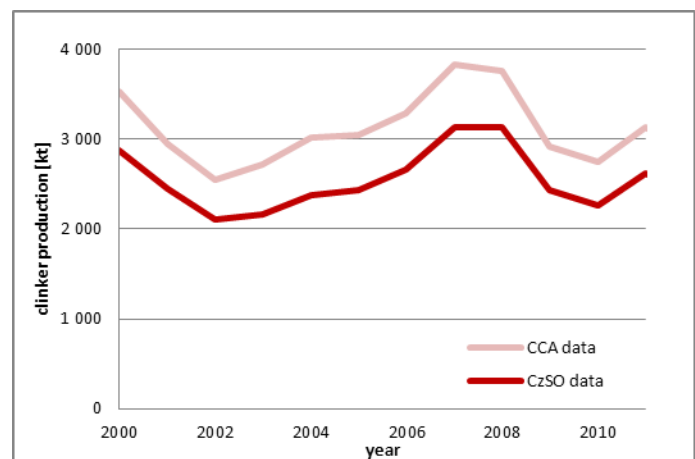


Fig. 4-4 Comparison of clinker production data provided by CzSO and CCA

4.2.2.1 Source category description

From a chemical point of view, lime is calcium oxide. CO₂ is released during calcination. During the production of lime, the limestone is heated up which leading to decomposition (i.e. calcination) of CaCO₃/MgCO₃ to the lime (CaO, CaO·MgO) and CO₂ which is released to the atmosphere.

4.2.2.2 Methodological issues

Emissions from lime production are calculated in line with 2000 GPG (IPCC, 2000). Only CO₂ emissions generated in the process of the calcination step of lime treatment are considered in this category. CO₂ emissions from combustion processes (heating of kilns and furnaces) are reported under category 1A2f. National EF reflects the production of lime and quick lime (0.7884 t CO₂ / 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 statistics from the Czech Lime Association (CLA, 2013), 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 shows comparison of CO₂ emissions calculated according to IPCC methodology and process-related emissions reported for EU ETS. ETS data closely corresponds to the IPCC methodology and national circumstances. Two lime producers are not included in the EU ETS data.

Tab. 4-5 Comparison of CO₂ emissions from lime production 2005 – 2012

| | Lime produced [t / year] | Process-specific CO ₂ emissions [Gg] | |
|------|-----------------------------|--|--------|
| | | IPCC methodology | EU ETS |
| 2005 | 1 040 | 763 | 738 |
| 2006 | 1 034 | 758 | 748 |
| 2007 | 1 083 | 794 | 772 |
| 2008 | 1 012 | 742 | 717 |
| 2009 | 853 | 625 | 596 |
| 2010 | 915 | 671 | 646 |
| 2011 | 943 | 691 | 676 |
| 2012 | 830 | 609 | 597 |

Tab. 4-6 lists activity data for lime production, emission factors and CO₂ emissions for the whole time series.

Tab. 4-6 Activity data, CO₂ emission factor and CO₂ emissions in 2A2 Lime Production category in 1990 - 2012

| | 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 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 |
| 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 |
|---------------------------|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Lime production | kt | 1 112 | 1 102 | 1 103 | 1 040 | 1 034 | 1 083 | 1 012 | 853 | 915 | 943 | 830 |
| EF CO ₂ | t CO ₂ /t CaCO ₃ | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 |
| Emissions CO ₂ | Gg | 815 | 808 | 809 | 763 | 758 | 794 | 742 | 625 | 671 | 691 | 609 |

4.2.2.3 Uncertainty and time-series consistency

In 2012 the research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006). Since activity data are based on the CLA statistics, 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 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

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 Czech Lime Association and EU ETS data are used for verification of the CO₂ 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.

The quality control was held by fulfilling the QA/QC form presented in Annex 8.

4.2.2.5 Source-specific recalculations

No recalculations are applicable for this year.

4.2.2.6 Source-specific planned improvements

The Tier 2 methodology is used for computation of emissions in this category. Currently, this method is considered to be sufficient. However an effort will be made to use Tier 3.

4.2.3 Limestone and Dolomite Use (2A3)

CO₂ emissions in category *2A3 Limestone and Dolomite Use* are emitted from sulphur removal using limestone and emissions from limestone and dolomite use in sintering plants. Emissions from sulphur removal have increased since 1996, when the first sulphur-removal unit came into operation. All Czech thermal power plants have been equipped with sulphur-removal units since 1999.

Since 1999 CO₂ emissions have slightly varied around 1000 Gg CO₂ according to electricity production from thermal (brown coal) power plants. Emissions from limestone and dolomite use in sintering plants have fluctuated and were influenced by the transition from a planned economy to a market economy, and restructuring and modernization of the iron and steel industry. The decrease in emissions in 2008 and 2009 was caused by the economic crisis. In 2010 - 2012 a slight improvement in the economy followed by an increase in emissions was observed.

4.2.3.1 Source category description

From the chemical point of view sulphur removal from combustion products from coal using limestone is source of CO₂ emissions. Here, it holds that one mole of SO₂ removed releases one mole of CO₂ without regard to the sulphur-removal technology employed and the stoichiometric excess. Limestone and dolomite are added to sinter where they are calcined, the products subsequently acting as slag formers in blast furnaces.

Emissions from limestone and dolomite which are used for cement production are reported under cement production, similarly to lime and glass production. There is no other known production or process which uses limestone and/or dolomite and produces CO₂ emissions in the CR.

4.2.3.2 Methodological issues

CO₂ emissions from sulphur removal were calculated from coal consumption for electricity production, the sulphur content and the effectiveness of sulphur removal units between 1996, when the first sulphur removal units came into operation, and 2005. In 2005, these data were verified by comparison with data from the

individual operators, which were collected for EU ETS preparation and which cover the years 1999 – 2005. The EU ETS data form has been used since 2006. The methodology used for estimation of the CO₂ emissions must be in accordance with the national legislation (Vyhláška 12/2009 o stanovení postupu zjišťování, vykazování a ověřování množství emisí skleníkových plynů / Decree 12/2009 establishing a procedure for identifying, reporting and verifying emissions of greenhouse gases) 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).

Emissions from limestone and dolomite use in sintering plants were new source, in 2006 submission, which was identified in the process of preparation of the EU Emission Trading Scheme. Only 2 sintering plants have existed in the CR in recent times. CO₂ emissions from this category are calculated on the basis of data from statistics (The Steel Federation, Inc. - production of agglomerate / sinter) and the EF value, which was derived from EU ETS CO₂ emission data based on the limestone and dolomite compositions and consumptions (0.08 t CO₂ / t sinter). Tab. 4-7 lists data for this category.

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

Tab. 4-7 CO₂ emissions from Limestone and Dolomite Use in desulphurization unit, sinter plant, in 1990 – 2012 [Gg]

| | CO ₂ emissions from desulfurization | CO ₂ emissions from sinter plant |
|------|--|---|
| 1990 | NO | 678 |
| 1991 | NO | 605 |
| 1992 | NO | 283 |
| 1993 | NO | 251 |
| 1994 | NO | 291 |
| 1995 | NO | 519 |
| 1996 | 76 | 587 |
| 1997 | 241 | 510 |
| 1998 | 417 | 492 |
| 1999 | 537 | 438 |
| 2000 | 540 | 468 |
| 2001 | 551 | 482 |
| 2002 | 551 | 492 |
| 2003 | 560 | 473 |
| 2004 | 551 | 494 |
| 2005 | 589 | 467 |
| 2006 | 587 | 483 |
| 2007 | 614 | 492 |
| 2008 | 607 | 411 |
| 2009 | 600 | 345 |
| 2010 | 651 | 370 |
| 2011 | 739 | 412 |
| 2012 | 699 | 407 |

4.2.3.3 *Uncertainty and time-series consistency*

In 2012 the research was conducted in order to develop new uncertainty estimates. The uncertainty for the activity data is in line with Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and was determined at the level of 5 %. The uncertainty for the emission factor is in line with the 2006 Guidelines (IPCC, 2006) and was determined at the level of 4 %. Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured for the limestone and dolomite use in sintering plants as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

4.2.3.4 *Source-specific QA/QC and verification*

The sector-specific QA/QC plan is formulated, closely related to the QA/QC plan of the National Inventory System.

The calculations in the limestone and dolomite use category are based on data taken from CzSO and EU ETS. The EU ETS data are verified by independent verifiers.

CzSO has its own verification procedures employed before data is published.

4.2.3.5 *Source-specific recalculations*

No recalculations are applicable for this year.

4.2.3.6 *Source-specific planned improvements*

Since country-specific method is used for computation in this category, there is no significant improvement planned in this category.

4.2.4 Soda Ash Production and Use (2A4)

4.2.4.1 Source category description

CO₂ emissions from Soda Ash Production and Use (2A4) category come only from soda ash use. Soda ash is not produced in the Czech Republic. Except for the Glass production category, soda ash is used in only one other installation. CO₂ emissions from this category are small and insignificant (varied between 0.1 and 1.1 Gg CO₂) compared to the other categories. The maximum value of the emissions reported in this category is 1.09 Gg CO₂ in 2012.

4.2.4.2 Methodological issues

For each mole of soda ash use, one mole of CO₂ is emitted, so that the mass of CO₂ 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 Uncertainty and time-series consistency

In 2012 the research was conducted in order to develop new uncertainty estimates. Since no default uncertainty data was found in the methodology, the uncertainties in this category are still based on the expert judgment, i.e. 5 % for the activity data and 10 % for the emission factor. Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year of 2001, when the use of soda started, to 2012.

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

No recalculations performed in this submission.

4.2.4.6 Source-specific planned improvements

Since plant-specific data and simple stoichiometry are used for computation in this category there is no significant improvement planned in this category.

4.2.5 Other (2A7)

The 2A7 *Other* category summarizes in Czech Republic emissions from *Glass Production* (2A7.1 – CO₂) and from *Brick and Ceramics Production* (2A7.2 – CO₂ and CH₄). CO₂ emissions from 2A7.1 *Glass production* equalled 148 Gg in 2012. CO₂ emissions from *Brick and Ceramics Production* (2A7.2) amounted to 106 kt CO₂ in 2012.

4.2.5.1 Source category description

CO₂ emissions from *Glass Production* (2A7.1) are derived particularly from the decomposition of alkaline carbonates added to glass-making sand. CO₂ and CH₄ emissions from *Brick and Ceramics Production* are derived particularly from the decomposition of alkaline carbonates, fossil and biogenic carbon based substances included in the raw materials.

4.2.5.2 Methodological issues

The emission factor value of 0.14 t CO₂ / t glass was taken from the new version of the guidebook (EMEP / CORINAIR Atmospheric Emission Inventory Guidebook, 1999). Activity data were collected and published by the Association of the Glass and Ceramic Industry of the Czech Republic in previous years. Beginning with this submission, the activity data are available from CzSO.

Emissions from *2A7.2 Brick and Ceramics Production* are derived particularly from the decomposition of alkaline carbonates fossil and biogenic carbon based substances included in the raw materials. The EF value was derived from individual installation data collected for EU ETS (emissions) and from CzSO (production). The calculation is based on the total production of ceramic products (fine ceramics, tiles, roofing tiles, and bricks) and the EF value.

4.2.5.3 Uncertainty and time-series consistency

In 2012 the research was conducted in order to develop new uncertainty estimates. 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 CO₂ emission factor. The uncertainty for the CH₄ emission factor was determined at the level of 50 %. Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

4.2.5.4 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 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.

4.2.5.5 Source-specific recalculations

No recalculations performed in this submission.

4.2.5.6 Source-specific planned improvements

It is planned to verify emission estimates with data from the EU ETS system and other available sources.

4.3 Chemical Industry (2B)

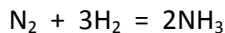
Of the categories of sources classified under the Chemical industry (2B), categories 2B1, 2B2 and 2B5 are relevant for the Czech Republic, while adipic acid (2B3) and carbides (2B4) are not produced here.

4.3.1 Ammonia production (2B1)

The production of ammonia constitutes an important source of CO₂ derived from non-energy use of fuels in the chemical industry. CO₂ emissions from ammonia production in 2012 equalled 574.0 Gg of CO₂, corresponding to approx. 0.5 % of total greenhouse gas emissions without LULUCF. These emissions decreased by 28.9 % compared to 1990; however, emissions in period 2005 - 2012 are almost constant, with slight fluctuations. Ammonia production (CO₂ emissions) was not identified as a key category this year (in contrast to some previous years). However, it remains just under the threshold value in the determination by level assessment.

4.3.1.1 Source category description

Industrial ammonia production is based on the catalytic reaction between nitrogen and hydrogen:



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 technologically-specific emission factor 2.40 Gg CO₂ / Gg NH₃ (Markvart and Bernauer, 2005 - 2012). This emission factor was derived from the relevant technical literature - Ullman's Encyclopedia (Wiley, 2005) corresponding to the ammonia production employed in the Czech Republic, including information required for deriving the carbon dioxide emission factor: 56.25 t NH₃ are produced from 44 t of residual oil containing 84.6 % C. Simple stoichiometric calculation yields the value of the emission factor EF CO₂ = 2.402 t CO₂/t NH₃. This emission factor includes the efficiency of the conversion of carbon contained in the starting material to carbon dioxide, equal to 99 % (i.e. an oxidation factor of 0.99).

A potential uncertainty in the emission factor for ammonia would not influence the total sum of CO₂ 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. 4-8 Activity data and CO₂ emissions from ammonia production in 1990 – 2012.

Tab. 4-8 Activity data and CO₂ emissions from ammonia production in 1990 – 2012

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|--------|--------|--------|--------|--------|--------|--------|--------|
| Residual fuel oil used for NH ₃ product., [TJ] | 11 113 | 10 770 | 11 104 | 10 383 | 11 593 | 10 235 | 11 015 | 10 095 |
| Ammonia produced, [kt] | 335.9 | 325.5 | 335.6 | 313.8 | 350.4 | 309.3 | 332.9 | 305.1 |
| CO ₂ from 2B1, [Gg] | 806.8 | 781.9 | 806.1 | 753.8 | 841.6 | 743.0 | 799.7 | 732.9 |

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|--------|-------|--------|-------|-------|-------|-------|-------|
| Residual fuel oil used for NH ₃ product., [TJ] | 10 407 | 8 864 | 10 144 | 8 538 | 7 449 | 9 696 | 9 721 | 8 478 |
| Ammonia produced, [kt] | 314.5 | 267.9 | 306.6 | 258.0 | 225.1 | 293.0 | 290.8 | 253.6 |
| CO ₂ from 2B1, [Gg] | 755.5 | 643.6 | 736.5 | 619.9 | 540.8 | 703.9 | 698.7 | 609.3 |

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|-------|-------|-------|-------|-------|-------|-------|
| Residual fuel oil used for NH ₃ product., [TJ] | 8 086 | 7 575 | 8 487 | 8 739 | 8 510 | 7 616 | 7 899 |
| Ammonia produced, [kt] | 241.9 | 226.6 | 256.5 | 264.1 | 257.2 | 230.2 | 238.7 |
| CO ₂ from 2B1, [Gg] | 581.1 | 544.4 | 616.3 | 634.4 | 617.8 | 553.0 | 573.5 |

4.3.1.3 Uncertainty and time consistency

Uncertainty estimates of activity data and emission factors have so far been based mainly on expert judgment.

In 2012, estimates of the uncertainty parameters were again verified in the study (Markvart and Bernauer, 2012) 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 (CO₂ 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 2012.

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 CO₂ 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). The quality control was held by fulfilling the QA/QC form presented in Annex 8.

4.3.1.5 Source-specific recalculations

No recalculations were employed in this category in this submission.

4.3.1.6 Source-specific planned improvements

In the next submission the 2006 Guidelines methodology will be used for emission estimates. Application of this methodology will introduce some changes also to category of ammonia production, for instance the CO₂ emissions from urea will be extracted from this category.

4.3.2 Nitric acid production (2B2)

The production of nitric acid constitutes one of the most important sources of N₂O in the chemical industry. N₂O emissions from production of nitric acid in 2012 equalled 1.38 Gg N₂O, 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 2012, the production of nitric acid (N₂O emissions) was identified as a key category by trend assessment. In former years, when N₂O 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 N₂O. Since 2004, the technology to reduce N₂O 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 *2B2 Nitric Acid Production* are generated as a by-product in the catalytic process of oxidation of ammonia. It follows from domestic studies (Markvart and Bernauer, 1999, 2000, 2003), describing conditions prior to 2004, that the resulting emission factor depends on the technology employed: higher emission factor values are usually given for processes carried out at normal pressure, while lower values are usually given for medium-pressure processes. Two types of processes were carried out in this country before 2004, at pressures of 0.1 MPa and 0.4 MPa. The amount of nitrous oxide in the exit gases is also

affected by the type of process employed to remove nitrogen oxides, NO_x (i.e. NO and NO₂). In this country, the process of Selective Catalytic Reduction (SCR) is mostly used, which slightly increases the amount of N₂O, and also to a certain degree Non-Selective Catalytic Reduction (NSCR), which also removes N₂O 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. 4-9. 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 N₂O was evaluated on the basis of the balance calculations presented in studies (Markvart and Bernauer, 2000, 2003).

Tab. 4-9 Emission factors for N₂O 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 ₂ O [kg N ₂ O / t HNO ₃] | 9.05 | 9.20 | 1.80 | 5.43 | 5.58 | 1.09 |

Collection of activity data for HNO₃ 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 N₂O 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. 4-10 Emission factors for N₂O 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 ₂ O / t HNO ₃ (100 %) | 9.05 | 4.9 | 1.09 | 7.8 ^{a)} |

^{a)} EF without N₂O mitigation. Cases of N₂O mitigation in 2005 - 2008 are shown in Tab. 4-11

In the last quarter of 2005, a new N₂O mitigation unit based on catalytic decomposition of N₂O 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 N₂O/t HNO₃ (100 %). Therefore, the mean value in 2005 for the 0.7 MPa technology was equal to 7.02 kg N₂O/t HNO₃ (100 %), (Markvart and Bernauer, 2006).

In 2006 - 2012, the mitigation unit described above was utilized in a more effective way, see (Markvart and Bernauer, 2007 - 2012). The decrease in the emission factor for 0.7 MPa technology as a result of installation of the N₂O mitigation unit and gradual improvement of the effectiveness is given in Tab. 4-11.

Two high temperature N₂O 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 N₂O was 3.10 kg N₂O/ t HNO₃ (100 %); in the July-November 2009 period, EF N₂O was 3.30 kg N₂O/ t HNO₃ (100 %). The second system consisting of high temperature N₂O decomposition catalyst developed by YARA company, decreased EF N₂O in the November-December 2009 period to the value 0.95 kg N₂O/ t HNO₃ (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 N₂O and slow deactivation of the N₂O decomposition catalyst. Thus, the mean value of EF N₂O for this high pressure nitric acid technology in 2009 was assessed at a value of 2.85 kg N₂O/ t HNO₃ (100 %) (Tab. 4-11).

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 N₂O decomposition catalyst (i.e. YARA catalyst) is employed, the EF N₂O could be approximately close to 1.3 kg N₂O/ t HNO₃ (100 %).

YARA's catalyst, which was also used in 2011 and 2012, exhibits excellent stability with respect to N₂O conversion and the catalyst efficiency was practically constant during the last three years in the high-pressure (0.7 MPa) nitric acid unit.

Tab. 4-11 Decrease in the emission factor for 0.7 MPa technology due to installation of the N₂O mitigation unit

| Year | 2004 ^{a)} | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--|--------------------|------|------|------|------|------|------|------|------|
| EF, kg N ₂ O / t HNO ₃ (100 %) | 7.8 | 7.02 | 5.94 | 4.37 | 4.82 | 2.85 | 1.29 | 1.30 | 1.45 |
| Effectiveness of mitigation, % | - | 10 | 23.9 | 43.9 | 38.2 | 63.4 | 83.4 | 83.3 | 81.4 |

^{a)} EF without N₂O mitigation.

The emission factors used in the Czech Republic are compared with the EFs presented in the IPCC methodology (IPCC, 2000) in the Tab. 4-12.

Tab. 4-12 Comparison of emission factors for N₂O from HNO₃ production

| Production process | N ₂ O Emission factor (kg N ₂ O/t 100% HNO ₃) | Reference |
|--|---|-------------------------------------|
| Canada Plants without NSCR Plants with NSCR | 8.5 <2 | (IPCC, 2000) |
| USA Plants without NSCR Plants with NSCR | 9.5 2 | (IPCC, 2000) |
| Norway Process-integrated N ₂ O destruction Atmospheric pressure plant Medium pressure plant | <2 4–5 6–7.5 | (IPCC, 2000) |
| Other countries Dual-pressure plant (European design) Older plants (pre-1975), without NSCR | 8–10 10–19 | (IPCC, 2000) |
| Czech Republic Atmospheric pressure plants Medium pressure plants with SCR Medium pressure plants with NSCR High pressure plants SCR (no N ₂ O decomposition) High pressure plants SCR (with N ₂ O decomposition) | 9.05 4.9 1.09 7.8 4.82 – 1.29 | (Markvart and Bernauer, 2009, 2010) |

Tab. 4-13 gives the N₂O emissions from production of nitric acid, including the production values.

Tab. 4-13 Emission trends for HNO₃ production and N₂O emissions

| | Production of HNO ₃ , [Gg HNO ₃ (100 %)] | Emissions of N ₂ O [Gg N ₂ O] from HNO ₃ production | Implied Emission Factor IEF [Mg N ₂ O/ Gg HNO ₃] |
|------|---|---|--|
| 1990 | 530.0 | 3.63 | 6.86 |
| 1991 | 349.6 | 2.37 | 6.78 |
| 1992 | 439.4 | 2.98 | 6.77 |
| 1993 | 335.9 | 2.27 | 6.77 |
| 1994 | 439.8 | 2.94 | 6.68 |
| 1995 | 498.3 | 3.37 | 6.68 |
| 1996 | 484.8 | 3.06 | 6.68 |
| 1997 | 483.1 | 3.33 | 6.92 |
| 1998 | 532.5 | 3.59 | 6.74 |
| 1999 | 455.0 | 2.95 | 6.49 |
| 2000 | 505.0 | 3.36 | 6.65 |
| 2001 | 505.1 | 3.32 | 6.57 |
| 2002 | 437.1 | 2.87 | 6.57 |
| 2003 | 500.6 | 2.86 | 5.72 |
| 2004 | 533.7 | 3.27 | 6.13 |
| 2005 | 532.2 | 3.09 | 5.80 |
| 2006 | 543.1 | 2.76 | 5.09 |
| 2007 | 554.2 | 2.28 | 4.11 |
| 2008 | 507.0 | 2.14 | 4.21 |
| 2009 | 505.2 | 1.63 | 3.23 |
| 2010 | 441.7 | 1.21 | 2.73 |
| 2011 | 561.8 | 1.35 | 2.40 |
| 2012 | 550.5 | 1.38 | 2.50 |

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. 4-9 and Tab. 4-10, 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. 4-11) 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 HNO₃.

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 HNO₃ 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 N₂O 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 (N₂O 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 2012.

4.3.2.4 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 N₂O 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 Recalculations

No recalculations in the 2B2 category were employed in this submission.

4.3.2.6 Source-specific planned improvements

No improvement is planned for the next submission.

4.3.3 Other (2B5)

4.3.3.1 Source category description

This category includes methane emissions from the production of carbon black, ethylene, dichloroethylene, styrene, methanol and N₂O emissions from the production of caprolactam. These are all less important sources.

4.3.3.2 Methodological issues

Default emissions from the IPCC methodology (IPCC, 1997) are employed to determine methane emissions from the production of carbon black, ethylene, dichloroethylene and styrene.

CH₄ emissions from the production of carbon black

The nominal capacity is currently 300 t p.a. Exact information on activity data is not available for the individual years; thus, the data were taken as the expert estimates mentioned in the study (Markvart and Bernauer, 2012), taking into account the increase in carbon black consumption in the rubber industry:

| | |
|-----------|-------------------------|
| 1990-2000 | 200 t carbon black p.a. |
| 2001-2005 | 250 t carbon black p.a. |
| 2006-2012 | 300 t carbon black p.a. |

The emission factor taken from the IPCC method equals 0.011 kt CH₄/kt carbon black, so that the highest value of methane emissions over the past few years is practically insignificant (0.0033 Gg).

CH₄ emissions from the production of ethylene

Reliable data for the production of ethylene are available from CzSO. The IPCC methodology yields a value of 0.001 kt/kt for the default emission factor for methane. In 1990 – 2012, methane emissions varied between 0.3 and 0.5 Gg CH₄ (emissions equalled 0.441 Gg CH₄ in 2012).

CH₄ emissions from the production of dichloroethylene

While CzSO does not publish information on the amount of dichloroethylene produced, it does give data on the amount of PVC produced. The study (Markvart and Bernauer, 2011) recommends multiplying the amount of PVC produced by a coefficient of 1.23 derived from the stoichiometry. The IPCC methodology yields a value of 0.0004 kt/kt for the default emission factor for methane. Because of the low emission factor value, the values of methane emissions varied in 1990 – 2012 between 0.04 and 0.06 Gg CH₄ – and this is thus a not very significant value. Emissions equalled 0.046 Gg CH₄ in 2012.

CH₄ 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. |
| 2005-2009 | 150 kt styrene p.a. |
| from 2010 | 170 kt styrene p.a. |

These estimates of data on the amount of styrene produced, mentioned in the study (Markvart and Bernauer, 2013), are based on the data given in the article (Dvořák and Novák, 2010). The emission factor taken from the IPCC methodology equals 0.004 kt CH₄/kt styrene. In 1990 – 2012, methane emissions varied between 0.3 and 0.7 Gg CH₄ (emissions equalled 0.68 Gg CH₄ in 2012).

Methanol is not produced in the Czech Republic and thus the notation key “NO” applies to the entire time period from 1990.

Production of caprolactam

As mentioned in the references (Markvart and Bernauer, 2004 – 2013), there is only one caprolactam production plant in the Czech Republic; this is not a very important source of N₂O emissions. CzSO does not monitor production data on the production of caprolactam; however, the series of studies by Markvart and Bernauer (Markvart and Bernauer, 2004 – 2012), based on a study in the production factory, yields an approximate value of 0.27 Gg N₂O for the period to 2005 and, following 2006, a value of 0.305 Gg N₂O, based on increased production capacity. More exact data should be available in the coming years, when the N₂O emissions from the production of caprolactam will be continuously measured from 2012 as a consequence of inclusion of the production in the emission trading scheme (EU ETS) and thus recording in the relevant register.

4.3.3.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2B5, 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; the numerical values are given in Chapter 1-7.

4.3.3.4 QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2B5, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

4.3.3.5 Recalculations

In submissions prior to the 2011 submission, CH₄ emissions were reported for the production of carbon black, dichloroethylene and styrene only following 2008 because of the lack of the activity data required for determining emissions. However, the authors of the study (Markvart, Bernauer, 2011) recently managed to obtain the data required for determining CH₄ emissions from 1990 (see the “Methodical Issues” section). The newly determined values (replacing symbol “NE”) must be seen as recalculations. This increase of completeness of the inventory has resolved the repeated recommendations of the international inspection team over the past years. In this submission (2014 submission) no recalculation was carried out.

4.3.3.6 Source-specific planned improvements

In the next submission the 2006 Guidelines methodology will be used for emission estimates. Application of this methodology will introduce some changes also to the category of chemical industry, for instance the CO₂ emissions from ethylene production, which are now reported in 1A, will be reported in category 2B8b Ethylene.

Furthermore more exact data on N₂O emissions will be available, when the N₂O emissions from the production of caprolactam will be continuously measured beginning in 2013 as a consequence of inclusion of the production in the emission trading scheme (EU ETS) and thus recording in the relevant register.

4.4 Metal Production (2C)

4.4.1 Source category description

This category includes mainly CO₂ emissions from *2C1 Iron and Steel Production*. CO₂ emissions from iron and steel are identified as a key category (by both level and trend assessments). A small amount of CH₄ is also emitted.

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).

Ferro-alloys were manufactured in limited amounts in a small production unit in the Czech Republic; this process could constitute an unsubstantial source of CO₂ emissions. Unfortunately, CzSO does not monitor any data on this production process. Investigation revealed one smaller production plant, which reported that aluminium was used as a reducing agent; this did not lead to CO₂ emissions. In 2009 this production was stopped.

4.4.2 Methodological issues

Since this submission CO₂ emissions in 2C1 category were determined based on the Tier 2 in line with 2000 Good Practice Guidance (IPCC, 2000). The computation (Tier 2) is based on balance of the amount of carbon occurred during the iron and steel production. The total amount of emitted carbon was determined based on the amount of coke consumed in blast furnaces (C from coke in blast furnaces), on the amount of produced steel (C in produced steel), on the amount of C in scrap and on the amount of C in electrodes. In this respect it is necessary to highlight that the carbon from the blast furnace coke (considered also earlier in the Tier 1 method) contributes dominantly to CO₂ emissions. Therefore the difference between emission estimates determined by Tier 2 and by Tier 1 methods is relatively low.

All activity data are based on officially submitted statistic of CzSO and were examined and confirmed by the representative of The Steel Federation, Inc.

Determination of carbon from coke used in blast furnaces is in 2012 carried out using net calorific value, emission factor and oxidation factor given in Tab. 3-13. Emission and oxidation factors are default factors provided by Revised 1996 Guidelines (IPCC, 1997), net calorific value is the country specific value based on the official CzSO Questionnaire. Parameters necessary for estimation of carbon amount in scrap and steel were used based on 2006 Guidelines, Table 4.3 (IPCC, 2006).

The amounts of blast furnace coke consumed and corresponding emissions are given in Tab. 4-14.

Tab. 4-14 The amounts of blast furnace coke consumed and CO₂ emissions from iron and steel in 1990 – 2012

| | Coke consumed in blast furnaces | CO ₂ from 2C1 [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 |

| | Coke consumed in blast furnaces | CO ₂ from 2C1 [Gg] |
|------|---------------------------------|-------------------------------|
| 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 |

Estimation of CH₄ from metal production is based on the CORINAIR methodology. Metal production emits only 2.3 – 6.0 Gg of methane.

Emissions of methane in 2012 equalled 2.6 Gg, of which 1.2 Gg corresponds to the contribution of methane emissions from coke production. In this case, the relevant activity data correspond to the amount of coke produced from the Energy Balances of the CR are given in CRF Tables

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

4.4.3 Uncertainty and time consistency

The uncertainty estimates 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 (CO₂) 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 2012.

4.4.4 QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. The greatest attention was focused on identifying gaps and imperfections using the new reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs. Attention was also focused on checking sources from inter-sector boundaries (Energy, Industry) that they are neither omitted nor counted twice. CO₂ 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.

The quality control was held by fulfilling the QA/QC form presented in Annex 8.

4.4.5 Recalculations

Since this submission CO₂ emissions are determined based on the Tier 2 methodology. This improvement follows the official Improvement plan of the Czech Republic. Implementation of higher Tier brings recalculation of the whole time series. This recalculation caused decline in CO₂ emissions for 0.8 % in 1990 and for 2.2 % in 2011.

4.4.6 Source-specific planned improvements

In the next submission the 2006 Guidelines methodology will be used for emission estimates. Application of this methodology will introduce some changes also to 2C1 category, for instance the CO₂ emissions from Limestone and Dolomite Use in metal industry should be covered here (instead of 2A3 category).

4.5 Other Production (2D)

In this sector are reported only indirect GHGs and SO₂ from sectors Pulp and Paper; Food and Drink.

4.6 Production of Halocarbons and SF₆ (2E)

Halocarbons and SF₆ are not produced in Czech Republic.

4.7 Consumption of Halocarbons and SF₆ (2F)

4.7.1 Source category description

Emissions of F-gases (HFCs, PFCs, SF₆) in the Czech Republic are at a relatively low level due to the absence of large industrial sources of F-gases emissions. As mentioned above, F-gases are not produced in the Czech Republic and therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (CFCs, HCFCs, etc.) that could lead to by-product F-gases emissions and there is no primary aluminium and magnesium industry in the Czech Republic. F-gases emissions are progressively increasing from the very beginning, probably not reaching its peak in 2012.

HFC emissions from 2.F.1 category dominates f-gases emissions as illustrated on Fig. 4-7, the use of PFCs is dropping and is expected to cease. Emissions of SF₆ keeps very steady trend in the whole series, thanks to its irreplaceable role in electrical equipment insulation, it's high price on the market prevents it to expand in the fields of other possible use.

Compared to 2011 the redistributed amounts (potential emissions) of f-gases dropped by significant margin but thanks to contribution of emissions from previous years and also exponentially rising emissions from decommissioned appliances the actual emissions keep still rapidly growing trend. For better understanding please inspect the following figures.

Accounted activities under Consumption of F-gases in Czech Republic are limited to these:

- SF₆ used in electrical equipment,
- SF₆ used in production of sound-proof windows,
- SF₆ used in special applications (laboratory),
- HFCs, PFCs and SF₆ used in semiconductor manufacturing,
- HFCs and PFCs used as refrigerants in refrigeration and air conditioning equipment,
- HFCs and PFCs used as solvents,
- HFCs used as propellants in aerosols,
- HFCs used as blowing agents,
- HFCs used as extinguishing agents in fixed fire-fighting systems.

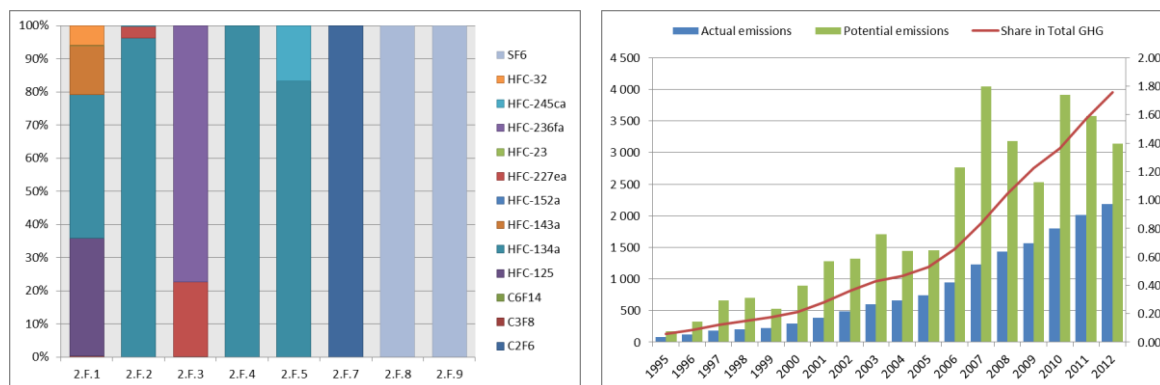


Fig. 4-1 Share of F-gases actual emissions in sectors (on the left); Trends of 2.F - Halocarbons and SF₆ consumption actual/potential emissions and share in total GHG emissions (including LULUCF) (on the right)

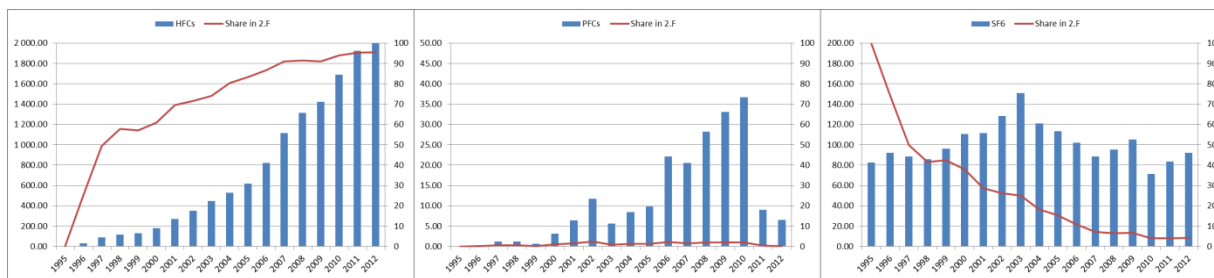


Fig. 4-2 Emissions of HFCs, PFCs and SF₆ in Gg CO₂ eq. and their percentual share in category 2F (from left: HFCs, PFCs, SF₆)

No official statistics that would allow easy disaggregated reporting and/or use of the highest tiers are currently available in the Czech Republic. Inventory of potential and actual emissions of F-gases is based on customs statistics, the national database of obligatory reporting (ISPOP) and individual verification/rectification 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.

For source consumption of F-gases, potential emissions increased from 169.38 Gg CO₂ eq. in 1995 to 3 141.38 Gg CO₂ eq. in 2012. The decrease in 2012 compared to 2010 could be explained by economic recession or might as well be an indicator of the approaching overall F-gas peak. For the source consumption of F-gases, actual emissions increased from 82.87 Gg CO₂ eq. in 1995 to 2 181.43 Gg CO₂ eq. in 2012. 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 and potential emissions is given in Tab. 4-154 and in the CRF Tables, for clear visual comparison please inspect Fig. 4-6 and Fig. 4-7.

Tab. 4-15 Potential and actual emissions of HFCs, PFCs and SF₆ in 1995 - 2011 [Gg CO₂ eq.]

| | Potential | | | | Actual | | | |
|------|-----------|-------|-----------------|----------|----------|-------|-----------------|----------|
| | HFCs | PFCs | SF ₆ | Total | HFCs | PFCs | SF ₆ | Total |
| 1995 | 2.21 | 0.35 | 166.82 | 169.38 | 0.21 | 0.01 | 82.65 | 82.87 |
| 1996 | 134.51 | 4.22 | 183.07 | 321.80 | 31.45 | 0.38 | 92.28 | 124.10 |
| 1997 | 479.44 | 1.17 | 180.49 | 661.10 | 88.07 | 1.24 | 88.69 | 178.01 |
| 1998 | 577.87 | 1.17 | 126.02 | 705.07 | 118.76 | 1.21 | 85.67 | 205.65 |
| 1999 | 411.87 | 2.74 | 110.90 | 525.50 | 129.47 | 0.66 | 96.14 | 226.27 |
| 2000 | 674.32 | 9.45 | 206.02 | 889.79 | 178.36 | 3.12 | 110.82 | 292.29 |
| 2001 | 1 045.13 | 14.49 | 223.23 | 1 282.84 | 270.18 | 6.49 | 111.35 | 388.02 |
| 2002 | 1 092.41 | 17.91 | 211.85 | 1 322.17 | 351.50 | 11.69 | 128.36 | 491.54 |
| 2003 | 1 343.94 | 28.64 | 339.26 | 1 711.84 | 446.50 | 5.67 | 150.91 | 603.07 |
| 2004 | 1 215.00 | 20.98 | 208.00 | 1 443.98 | 529.96 | 8.46 | 121.15 | 659.57 |
| 2005 | 1 280.55 | 13.77 | 156.88 | 1 451.20 | 617.02 | 9.77 | 113.19 | 739.98 |
| 2006 | 2 573.99 | 30.33 | 161.90 | 2 766.21 | 820.64 | 22.18 | 102.08 | 944.90 |
| 2007 | 3 884.78 | 27.57 | 133.84 | 4 046.18 | 1 116.45 | 20.57 | 88.71 | 1 225.73 |
| 2008 | 3 053.38 | 38.25 | 85.32 | 3 176.95 | 1 314.12 | 28.23 | 95.19 | 1 437.54 |
| 2009 | 2 355.90 | 39.38 | 132.17 | 2 527.44 | 1 423.87 | 33.13 | 105.45 | 1 562.46 |
| 2010 | 3 854.52 | 44.25 | 16.73 | 3 915.50 | 1 688.82 | 36.66 | 71.45 | 1 796.93 |
| 2011 | 3 475.38 | 2.43 | 97.50 | 3 575.31 | 1 924.52 | 9.07 | 83.67 | 2 017.27 |
| 2012 | 2 984.41 | 1.38 | 155.59 | 3 141.38 | 2 082.75 | 6.57 | 92.11 | 2 181.43 |

4.7.2 General methodological issues

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

According to the Revised 1996 Guidelines (IPCC, 1997), potential emissions have been calculated from the consumption of F-gases (sum of domestic production and import minus export and environmentally sound disposal). Due to the relatively short time of use of F-gases, the disposed amount is relatively small and considered negligible for the inventory process. In 2012, a small amount of destroyed F-gases was reported, where the main volume of recovered and destroyed F-gases 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 potential methodology is the same for all categories of use of F-gases. 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 are of key importance. Individual F-gases do not have separate custom codes in the customs tariff list as individual chemical substances. SF₆ is listed as part of a cluster of non-metal halogenides and oxides, 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 potential and actual emissions. Emissions of F-gases are based on data on import and export of individual chemicals or their mixtures (as bulk), but not contents in products.

4.7.3 Sector-specific methodological issues

This chapter specifies the actual emission methodology used for a given sector. In the following chapters, individual sectors with similar methodology are combined. A similar approach is used in the foam blowing and sound-proof windows sectors for estimation of actual emissions, and thus the approach is described in one joint chapter. Detailed information on the data and methodology used are included in a special report prepared by external sectoral expert, Mr. Řeháček (Řeháček, 2013).

The most important category in the range of actual emissions is Refrigeration and Air Conditioning Equipment, which is responsible for 93.66 % of actual F-gases emissions.

4.7.3.1 Refrigeration and Air Conditioning Equipment

In the CRF Tables, emissions from this category are divided into only two sub-categories:

2.F.1.1 Domestic Refrigeration and 2.F.1.6 Mobile Air-Conditioning; emissions from other subcategories are included in these two categories because of the lack of detailed information. The methodology used in these calculations underestimates the real emissions, as information about marketed products containing F-gases is not taken into account. The underestimation for 2011 is relatively low measures to obtain relevant data to split the emission categories are in progress.

Tab. 4-15 Parameters for use in slightly modified eq. 3.40 2000 GPG (IPCC, 2000)

| Sub-application | Lifetimes (years) | Emission Factors (% of initial charge/year) | | End-of-Life Emission (%) | |
|--------------------------|-------------------|---|--------------------|--------------------------|--------------------------|
| Factor in Equation | d | k | x | $\eta_{rec,d}$ | 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 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 table 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 HFC134a 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 50/50.

In 2012 no significant change occurred in the collection and treatment policies of discarded refrigeration appliances. Companies in the market remained unchanged. Experiments have been performed in the true regeneration of disposed F-gases by only one company. They used privately constructed distilling machinery to process approx. 2 tonnes of HFC134a contaminated by mineral oil fractions. The HFC was collected and stored during previous years. Emissions from this process were 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 12-year life cycle (as reported by CzSO) in accordance with expectations. 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 process than air-conditioning or refrigeration. A very small amount of coolant medium (R 410) is exported for purposes of re-generation, 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. The calculation was performed using Equation 3.44 from 2000 GPG (IPCC, 2000); recently, it has been assumed that emissions from disposal and destruction are negligible because of the relatively short time of use of F-gases in this sector. This fact is also supported by the information on disposed refrigerants (Řeháček, 2013). The contribution of this sector to total actual F-gases emissions was 22.35 % in 2012. It can be anticipated that emissions from this category will increase in the future.

Emissions from Stationary Refrigeration include emissions from servicing old equipment and emissions from production of new air-conditioning equipment. The calculation is performed using the Tier 2 top-down approach methodology (Equation 3.40 from 2000 GPG). This sector has the greatest share in the total actual emissions of F-gases, which equalled 71.31 % in 2012.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl in 2014.

4.7.3.2 Foam Blowing and Production of Sound-Proof Windows

F-gases were used in the Czech Republic only for producing hard foam. Only HFC-143a was 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 2012. Due to high costs, HFCs are being replaced by other hydrocarbons.

Emissions of SF₆ in this category were introduced in 1996 its usage for production of sound-proof windows is dropping and the amount used has been decreasing since 2003. SF₆ was not reported for use in the first fills of new sound-proof windows and emissions in 2012 came only from stock. SF₆ is being replaced by argon and its mixtures with other hydrocarbons. Overall stocks of SF₆ reached 15 t in 2008 and slowly decreases ever after. Methodology uses default EF and follows equations 3.24-25 (IPCC GPG). Decommissioning emissions are not accounted for due to unfulfilled life-time of the equipment since 1996. Actual emissions from this sector account for approx. 0.15 t of SF₆ annually.

Emissions from these different categories are calculated in a similar way. The default methodology and EF described in 2000 GPG (IPCC, 2000) are used for sound-proof windows, specifically equations 3.24 and 3.35. Similar equations are used for foam blowing. The contribution of foam blowing and production of sound-proof windows to total emissions of F-gases equalled 0.12 % and 0.16 %, respectively, in 2012.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.3.3 Fire Extinguishers

Emissions from this category are calculated on the basis of GPG 2000 (IPCC, 2000). Calculations are based on data about production of new equipment and data about servicing the old equipment. The share of this sector in total actual F-gases emissions was 1.18 % in 2012.

It was revealed in consultations with servicing companies that first-fill leakages are very low and remain below 2 %. Operational leakages are virtually non-existent and depend solely upon activation of fire alarms. The major operator of fire brigades in the Czech Republic claims zero activation in 2012.

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 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.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.3.4 Aerosols / Metered Dose Inhalers and Solvents

Emissions from these categories (2F4 Aerosols / Metered Dose Inhalers and 2F5 Solvents) are based on 2000 GPG (IPCC, 2000) and Equation 3.35; EF equals 50 %. A small amount of F-gases used as solvents was reported in the Czech Republic in 2011. The contribution of these two sectors to the total actual F-gas emissions equalled 0.77 % in 2012. F-gases as propellants for aerosols are currently being replaced by cheaper propellants, specifically dimethylether and other hydrocarbons.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.3.5 Semiconductor Manufacture

Actual emissions in this category are calculated on the basis of Tier 1 methodology. In 2012, emissions in this category equalled 0.92 Gg CO₂, which corresponds to 0,04 % of total f-gas emissions. This category is not very important and its reported emissions do not exceed the overall uncertainty in emissions in this sector.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.3.6 Electrical Equipment

Emissions from this category are calculated in line with 2000 GPG (IPCC, 2000), specifically Equation 3.13, which is called the Tier 3a method. Basic data about new equipment and services can be obtained from the above-mentioned questionnaires. This equipment is produced by only one company and is serviced by several other companies. Emissions from this category correspond to 4.06 % of the total actual emissions of F-gases in 2012. The share of this category in the total actual emissions has decreased significantly since 1995 due to a steady use of SF₆ in this sector but progressive increase in the use of HFCs in refrigeration and air-conditioning.

The users of electrical equipment maintain eco-friendly policies, also due to the high costs of the coolant media. Operational leakage is not measured (legislation does not force operators to do so) but operators usually distinguish between amount of SF₆ 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 SF₆ does not even require the operator to report SF₆ usage in ISPOP.

SF₆ 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.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.3.7 Others

This category includes two sub-categories:

- 2F9 Other / Laboratories category. This category was included in the 2006 submission for the first time and encompasses emissions of SF₆ from laboratory use. Emissions of F-gases were not identified in this category in 2012.

- 2F9 Other / Sound-proof windows category. This category estimates emissions from double-glazed sound-proof windows.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

4.7.4 Uncertainty and time-series consistency

The uncertainty estimates were based on expert judgment (see Chapter 1.7 Uncertainty Analysis). Their improvement is in progress.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

4.7.5 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.

4.7.6 Source-specific recalculations

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 sector which resulted in revisions of the calculation spreadsheets. The revision process has not been fully completed as of 15th March and the results are yet to be double checked.

Emission estimates from refrigeration have been partially reworked, 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 necessary expert judgement was used.

Methodology implementation has been revised in 2013 as a part of QA/QC process, this process has not been finished yet and should finish before implementation of IPCC 2006 Gl. in 2014.

Methodology revision resulted in minor recalculations.

4.7.7 Source-specific planned improvements

Accounting for F-gases contained in products is still being developed and its inclusion is planned in future submissions.

4.8 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 Solvent and Other Product Use (CRF Sector 3)

NMVOC emission shows a long-term decreasing trend. This is caused by many factors, the chief of which are primarily gradual replacement of synthetic coatings and other agents with a high content of volatile substances by water-based coatings and other preparations with low solvent contents in industry and amongst the population. In addition, BAT have been introduced in large industrial sources, especially those covered by the regime of Act No. 76/2002 Coll., on integrated prevention (IPPC). This favourable trend has been slowed down recently by increasing domestic production, especially in the automobile industry. Fig. 5-1 indicates the trend of NMVOC emissions in 2012 and the share of individual subcategories in the whole sector 3.

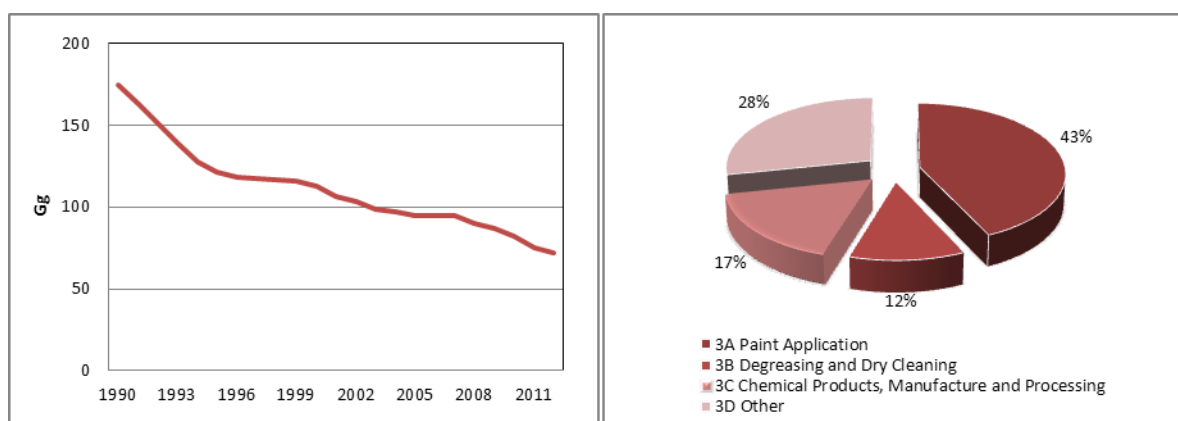


Fig. 5-1 Trend of NMVOC emissions from Solvent and Other Product Use in 2012; share of individual subcategories in the whole sector 3 Solvent and Other Product Use

5.1 Source category description

This category includes particularly emissions of NMVOC (ozone precursor) from the use of solvents, which are simultaneously considered to be a source of CO₂ emissions (these solvents are mostly obtained from fossil fuels), as their gradual oxidation in the atmosphere is also a factor. However, the use of solvents is not an important source of CO₂ emissions - in 2012, CO₂ emissions were calculated at the level of 0.237 Mt CO₂.

This category (Solvent and Other Product Use) also includes N₂O emissions from the use of this substance in the food industry (aerosol cans) and in health care (anaesthesia). These not very significant emissions corresponding to 0.75 Gg N₂O were derived from production in the Czech Republic (0.6 Gg N₂O) and from import of N₂O (0.15 Gg N₂O), see (Markvart and Bernauer, 2010, 2011, 2012, 2013).

So far, in the Czech Republic, no relevant data have been available to distinguish between N₂O used in anaesthesia and for aerosol cans. Therefore, the existing split (50 % for anaesthesia) was based only on a rough estimate.

Now the authors of the study (Markvart and Bernauer, 2013) have managed to perform studies leading to the qualified estimate that approx. 80 % of the N₂O is used in medicine (anaesthesia). This estimate applies to the entire 1990 – 2012 time period.

5.2 Methodological issues

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

Tab. 5-1 Conversion from SNAP into IPCC nomenclature

| SNAP | SOLVENT AND OTHER PRODUCT USE | IPCC | |
|-------|--|------|-----------------------------|
| 06 01 | Paint application | 3A | Paint application |
| | Items 06.01.01 to 06.01.09 | | |
| 06 02 | Degreasing, dry cleaning and electronic | 3B | Degreasing and dry cleaning |
| | Items 06.02.01 to 06.02.04 | | |
| 06 03 | Chemical products manufacturing or processing. | 3C | Chemical products |
| | Items 06.03.01 to 06.03.14 | | |
| 06 04 | Other use of solvents + related activities | 3D | Other |
| | Items 06.04.01 to 06.04.12 | | |
| 06 05 | Use of N ₂ O | 3D | Other |
| | Items 06.06.01 to 06.06.02 | | |

Inventory of NMVOC emissions for 2012 for this sector is based on a study prepared by SVÚOM Ltd. Prague (Geimprová, 2013). This study is elaborated annually for the UNECE / CLRTAP inventory in NFR and is also adopted for the National GHG inventory.

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

- statistical information on producers and imports from the Czech Statistical Office,
- REZZO data,
- annual reports of the Association of Coatings Producers and Association of Industrial Distilleries,
- information from the Customs Administration.
- regular monitoring of economic activities and economic developments in the CR, knowledge and monitoring of important operations in the sphere of surface treatments, especially in the area of application of coatings, degreasing and cleaning;
- regular monitoring of investment activities is performed in the CR for technical branches affecting the consumption of solvents and for overall developmental technical trends of all branches of industry;
- monitoring of implementation of BAT in the individual technical branches;
- technical analysis of consumption of solvents in households; NMVOC emissions from households are entirely fugitive and, according to qualified estimates, contribute approximately 16.5 % to total NMVOC emissions.

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

It is apparent from the Tab. 5-2 that uniform expression of the activity data cannot be employed, as this corresponds in the individual cases to consumption of coatings, degreasing agents, solvents and, in some cases, the weight of the final production, e.g. Dry Cleaning. Consequently, total NMVOC emissions are employed as activity data in the CRF Reporter.

NMVOC emissions oxidize relatively rapidly in the atmosphere, so that CO₂ emissions generated as a consequence of this atmospheric oxidation are also reported in CRF. The CO₂ emissions are calculated using a conversion factor that contains the ratio C/NMVOC = 0.855 and a recalculation ratio of C to CO₂ equal to 44/12. The overall conversion factor has a value of 3.14.

Tab. 5-2 Structure for basic processing of emission data and the dimensions of activity data

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

5.3 Uncertainties and time-series consistency

In 2012 the research was conducted in order to develop new uncertainty estimates. In sector 3, only uncertainties for activity data in category 3D1 Use of N₂O for Anaesthesia, i.e. 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 N₂O). Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2012.

5.4 Source-specific QA/QC and verification

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

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

5.5 Source-specific recalculations

No recalculations performed in this submission.

5.6 Source-specific planned improvements

The value of the conversion factor (3.14) is slightly higher compared to other countries. It is planned to try to obtain background information for a country-specific value. Because of funding shortage it was not possible to obtain data about carbon content in solvents used in CR.

* Provisions of this chapter have been changed due to findings during UNFCCC expert review. Body of the chapter remained unchanged, for detailed information on the changes see page 10.

6 Agriculture (CRF Sector 4)

6.1 Overview of sector

Agricultural greenhouse gas emissions under Czech national conditions consist mainly of emissions from enteric fermentation (CH₄ emissions only), manure management (CH₄ and N₂O emissions) and agricultural soils (N₂O emissions only). The other IPCC subcategories – rice cultivation, prescribed burning of savannas, field burning of agricultural residues and “other” – do not occur in the Czech Republic.

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

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

6.1.1 Key categories

For Agriculture, five of six relevant categories of sources were evaluated by analysis described in IPCC (2000 and 2003) as the key categories. An overview of sources, including their contribution to aggregate emissions, is given in Tab 6-1.

Tab. 6-1 Overview of significant categories in this sector (2012)

| Category | Character of category | Gas | % of total GHG* |
|--|-----------------------|------------------|-----------------|
| 4.D.1 Agricultural Soils, Direct Emissions | LA,TA | N ₂ O | 2.775 |
| 4.D.3 Agricultural Soils, Indirect Emissions | LA,TA | N ₂ O | 1.786 |
| 4.A Enteric Fermentation | LA,TA | CH ₄ | 1.571 |
| 4.B Manure Management | LA,TA | N ₂ O | 0.554 |
| 4.B Manure Management | LA,TA | CH ₄ | 0.394 |

* assessed without considering LULUCF

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

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

6.1.2 Quantitative overview

Agriculture is the third largest sector in the Czech Republic with 6.5 % of total GHG emissions (incl. LULUCF) in 2012 with 8 058.37 Gg CO₂ eq.; 61 % of emissions is coming from Agricultural Soils, 25 % from Enteric Fermentation and 14 % from Manure Management.

The CH₄ emissions from agriculture present 24 % of total national CH₄ emissions (excl. LULUCF) and the N₂O emissions from agriculture present 72 % of total national N₂O emissions in 2012 (excl. LULUCF). During period 1990-2012 emissions from Agriculture decreased by more than 50 %. The quantitative overview and emission trends in reported period are provided in Fig.6.1 and Tab. 6-2.

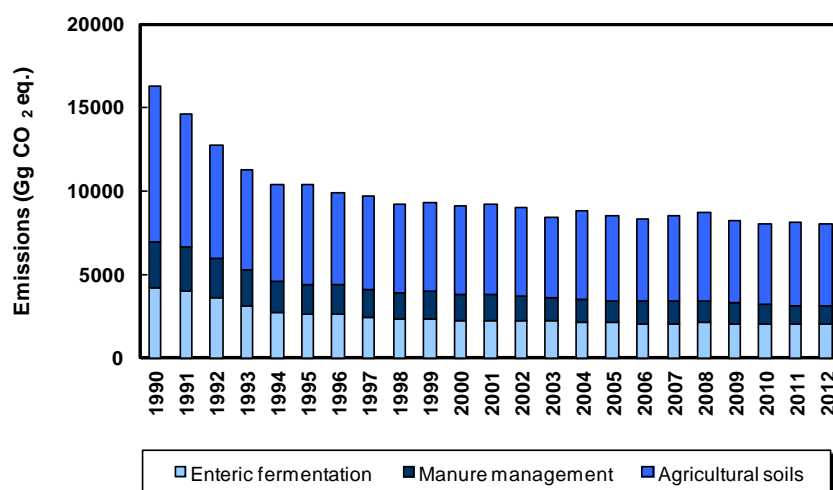


Fig. 6-1 The emission trend in agricultural sector during reporting period 1990–2012 (in Gg CO₂ eq.)

Tab. 6-2 Emissions of Agriculture in period 1990-2012 (sorted by categories)

| Year | Total Emissions | Enteric Fermentation (4A) | Manure Management (4B) | Agricultural Soils (4D) |
|------|--------------------------|------------------------------|---------------------------|----------------------------|
| | [Gg CO ₂ eq.] | | | |
| 1990 | 16 307 | 4 219 | 2 784 | 9 304 |
| 1991 | 14 673 | 3 980 | 2 646 | 8 046 |
| 1992 | 12 786 | 3 568 | 2 399 | 6 819 |
| 1993 | 11 247 | 3 088 | 2 149 | 6 011 |
| 1994 | 10 408 | 2 705 | 1 898 | 5 806 |
| 1995 | 10 364 | 2 632 | 1 774 | 5 959 |
| 1996 | 9 957 | 2 608 | 1 792 | 5 557 |
| 1997 | 9 728 | 2 436 | 1 714 | 5 578 |
| 1998 | 9 263 | 2 284 | 1 633 | 5 346 |
| 1999 | 9 346 | 2 334 | 1 655 | 5 357 |
| 2000 | 9 120 | 2 241 | 1 569 | 5 310 |
| 2001 | 9 269 | 2 257 | 1 531 | 5 481 |
| 2002 | 9 038 | 2 209 | 1 496 | 5 332 |
| 2003 | 8 424 | 2 186 | 1 460 | 4 778 |
| 2004 | 8 860 | 2 139 | 1 408 | 5 313 |
| 2005 | 8 498 | 2 094 | 1 350 | 5 054 |
| 2006 | 8 363 | 2 064 | 1 331 | 4 968 |
| 2007 | 8 521 | 2 084 | 1 330 | 5 107 |
| 2008 | 8 707 | 2 103 | 1 303 | 5 301 |
| 2009 | 8 255 | 2 047 | 1 228 | 4 980 |
| 2010 | 8 058 | 1 999 | 1 173 | 4 886 |
| 2011 | 8 162 | 2 003 | 1 140 | 5 019 |
| 2012 | 8 058 | 2 027 | 1 131 | 4 901 |

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 (see Tab 6-3).

Tab. 6-3 Animal population in the period 1990-2012 (in 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 | 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 |
|----------------|------------|------------|------------|------------|------------|
| Cattle | 1 401 607 | 1 363 213 | 1 349 286 | 1 343 686 | 1 353 685 |
| Pigs | 2 432 984 | 1 971 417 | 1 909 232 | 1 749 092 | 1 578 827 |
| Sheep | 183 618 | 183 084 | 196 913 | 209 052 | 221 014 |
| Poultry | 27 316 866 | 26 490 848 | 24 838 435 | 21 250 147 | 20 691 308 |

During the in-country review in August/September 2010, the expert review team (ERT) identified the estimation of N₂O emissions from Manure management of dairy cattle as a potential problem. 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 an 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. 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 the "Suckler cows" sub-category from Dairy cattle to Non-dairy cattle
- 2) More accurate animal population data (not rounded off to thousands) reported (cattle, swine, sheep and poultry).
- 3) More accurate data for individual cattle sub-categories (suckler and dairy cows, young heifers, young bulls and calves) reported (not rounded off to thousands) for the period since 2006 (since when the detailed data are available).
- 4) Recalculation of N₂O 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. Tier 2 methods implemented for the emission estimation of Manure management of dairy and non-dairy cattle.
- 5) Additionally, a new country-specific parameter on digestibility (DE, in %) was determined and implemented in the 2012 submission.

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), it led to changes in N₂O emissions from Animal manure applied to soils, Pasture, range and paddocks (PRP),

Atmospheric deposition and N-lost through leaching and run-off. These changes apply to the entire reporting period.

The recalculation requested based on the document “Potential problems from ERT (Saturday paper)” led to increased emissions by about 14 % relative to the older approach (submission 2011). The use of updated country-specific data for cattle in calculation of emissions in the 2012 submission resulted in a decrease in emissions by about 1.2 % in 1990 and increase by about 0.6 % in 2009 compared to the 2011 submission.

Two categories were recalculated in the 2012 resubmission. Potatoes, sugarbeets, clover and alfalfa were included in the source of emissions in the Agricultural soils categories (4D1.3 a 4D1.4). The addition of new country-specific data in the calculation resulted in an increase in the total emissions from the Agriculture sector by 2.3 % in 2012. A detailed description of the recalculation is presented in the appropriate chapter (6.4 - Agricultural soils).

According to the previous reiterated ERT recommendation (ARR reports), the Czech Republic recalculated the methane emissions from Manure Management of cattle. In line with the IPCC GPG a higher-tier method to estimate the CH₄ 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. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (see Table 6-1). 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 (4B) increased after recalculation by 7 % in 1990, resp. by 26 % in 2011.

6.2 Enteric Fermentation (4A)

6.2.1 Source category description

This chapter describes estimation of the CH₄ emissions from Enteric Fermentation. In 2012, 81.2 % of agricultural CH₄ emissions arose from this source category (Table 6-2). 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.

6.2.2 Methodological issues

Emissions from enteric fermentation of domestic livestock have been calculated by using IPCC Tier 1 and Tier 2 methodologies presented in the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000). Methane emissions for cattle, which are a dominant source in this category, have been calculated using the Tier 2 method, while for other livestock the Tier 1 method was used. The contribution of emissions from livestock other than cattle to the total emissions from enteric fermentation is not significant.

6.2.2.1 Enteric fermentation of cattle

As the most important output of the national study (Kolar, Havlikova and Fott, 2004), a system of calculation spreadsheets have been developed and used for all the relevant calculations of CH₄ emissions.

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

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

where the “daily food intake” (MJ/day) is taken as the mean feed ration for the given type of cattle (there are several subcategories of cattle) and Y is the conversion factor, which is considered to be Y = 0.06 for cattle. Coefficient 55.65 has dimensions of MJ/kg CH₄.

In principle, this equation should be solved for each cattle subcategory, denoted by index *i*. The Czech Statistical Office, see Statistical Yearbooks (CzSO, 1990–2012), provides following categorization of cattle:

- Calves younger than 6 months¹ of age (male and female)
- Young bulls and heifers (6-12 months of age²)
- 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 1990-2012 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, 1997 and IPCC, 2000), the "daily food intake" for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight (including the final weight of mature animals), weight gain (for growing animals), daily milk production including the percentage of fat (for cows) and the feeding situation (stall, pasture). The national zoo-technical inputs (noted above) were updated by expert from the Czech University of Agriculture in Prague in 2006 and 2011. Examples of input data used (Hons and Mudřík, 2003, Mudřík and Havránek, 2006, Kvapilík J. 2011) are given below, Tab. 6-4 and Tab. 6-5.

Tab. 6-4 Weights of individual categories of cattle, 1990–2012, 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 | 540* |
| Calves to 6 months | 128 | 132 | 133 | 135 | 135* |

Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.

Tab. 6-5 Feeding situation, 1990–2012, 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 | 22 | 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.

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.

Tab. 6-6 The number of 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 | 40 | 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. 6-7), in which only milk from dairy cows is considered, increased to 20.31 litres/day/head in 2012, 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”, as well as the relevant cells in the CRF. 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. Based on 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 1995 and Zeman et. al., 2006; Třináctý 2009; Čermák et al., 2008). Dr. Pozdišek (expert from the Research Institute for Cattle Breeding, Ltd., pers. communication) 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. 6-6. It is obvious that EFs have increased slightly since 1990 because of the increasing weight and milk production for cows and because of the increasing weight and weight gain for other cattle. On the other hand, CH₄ emission from enteric fermentation of cattle dropped during the 1990-2012 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

Tab. 6-7 Milk production of dairy cows and fat content (1990–2012)

| | Dairy cows [thousands] | Daily production [liters / day head] | Fat content [%] |
|------|---------------------------|---|--------------------|
| 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 |

| | Dairy cows | Daily production | Fat content |
|------|-------------|---------------------|-------------|
| | [thousands] | [liters / day head] | [%] |
| 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 |

Tab. 6-8 Methane emissions from enteric fermentation, cattle (Tier 2, 1990–2012)

| | 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 |
| 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 |

6.2.3 Enteric fermentation of other livestock

Compared to cattle, the contribution of other farm animals to the whole CH₄ emissions from enteric fermentation is much smaller, only about 5.5 %. Therefore, CH₄ emissions from enteric fermentation of other farm animals (other than cattle) are estimated by the Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighbouring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed. The obsolete national approach used in the past, which was found not to be comparable with other European countries (Dolejš, 1994 and Jelínek et.al., 1996), was definitively abandoned. The estimated values are presented for the whole period since 1990.

Sheep, goats, swine and horses

The Czech Statistical Office (CZSO) publishes data on the number of goats, sheep, swine, horses and poultry annually in the Statistical Yearbooks (1990-2012).

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

Poultry

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

6.2.4 Uncertainties and time-series consistency

As mentioned above, methane emissions from the breeding of farm animals are caused both by enteric fermentation and also by the decomposition of animal excrements (manure). Determination of these emissions was prepared at the level of both Tier 1 and Tier 2. As enteric fermentation is considered according to Tab. 6-1 to constitute a key source, preference should be given to determination in Tier 2.

For quite a long time, calculations were based on historical studies (Dolejš, 1994) and (Jelínek et al., 1996). In principle, emissions from animal excrements could be calculated according to Tier 1 (this is not a key source); however, because of tradition and for consistency of the time series, the final values were also calculated according to Tier 2 using the emission factors from above-mentioned studies (Dolejš, 1994; Jelínek et al., 1996). An approach based on historical studies was indicated to be obsolete in many reviews organized by UNFCCC. Moreover, IEFs (implied emission factors) were mostly found as outliers: especially EFs for enteric fermentation in cattle seemed to be substantially underestimated. Details of the historical approach are given in former NIRs (submitted before 2006).

The Czech team accepted critical remarks put forth by the International Review Teams (ERT) and prepared a new concept for calculation of CH₄ emissions. This concept, in accordance with the plan for implementing Good Practice, is based on the following options:

- 1) Emissions of methane from enteric fermentation of livestock (a key source) come predominantly from cattle. Therefore Tier 2, as described in Good Practice (Good Practice Guidance, 2000) is applied only to cattle.
- 2) CH₄ emissions from enteric fermentations of other farm animals are estimated by the Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighbouring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed.

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

situation were revised in 2006. The new values were estimated in a similar way by our external experts (Mudrik and Havranek, 2006) for the next period.

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 based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor equals 20 %.

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

6.2.5 Source-specific QA/QC and verification

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

6.2.6 Source-specific recalculations

No recalculation performed in this category in the 2014 submission.

6.2.7 Source-specific planned improvements

The analysis of uncertainties is currently in progress.

6.3 Manure Management (4B)

This chapter describes the estimation of CH₄ and N₂O emissions from animal manure. In 2012, 18.81 % of agricultural CH₄ emissions (22.36 Gg CH₄) and 11.9 % of agricultural N₂O emissions (2.13 Gg N₂O) were caused by this source category. Total emissions from Manure Management are 1130.54 Gg CO₂ eq. in 2012.

6.3.1 Source category description

During period 1990-2012 emissions from Manure Management decreased by 60 %. 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 (N₂O) and methane (CH₄) emissions from manure management of livestock (cattle, swine, sheep, horses, goats and poultry) are reported. The animal waste management systems (AWMS) are distinguished for N₂O emission estimations: liquid system, daily spread, solid storage & dry lot and other manure management systems. Nitrous oxide is produced by the combined nitrification-denitrification processes occurring in the manure nitrogen. Methane is produced in manure during decomposition of organic material by anaerobic and facultative bacteria under anaerobic conditions. The amount of emissions is dependent on the amount of organic material in the manure and climatic conditions.

Tab. 6-9 Manure Management emissions in the period 1990-2012

| Year | Emissions from <i>Manure Management</i> | | | |
|------|---|--------------------------|----------------------------|--------------------------|
| | CH ₄ emissions | | N ₂ O emissions | |
| | [Gg CH ₄] | [Gg CO ₂ eq.] | [Gg N ₂ O] | [Gg CO ₂ eq.] |
| 1990 | 51.20 | 1075.10 | 5.51 | 1708.42 |
| 1991 | 48.81 | 1024.95 | 5.23 | 1621.43 |
| 1992 | 44.66 | 937.95 | 4.71 | 1460.79 |
| 1993 | 40.40 | 848.31 | 4.19 | 1300.32 |
| 1994 | 35.25 | 740.22 | 3.73 | 1157.37 |
| 1995 | 33.30 | 699.39 | 3.47 | 1074.20 |
| 1996 | 31.46 | 660.57 | 3.65 | 1131.20 |
| 1997 | 29.44 | 618.20 | 3.54 | 1096.25 |
| 1998 | 28.31 | 594.41 | 3.35 | 1038.31 |
| 1999 | 28.84 | 605.63 | 3.39 | 1049.53 |
| 2000 | 28.52 | 599.02 | 3.13 | 970.10 |
| 2001 | 28.74 | 603.62 | 2.99 | 927.67 |
| 2002 | 29.72 | 624.03 | 2.81 | 872.14 |
| 2003 | 30.19 | 634.06 | 2.67 | 826.25 |
| 2004 | 28.99 | 608.76 | 2.58 | 799.00 |
| 2005 | 27.95 | 586.85 | 2.46 | 762.87 |
| 2006 | 27.62 | 580.04 | 2.42 | 751.01 |
| 2007 | 27.73 | 582.30 | 2.41 | 748.01 |
| 2008 | 27.04 | 567.86 | 2.37 | 735.10 |
| 2009 | 25.20 | 529.27 | 2.26 | 699.20 |
| 2010 | 23.38 | 490.94 | 2.20 | 682.20 |
| 2011 | 22.69 | 476.55 | 2.14 | 663.87 |
| 2012 | 22.36 | 469.66 | 2.13 | 660.88 |

6.3.2 Methodological issues

6.3.2.1 Methane emissions

CH₄ emissions from manure management were identified as a *key source* only by trend assessment (TA). According to the previous reiterated ERT recommendation (ARR reports), the Czech Republic recalculated the methane emissions from Manure Management of cattle. In line with the IPCC GPG a higher-tier method to estimate the CH₄ 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. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (see Table 6-1).

6.3.2.1.1 Cattle category

The activity data as cattle population distributed by age comes from the Czech statistical office (CSO). This is a consistent time series of number of animals during entire reported period (1990-2012). Gross energy (GE) values are estimated based on the national study Kolář et al. (2004). These GE parameters are annually reported in CRF as a country-specific data for the entire reported period (Tab. 6-10).

Tab. 6-10 Gross Energy (GE, MJ/head/day) of cattle in period 1990-2012

| Year | 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 |
| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | |
| Dairy cows | 258.1 | 264.2 | 269.9 | 275.6 | 278.4 | 282.2 | 286.8 | 289.2 | 290.3 | 296.2 | 302.2 | |
| Other cattle | 120.2 | 121.0 | 120.8 | 122.8 | 122.9 | 123.1 | 124.2 | 123.9 | 121.7 | 122.7 | 122.6 | |

The current updated data of AWMS distribution were applied for emission estimation. There are the other specific parameters for estimation of emission factors for cattle were obtained (Bo, MCF) in Dämmgen *et al.* (2012). The specific parameters recommended for use by study in neighboring 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) was utilized for the emission estimation (Tab. 6-11).

Tab. 6-11 List of parameters for methane emission factor estimation in Manure Management in Czech conditions

| Parameters | Dairy cows | Other cattle |
|---------------------------|------------|--------------|
| B ₀ | 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. 6-12 Recalculated values of methane emission factors and methane emissions from Manure Management in period 1990-2012

| | Methane emission factor (kg CH ₄ /head/year) | | Emissions (Gg/year) | |
|------|---|--------------|---------------------|------------------------|
| | Dairy cows | Other cattle | Gg CH ₄ | Gg CO ₂ eq. |
| 1990 | 13.14 | 7.98 | 34.21 | 718.34 |
| 1991 | 12.62 | 8.05 | 32.38 | 680.03 |
| 1992 | 12.88 | 7.91 | 28.34 | 595.11 |
| 1993 | 12.93 | 7.86 | 24.32 | 510.68 |
| 1994 | 12.91 | 7.87 | 21.02 | 441.42 |
| 1995 | 12.82 | 7.84 | 19.56 | 410.78 |
| 1996 | 9.94 | 7.91 | 17.18 | 360.69 |
| 1997 | 8.02 | 8.05 | 14.99 | 314.89 |
| 1998 | 8.40 | 8.10 | 13.95 | 292.96 |
| 1999 | 8.89 | 8.61 | 14.43 | 302.98 |
| 2000 | 11.11 | 8.70 | 15.01 | 315.13 |
| 2001 | 11.44 | 9.47 | 16.03 | 336.56 |
| 2002 | 14.30 | 9.68 | 17.01 | 357.16 |
| 2003 | 17.06 | 9.76 | 17.96 | 377.16 |
| 2004 | 17.41 | 9.75 | 17.57 | 368.95 |
| 2005 | 17.60 | 9.97 | 17.28 | 362.84 |
| 2006 | 17.78 | 10.00 | 17.03 | 357.64 |
| 2007 | 18.02 | 10.05 | 17.25 | 362.29 |
| 2008 | 18.31 | 10.15 | 17.54 | 368.27 |
| 2009 | 18.46 | 10.14 | 17.15 | 360.08 |
| 2010 | 19.18 | 8.62 | 15.68 | 329.20 |
| 2011 | 19.56 | 8.65 | 15.70 | 329.75 |
| 2012 | 19.95 | 8.65 | 15.92 | 334.39 |

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 (IPCC 2006 Gl., p. 10.37) was used:

$$CH_4 \text{ emissions (Gg/year)} = \Sigma (EF * \text{cattle population} / 10^6 \text{ (kg/Gg)})$$
- 2) To estimate the VS parameter the Eq. 10.24 (IPCC 2006 Gl., 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:

$$EF = VS * 365 * B_0 * 0.67 * \Sigma (MCF * MS)$$

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 (4B) increased after recalculation by 7 % in 1990, resp. by 26 % in 2011 (Tab. 6-12). The study Exnerova (2013, in Czech) describing a new method was elaborated.

6.3.2.1.2 Other livestock

The emissions for other than cattle farm animals are estimated by the Tier 1 approach. Default EFs for Western Europe were employed for similar reasons as in the previous paragraph (Tab. 6-13). Similarly as for enteric fermentation, the obsolete national approach used in the past was abandoned because of lack of comparability with other countries. Relation to the decreasing trend in animal population (especially cattle and swine, the emissions from *Manure Management* rapidly declined during 1990-2003.

Tab. 6-13 Table 6.8 IPCC default emission factors used to estimate CH₄ 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 |

6.3.2.2 Nitrous oxide emissions

N₂O emissions from manure management were identified as a key source; Tier 2 methodology is used for emission estimation for the cattle category (Tier 1 for other animal categories). Emissions are calculated on the basis of N excretion per animal and animal waste management system. Following the guidelines, all emissions of N₂O taking place before the manure is applied to soils are reported under Manure Management. The IPCC Guidelines method for estimating N₂O 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.

The estimation of N₂O emissions from Manure management is performed using the revised Nex values for dairy and non-dairy cattle (see Tab. 6-14) 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) are used to calculate Nex and 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 based on 3.3 % (Poustka 2007, Ingr 2003 and Turek 2000) and protein content in feed (in dry matter) of 18 % (Zeman - Czech feed standards 12-21 %, Central Institute for Supervising and Testing in Agriculture 18 %, Karabcová pers. commun. 16-18 %).

Country-specific redistribution of manure management practices across AWMS for cattle (Tab. 6-15) is taken from Hons and Mudrik (2004) for the 1990-1999 period and updated data from Kvapilík J. (2011) was used for the 2000-2011 period. Dr. Kvapilík (author of the Annual report of Czech cattle breeding of the Institute of Animal Science in Prague) also provided national data on grazing animals (feed situation of cattle categories, see Tab. 6-5 and Tab. 6-6).

Input data consists in the mass fraction $X_{i,j}$ of animal excrement in animal category i (i = dairy cows, other cattle, pigs, ...) for various types of excrement management (AWMS - Animal Waste Management System) j (j = anaerobic lagoons, liquid manure, solid manure, pasturage, daily spreading in fields, other). Here, it holds that $X_{i,1} + X_{i,2} + \dots + X_{i,6} = 1$. For Tier 1, (Revised 1996 IPCC Guidelines, 1997) gives only the values of matrix X for typical means of management of animal excrement in Eastern and Western Europe. AWMS parameters presented in the IPCC methodology (IPCC 1997) were determined for the Western Europe and partly for the Czech conditions. The Czech specific AWMS parameters are available distributed to dairy and non-dairy cattle categories (Tab. 6-15).

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 agricultural land can save fertilizer again after four years after soil cultivation of 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.

The IPCC default nitrogen excretion (Nex) values and distribution of AWMS systems for other animal categories (excl. cattle) are presented in Tab. 6-16. 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. 6-17.

Tab. 6-14 Czech national Nex (nitrogen excretion) values used to estimate N₂O emissions from Manure Management

| Year | 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 | 69.49 |
| 2010 | 132.59 | 68.76 |
| 2011 | 133.83 | 69.17 |
| 2012 | 135.78 | 69.10 |

Tab. 6-15 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 | 51 | 1 | 33 | 15 |
| 1995 | 48 | 1 | 31 | 20 |
| 2000 | 49 | 1 | 33 | 17 |
| 2005 - now | 52 | 1 | 27 | 20 |

Tab. 6-16 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. 6-17 Manure production distributed by individual AWMS in 2012

| AWMS | Nitrogen Production in Manure (kg N/yr) |
|----------------------------|--|
| Liquid systems | 67 707 649 |
| Solid storage & drylot | 61 625 132 |
| Other | 11 287 210 |
| Daily spread | 1 112 945 |
| Pasture range and paddock* | 26 515 995 |
| Total | 168 248 931 |

Note: * Emissions coming from this category are reported under 4D-category (PRP)

6.3.2.3 Emission factors

To estimate N₂O emissions from manure management, the default emission factors for the different animal waste management systems were taken from the Good Practice Guidance, Table 4-22 (IPCC, 2000), see Tab. 6-18.

Tab. 6-18 IPCC default emission factors of animal waste per different AWMS

| AWMS | Emission Factor (EF3) (kg N ₂ O-N per kg N excreted) |
|---------------|--|
| Liquid | 0.001 |
| Solid Storage | 0.020 |
| Other Systems | 0.005 |

6.3.3 Uncertainties and time-series consistency

As mentioned above, methane emissions from the breeding of farm animals are caused both by enteric fermentation and also by the decomposition of animal excrements (manure). Determination of the second of them was prepared at the level Tier 1, besides the cattle where the emissions are calculated by Tier 2 since submission 2012.

The Czech team accepted critical remarks put forth by the Expert Review Teams (ERT). A concept, in accordance with the plan for implementing Good Practice, is based on option, that CH₄ emissions from manure management for all farm animals are estimated by the Tier 1 approach. For similar reasons as in the previous paragraphs, the default emission factors for Western Europe were employed.

On the basis of the recommendations of the ERT 2009, the estimation of manure management N₂O 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 Revised 1996 Guidelines (IPCC, 1997) default values. The total emissions from the category “N₂O 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). In addition, national data on the distribution of manure management practices across AWMS were collected and updated (Kvapilík J. 2011).

Application of the higher-tier method to methane emission estimation in 2014 submission has the effect of reducing the uncertainties of this sub-category.

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor for estimation of CH₄ emissions equals 20 %; for estimation of N₂O emissions, this value equals 30 %.

The combined uncertainty for CH₄ emissions equals 20.6 % and that for N₂O emissions equals 30.41 %.

6.3.4 Source-specific QA/QC and verification

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

6.3.5 Source-specific recalculations

In line with the IPCC GPG a higher-tier method was implemented to estimate the CH₄ emissions from Manure Management in 2014 submission. The aim of the recalculation was to review the estimation of methane emissions from Manure Management of cattle. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (Table 6-1). 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 (4B) increased after recalculation by 7 % in 1990, resp. by 26 % in 2011.

6.3.6 Source-specific planned improvements

The analysis of uncertainties is in progress.

6.4 Agricultural Soils (4D)

6.4.1 Source category description

This source category includes direct and indirect nitrous oxide emissions from agricultural soils. Both these categories (direct and indirect) of N₂O soil emissions are the key sources (Tab. 6-1). Nitrous oxide is produced in agricultural soil as a result of microbial nitrification-denitrification processes. The processes are influenced by chemical and physical characteristics (availability of mineral N substrates and carbon, soil moisture, temperature and pH). Thus, addition of mineral nitrogen in the form of synthetic fertilizers, animal manure applied to soils, crop residue, N-fixing crops enhance the formation of nitrous oxide emissions.

Nitrous oxide emissions from agriculture include these subcategories:

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

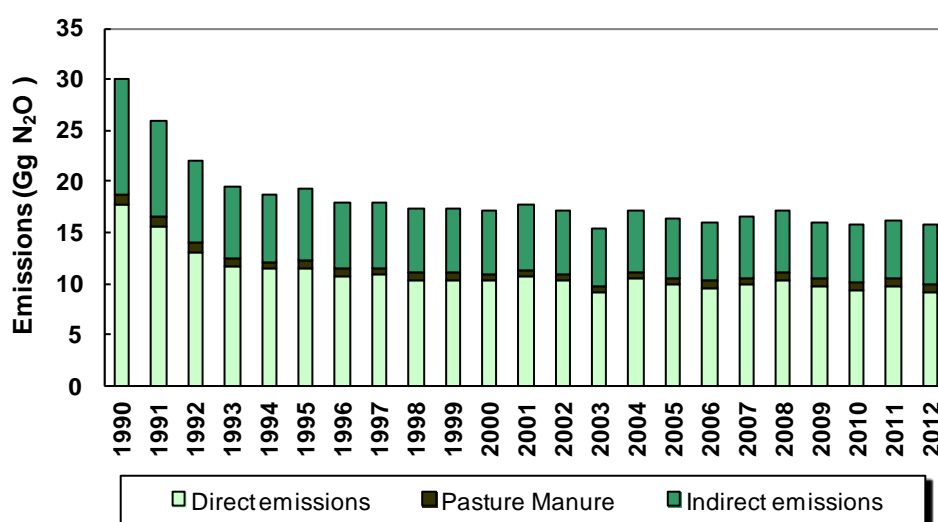


Fig. 6-3 Nitrous oxide emissions from Agricultural soils (sub-categories)

In 2012, 88.1 % of total N₂O emissions from Agriculture originated from Agricultural Soils, while the rest originated from Manure Management (11.9 %). The trend in N₂O emissions from this category is decreasing: in 2012 emissions (4 900.95 Gg CO₂ eq.) were 47.3 % below the base year level. Tab. 6-19 and Figure 6.2 present the N₂O emissions of Agricultural soils by individual sub-category.

Tab. 6-19 N₂O emissions come from Agricultural Soils (4D category) in period 1990-2012 in Gg N₂O.

| Year | Total emissions | Direct emissions | | | | Pasture Manure | Indirect emissions | |
|------|-----------------|------------------|------|------|------|----------------|---------------------|----------|
| | | a | b | c | d | | Atmosph. deposition | Leaching |
| 1990 | 30.01 | 7.39 | 5.50 | 1.74 | 3.05 | 1.02 | 1.86 | 9.44 |
| 1991 | 25.96 | 5.26 | 5.25 | 2.29 | 2.73 | 0.99 | 1.62 | 7.82 |
| 1992 | 22.00 | 4.00 | 4.85 | 1.93 | 2.32 | 0.87 | 1.41 | 6.63 |
| 1993 | 19.39 | 3.19 | 4.38 | 1.87 | 2.31 | 0.72 | 1.23 | 5.68 |
| 1994 | 18.73 | 3.59 | 3.84 | 1.69 | 2.34 | 0.61 | 1.15 | 5.51 |
| 1995 | 19.22 | 4.05 | 3.61 | 1.60 | 2.27 | 0.80 | 1.16 | 5.71 |
| 1996 | 17.92 | 3.36 | 3.64 | 1.48 | 2.30 | 0.78 | 1.10 | 5.26 |
| 1997 | 17.99 | 3.64 | 3.51 | 1.31 | 2.37 | 0.73 | 1.10 | 5.33 |
| 1998 | 17.25 | 3.59 | 3.37 | 1.11 | 2.29 | 0.67 | 1.06 | 5.17 |
| 1999 | 17.28 | 3.54 | 3.41 | 1.06 | 2.37 | 0.67 | 1.06 | 5.17 |

| Year | Total emissions | Direct emissions | | | | Pasture Manure | Indirect emissions | |
|------|-----------------|------------------|------|------|------|----------------|---------------------|----------|
| | | a | b | c | d | | Atmosph. deposition | Leaching |
| 2000 | 17.13 | 3.77 | 3.24 | 1.05 | 2.19 | 0.65 | 1.05 | 5.18 |
| 2001 | 17.68 | 3.99 | 3.17 | 1.05 | 2.48 | 0.65 | 1.05 | 5.28 |
| 2002 | 17.20 | 4.02 | 3.12 | 0.86 | 2.27 | 0.63 | 1.04 | 5.26 |
| 2003 | 15.41 | 3.39 | 3.05 | 0.67 | 1.94 | 0.62 | 0.97 | 4.78 |
| 2004 | 17.14 | 3.83 | 2.92 | 0.89 | 2.94 | 0.61 | 0.98 | 4.97 |
| 2005 | 16.30 | 3.65 | 2.80 | 0.91 | 2.59 | 0.64 | 0.95 | 4.77 |
| 2006 | 16.03 | 3.80 | 2.76 | 0.86 | 2.16 | 0.63 | 0.95 | 4.85 |
| 2007 | 16.47 | 3.95 | 2.76 | 0.79 | 2.40 | 0.65 | 0.97 | 4.95 |
| 2008 | 17.10 | 4.21 | 2.68 | 0.72 | 2.77 | 0.67 | 0.98 | 5.07 |
| 2009 | 16.06 | 3.92 | 2.49 | 0.74 | 2.61 | 0.66 | 0.91 | 4.73 |
| 2010 | 15.76 | 4.00 | 2.36 | 0.67 | 2.30 | 0.80 | 0.91 | 4.73 |
| 2011 | 16.19 | 4.22 | 2.27 | 0.64 | 2.52 | 0.82 | 0.91 | 4.82 |
| 2012 | 15.81 | 4.38 | 2.23 | 0.54 | 2.00 | 0.83 | 0.92 | 4.91 |

Note: a, b, c, d = individual sources of direct emissions; (a) Synthetic fertilizers, (b) Animal manure applied to soils, (c) N-fixing crops and (d) Crop residue

6.4.2 Methodological issues

Although nitrous oxide emissions from agriculture are key sources, emissions are estimated and analysed by the Tier 1 approach of the IPCC methodology (IPCC, 1997). A set of interconnected spreadsheets in MS Excel has been used for the relevant calculations for several years. The emissions from nitrogen excreted to pasture range and paddocks by animals are reported under animal production in CRF table 4D2. The nitrogen from manure that is spread daily is consistently included in the manure nitrogen applied to soils.

6.4.2.1 Activity data

The standard calculation of Tier 1 required the following input information based on on Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990-2012):

- number of heads of farm animals (dairy cows, other cattle, pigs, sheep, poultry, horses, goats),
- annual amount of nitrogen applied in the form of industrial nitrogen fertilizers - the application of agricultural fertilizers was previously intensive in this country, but decreased radically during the 1990s. The amount of nitrogen fertilizers applied in 1990 equaled over 418 kt decreased to 248 kt in 2012. This corresponds to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Sálusová et al., 2006);
- annual harvests of crops, pulses, soya beans, potatoes, sugar-beets, alfalfa and clover (see Tab. 6-20);
- annual manure production during grazing of animals, PRP category in Tab. 6-17.

Tab. 6-20 Annual harvests of agricultural products in period 1990-2012

| Year | Crop | Pulses | Soya | Potatoes | Sugarbeet | Alfalfa | Clover |
|------|--------------------|--------|------|----------|-----------|---------|--------|
| | [in thous. tonnes] | | | | | | |
| 1990 | 8 947 | 152 | 2.2 | 1 755 | 4 026 | 1 088 | 1 344 |
| 1991 | 7 845 | 195 | 6.4 | 2 043 | 4 009 | 1 522 | 1 648 |
| 1992 | 6 565 | 203 | 3.7 | 1 969 | 3 871 | 1 279 | 1 311 |
| 1993 | 6 468 | 227 | 0.7 | 2 396 | 4 308 | 1 214 | 1 256 |
| 1994 | 6 777 | 163 | 0.7 | 1 231 | 3 240 | 1 203 | 1 069 |
| 1995 | 6 602 | 144 | 0.6 | 1 330 | 3 712 | 1 123 | 1 071 |
| 1996 | 6 644 | 136 | 0.5 | 1 800 | 4 316 | 1 037 | 982 |
| 1997 | 6 983 | 104 | 0.3 | 1 402 | 3 722 | 884 | 947 |
| 1998 | 6 669 | 133 | 0.3 | 1 520 | 3 479 | 743 | 709 |
| 1999 | 6 928 | 119 | 0.6 | 1 407 | 2 691 | 726 | 676 |
| 2000 | 6 454 | 85 | 2.3 | 1 476 | 2 809 | 755 | 698 |
| 2001 | 7 338 | 91 | 4.3 | 1 130 | 3 529 | 761 | 669 |
| 2002 | 6 771 | 65 | 6.4 | 901 | 3 832 | 662 | 504 |
| 2003 | 5 762 | 62 | 11.9 | 683 | 3 495 | 500 | 375 |

| Year | Crop | Pulses | Soya | Potatoes | Sugarbeet | Alfalfa | Clover |
|--------------------|-------|--------|------|----------|-----------|---------|--------|
| [in thous. tonnes] | | | | | | | |
| 2004 | 8 784 | 88 | 12.9 | 862 | 3 579 | 673 | 486 |
| 2005 | 7 660 | 96 | 18.9 | 1 013 | 3 496 | 695 | 459 |
| 2006 | 6 386 | 88 | 17.8 | 692 | 3 138 | 668 | 434 |
| 2007 | 7 153 | 65 | 13.2 | 821 | 2 890 | 610 | 432 |
| 2008 | 8 370 | 48 | 9.4 | 770 | 2 885 | 584 | 386 |
| 2009 | 7 832 | 62 | 13.6 | 753 | 3 038 | 587 | 377 |
| 2010 | 6 878 | 58 | 16.1 | 665 | 3 065 | 527 | 338 |
| 2011 | 8 285 | 64 | 17.9 | 805 | 3 899 | 476 | 338 |
| 2012 | 6 595 | 39 | 13.1 | 662 | 3 869 | 405 | 320 |

6.4.2.2 Emission factors and other parameters

IPCC default emission factors have been used for estimating most of N₂O emissions from agricultural soils, excluding part of direct emissions.

According to ERT recommendation the emissions from crop residue of potatoes and sugarbeets and N-fixing crops of clover and alfalfa were added to the emission inventory, which are estimated by Tier 2 using country-specific parameters.

6.4.2.2.1 N₂O emissions from N-fixing crops (alfalfa and clover) and Crop residue (potatoes and sugarbeets)

The production data comes from the Czech Statistical Office (CzSO). The country-specific data for the fraction of nitrogen (FracNCRBF) and the fraction of dry matter content (FracDM) in aboveground biomass of forage crops were employed in the emission inventory. The fraction of dry matter and fraction of nitrogen were determined on the basis of the materials (results of research projects) obtained from the Faculty of Agronomy, South Bohemia University (Jeteloviny - internal study material, www.zf.jcu.cz) (see Tab. 6-21). The default N₂O EFs and default values for other relevant parameters were used in accordance with the IPCC GPG methodology.

Tab. 6-21 National parameters used to estimate direct N₂O emissions from clover and alfalfa

| | Frac _{DM} | Frac _{NCRBF} |
|---------|--------------------|-----------------------|
| Clover | 0.15 | 0.19 |
| Alfalfa | 0.18 | 0.21 |

Equation 4.29 (Tier 1b, GPG IPCC 2000, page 4.59) was used to estimate N₂O emissions from potatoe and sugarbeet production. The calculation was based on the default N₂O 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 sugarbeets (Table 4-16, IPCC 2000, page 4.58) and default fraction of crop residue removed from the field as crop (Table 4-17, IPCC 1996, Reference Manual, page 4.85). The country-specific data for the dry matter fraction was used. The value of FracDM for potatoes is based on the study of Cabajova, MU LF Brno (2009) and corresponds to other available sources. The value of FracDM for sugarbeets is based on the study of Blaha, CZU Prague (1986) and corresponds to other available sources. Both national parameters correspond to the interval of IPCC default values (see Tab. 6-22). The fraction of crop residue that is burned on the field equals zero.

Tab. 6-22 National parameters used to estimate direct N₂O emissions from potatoes and sugarbeets

| | Res/Crop | Frac _{DM} | Frac _{NCRO} |
|-----------|----------|--------------------|----------------------|
| Potatoes | 0.40 | 0.30 | 0.011 |
| Sugarbeet | 0.20 | 0.12 | 0.004 |

6.4.2.2.2 Default parameters used to estimate of N₂O emissions from soils

The emission factors used for calculation of direct N₂O emissions from the other agriculture products (pulses, cereals and soya), indirect emissions from atmospheric deposition and leaching are shown in Tab. 6-23. The default fraction values used to estimate N₂O emissions are presented in Tab. 6-24. The fraction of livestock N excreted and deposited onto soil during grazing (Frac_{GRAZ}) varied from 0.085 in 1990 to 0.158 in 2012.

Tab. 6-23 IPCC default parameters/fractions used for emission estimation

| Parameters/Fractions | Default values |
|----------------------|----------------|
| FracGASM | 0.20 |
| FracNCR0 | 0.015 |
| FracNCRBF | 0.03 |
| FracR | 0.45 |
| FracBURN | 0.00 |

Tab. 6-24 Emission factors (EFs) for the calculation of Agricultural Soils

| | | |
|---------------------------------|------------------------|---|
| Direct emissions | Synthetic fertilizer | EF1 = 0.0125 kg N ₂ O-N/kg N |
| | Animal Waste | |
| | N-fixing crops | |
| | Crop residue | |
| Pasture, range & paddock manure | Grazing animals | EF3 = 0.02 kg N ₂ O-N/kg N |
| Indirect emissions | Atmospheric Deposition | EF4 = 0.01 kg N ₂ O-per kg emitted NH ₃ and NO _x |
| | Nitrogen Leaching | EF5 = 0.025 kg N ₂ O - per kg of leaching N |

6.4.3 Uncertainties and time-series consistency

In relation to the consistency of the emission series for N₂O (agricultural soils), it should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology of Revised 1996 Guidelines (IPCC, 1997). Emission estimates for 1990, 1992, 1994 and 1995 were obtained and reported in several recent years; the data for 1991 and 1993 are reported (together with year 2004) this year as part of the 2006 submission.

The quantitative overview and emission trends during period 1990-2012 are shown in Tab. 6-2. The trend in N₂O emissions from agricultural soils is summarized in Tab. 6-19. During 1990-2012 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 (N₂O 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.

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), it led to changes in N₂O emissions from i) animal manure applied to soils (4D1b), ii) PRP (4D2), iii) atmospheric deposition (4D3.1) and iv) N lost through leaching and run-off (4D3.2). 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 N₂O 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 N₂O 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 N₂O 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 Guidelines, and thus it was requested that these emission categories 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 N₂O emissions for the entire time series and
- 2) potatoes and sugarbeet crops produced in the country were included in the estimations of N₂O emissions from crop residues returned to soils for the entire time series

The “Saturday paper” recalculation led to increased emissions in category 4D.1 (Direct emissions from agricultural soils) after recalculation by approx. 6 % in 2011, leading to an increase in total N₂O emissions by about 3 % in 2011.

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data for estimation of direct and indirect emissions from agricultural soils equals 20 %; for Pasture, Range and Paddock Manure (PRP) this value equals 10 %.

The uncertainty in the emission factor for estimation of direct and indirect emissions from agricultural soils equals 50 %; for estimation of emissions from PRP Manure this value equals 100 %.

The combined uncertainty for the direct and indirect emissions from agricultural soils equals 53.85 %; for N₂O emissions from PRP Manure this value equals 100.5 %.

6.4.4 Source-specific QA/QC and verification

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

6.4.5 Source-specific recalculations

No recalculation performed in this category in the 2014 submission.

6.4.6 Source-specific planned improvements

The analysis of uncertainties is in progress.

6.5 Source-specific QA/QC and verification

Following the recommendation of the latest in-country review, a sector-specific QA/QC plan was formulated, tightly linked to the corresponding QA/QC plan of the National Inventory System, chapter 1.5. The plan describes the key procedures of inventory compilation, provides a table of personal responsibilities and a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates effective quality control of the Agriculture inventory.

The Institute of Forest Ecosystem Research (IFER) is the sector-solving institution for this category.

The agricultural greenhouse gas inventory is compiled by an experienced expert from the IFER, including performance of self-control. Czech University of Life Sciences, Institute of Animal Science Prague, Research Institute for Cattle Breeding and the AGROBIO are other institutes contributing information used in the sector of Agriculture. Slovak agricultural experts (SHMI) also participate in debates on inventory improvements.

Potential errors and inconsistencies are documented and corrections are made if necessary. In addition to the official review process, emission inventory methods and results are internally reviewed by the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors.

To comply with QA/QC, is necessary to check to comply

- The inclusion of all activity data for animal categories, selected harvests (crops, pulses, soya beans), amount of synthetic fertilizers (agricultural statistics)
- The consistency of time-series activity data and emission factors (agricultural statistics)
- The annual update of national zoo-technical data
- All the emission factors and used parameters/fractions

QA/QC includes checking of activity data, emission factors and methods employed. All the differences are discussed and, if necessary, also corrected. The procedure of inventory compiling is initiated by IFER, where all the necessary data, obtained from the Czech Statistical Office (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 (specifically concerned with 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 CRF Tables are sent to the NIS coordinator for final time-series checking and 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 (4A, 4B and 4D). 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.

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

7.1 Overview

The emission inventory of the 5 Land Use, Land Use Change and Forestry (LULUCF) sector includes emissions and removals of greenhouse gases (GHG) resulting from land use, land-use change and forestry. The inventory is based on application of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003, further also abbreviated as GPG for LULUCF) and the reporting format adopted by the 9th Conference of Parties to UNFCCC. The application of GPG for LULUCF in the national emission inventory entails manifold specific requirements on the inventory of the sector, which have been implemented gradually. The current inventory of the LULUCF sector is at its final phase of this implementation. It employs a refined system of land use identification at the level of the individual cadastral units, which was also utilized for determination of land-use changes. This inventory submission contains new improvements to the most possible degree reflecting the suggestions following from the latest reviews of the LULUCF emission inventory. Where feasible, the methodological elements from 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) for the Agriculture, Forestry and Other Land Use (AFOLU) were used. Although the Czech LULUCF inventory is still expected to undergo further refinement and consolidation, it already represents a solid system for providing information on GHG emissions and removals in the LULUCF sector, as well as for providing the additional information on the LULUCF activities required under the Kyoto protocol.

The current inventory includes CO₂ emissions and removals, and emissions of non-CO₂ gases (CH₄, N₂O, NO_x and CO) from biomass burned in forestry and disturbances associated with land-use conversion. The inventory covers all six major LULUCF land-use categories, namely 5A Forest Land, 5B Cropland, 5C Grassland, 5D Wetlands, 5E Settlements and 5F Other Land, which were linked to the Czech cadastral classification of lands. The emissions and/or removals of greenhouse-gases are reported for all mandatory categories. The current submission covers the whole reporting period from the base year of 1990 to 2012 (Fig. 7-1).

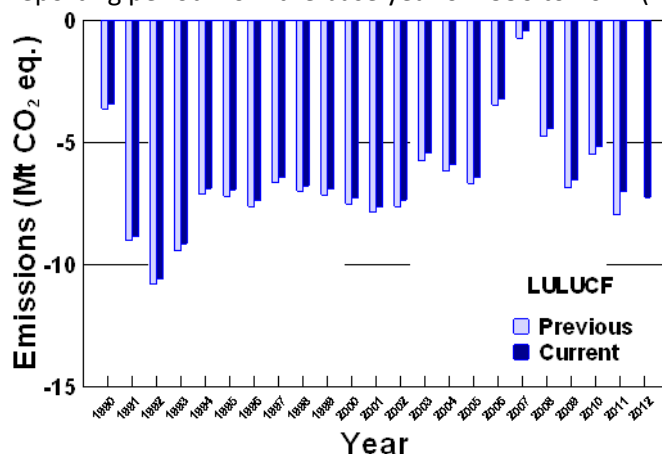


Fig. 7-1 Current and previously reported assessment of emissions for the LULUCF sector. The values are negative, hence representing net removals of green-house gases

The refined information on land use and implementation of improved emission factors implemented in this inventory submission resulted in recalculations for the entire reporting period. These are visually notable in Fig. 7-1. The implemented improvements led to an overall decrease of the previously reported emission removals for the entire period by about 4.5 %. The detailed information on the performed recalculations is provided below for the respective land-use categories.

7.1.1 Estimated emissions

Tab. 7-1 provides a summary of the LULUCF GHG estimates for the base year 1990 and the most recently reported year 2012. In 2012, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equalled -7.252 Mt CO₂ 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 2012, the removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 5.6 %. Correspondingly, for the base year of 1990, the total emissions and removals in the LULUCF sector equalled -3.437 Mt CO₂ eq. In relation to the emissions generated in all other sectors, the inclusion of the LULUCF estimate reduces the total emissions by 1.75 % for the base year of 1990. It is important to note that the emissions within the LULUCF sector exhibit high inter-annual variability (Fig. 7-1) and the values shown in Tab. 7-1 should not be interpreted as trends. The entire data series can be found in the corresponding CRF Tables.

Tab. 7-1 GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2012

| Sector/category | Emissions 1990 Gg CO ₂ eq. | Emissions 2012 Gg CO ₂ eq. |
|---------------------------------------|--|--|
| 5 Total LULUCF | -3 437 | -7 252 |
| 5A Forest Land | -4 682 | -7 255 |
| 5A1 Forest Land remaining Forest Land | -4 461 | -6 916 |
| 5A2 Land converted to Forest Land | -221 | -340 |
| 5B Cropland | 1 209 | 181 |
| 5B1 Cropland remaining Cropland | 1089 | 93 |
| 5B2 Land converted to Cropland | 120 | 88 |
| 5C Grassland | -83 | -302 |
| 5C1 Grassland remaining Grassland | 58 | 5 |
| 5C2 Land converted to Grassland | -141 | -306 |
| 5D Wetlands | 22 | 25 |
| 5D1 Wetlands remaining Wetlands | (0) | (0) |
| 5D2 Land converted to Wetlands | 22 | 25 |
| 5E Settlements | 84 | 99 |
| 5E1 Settlements remaining Settlements | (0) | (0) |
| 5E2 Land converted to Settlements | 84 | 99 |
| 5F Other Land | (0) | (0) |
| 5G Other | 12 | 0 |

Note: Emissions of non-CO₂ gases (CH₄ and N₂O) are also included.

7.1.2 Key categories

Tab. 7-2 Key categories of the LULUCF sector (2012)

| Category | Character of category | Gas | % of total GHG |
|---------------------------------------|-----------------------|-----------------|----------------|
| 5A1 Forest Land remaining Forest Land | KC (LA, TA) | CO ₂ | 5.298 |
| 5B1 Cropland remaining Cropland | KC (TA) | CO ₂ | 0.067 |

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

% of total GHG: relative contribution of category to net GHG (including LULUCF)

Of the main categories listed in Tab. 7-1, two of them were identified as key categories according to the IPCC Good Practice (Good Practice Guidance, IPCC 2000, Good Practice Guidance for LULUCF, IPCC 2003). Of these LULUCF categories, the largest effect on the overall emission inventory in the country is attributed to 5A1 Forest Land remaining Forest Land. With a contribution of 5.33 %, it is the only LULUCF category identified by the level assessment for the year 2012 (Tab. 7-2). It was also identified as a key category by the trend assessment. The emissions of this category are determined by the changes in biomass carbon stock. Additionally, one LULUCF category was identified by the trend assessment, namely 5B1 Cropland remaining Cropland (Tab. 7-2). In 5B1, the trend analysis basically reflected the effect of liming on emissions from agricultural soils, which decreased rapidly in early 1990s compared to the following years.

7.2 General methodological issues

7.2.1 Methodology for representing land-use areas

The reporting format requires the estimation of GHG emissions into the atmosphere by sources and sinks for six land-use categories, namely Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land. Each of these categories is divided into lands remaining in the given category during the inventory year, and lands that are newly converted into the category from a different one. Accordingly, GPG for LULUCF outlines the appropriate methodologies for estimation of emissions.

Consistent representation of land areas and identification of land-use changes constitute the key steps in the inventory of the sector in accordance with GPG for LULUCF. The adopted land-use representation and land-use change identification system was built gradually since the 2007 NIR submission. It was radically improved in the 2008 NIR submission and further refined in 2009 inventory submission.

Initially, the identification of land-use categories was based on two key data sources. Information on areas of the individual land-use categories was obtained from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). It provided annually updated cadastral information, published as aggregated data in the statistical yearbooks. The second data source utilized previously was the Land Cover Database of the Pan-European CORINE project (reference years 1990 and 2000), administered by the Czech Ministry of the Environment. The combination of COSMC cadastral data and CORINE land-use change trends permitted estimation of land-use changes. Although this method was endorsed by the 2007 in-country review, the aggregated land-use information did not provide sufficient spatial details and the CORINE-derived trends remained uncertain for several reasons.

Since the 2008 NIR submission, the land-use representation and the land-use change identification system has been based exclusively on the annually updated COSMC data, elaborated at the level of about 13 thousands individual cadastral units. This system was built in several steps, including 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time series. These steps are described below. The result is a system of consistent representation of land areas having the attributes of both Approach 2 and Approach 3 (GPG for LULUCF), permitting accounting for all land-use transitions in the annual time step.

7.2.1.1 Source data compilation

The methodology requirements and principles associated with the approaches recommended by the GPG for LULUCF (IPCC, 2003) imply that, for the reported period of 1990 to 2012, 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" (AALC). The AALC data were compiled at the level of the individual cadastral units (1992-2012) and individual districts (1969-2012). 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 2012, the total number of cadastral units varied between 13 027 and 13 079.

To identify the administrative separation and division of cadastral units, these were crosschecked by comparing the areas in subsequent years using a threshold of one hectare difference. Neighbouring cadastral units mutually changing their areas in subsequent years were integrated. Until the reported year of 2006, this concerned a total of 706 former and/or current units that were integrated into 235 newly 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 2012, there were 12 integrated cadastral units, which affected a total of 26 individual cadastral units. This further increased the spatial resolution of the system, as the land use change identification could be analysed for 13 013 individual units in 2012 as compared to 12 624 units for the years until 2006 (Fig. 7-2).

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. 7-2.

7.2.1.2 Linking land-use definitions

The analysis of land use and land-use change is based on the data from the “Aggregate areas of cadastral land categories” (AACLC), centrally collected and administered by COSMC and regulated by Act No. 265/1992 Coll., on Registration of proprietary and other material rights to real estate, and Act No. 344/1992 Coll., on the real estate cadastre of the Czech Republic (the Cadastral Act), both as amended by later regulations. AACLC distinguishes ten land categories, six of them belonging to land utilized by agriculture (arable land, hop-fields, vineyards, gardens, orchards, grassland) and four under other use (forest land, water surfaces, built-up areas and courtyards, and other land). Additionally, the land register included information on land use for every land

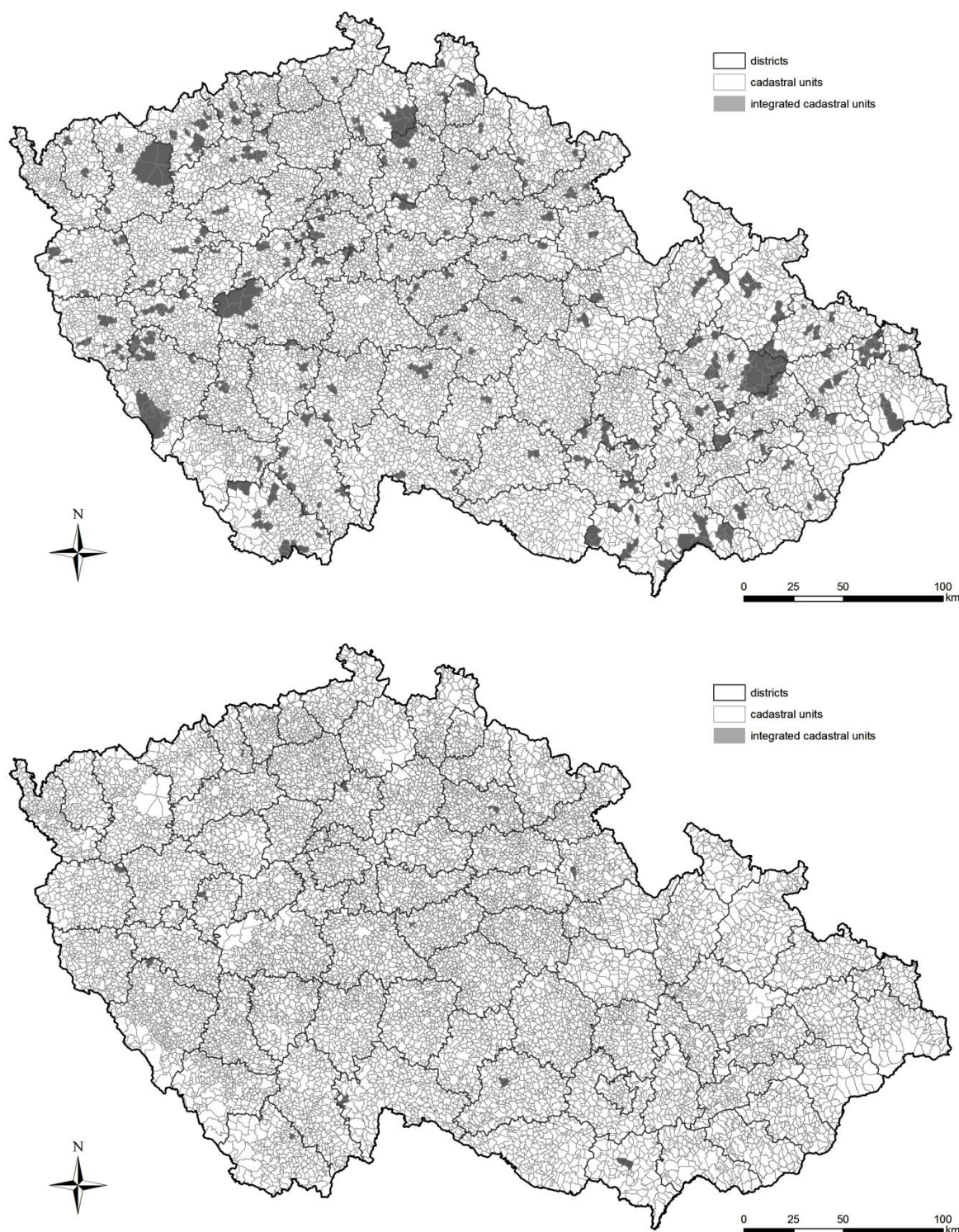


Fig. 7-2 Cadastral units (grey lines), integrated cadastral units (shading) and district borders (black lines) as used until year 2006 (top) and the currently refined situation for year 2012 (bottom)

parcel. Different AALC land categories may have identical use. Both land categories and land use in the COSMC database were linked so as to most closely match the default definitions of the six major land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land) as given by GPG for LULUCF (IPCC, 2003). The specific definition content can be found in the respective Chapters 7.3 to 7.8 devoted to each of the major land-use categories.

7.2.1.3 Land-use change identification

The critical issue of any LULUCF emission inventory is the determination of land-use change. This inventory identifies and quantifies land-use change by balancing the six major land-use areas for each of the individual or integrated cadastral units (13 013 units in year 2012) on an annual basis using the subsequent years of the available period. The approach is exemplified in Fig. 7-3. In the example of the cadastral 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. 7-3 Example of land-used change identification for year 2006 and cadastral unit 656306 (Jablunkov); all spatial units are in m²

7.2.1.4 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 2012, 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. Since there might be a discrepancy between the identified land use conversions at the two spatial levels, the previous inventories used an adjustment of the district level data using based on a linear regression function between R (the ratio of identified land conversions at the level of the districts and individual cadastral units) and the logarithmically transformed areas from the data at the district level. That correction was derived at the level of the major land-use categories, using the annual data from the period of 1993 to 2006, for which the land-use conversions could be estimated independently at both spatial levels, i.e., districts and individual cadastral units (Cienciala and Apltauer 2007). However, this approach also resulted in minor inconsistencies in land use matrices for the initial years of the reporting period. Based on the recommendations of the recent reviews to address this inconsistency, the procedure was newly addressed by the inventory team in 2013. This also involved a consultation 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 inventory³. Based on the internal analysis and the recommendations of COSMC, the current inventory reverts to the exclusive use of the original data on land use without any further corrections. The source information on land use since 1969 required for building the LULUCF land use representation and land use change identification system was revised and the entire time series recalculated. Due to the IPCC default time period of 20 years used for reporting the converted land, the above revision affects most of the reporting period. Hence, the current extensive revision represents the most detailed and most objective information on land use and land use change pragmatically achievable on the basis of the available source data required for the reporting period.

7.2.2 Land-use change – overall trends and annual matrices

The overall trends in the areas of the major land-use categories in the Czech Republic for the 1970 to 2012 period are shown in Fig. 7-4. The largest quantitative change is associated with the Cropland and Grassland land-use categories.

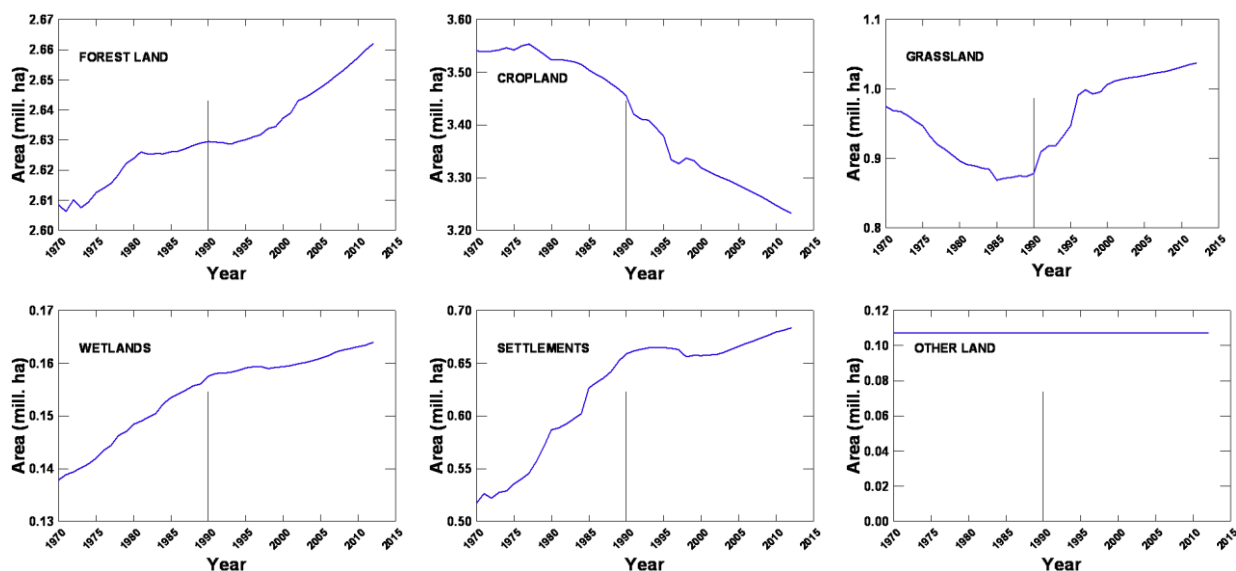


Fig. 7-4 Trends in areas of the six major land-use categories in the Czech Republic between 1970 and 2012 (based on information from the Czech Office for Surveying, Mapping and Cadastre)

An insight into the net trends shown in Fig. 7-4 is provided by analysis of land-use changes as described in Section 7.1.2. Table 7-3 shows a product of that analysis, namely the areas of land-use change among the major land-use categories over the 1990 to 2012 period in the form of land-use change matrices for the individual years. It is important to note that the annual totals for the individual years in the matrices do not necessarily correspond to the areas that appear in the CRF Tables, which accounts for the progressing 20-year transition period that began in 1970. This is a Tier 1 assumption of GPG for LULUCF for estimation of changes in soil carbon stock. This also implies that the areas relevant to the biomass pool are not the same as those for the soil pools; this is important for interpretation of the emission factors estimated from the land-use change areas accumulated over 20-year periods. Secondly, for Forest Land, the available input information at a detailed (cadastral, district) level did not permit separation of the fraction of permanently unstocked Forest Land devoted to use other than growing forests. This small fraction of Forest Land was separated ex-post after estimating land-use changes and summing over the whole country, when it was assigned to Grassland.

³ The Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) representatives also provided the latest update on the progress in 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. On request of the inventory team, this information was also provided in written and digital form, which is available at request from the inventory team.

Tab. 7-3 Land-use matrices describing initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories for years 1990 to 2012.

| 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 (kha) |
|--------------|-------------|----------------|-----------|----------|----------|-------------|------------|---------------|
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (1996) | Forest Land | 2 629.2 | 0.4 | 0.9 | 0.0 | 0.5 | 0.0 | 2 631.0 |
| | Grassland | 0.3 | 943.7 | 45.4 | 0.1 | 1.3 | 0.0 | 990.9 |
| | Cropland | 0.2 | 2.2 | 3 330.8 | 0.1 | 0.8 | 0.0 | 3 334.0 |
| | Wetland | 0.0 | 0.1 | 0.1 | 158.8 | 0.3 | 0.0 | 159.3 |
| | Settlements | 0.4 | 0.5 | 1.4 | 0.1 | 661.8 | 0.0 | 664.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 630.1 | 946.9 | 3 378.6 | 159.1 | 664.7 | 107.2 | 7 886.7 |
| Year 1997 | | Initial (1996) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (1997) | Forest Land | 2 630.1 | 0.4 | 0.3 | 0.0 | 0.9 | 0.0 | 2 631.8 |
| | Grassland | 0.2 | 987.2 | 10.2 | 0.1 | 1.1 | 0.0 | 998.8 |
| | Cropland | 0.2 | 2.6 | 3 322.2 | 0.1 | 1.3 | 0.0 | 3 326.4 |
| | Wetland | 0.0 | 0.1 | 0.1 | 159.0 | 0.2 | 0.0 | 159.4 |
| | Settlements | 0.4 | 0.6 | 1.1 | 0.1 | 660.8 | 0.0 | 662.9 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 630.9 | 990.9 | 3 334.0 | 159.3 | 664.3 | 107.2 | 7 886.6 |
| Year 1998 | | Initial (1997) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (1998) | Forest Land | 2 630.3 | 0.7 | 0.5 | 0.1 | 2.3 | 0.0 | 2 633.8 |
| | Grassland | 0.4 | 983.6 | 5.8 | 0.3 | 2.8 | 0.0 | 992.9 |
| | Cropland | 0.4 | 13.4 | 3 318.3 | 0.4 | 4.5 | 0.0 | 3 337.0 |
| | Wetland | 0.1 | 0.2 | 0.1 | 158.2 | 0.4 | 0.0 | 159.0 |
| | Settlements | 0.5 | 0.9 | 1.5 | 0.3 | 652.9 | 0.0 | 656.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 631.7 | 998.8 | 3 326.2 | 159.3 | 662.8 | 107.2 | 7 886.0 |
| Year 1999 | | Initial (1998) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (1999) | Forest Land | 2 632.9 | 0.5 | 0.3 | 0.0 | 0.7 | 0.0 | 2 634.5 |
| | Grassland | 0.1 | 991.1 | 4.1 | 0.0 | 0.4 | 0.0 | 995.7 |
| | Cropland | 0.1 | 0.9 | 3 330.6 | 0.0 | 0.6 | 0.0 | 3 332.2 |
| | Wetland | 0.1 | 0.1 | 0.2 | 158.7 | 0.1 | 0.0 | 159.2 |
| | Settlements | 0.6 | 0.6 | 1.9 | 0.1 | 654.4 | 0.0 | 657.5 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 633.8 | 993.1 | 3 337.1 | 159.0 | 656.2 | 107.2 | 7 886.4 |
| Year 2000 | | Initial (1999) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2000) | Forest Land | 2 633.8 | 0.5 | 0.5 | 0.1 | 2.4 | 0.0 | 2 637.3 |
| | Grassland | 0.1 | 992.9 | 13.1 | 0.1 | 0.4 | 0.0 | 1 006.6 |
| | Cropland | 0.1 | 1.7 | 3 316.6 | 0.1 | 0.3 | 0.0 | 3 318.8 |
| | Wetland | 0.1 | 0.1 | 0.2 | 158.9 | 0.1 | 0.0 | 159.3 |
| | Settlements | 0.4 | 0.5 | 1.9 | 0.1 | 654.3 | 0.0 | 657.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 634.5 | 995.8 | 3 332.2 | 159.3 | 657.5 | 107.2 | 7 886.5 |
| Year 2001 | | Initial (2000) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2001) | Forest Land | 2 636.8 | 0.5 | 0.4 | 0.0 | 1.1 | 0.0 | 2 638.9 |
| | Grassland | 0.1 | 1 004.8 | 6.0 | 0.0 | 0.5 | 0.0 | 1 011.4 |
| | Cropland | 0.1 | 0.8 | 3 310.3 | 0.0 | 0.3 | 0.0 | 3 311.6 |
| | Wetland | 0.0 | 0.1 | 0.1 | 159.2 | 0.1 | 0.0 | 159.6 |
| | Settlements | 0.3 | 0.4 | 1.9 | 0.1 | 655.1 | 0.0 | 657.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 637.3 | 1 006.6 | 3 318.7 | 159.4 | 657.2 | 107.2 | 7 886.5 |

| Year 2002 | | Initial (2001) | | | | | | Area (kha) |
|--------------|-------------|----------------|-----------|----------|----------|-------------|------------|---------------|
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2002) | Forest Land | 2 638.4 | 0.9 | 1.1 | 0.0 | 2.5 | 0.0 | 2 643.1 |
| | Grassland | 0.1 | 1 009.3 | 3.7 | 0.0 | 0.9 | 0.0 | 1 014.0 |
| | Cropland | 0.0 | 0.3 | 3 303.9 | 0.1 | 0.1 | 0.0 | 3 304.5 |
| | Wetland | 0.1 | 0.1 | 0.2 | 159.4 | 0.2 | 0.0 | 159.9 |
| | Settlements | 0.3 | 0.8 | 2.6 | 0.1 | 654.3 | 0.0 | 658.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 638.9 | 1 011.4 | 3 311.6 | 159.6 | 658.0 | 107.2 | 7 886.8 |
| Year 2003 | | Initial (2002) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2003) | Forest Land | 2 642.1 | 0.6 | 0.7 | 0.0 | 0.7 | 0.0 | 2 644.2 |
| | Grassland | 0.1 | 1 011.2 | 4.6 | 0.0 | 0.3 | 0.0 | 1 016.3 |
| | Cropland | 0.1 | 1.5 | 3 296.9 | 0.0 | 0.1 | 0.0 | 3 298.6 |
| | Wetland | 0.0 | 0.1 | 0.2 | 159.7 | 0.1 | 0.0 | 160.1 |
| | Settlements | 0.5 | 0.6 | 2.1 | 0.1 | 656.9 | 0.0 | 660.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 642.9 | 1 014.0 | 3 304.5 | 159.9 | 658.1 | 107.2 | 7 886.7 |
| Year 2004 | | Initial (2003) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2004) | Forest Land | 2 643.5 | 0.8 | 0.8 | 0.0 | 0.6 | 0.0 | 2 645.7 |
| | Grassland | 0.1 | 1 013.8 | 3.1 | 0.0 | 0.4 | 0.0 | 1 017.4 |
| | Cropland | 0.1 | 0.7 | 3 291.9 | 0.0 | 0.2 | 0.0 | 3 292.8 |
| | Wetland | 0.0 | 0.2 | 0.2 | 159.9 | 0.1 | 0.0 | 160.5 |
| | Settlements | 0.5 | 0.9 | 2.7 | 0.1 | 658.9 | 0.0 | 663.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 644.2 | 1 016.4 | 3 298.7 | 160.1 | 660.2 | 107.2 | 7 886.8 |
| Year 2005 | | Initial (2004) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2005) | Forest Land | 2 645.1 | 0.9 | 0.9 | 0.0 | 0.6 | 0.0 | 2 647.4 |
| | Grassland | 0.1 | 1 015.1 | 4.0 | 0.0 | 0.3 | 0.0 | 1 019.5 |
| | Cropland | 0.1 | 0.4 | 3 284.9 | 0.0 | 0.2 | 0.0 | 3 285.7 |
| | Wetland | 0.0 | 0.2 | 0.2 | 160.4 | 0.1 | 0.0 | 160.9 |
| | Settlements | 0.4 | 0.8 | 2.7 | 0.1 | 661.9 | 0.0 | 666.0 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 645.7 | 1 017.4 | 3 292.8 | 160.5 | 663.1 | 107.2 | 7 886.7 |
| Year 2006 | | Initial (2005) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2006) | Forest Land | 2 647.0 | 0.7 | 1.0 | 0.0 | 0.4 | 0.0 | 2 649.1 |
| | Grassland | 0.1 | 1 017.6 | 4.0 | 0.0 | 0.2 | 0.0 | 1 021.9 |
| | Cropland | 0.1 | 0.4 | 3 277.5 | 0.0 | 0.2 | 0.0 | 3 278.2 |
| | Wetland | 0.0 | 0.2 | 0.3 | 160.7 | 0.2 | 0.0 | 161.4 |
| | Settlements | 0.3 | 0.7 | 2.8 | 0.1 | 664.9 | 0.0 | 668.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 647.4 | 1 019.5 | 3 285.6 | 160.9 | 665.9 | 107.2 | 7 886.7 |
| Year 2007 | | Initial (2006) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2007) | Forest Land | 2 648.8 | 0.6 | 0.9 | 0.0 | 0.9 | 0.0 | 2 651.2 |
| | Grassland | 0.1 | 1 019.9 | 3.5 | 0.0 | 0.2 | 0.0 | 1 023.7 |
| | Cropland | 0.0 | 0.5 | 3 270.4 | 0.0 | 0.2 | 0.0 | 3 271.2 |
| | Wetland | 0.0 | 0.2 | 0.3 | 161.2 | 0.4 | 0.0 | 162.1 |
| | Settlements | 0.3 | 0.7 | 3.0 | 0.1 | 667.1 | 0.0 | 671.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 649.1 | 1 021.9 | 3 278.1 | 161.4 | 668.8 | 107.2 | 7 886.7 |

| Year 2008 | | Initial (2007) | | | | | | Area (kha) |
|--------------|-------------|----------------|-----------|----------|----------|-------------|------------|------------|
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| Final (2008) | Forest Land | 2 650.8 | 0.5 | 0.8 | 0.1 | 0.9 | 0.0 | 2 653.0 |
| | Grassland | 0.0 | 1 021.8 | 3.3 | 0.0 | 0.1 | 0.0 | 1 025.4 |
| | Cropland | 0.1 | 0.4 | 3 263.6 | 0.0 | 0.2 | 0.0 | 3 264.4 |
| | Wetland | 0.0 | 0.2 | 0.3 | 161.9 | 0.1 | 0.0 | 162.5 |
| | Settlements | 0.3 | 0.7 | 3.1 | 0.1 | 669.8 | 0.0 | 674.0 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 107.2 | 107.2 |
| | Area (kha) | 2 651.2 | 1 023.6 | 3 271.1 | 162.1 | 671.2 | 107.2 | 7 886.5 |
| Year 2009 | | Initial (2008) | | | | | | Area (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 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 (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 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 (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 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 (kha) |
| | Category | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 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 |

7.2.3 Methodologies to estimate emissions

The estimation of emissions and removals of CO₂ and non-CO₂ gases for the sector was performed according to Chapter 3 of GPG for LULUCF (IPCC, 2003). Additionally, the 2006 Guidelines for National Greenhouse Gas Inventories – Agriculture, Forestry and Other Land Use (IPCC, 2006) were consulted whenever appropriate. The following text describes the inventory for the individual land-use categories, noting vital information on the category within the conditions of the Czech Republic, the methodology employed, uncertainty and time consistency, QA/QC and verification, recalculations and source-specific planned improvements.

7.3 Forest Land (5A)

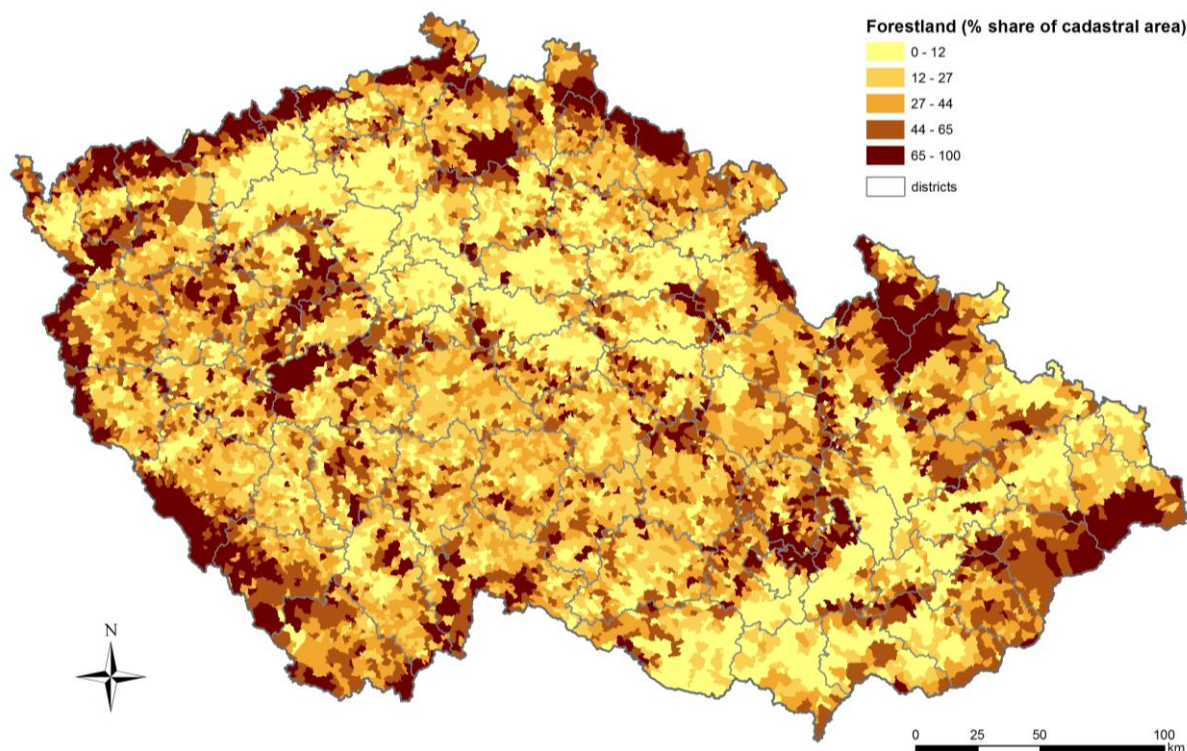


Fig. 7-5 Forest Land in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2012)

7.3.1 Source category description

The Czech Republic is a country with a long forestry tradition. Practically all the forests can be considered to be temperate-zone managed forests under the IPCC definition of forest management (GPG Chapter 3, IPCC 2003). With respect to the definition thresholds of the Marrakesh Accords, Forest Land is defined as land with woody vegetation and with tree crown cover of at least 30 %, over an area exceeding 0.05 ha containing trees able to reach a minimum height of 2 m at maturity⁴. 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 2012, the stocked forest area (timberland) qualifying under the category of Forest Land in this emission inventory equalled 2 609 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, 2013). The tree species composition is dominated by conifers, which represent 73.2 % of the timberland area. The four most important tree species in this country are spruce, pine, beech and oak, which account for 51.4, 16.7, 7.7 and 7.0 % of the timberland area, respectively (MA, 2013). Broadleaved tree species have been favored in new afforestation since 1990. The proportion of broadleaved tree species increased from 21 % in 1990 to almost 26

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

% in 2012. The total growing stock (merchantable wood volume) in forests in the country has increased during the reported period from 564 mil. m³ in 1990 to 686 mil. m³ (under bark) in 2012 (MA, 2013).

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 consists in 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. This emission inventory is dominantly based on the FMP data, which have also been used for all the international reporting on forests of the Czech Republic to date. Whenever feasible, the information from other inventory programs mentioned above and/or other sources was also utilized.

FMP data were aggregated in line with the country-specific approaches at the level of the four major tree species (i-beech: all broadleaved species except oaks, ii-oak: all oak species, iii-pine: pines and larch, iv-spruce: all conifers except pines and larch) and age-classes (10-year intervals). For these categories, growing stock (merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm), the corresponding areas and other auxiliary information were available for each inventory year. It can be observed in Fig. 7-6 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 2012, clear-cut areas represented 1.1 % 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 m³/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 project show a mean growing stock volume of 305 m³/ha under bark (IFER, 2010), i.e., lower than the estimates of FMI (2007).

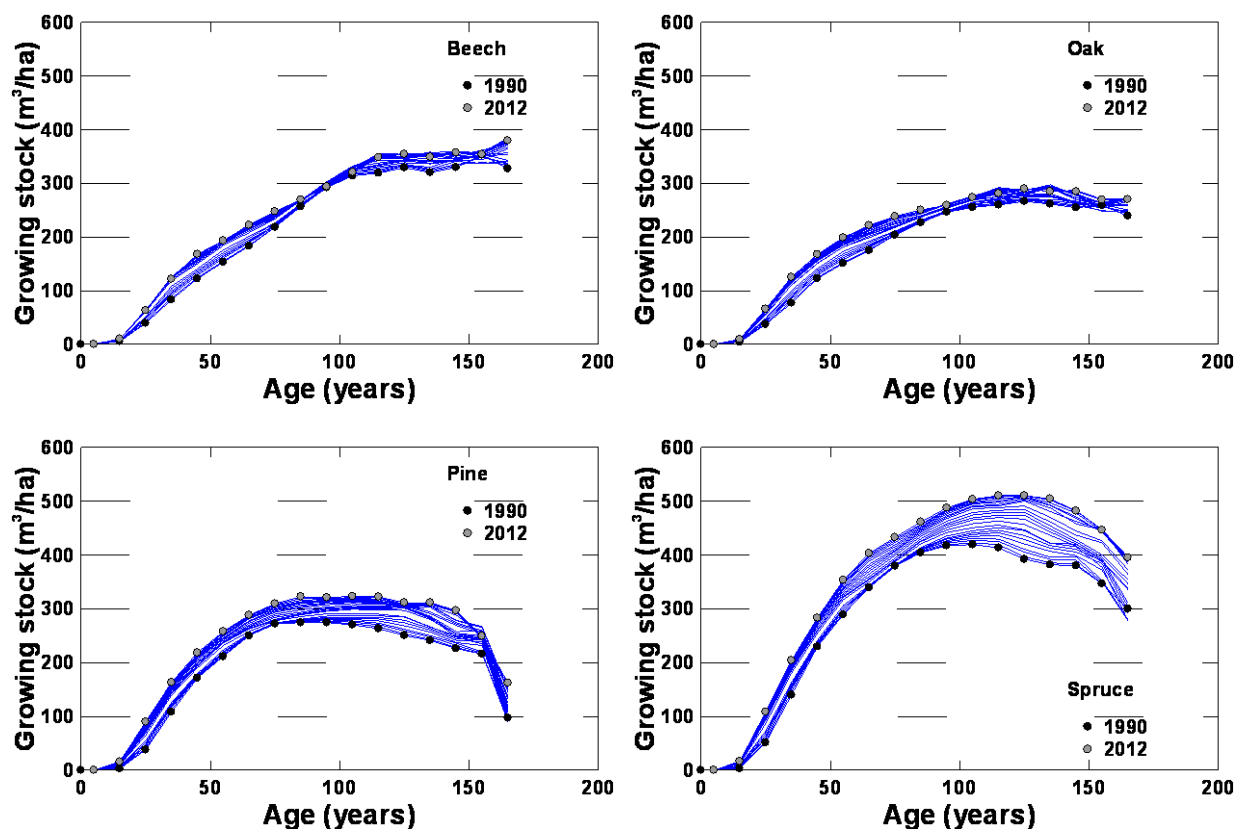


Fig. 7-6 Activity data – mean growing stock volume against stand age for the four major groups of species during 1990 to 2012; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2012

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. m³ in 1990 to 15.1 mil. m³ (under bark) in 2012, down from the all-time high 18.5 mil. m³ harvested in 2007 (all data refer to underbark volumes, MA 2013).

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 newly includes the officially reported estimates from the Czech Statistical Office (CzSO), 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 of coniferous species, which are commonly 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, insect 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 2013). In 2012, the applicable volume of total annual harvest drain reached 17.0 mill. m³, down from the maximum of 21.0 mill. m³ estimated for 2007. The harvest drain applicable for the emission inventory for the entire reporting period since 1990 to 2012 is shown in Fig. 7-7.

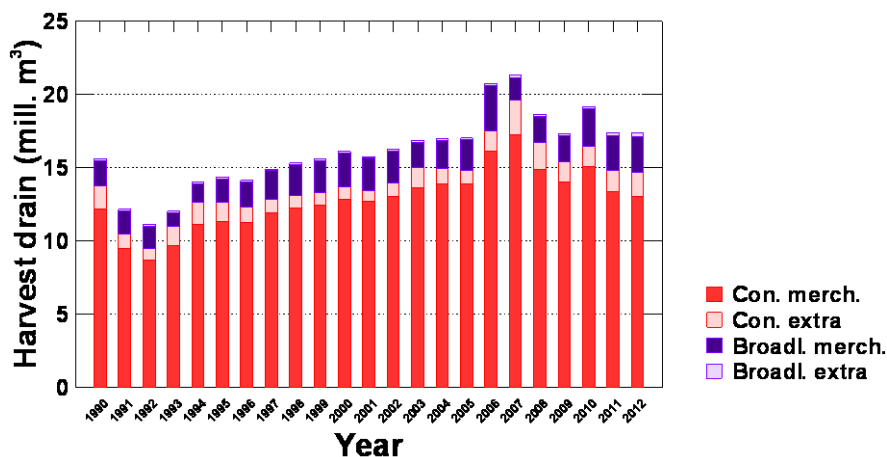


Fig. 7-7 The applicable total annual harvest drain for coniferous (Con.) and broadleaved (Broadl.) tree species, which includes both the reported quantities of merchantable wood for the two categories (Con. merch, Broadl. merch.) and the associated harvest loss (Con. extra, Broadl. extra) for the entire reporting period 1990 to 2012.

7.3.2 Methodological issues

Category 5A *Forest Land* includes emissions and sinks of CO₂ associated with forests and non-CO₂ gases generated by burning in forests. This category is composed of 5A1 *Forest Land remaining Forest Land*, and 5A2 *Land converted to Forest Land*. The following text describes the major methodological aspects related to emission inventories of both forest sub-categories.

The methods of area identification described in Section 7.1.2 distinguish the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory 5A1 *Forest Land remaining Forest Land*. The other part represents subcategory 5A2 *Land converted to Forest Land*, i.e., the forest areas “in transition” that were converted from other land-use categories over the 20 years prior to the reporting year. The areas of forest subcategories, i.e., 5A1 and 5A2 accumulated over a 20-year rolling period can be found in the corresponding CRF Tables. The annual matrices of identified land-use and land-use changes are given in Tab 7-3 above.

7.3.2.1 Forest Land remaining Forest Land

Carbon stock change in category 5A1 *Forest Land remaining Forest Land* is given by the sum of changes in living biomass, dead organic matter and soils. The carbon stock change in living biomass was estimated using the default method⁷ according to eq. 3.3.2 of GPG for LULUCF. This method is based on separate estimation of increments and removals, and their difference.

The reported growing stock of merchantable volume from the database of FMP formed the basis for assessment of the carbon increment (Eqs. 3.2.4 and 3.2.5 of GPG for LULUCF). The key input to calculate the carbon increment is the volume increment (I_v) data. In the Czech Republic, these values have been traditionally calculated at FMI⁸ (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. 7-8).

⁷ Alternative approaches of the stock-change method (Eq. 3.2.3; IPCC 2003) were also analyzed (Cienciala et al. 2006a) for this category. However, for several reasons the default method was finally adopted, which is discussed in the cited study.

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.

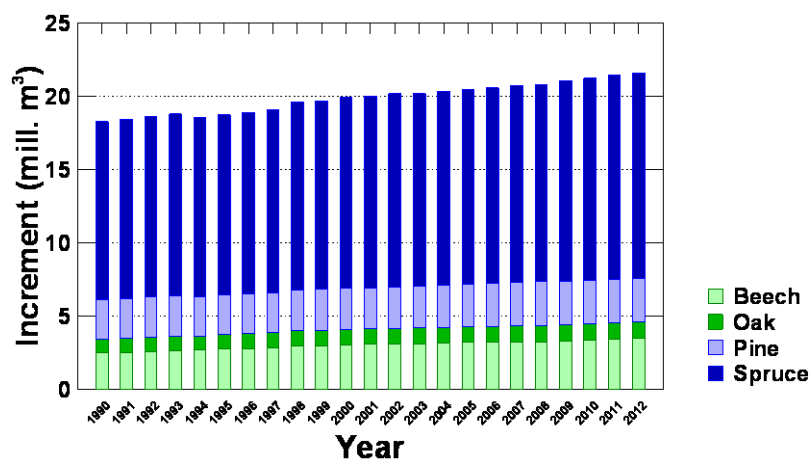


Fig. 7-8 Current annual increment (Increment, mill. m³ underbark) by the individual tree species groups as used in the reporting period 1990 to 2012.

The merchantable volume increment (I_v) is converted to the biomass increment (G_{Total}), biomass conversion and expansion factors applicable for increment ($BCEF_i$) using Eqs. 2.9 and 2.10 (AFOLU, 2006) as follows:

$$\Delta C_G = \sum_j (A_j * G_{Total,j} * CF_j) \quad (1)$$

where A_j and CF_j represent the actual stand area (ha) and carbon fraction of dry matter (t C per t dry matter), respectively, for each major tree species type j (beech, oak, pine, spruce), while G_{Total} is calculated for each j as follows:

$$G_{Total} = \sum \{I_v * BCEF_i * (1 + R)\} \quad (2)$$

where R is a root/shoot ratio to include the below-ground component. The total biomass increment is multiplied by the carbon fraction and the applicable forest land area. Tab. 7-4 lists the factors used in the calculation of the biomass carbon stock increment.

Tab. 7-4 Input data and factors used in carbon stock increment calculation (1990 and 2012 shown) for beech, oak, pine and spruce species groups, respectively

| Variable or conversion factor | Unit | Year 1990 | Year 2012 |
|---|---------------------------------|------------------------|------------------------|
| Area of forest land remaining forest land (A) | kha | 374; 153; 457; 1510 | 476; 180; 427; 1 449 |
| 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; 6.12; 6.91; 9.52 |

In Tab. 7-4, A represents only the areas of 5A1 *Forest Land remaining Forest Land*, updated annually. The applied biomass conversion and expansion factors applicable for the increment ($BCEF_i$) and growing stock volumes ($BCEF_h$) are based on national allometric studies (Cienciala et al., 2006a, 2006b, 2008a) or biomass compilations that include data from the Czech Republic (Wirth et al., 2004, Wutzler et al., 2008). Since the biomass conversion and expansion factors are age-dependent (Lehtonen et al., 2004, 2007), they respect the actual age-class distribution of the dominant tree species. Hence, the $BCEF_i$ values shown in Tab. 7-4 are weighted means considering the actual volumes of the individual age classes for each of the major tree species. Besides the allometric equations noted above, the source dendrometrical material used for derivation of the country-specific $BCEF_i$ values were the data of the landscape inventory program CzechTerra (Černý, 2009). Its first cycle was completed in 2009 and these dendrometrical data hence represent the most current information on the Czech Forests available in the country. The tree level data together with the information of age was used to assess the median $BCEF_i$ values for each age class and major tree species. Since this 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. 7-4). 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 *5A1 Forest Land remaining Forest Land* basically follows eq.s. 3.2.6, 3.2.7 and 3.2.8 (IPCC, 2003). 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 otherwise follows eq. 2.12 (AFOLU 2006) as

$$L_{\text{wood-removals}} = H * BCEF_h * (1 + R) * CF \quad (3)$$

where $BCEF_h$ represents a biomass expansion and conversion factor applicable to harvested volumes, derived from national studies or regional compilations that include the data from the Czech Republic as noted and mentioned above. The application of $BCEF_h$ considers the share of the planned harvested volume and the actual salvage logging that was not planned. In the case of planned harvest volumes, the age-dependent $BCEF_h$ values also consider the mean felling age, which is taken from the national reports of the Ministry of Agriculture. For salvage logging, $BCEF_h$ represents the volume-weighted mean of all age classes for the individual dominant tree species, as the actual stand age of those harvested volumes is unknown. The other factors (CF , R) are identical to those described under Tab. 7-4. The specific values of input variables and conversion factors used to calculate L are listed in Tab. 7-5.

Tab. 7-5 Specific input data and factors used in calculation of carbon drain (1990 and 2012 shown) for beech, oak, pine and spruce species groups, respectively

| Variable or conversion factor | Unit | Year 1990 | Year 2012 |
|---|----------------------|------------------------|------------------------|
| Harvest drain volume (H , incl. F_{HL}) | mill. m ³ | 0.95; 0.35; 1.50; 12.2 | 1.72; 0.54; 2.14; 12.6 |
| Biomass expansion factor ($BCEF_h$) | Mg m ⁻³ | 0.69; 0.81; 0.52; 0.59 | 0.69; 0.81; 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 2013) 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.

The assessment of the net carbon stock change in organic matter (deadwood and litter) followed the Tier 1 (default) GPG for LULUCF assumption of zero change in these carbon pools. This is a safe assumption, as the country did not experience significant changes in forest types, disturbance or management regimes within the reporting period.

The above assumption also applies to the soil carbon pool, in which the net carbon stock change was considered to equal zero (Tier 1, IPCC, 2003). This concerns both mineral and organic soils. The organic soils occur only in the areas of the Spruce sub-category on *5A1 Forest Land remaining Forest Land*. They represent protected peat areas in mountainous regions dominated by spruce stands, with no or specific management practices. No such areas occur under the other sub-categories with the predominant species of Beech, Oak and Pine.

Emissions in category *5A1 Forest Land remaining Forest Land* include, in addition to CO₂, also other greenhouse gases (CH₄, CO, N₂O and NO_x) resulting from burning. This encompasses both prescribed fires

associated with burning of biomass residues and also emissions due to wildfires. The emissions from burning of biomass residues were estimated according to eq. 3.2.19 and the emission ratios in Table 3A.1.15 (Tier 1, IPCC, 2003). Under the conditions in this country, part of the biomass residues is burnt in connection with final cut. Hence, this practice is limited to category *5A1* and does not occur on *5A2 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 588 Gg in 1990 and 316 Gg in 2012.

The emissions of greenhouse gases due to wildfires were estimated on the basis of known areas burnt annually by forest fires and the average biomass stock in forests according to eq. 3.2.9 (IPCC, 2003). This equation used a default factor of biomass left to decay after burning (0.45; Table 3A.1.12). The associated amounts of non- CO_2 gases (CH_4 , CO , N_2O and NO_x) were estimated according to eq. 3.2.19. The amount of biomass (dry matter) burned in wildfires was estimated as 10.2 Gg in 1990 and 47.0 Gg in 2012. The value estimated for 2012 is the highest since 2003, when almost 87 Gg of biomass was burned in wildfires. However, the most extreme year of the reporting period was 1997, when about 228 Gg of biomass was burned due to wildfires. The full time series and the associated emissions of non- CO_2 gases can be found in the corresponding CRF Tables.

There are no direct N_2O emissions from N fertilization on Forest Land, as there is no practice of nitrogen fertilization of forest stands in the Czech Republic. Similarly, non- CO_2 emissions related to drainage of wet forest soils are not reported, as this activity no longer occurs in practice.

7.3.2.2 Land converted to Forest Land

The methods employed to estimate emissions in the *5A2 Land converted to Forest Land* category are similar to those for the category of Forest Land remaining Forest Land, but they differ in some assumptions, which follow the recommendations of GPG for LULUCF.

For estimation of the net carbon stock change in living biomass on Land converted to Forest Land by the Tier 1 method (IPCC, 2003), the carbon increment is proportional to the extent of afforested areas and the growth of biomass. The revised methodology of land-use change identification (Section 7.1.2) provides areas of all conversion types updated annually. Land areas are considered to be under conversion for a period of 20 years, according the Tier 1 assumption of GPG for LULUCF. Under the conditions in this country, all newly afforested lands are considered as intensively managed lands under the prescribed forest management rules as specified by the Czech Forestry Act.

Until 2006, the increment applicable to age classes I and II (stand age up to 20 years) was estimated from the actual wood volumes and areas that were available per major species groups. Using the available activity stand level data categorized by species and age classes and the national growth and yield model SILVISIM (Černý, 2005), the wood increment was derived for all the age classes above 20 years. For age class one (1-10 years), the increment was simply calculated from the reported areas and volumes, assuming a mean age of five years. The increment of age class two (11 to 20 years) was estimated from linear interpolation between the increment of age classes I and III. For the year 2007 and forward, increment is derived for individual tree species using the ratio of increment for individual tree species to the total stand increment estimated from the period 2000 to 2006.

Since the specific species composition of the newly converted land is unknown, the increment estimated for the major tree species was averaged using the weight of actual areas for the individual tree species known from the unchanged (remaining) forest land. Expressed in terms of aboveground biomass, the estimated aggregated mean increment for 2012 was 3.17 t/ha, a value matching that for temperate coniferous (3 t/ha) and somewhat lower than that for broadleaved (4 t/ha) forests given as defaults in GPG for LULUCF. The estimation of increment in terms of aboveground biomass is facilitated by the age and species dependent $BCEF_i$ values as described in Section 7.3.2.1 above. The estimated species-specific values of $BCEF_i$ applicable for young trees until 20 years were 0.99, 1.25, 0.65 and 0.93 for beech, oak, pine and spruce, respectively.

The carbon loss associated with biomass in the category of Land converted to Forest Land was assumed to be insignificant (zero). This is because the first significant thinning occurs in older age classes, which is implicitly accounted for within the category Forest Land remaining Forest Land. It is also important to note (in response

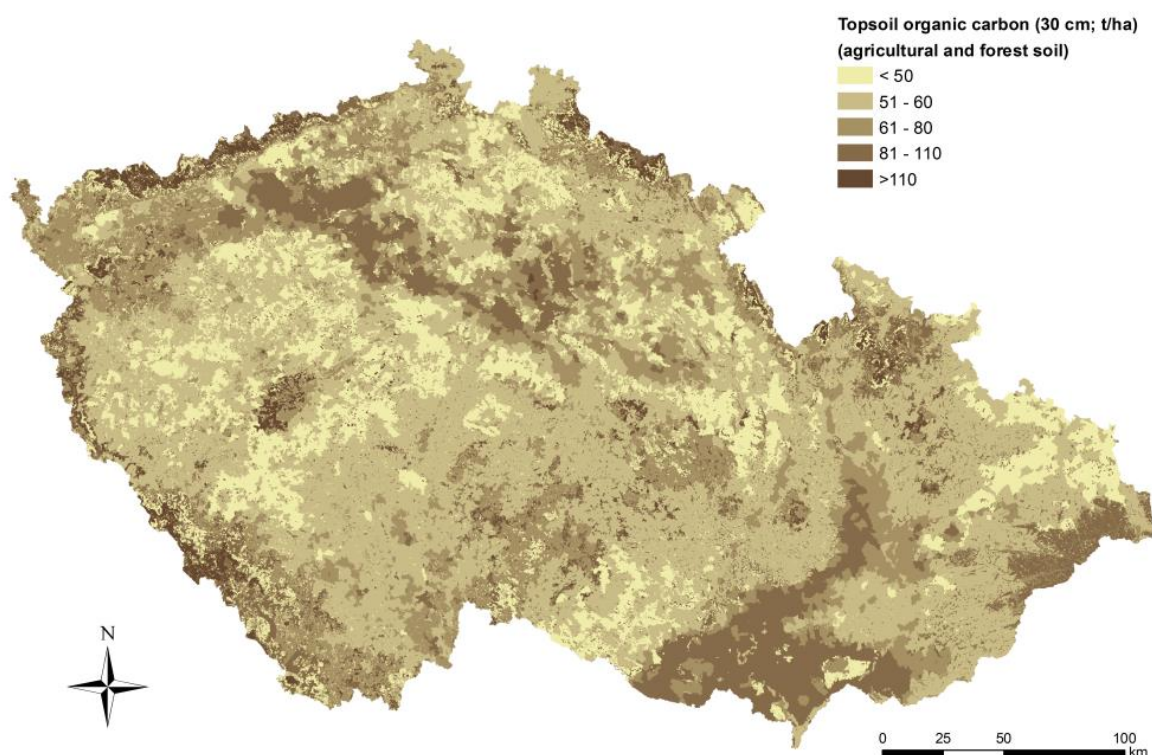
to the previous inventory reviews) that in the conditions of the country, there no biomass loss due to disturbance on the land converted to forest land. It actually represents a land of newly established forest with age of 1 to 20 years. As also apparent from the national statistics, there is no volume 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, 2003).

The net change of carbon stock in mineral soils was estimated using the country-specific Tier 2/Tier 3 method. It was based on the vector map of topsoil organic carbon content (Macků et al., 2007; Šefrna and Janderková 2007; see Fig. 7-9). 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=13 013 in 2012), serving as reference levels of soil carbon stock applicable to forest and agricultural soils. Since agricultural soils include both Cropland and Grassland land-use categories, the bulk soil carbon content obtained from the map was adjusted for the two categories. This was performed by applying a ratio of 0.85 relating the soil carbon content between Cropland and Grassland (J. Šefrna, personal communication 2007) and considering the actual areas of Cropland and Grassland in the individual cadastral units. This system permitted estimation of the soil carbon stock change among categories *5A Forest Land*, *5B Cropland* and *5C Grassland*. The estimated quantities of carbon stock change at the level of the individual spatial units entered 20-year accumulation matrices distributing carbon into fractions over 20 years (Tier 1, IPCC 2003). These quantities, together with the accumulated areas under the specific conversion categories, were used for estimation of emissions and removals of CO₂.

The net changes of carbon stock in organic soils, occurring only in the sub-category of stands dominated by spruce, were assumed to be insignificant (zero). This is in accordance with the general assumption of the Tier 1 method applicable for forest soils, as no other specific methodology is available for organic soils besides the drained ones (IPCC, 2003).

Non-CO₂ emissions from burning are not estimated for category *5A2 Land converted to Forest Land*, as there is no such practice in this country. The same applies to the N₂O emissions from nitrogen fertilization, which is not employed in this country.



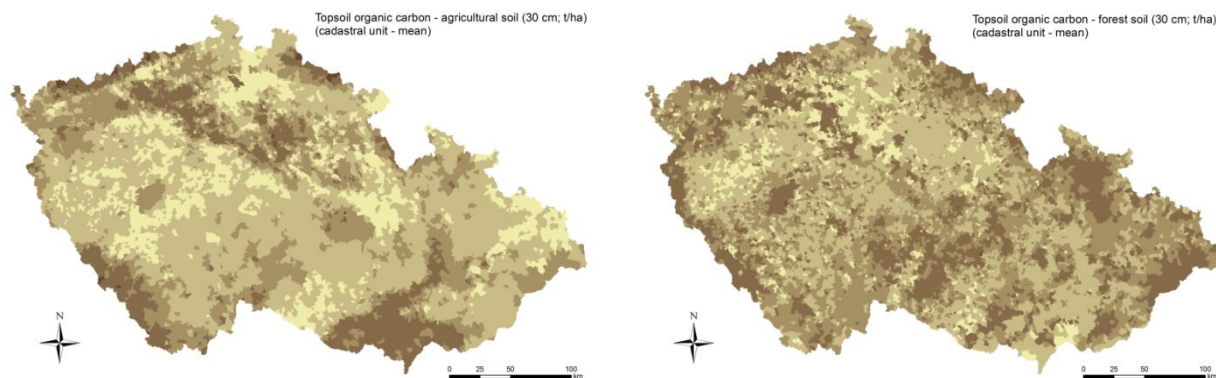


Fig. 7-9 Top - topsoil (30 cm) organic carbon content map adapted from Macků et al. (2007), Šefrna and Janderková (2007); bottom –topsoil carbon content for agricultural (left) and forest (right) soils estimated as cadastral unit means from the source maps. The unit (t/ha) and unit categories are identical for all maps

7.3.3 Uncertainties and time consistency

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2012.

The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003), employing the following equations:

$$U_{Total} = \sqrt{U_1^2 + U_1^2 + \dots + U_n^2} \quad (4)$$

where U_{total} is the percentage uncertainty in the product of the quantities and U_i denotes the percentage uncertainties with each of the quantities (Eq. 5.2.1, IPCC 2003).

For the quantities that are combined by addition or subtraction, we used the following equation to estimate the uncertainty:

$$U_E = \frac{\sqrt{(U_1 * E_1)^2 + (U_2 * E_2)^2 + \dots + (U_n * E_n)^2}}{|E_1 + E_2 + \dots + E_n|} \quad (5)$$

where U_E is the percentage uncertainty of the sum, U_i is the percentage uncertainty associated with source/sink i , and E_i is the emission/removal estimate for source/sink i (Eq. 5.2.2, IPCC 2003).

It should be noted, however, that eq. 5 as exemplified in GPG for LULUCF, is not well applicable for the LULUCF sector. Summing negative (removals) and positive (emission) members (E_i) in denominator of 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 equation 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 2012, the uncertainty estimates for the categories *5A1 Forest Land remaining Forest Land* and *5A2 Land converted to Forest Land* using the above described approach reached 15.5 and 39.0 %, respectively. Correspondingly, the uncertainty for the entire category *5A Forest Land* reached 14.9 %.

7.3.4 Category-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 5.5.1 of GPG for LULUCF (IPCC, 2003).

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

Apart from official review process, emission inventory methods and results are internally reviewed among the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors. Whenever feasible, the methods are subject to peer-review in case of the cited scientific publications, and expert team reviews within the relevant national research projects.

Within the effort associated with preparation of this inventory report, 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.

7.3.5 Category-specific recalculations

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data included the land use areas and data on biomass residues associated with wood harvest on forest land. As for the land use data, on request of the latest review, these data were newly crosschecked in order to improve data consistency. This request concerned primarily the historical data since 1969 to 1992, which are available at the country level (NUTS 4). Following the consultation with the supplier, i.e., the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz), these data are now used in its original form with no additional corrections applied. These changes in practice mean rectifying land use matrices for the entire reporting period and for the all land use categories. It is due to the adopted IPCC default of 20 years applicable for soil carbon pool change due to land conversions, which technically requests activity data since 1969 and any corrections in land areas affect the period of 20 years following the year of intervention. As for the activity data on biomass residues applicable to wood loss, the Czech emission inventory use a new information on harvest residues reported by the Czech Statistical Office. For the remaining (older) period, the expert judgment of harvest loss as adopted earlier is retained equally for all tree species.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). These corrections leading to somewhat more conservative estimates affect all emission categories associated with forest land and its conversion. They also affect the emissions from burning, which also use the above implemented emission factors.

The resulting effect of the recalculation performed for the category *5A Forest Land* can be seen in Fig. 7-10. On average, the emission removals decreased by 4.5 % as compared to the previously reported estimates.

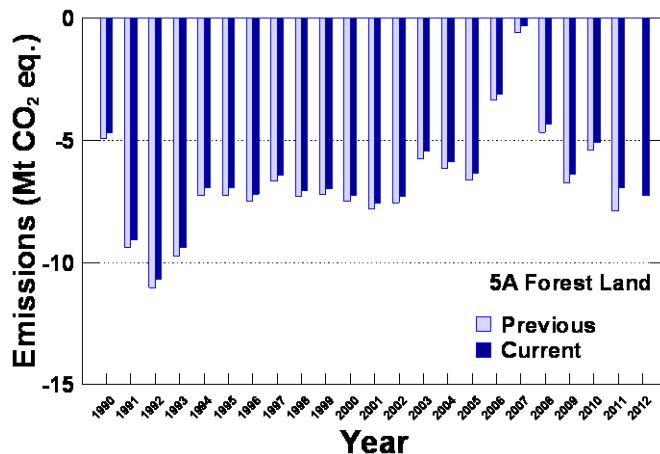


Fig. 7-10 Current and previously reported assessment of emissions for category 5A Forest Land. The values are negative, hence representing net removals of green-house gases

7.3.6 Category-specific planned improvements

The current report applicable for 5A Forest Land includes several important improvements following 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, which is 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, utilization of the stock change method in as explored in Cienicala et al. (2006a) will be considered, once the data from the repeated survey of the Czech National Forest Inventory (field survey in progress as of 2014) will be available.

Emissions from lime application on forest land remain being reported under the category *5G Other* due to the current technical limitations of the CRF Reporting software. The addition of emissions from lime application on forest land makes the reporting under Convention compatible with that of KP LULUCF activities where emissions from lime applications are also reported for the activities related to forest land.

7.4 Cropland (5B)

7.4.1 Source category description

In the Czech Republic, Cropland is predominantly represented by arable land (93 % of the category in 2012), while the remaining area includes hop-fields, vineyards, gardens and orchards. These categories correspond to five of the six real estate categories on agricultural land from the database of "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC.

Cropland is spatially the largest land-use category in the country. Simultaneously, the area of Cropland has constantly decreased since the 1970s, with a particularly strong decreasing trend since 1990 (Fig. 7-4). While, in 1990, Cropland represented approx. 44 % of the total area of the country, this share decreased to 41 % in 2012. 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.

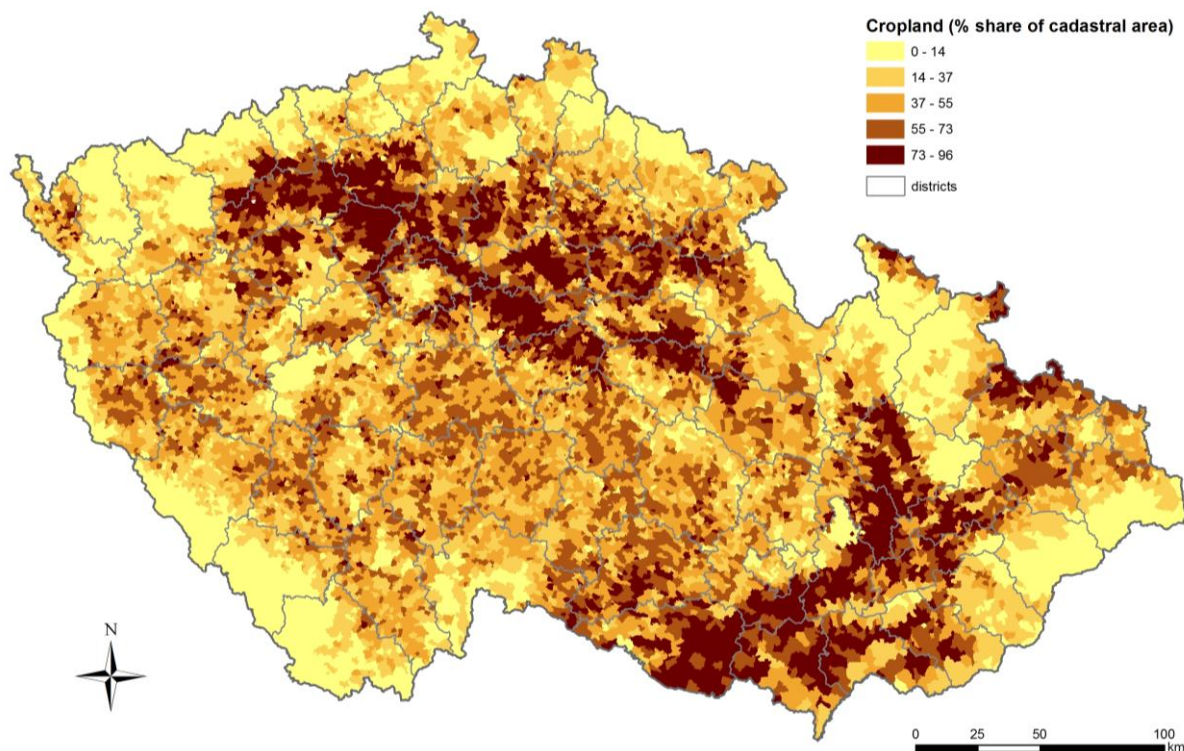


Fig. 7-11 Cropland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2012)

7.4.2 Methodological issues

The emission inventory of Cropland concerns sub-categories *5B1 Cropland remaining Cropland* and *5B2 Land converted to Cropland*. The emission inventory of Cropland considers changes in living biomass and soil. In addition, CO₂ emissions resulting from application of agricultural limestone and N₂O emissions associated with soil disturbance during land-use conversion to cropland are quantified for this category.

7.4.2.1 Cropland remaining Cropland

For category *5B1 Cropland remaining Cropland*, the changes in biomass can be estimated only for perennial woody crops. Under the conditions in this country, this might be applicable to the categories of vineyards, gardens and orchards. Hence, to estimate emissions associated with biomass on Cropland, we applied a default factor for the biomass accumulation rate (2.1 t C/ha/year, Table 3.3.2, IPCC 2003) and estimated changes in the areas concerned.

The carbon stock changes in soil in the category Cropland remaining Cropland are given by changes in mineral and organic soils. Organic soils basically do not occur on Cropland; they occur as peatland in mountainous regions on Forest Land. While organic soils practically do not occur on Cropland, emissions were estimated for mineral soils. Based on the average carbon content on Cropland estimated specifically for each of the 13 013 cadastral units from the detailed soil carbon maps (Fig. 7-9), 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.

The Cropland category also includes emissions due to liming, which were estimated from the reported limestone use and application area. Liming by either limestone (CaCO₃) or dolomite (CaMg(CO₃)₂) is used to

improve soil for crop growth by increasing the availability of nutrients and decreasing acidity. However, the reactions associated with limestone application also lead to evolution of CO₂, which must be quantified. Of the reported total limestone use in agriculture, 95 % was ascribed to Cropland (the reminder to Grassland), based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005). The quantification followed the Tier 1 method of GPG for LULUCF (Eq. 3.3.6 IPCC 2003), with an emission factor of 0.12 t C/t CaCO₃. 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. t, but decreased to less than 200 000 t annually during the most recent years (see the corresponding CRF Tables). This dramatic decrease makes the entire category of *5B1 Cropland remaining Cropland* a key category identified by trend, although its quantitative contribution to national emissions in recent years has been marginal. The activity data on liming were repeatedly verified. They correspond to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Salusová et. al., 2006). The application of limestone on agricultural land in 2012, however, increased again and reached almost 263 thousand tons. This is the largest reported quantity since 1991.

Non-CO₂ greenhouse gas emissions from burning do not occur in category *5A2 Land converted to Forest Land*, as there is no such practice in this country.

7.4.2.2 Land converted to Cropland

Category *5B2 Land converted to Cropland* includes land conversions from other land-use categories. Cropland has generally decreased in area since 1990, by far most commonly converted to Grassland. However, the adopted land-use identification system was also able to detect some land conversion in the opposite direction, i.e., to Cropland.

The estimation of carbon stock changes in biomass in the category *5B2 Land converted to Cropland* was based on quantifying the difference between the carbon stock before and after the conversion, including the estimate of one year of cropland growth (5 t C/ha; Table. 3.3.8, IPCC 2003), which follows Tier 1 assumptions of GPG for LULUCF and the recommended default values for the temperate zone. For biomass carbon stock on Forest Land prior conversion, the annually updated average growing stock volumes, species-specific volume-weighted biomass conversion and expansion factors (*BCEF*), and other factors such as the below-ground biomass ratio were used as described the *5A Forest Land* category in Section 7.2.2.1 above. For biomass carbon stock on Grassland prior the conversion, the default factors of 6.8 t/ha for above-ground and below-ground biomass were used (Table 6.4, IPCC, 2006). A biomass content of 0 t/ha was assumed after land conversion to *5B Cropland*.

The estimation of net carbon stock change in dead organic matter concerns the land use conversion from Forest Land. In this case, the input information on standing and lying deadwood was obtained from the recently (2008 to 2009) conducted field campaign of the Czech landscape inventory CzechTerra (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 m³/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/m³), reduction coefficients of 0.8, 0.5, 0.5, 0.2 (Cerny et al., 2002; Carmona et al., 2002) applicable to the above described decomposition categories, respectively, and the carbon fraction in the wood (0.5 t C/t biomass). A default, conservative assumption that no deadwood is present following the land use change was adopted in this calculation.

The estimation of the carbon stock change in soils for the category *5B2 Land converted to Cropland* in the Czech Republic concerns mineral soils. The soil carbon stock changes following the conversion from Forest Land and Grassland were quantified by the country-specific Tier 2/Tier 3 approach is described in detail in Section 7.2.2.2 above.

The Land converted to Cropland category represents a source of non-CO₂ gases, namely emissions of N₂O due to mineralization. The estimation followed the Tier 1 approach of eq.s. 3.3.14 and 3.3.15 (IPCC, 2003). Accordingly, N₂O was quantified on the basis of the detected changes in mineral soils employing a default emission factor of 0.0125 kg N₂O-N/kg N, and C:N ratio of 15.

Other non-CO₂ emissions may be related to those from burning. However, this is not common practice in this country and no other non-CO₂ emissions besides the above described are reported in the LULUCF sector.

7.4.3 Uncertainties and time series consistency

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2012, which applies also for the land use category of Cropland. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006). The following uncertainty 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).

For 2012, using the above uncertainty values, the total estimated uncertainty for category *5B1 Cropland remaining Cropland* was 11.5 %. The corresponding uncertainty for category *5B2 Land converted to Cropland* was 31 %. The overall uncertainty for category *5B Cropland* was estimated to be 16 %.

7.4.4 Category-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 GPG for LULUCF. The data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.4.5 Category-specific recalculations

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data relevant for the category 5B Cropland included the land use areas. On request of the latest review, these data were newly crosschecked in order to improve data consistency. This rectification is described in detail in Section 7.3.5 above and applies identically for the category 5B Cropland.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). These corrections affect the estimates of Forest Land converted to Cropland.

The resulting effect of the recalculation performed for the category 5B Cropland can be seen in Fig. 7-12. On average, the emissions decreased by 17.1 % as compared to the previously reported estimates. The differences are relatively larger for the years at the beginning of the reporting period and decrease towards the more recent reporting years.

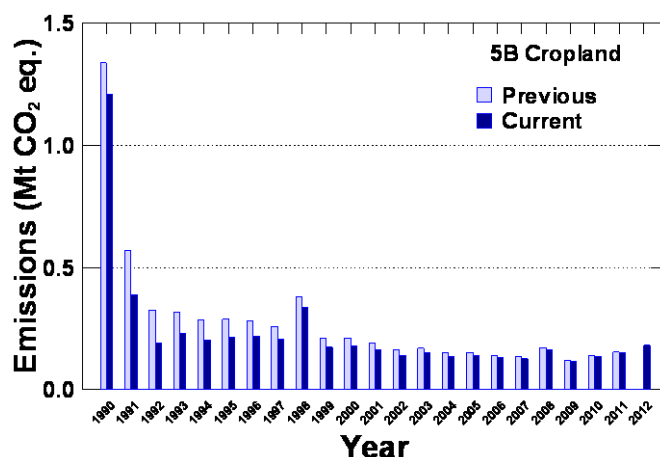


Fig. 7-12 Current and previously reported assessment of emissions for category 5B Cropland

7.4.6 Category-specific planned improvements

Similarly as for other categories, additional efforts will be exerted to further consolidate the current estimates for Cropland. Specific attention will be paid to 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.

7.5 Grassland (5C)

7.5.1 Source category description

Through its spatial share of about 14 % in 2012, 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. 7-4). 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 17 % (in 2012) since 1990.

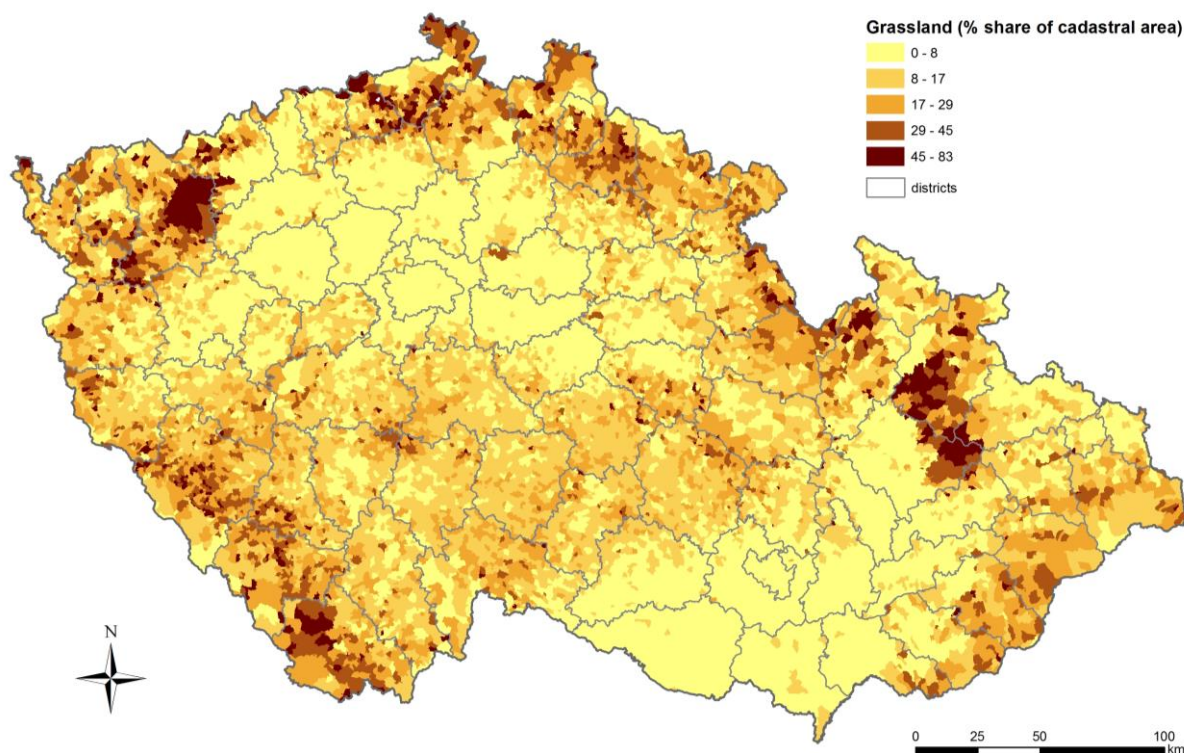


Fig. 7-13 Grassland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2012)

7.5.2 Methodological issues

The emission inventory of *5C Grassland* concerns sub-categories *5C1 Grassland remaining Grassland* and *5C2 Land converted to Grassland*. Similarly to *5B Cropland*, the emission inventory of *5C Grassland* considers changes in living biomass and soil. In addition, the effect of application of agricultural limestone is quantified for this category.

7.5.2.1 Grassland remaining Grassland

For category *5C1 Grassland remaining Grassland*, the assumption of no change in carbon stock held in living biomass was employed, in accordance with the Tier 1 approach of IPCC (2003). This is a safe assumption for the conditions in this country and any application of higher tier approaches would not be justified with respect to data requirements and the expected insignificant carbon stock changes.

The emissions estimates from changes in soil carbon stock were estimated for category *5C1*. These changes are due to an effect of different management regimes and the changing proportion of the concerned subcategories of *5C1*. 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 7.3.1). Other land belonging to the category of Grassland is considered as typically managed grassland. The reference soil carbon stock for this category is estimated as area-weighted mean for all the individual cadastral units. The analogous mean carbon content for the category of unmanaged grassland is determined using the corresponding factors (Table 5.5; IPCC 2006). These included the stock change factor for land use (F_{LU} ; 1.0), stock change factor for the management regime (F_{MG} ; 0.95) and stock change factor for input of organic matter (F_i ; 1.0). The estimated area-weighted average soil carbon stock for classically managed grassland was equal to 69 t C/ha, while that for unmanaged grassland was 65.5 t/ha. This is estimated for the whole reporting period and the soil carbon stock change was derived from the difference between the consecutive years. The changes in soil carbon stock associated with the annually changing proportion of land areas of cropland sub-categories result in emissions/removals. These are calculated after redistribution of the estimated carbon stock change over a 20-year rolling period.

Other explicitly quantified effect on soil carbon that results in CO₂ emissions is that of limestone application. This was quantified as described in Section 7.3.2.1 for *5B Cropland*. The applicable amount of limestone was set at 5 % of the reported limestone use on agricultural lands, based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005).

Non-CO₂ gases on category *5C1 Grassland remaining Grassland* do not concern the LULUCF sector in the Czech Republic.

7.5.2.2 Land converted to Grassland

For category *5C2 Land converted to Grassland*, the estimation concerns carbon stock changes in living biomass and soils.

For living biomass, the calculation used eq. 3.4.13 (IPCC, 2003) with the assumed carbon content before the conversion of *5B Cropland* set at 5 t C/ha (Table 3.4.8; IPCC 2003) and that of Forest Land calculated from the mean growing stock volumes as described in Section 7.3.2.2 above. The biomass carbon content immediately after the conversion was assumed to equal zero and carbon stock from one-year growth of grassland vegetation following the conversion was assumed to be 6.8 t C/ha (Table 3.4.9; IPCC 2003).

For dead organic matter, emissions are reported due to changes in deadwood that concern the category *5C21 Forest Land converted to Grassland*. Apart from the actual areas concerned, the emission estimation is identical as described in Section 7.4.2.2 above.

The estimation of carbon stock change in soils for category *5C2 Land converted to Grassland* in the Czech Republic concerns the changes in mineral soils. The soil carbon stock changes following the conversion from *5A Forest Land* and *5B Cropland* were quantified by the country-specific Tier 2/Tier 3 approach described in detail in Section 7.2.2.2 above.

7.5.3 Uncertainties and time series consistency

Similarly as for other land-use categories, the methods used in this inventory for Grassland were consistently employed across the whole reporting period from the base year of 1990 to 2012. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). 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 %, 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 2012, the total estimated uncertainty for category *5C1 Grassland remaining Grassland* reached 9.7 %. The corresponding uncertainty for category *5C2 Land converted to Grassland* reached 17.0 %. The overall combined uncertainty for category *5C Grassland* reached 16.7 %.

7.5.4 Category-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 GPG for LULUCF. Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.5.5 Category-specific recalculations

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data relevant for the category 5C Grassland included the land use areas. On request of the latest review, these data were newly crosschecked in order to improve data consistency. This rectification is described in detail in Section 7.3.5 above and applies identically for the category 5C Grassland.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). These corrections affect the estimates of Forest Land converted to Grassland.

The resulting effect of the recalculation performed for the category 5C Grassland can be seen in Fig. 7-14. On average, the emission removals decreased by 7.5 % 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.

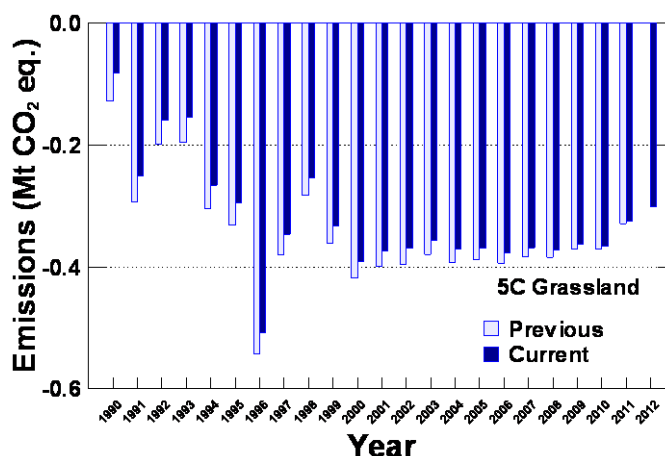


Fig. 7-14 Current and previously reported assessment of emissions for category 5C Grassland. The values are negative, hence representing net removals of green-house gases

7.5.6 Category-specific planned improvements

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 being explored.

7.6 Wetlands (5D)

7.6.1 Source category description

Category *5D Wetlands* as classified in this emission inventory includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and swamps. These areas correspond to the real estate category of water area of the “Aggregate areas of cadastral land categories” (AALC), collected and administered by COSMC. It should be noted that there are about 11 wetlands identified as Ramsar⁹ sites in this country. However, these areas are commonly located in several IPCC land-use categories and are not directly comparable with the actual content of the 5D emission category.

⁹ Convention on Wetlands, Ramsar, Iran, 1971

The area of *5D Wetlands* currently covers 2.1 % of the total territory. It has been growing steadily since 1990 (Fig. 7-4) 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 landscape¹⁰.

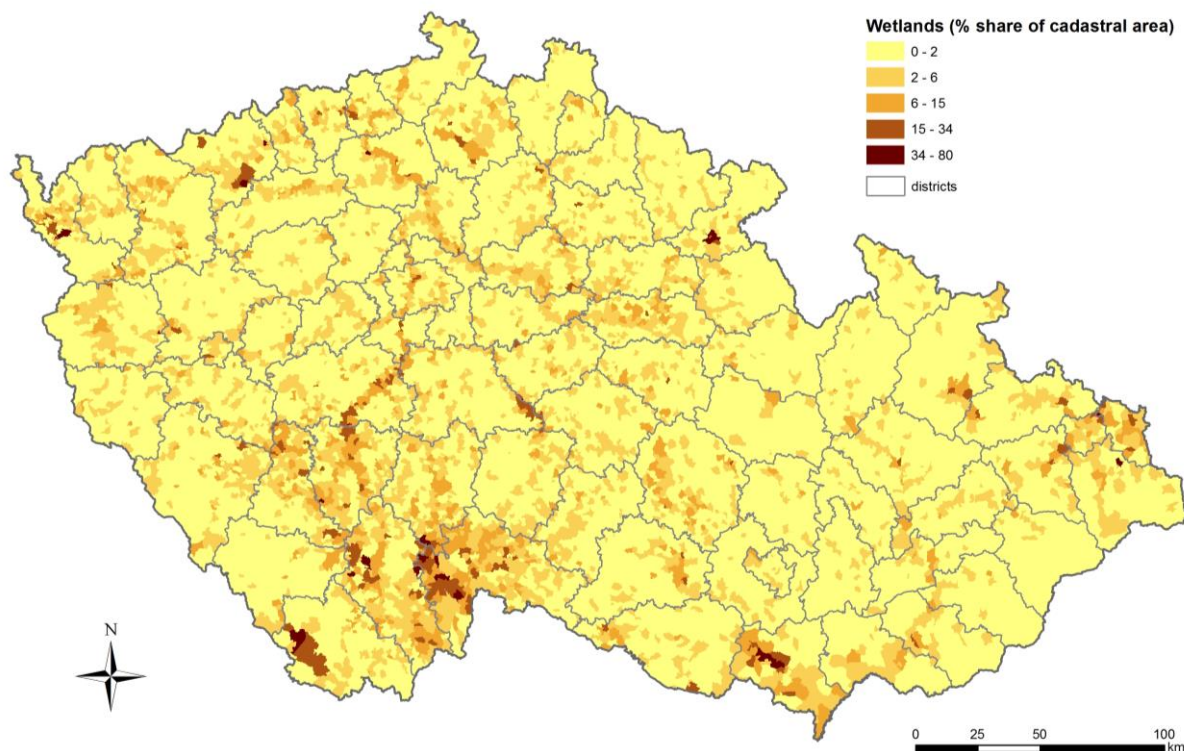


Fig. 7-15 Wetlands – distribution calculated as a spatial share of the category within individual cadastral units (as of 2012)

7.6.2 Methodological issues

The emission inventory of sub-category *5D1 Wetlands remaining Wetlands* can address the areas in which the water table is artificially changed, which correspond to peat-land draining or lands affected by water bodies regulated through human activities (flooded land). Both categories are insignificant under the conditions in this country. Hence, the emissions for *5D1 Wetlands remaining Wetlands* were not explicitly estimated and they can safely be considered negligible.

Sub-category *5D2 Land converted to Wetlands* encompass conversion from *5A Forest Land*, *5B Cropland* and *5C Grassland*. This is a very minor land-use change identified in this country, which corresponds to the category of land converted to flooded land. The emissions associated with this type of land-use change are derived from the carbon stock changes in living biomass and in the case of conversion from Forest land, also deadwood. The emissions were generally estimated using the Tier 1 approach and eq. 3.5.6 of GPG for LULUCF, which simply relates the biomass stock before and after the conversion. The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion in the *5A Forest Land*, *5B Cropland* and *5C Grassland* categories was estimated and/or assumed identically as described above in Sections 7.3.2.2 and 7.4.2.2. The latter section also describes the estimation of emissions related to deadwood component, which was applied identically in this land use category.

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)

7.6.3 Uncertainties and time series consistency

The methods used in this inventory for Wetlands were consistently employed across the whole reporting period from the base year of 1990 to 2012. Similarly as for the other land-use categories, the uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). 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 *5D2 Land converted to Wetlands*, the uncertainty is estimated for this category. For 2012, the estimated uncertainty for category *5D2* was 64 %.

7.6.4 Category-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 GPG for LULUCF. Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.6.5 Category-specific recalculations

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data relevant for the category *5D Wetlands* included the land use areas. On request of the latest review, these data were newly crosschecked in order to improve data consistency. This rectification is described in detail in Section 7.3.5 above and applies identically for the category *5D Wetlands*.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). These corrections affect the estimates of Forest Land converted to Wetlands.

The resulting effect of the recalculation performed for the category *5C Grassland* can be seen in Fig. 7-16. On average, the emissions decreased by 4.2 % as compared to the previously reported estimates. Similarly as observed for the other land use categories, the differences are largest for the years at the beginning of the reporting period and decrease towards the more recent reporting years.

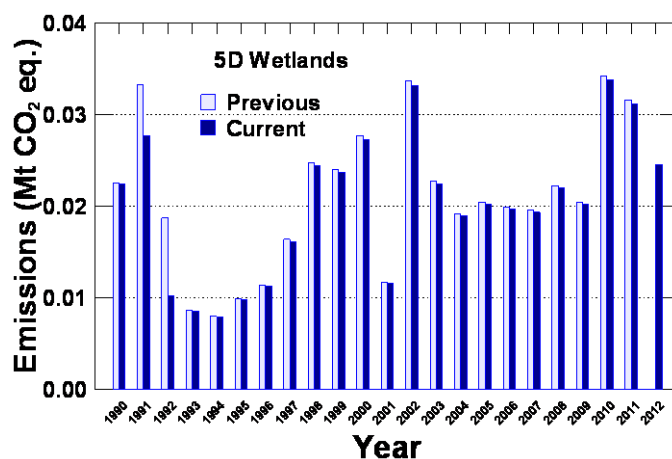


Fig. 7-16 Current and previously reported assessment of emissions for the category 5D Wetlands

7.6.6 Category-specific planned improvements

For the category of *5D Wetlands*, attention will be paid to a further consolidation of the uncertainty assessment and to overall formalization and enhancement of the QA/QC procedures.

7.7 Settlements (5E)

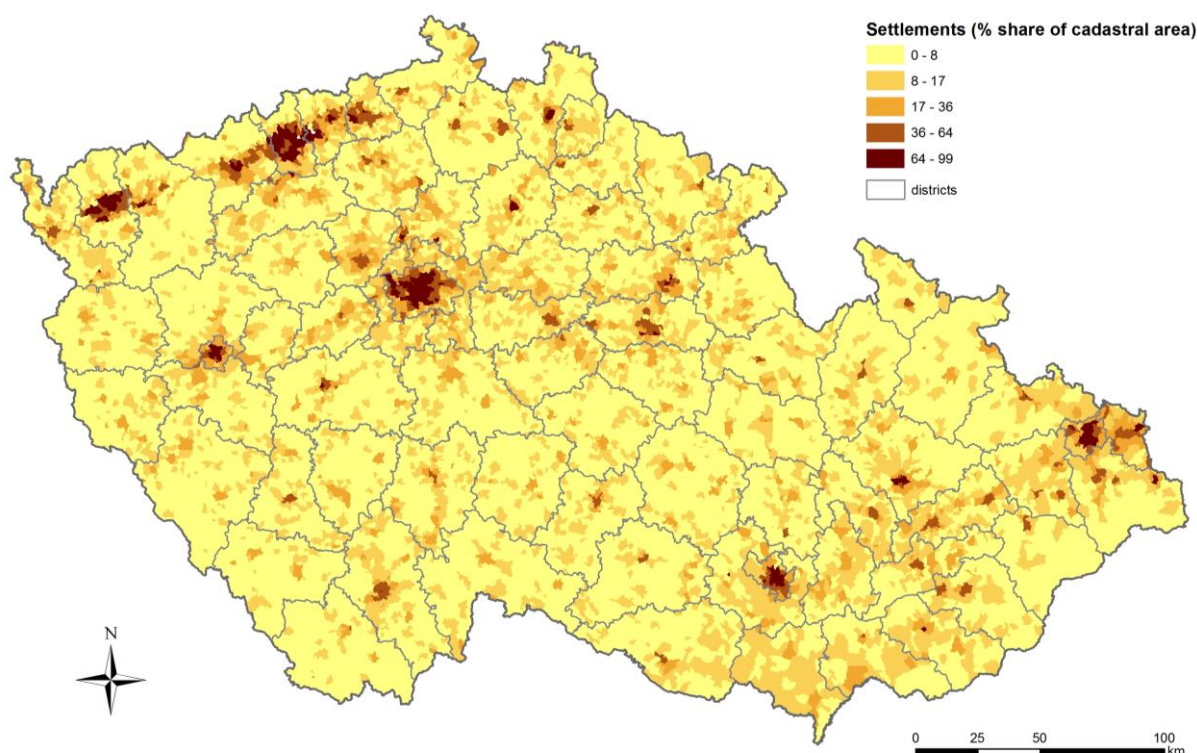


Fig. 7-17 Settlements – distribution calculated as a spatial share of the category within individual cadastral units (as of 2012)

7.7.1 Source category description

Category *5E Settlements* is defined by IPCC (2003) as all developed land, including transportation infrastructure and human settlements. For this emission inventory, the area definition under category *5E Settlements* was revised to better match the IPCC (2003) default definition. The category currently includes two

categories of the database “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC, namely “Built-up areas and courtyards” and “Other lands”. Of the latter AACLC category, all types of land-use were included with the exception of “unproductive land”, which corresponds to category *5F Other Land*. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks, previously included in category *5F Other Land*.

The category of Settlements as defined above currently represents about 8.7 % of the area of the country. The area of this category has increased since 1990 and especially during the most recent years (see Fig. 7-4).

7.7.2 Methodological issues

The emission inventory for this category concerns primarily *5E2 Land converted to Settlements*. As for category *5E1 Settlements remaining Settlements*, emissions of CO₂ were considered insignificant as no change in biomass, dead organic matter and soil carbon pools is assumed (Tier 1, IPCC 2006). Emissions quantified in this inventory concern the category *5E2 Forest Land converted to Settlements*. The emissions result mainly from the biomass carbon stock change, which was quantified using eq. 3.6.1 (IPCC, 2003). The carbon stock prior conversion was estimated as described in Section 7.3.2.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of GPG for LULUCF. Additional contribution to emissions is from deadwood component. It was estimated identically as described in Section 7.4.2.2 above, using the actual areas of the land use change concerned.

7.7.3 Uncertainties and time series consistency

The methods used in this inventory for *5E Settlements* were consistently employed across the whole reporting period from the base year of 1990 to 2011. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). 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 *5E2 Land converted to Settlements*; therefore, the uncertainty is estimated only for this category. For 2012, the estimated uncertainty for the category *5E2* was 102 %.

7.7.4 Category-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 GPG for LULUCF. The data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

7.7.5 Category-specific recalculations

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data relevant for the category *5E Settlements* included the land use areas. On request of the latest review, these data were newly crosschecked in order to improve data consistency. This rectification is described in detail in Section 7.3.5 above and applies identically for the category *5E Settlements*.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). These corrections affect the estimates of Forest Land converted to Settlements.

The resulting effect of the recalculation performed for the category 5C Grassland can be seen in Fig. 7-18. On average, the emissions decreased by 3.7 % as compared to the previously reported estimates. Similarly as observed for the other land use categories, the differences are largest for the years at the beginning of the reporting period and decrease towards the more recent reporting years (Fig. 7-18).

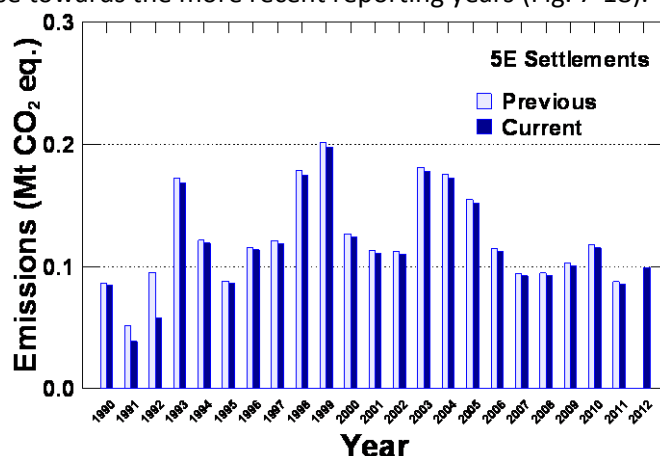


Fig. 7-18 Current and previously reported assessment of emissions for the category 5E Settlements

7.7.6 Category-specific planned improvements

Further efforts to consolidate the emission estimates are expected for the category of Settlements. The inventory team considers using the data from the statistical landscape inventory project CzechTerra (Cerny, 2009) once its repeated land use assessment will be finalized. Attention will also be paid to further improvement of the uncertainty assessment and overall formalization and enhancement of the QA/QC procedures.

7.8 Other Land (5F)

7.8.1 Source category description

Since NIR 2008 submission, the category *5F Other Land* represents unmanaged (unmanageable) land areas, matching the IPCC (2003) default definition. These areas were assessed from the database of “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC. It is a part the AACLC category “other lands” with the specific land use category “unproductive land”, assessed from the 2006 land census of COSMC. This category represents 1.0 % of the territory of the country and it is considered to be constant, not involving any land-use conversions.

7.8.2 Methodological issues

Change in carbon stocks and non-CO₂ emissions are not considered for *5F1 Other Land remaining Other Land* (IPCC, 2003). Since no land-use conversion involving “other land” is assumed by this inventory, no emissions were considered in the entire category *5F Other Land*.

7.8.3 Uncertainties and time series consistency

The uncertainty estimates are not reported here. Time series consistency is ensured as the inventory approaches and/or assumptions are applied identically across the whole reporting period from the base year 1990 to 2012.

7.8.4 Category-specific QA/QC and verification

The activity data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

The QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, limited to those relevant for this specific land-use category.

7.8.5 Category-specific recalculations

No recalculations concern category *5F Other Land*.

7.8.6 Category-specific planned improvements

There are no short-term plans concerning this category.

7.9 Other (5G)

7.9.1 Source category description

Since the 2012 submission, the category *5G Other* is reported. Unlike other land use categories, *5G Other* has no area representation and therefore it is not reported in land use matrices (Tab. 7-3). It was introduced to facilitate reporting of emissions from lime application on Forest land. This is due to the current technical restrictions of the CRF Reporter software, which does not permit adding emissions from lime application under the category of *5A Forest Land* where these emissions should actually be attributed to.

7.9.2 Methodological issues

For the emissions from lime application, the methodology described in Section 3.3.1.2.1 of GPG for LULUCF (IPCC, 2003) was used. The activity data in terms of forest area and amount of limestone applied were taken from the national reports on Czech forestry (Green report, MA 2013). In 2012, the amount of limestone applied to forest soils equalled 30 t and concerned an area of 13 ha.

7.9.3 Uncertainties and time series consistency

The uncertainty estimates are not specifically 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 2012.

7.9.4 Category-specific QA/QC and verification

The activity data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

The QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, limited to those relevant for this specific emission category.

7.9.5 Category-specific recalculations

No recalculations are applicable for the category *5G Other* and the emission quantities reported in the previous and current inventory reports are identical (Fig. 7-19).

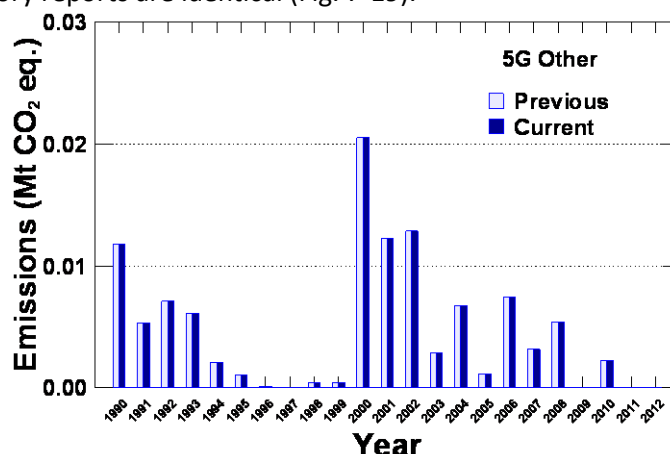


Fig. 7-19 The reported (current and previous) assessment of emissions for the category *5G Other*, represented solely by emissions from lime application on Forest land.

7.9.6 Category-specific planned improvements

The UNFCCC Secretariat will be further consulted to allow reporting of the emissions from lime application on forest land under the category *5A Forest Land*, where it logically belongs. Once this will be made possible in the CRF Reporter, the category *5G Other* will not be used for this purposes.

7.10 Acknowledgement

The authors would like to thank Vladimír Henžlík, formerly at the Forest Management Institute in Brandýs n. Labem, for some of the activity data and his expert advice. Thanks are also due to Jan Hána, 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 Helena Šandová, Petr Souček, Zuzana Loulová and Bohumil Janeček, 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 his help with the current inventory submission.

8 Waste (CRF sector 6)

8.1 Overview of sector

The waste sector consists of several categories. The main source category of this sector is 6A Methane emissions from solid waste disposal sites. In 2012, this category emitted 2770 Gg of CO₂ eq. in methane. The second source category is 6B emissions from waste-water, which is calculated as the sum of four subcategories – emissions of methane from industrial waste-water treatment, domestic waste-water treatment, on-site treatment and emissions of nitrous oxide from waste-water. These subcategories emitted 510.15 Gg CO₂ eq. in methane resp. 275.66 Gg CO₂ eq. in N₂O. The last source category in this sector is incineration of wastes, which was recalculated last year and split between two sectors. Waste used as a fuel for energy purposes was calculated and reported in category 1A1a other fuels. Industrial and hazardous waste remained in category 6 C and produced a total of 206.86 Gg of fossil CO₂. This inventory year sector 6 produced 3 766.54 Gg of CO₂ eq. in total.

Tab. 8-1 Overview of significant categories in this sector (2012)

| Category | Character of category | Gas | % of total GHG* |
|---------------------------------|-----------------------|-----------------|-----------------|
| 6A Solid Waste Disposal on Land | LA, TA | CH ₄ | 2.671 |
| 6B Waste Water Handling | LA | CH ₄ | 0.506 |

* 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

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

8.2 Solid Waste Disposal on Land (6A)

8.2.1 Source category description

Treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH₄). Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of CO₂ released from waste. These CO₂ 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 (N₂O), nitrogen oxides (NO_x) and carbon monoxide (CO). Only CH₄ is addressed in this report.

Category was recalculated last year. Based on suggestions in the in-country review, we gathered country-specific waste composition data. Using the default carbon content suggested in the Good Practice Guidelines (IPCC, 2000), we derived the country-specific DOC for particular waste streams.

8.2.2 Methodological issues

Waste disposal to SWDS

Key activity data for methane quantification from 6.A is the amount of waste disposed in landfills. Annual disposal is shown Tab. 8-2. Data for annual disposal are from mixed sources because correct 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 have been 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; we correlated waste production with social product (predecessor of current GDP) as a test method. The higher of the two estimates was used in the quantification.

Data used for present dates are based on information system of waste management (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 we experienced for a first time in modern history slight decline in waste deposited in to landfills. Unfortunately we think that this decline is only temporary and it is closely connected to increase of waste incinerated for energy purposes in 1A1a due to reconstruction of incinerator in Brno.

Tab. 8-2 MSW disposal in SWDS in the Czech Republic [Gg], 1990-2012

| 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 | | |
| 1993 | 2543 | 2000 | 2803 | 2007 | 3314 | | |
| 1994 | 2561 | 2001 | 2826 | 2008 | 3424 | | |
| 1995 | 2621 | 2002 | 2920 | 2009 | 3406 | | |
| 1996 | 2683 | 2003 | 2952 | 2010 | 3185 | | |

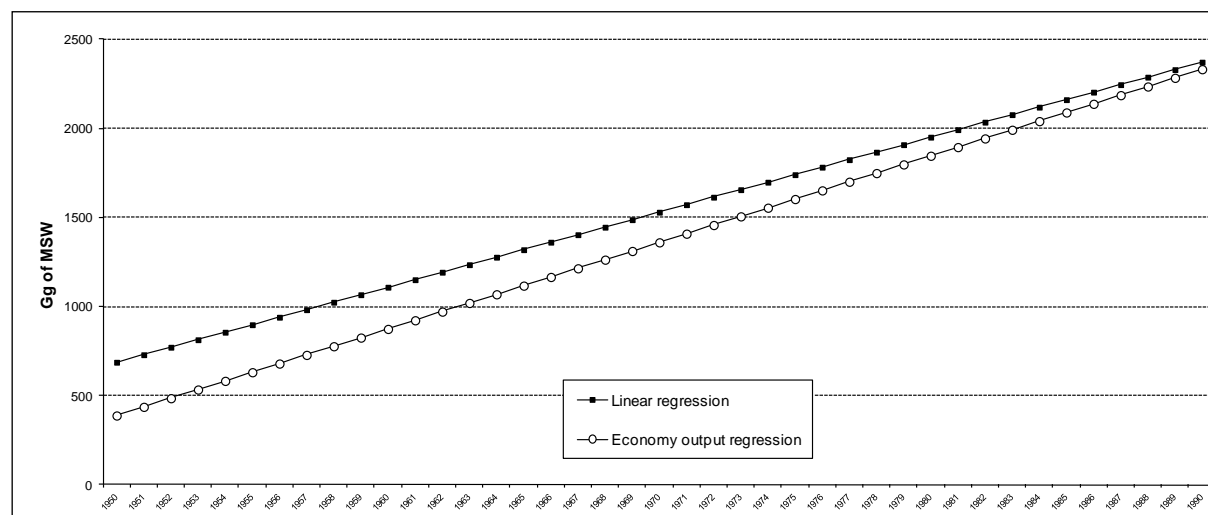


Fig. 8-1 MSW disposal in SWDS in the Czech Republic, 1950-1990

The method used for estimation of methane emissions from this source category is the *Tier 2* FOD approach (first-order decay model). The first-order decay (FOD) model assumes gradual decomposition of waste disposed in landfills. We calculated GHG emissions 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

Waste composition is crucial for emission estimations. We made several attempts to obtain country-specific data about waste composition (Tab. 8-3). Greyed data (1990-1995) are based on the IPCC default values for Eastern Europe, blackened data (1996-2000 and 2002-2004) are based on interpolation between data points. 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 we use latest available data and trying to encourage continuation of waste composition monitoring.

As can be noted table does not include all possible waste streams that might be deposited in to landfill. What is missing is sludge. Reality is that projects that we use to derive waste composition did not noted any sludge to be part of the waste mixture. However we are aware that research covered limited number of landfill and because the practice of sludge deposition is not wide spreaded they did not encountered its deposition. Therefore we do not calculate sludge in to waste mixture even when there probably is some. Doing so we don't underestimate emissions because mass deposited to landfills already include sludge (data are bottom up data from landfills) and average DOC by 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 composition of a particular substance and the available moisture. We used 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). The average DOC for particular waste streams is also based on the IPCC default values for particular categories of waste. The average DOC for a particular year is in the last column of the table.

Tab. 8-3 MSW composition for the Czech Republic used in the quantification (fractions of total, 1990-2012)

| | Paper | Food | Textil | Wood and straw | DOC |
|---------------|--|-------|--------|----------------|-------|
| k-rate | 0.06 | 0.185 | 0.06 | 0.03 | |
| DOC | 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 |

* 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 larger MCF values. 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. 8-4.

Tab. 8-4 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. 8-5 MCF values employed, 1950-2012

| | 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 CO₂. There is no conclusive agreement in the scientific community on how intensive the oxidation of methane is. Oxidation is indeed site-specific due to the effects of local conditions (including fissures and cracks, compacting, landfill cover etc.). No representative measurement or estimations of the oxidation factor are available for the Czech Republic. Some studies are quoted in Straka, 2001, which mentions a non-zero oxidation factor, but these figures seem to be site-specific (and really high) and therefore cannot be used as representative for the whole country. However, the methodology (IPCC, 2000) suggests that an oxidation factor higher than 0.1 should not be used if no site measurements are available (a larger value adds uncertainty). The author used the recommended oxidation factor of 0.1 in the report.

Delay time

When waste is disposed in SWDS, decomposition (and methanogenesis) do not start immediately. The assumption employed in the IPCC model is that the reaction starts on the first of January in the year after deposition, which is equivalent to an average delay time of six months before decay to methane commences. It is good practice to assume an average delay of two to six months. If a value greater than six months is chosen, evidence to support this must be provided. The Czech Republic has no representative country-specific value for delay time, so the author used a default value of 6 months.

Fraction of methane

This parameter indicates the share (mass) of methane in the total amount of *Landfill Gas* (LFG). In previous calculations of methane emissions from SWDS (NIR, 2004), a value 0.61 was used. This figure was based on measurement of a limited number of sites (Straka, 2001). This value is higher than the range of 0.5-0.6 suggested by IPCC. In this work, we revised these values based on new evidence (MIT, 2005). MIT receives annual reports from landfills capturing their LFG; SWDS report the net calorific value of their captured LFG. We used this value for comparison with the gross calorific value of pure methane, yielding a value of approx. 0.55, which well within the IPCC range and was used in the quantification.

Recovered methane

On SWDS in the country, methane is sometimes collected by an LFG collection system and incinerated for energy purposes. Based on Good Practice Guidelines (IPCC, 2000), this methane is converted to CO₂ and, having biogenic origin, it is not considered to constitute an emission of GHG. Recovered methane (R) is substituted in the equation in Appendix 1. There is no default value for R, so we used country estimates based on various sources. The Ministry of Industry and Trade conducts an annual survey of all SWDS. All the energy data about LFG is collected. An attempt is made to update old estimates as much as possible. Since the start of the survey in 2005, it has been possible to provide estimates for time series from 2003 to 2012. The estimates in Straka, 2001 were used for the 1990-1996 period. Linear intrapolation of recovered methane was used for the period between 2003 and 1996. In 2012 there were more than 60 facilities in the country recovering LFG which is two more than in previous year.

Total emissions of methane are based on the equation from the IPCC CH₄ model. Detailed time series from 1950 with breakdown into individual waste components are given in the paper by Havranek 2007, together with the other model outputs gives the trends in emissions of methane from SWDS following recalculation.

Tab. 8-6 Emissions of methane from SWDS [Gg], Czech Republic, 1990-2012

| | 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 |

8.2.3 Uncertainties and time-series consistency

This sector was extensively recalculated in 2012 reporting period. We changed waste composition to be consistent with the country estimates and we have changed recovered methane estimates to be consistent with the latest data collection work on LFG. Havranek, 2007 contains a sensitivity analysis for several key factors and assumption used in the previous recalculation when we moved from Tier 1 to Tier 2. This year there were no changes compared to 2012 report.

Overall quantification of the uncertainty for this category is still incomplete. This is considered a high priority and will be conducted in the following years as soon as budget constraints permit. This category entails the difficulty that the uncertainty does permeate through the whole waste management period of 1950-2012 and therefore it cannot be quantified by simple analysis.

8.2.4 Source-specific QA/QC and verification

During the year 2013 we updated QA/QC plan for the sector. Quality assurance entails structured checklists of activities that are dated and signed by sector reporter and verified by external control of activity data. Activity data taken for this sector are approved by the data producer and are verified by him before they are used for calculation.

Because waste sector is fairly small we do not use external subject to provide QC instead QC is done by NIS coordinator and its results are communicated to sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms but NIS team has limited insight in to it.

8.2.5 Source-specific recalculations

No recalculations were performed in this submission.

8.2.6 Source-specific planned improvements

No sectoral improvement has been performed.

8.3 Waste-water Handling (6B)

8.3.1 Source category description

This category has CRF code 6B and consists of four separately calculated sub-categories – emissions of methane from *6B1 Industrial Waste-water*, *6B2 Domestic and Commercial Waste-water* and *6B3 Other (Treatment on site)* and emissions of nitrous oxide from *6B2 Domestic and Commercial Waste-water*.

8.3.2 Methodological issues

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

The current IPCC methodology employs BOD for evaluation of municipal waste-waters and sludge and COD for industrial waste-waters. The new method is also extended to include determination of emissions from sludge that are primarily the products of various methods of treatment of waste-waters and, under anaerobic conditions, may contribute to methane production and methane emissions. The amount of nitrous oxide emitted from waste-waters is a function of protein consumption in the population rather than BOD or COD.

8.3.2.1 Industrial waste-water (6B1)

The main activity data for estimation of methane emissions from this subcategory is determination of the amount of degradable pollution in industrial waste-water. In this inventory we use specific production of pollution - the amount of pollution per production unit - kg COD / kg product and then we multiply it by the production, or the value obtained from the overall amounts of industrial waste-water and from a qualified estimate of their concentrations (in kg COD/m³). We use the procedure from the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000). The necessary activity data were taken from the material of CZSO (*Czech Statistical Office - Statistical Yearbook*) and the other parameters required for the

calculation were taken from the Good Practice Guidance (IPCC, 2000). On the basis of information on the total amount of industrial waste-water equal to 149 mil.m³ (actually only 148 mil.m³ were treated) we are able to correct our overestimation of possible waste-water generation of industry (45 mil.m³), which was assigned an average concentration of 3 kg COD/m³. 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 Revised 1996 Guidelines (IPCC, 1997), it was estimated that the amount of sludge equals 10 % of the total pollution in industrial water (25 % was assumed in the Meat & Poultry, Paper and Pulp and in Vegetables, Fruits & Juices category). These estimates are based on Dohanyos and Zábranská (2000); Zábranská (2004), see Tab. 8-7.

Tab. 8-7 Estimation of COD generated by individual sub-categories 2012

| | 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 ¹¹ | 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. 8-8 Parameters for CH₄ emissions calculation from industrial waste-water 1990-2012

| | MCF | 1990 | 1993 | 1996 | 1999 | 2002 | 2005 | 2009 | 2010 | 2011 | 2012 |
|-------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| 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 Good Practice Guidance (IPCC, 2000), the maximum theoretical methane production B₀ was considered to equal 0.25 kg CH₄/kg COD. This value is in accordance with the national factors presented in Dohanyos and Zábranská (2000).

The calculation of the emission factor for waste-water 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 waste-water and sludge because of the energy advantages of this means of treating waste-water. Tab. 8-7 describes this trend. The conversion factor for anaerobic treatment is 0.06 and, for aerobic treatment, 0.7.

In contrast to a quite stable ratio for waste-water treatment technologies (6B2), ratio used for sludge keeps shifting in favor of anaerobic treatment. This is mostly due its economic efficiency. The calculation of the emission factor for sludge was based on the assumption that 27 % is treated anaerobically with a conversion factor of 0.3 and the remaining 73 % by other, especially aerobic methods with a conversion factor of 0.1.

¹¹ Due to changes in the statistical data, we are no longer able to identify Pet. ref./Petrochemicals

Similarly as in 6B2, 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 waste-water is included. This assumption is based on national standards and regulations presented in the subchapter below (Zábranská, 2004). For calculation of methane emissions, it is sufficient to consider only aerobic processes (where the methane is not oxidized to biological CO₂). Experts at the *University of Chemical Technology* recommended the conversion factors and other parameters given in this part, see (Dohanyos and Zábranská, 2000; Zábranská, 2004).

Tab. 8-9 Emissions of CH₄ (Gg) from 6B1, 1990-2012, Czech Republic

| | 1990 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 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 |
| 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 |
| 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 |

8.3.2.2 Municipal and commercial waste-water treatment (6B2) and treatment on site (6B3)

The basic activity data (and their sources) for determining emissions from these subcategories are as follows:

- the number of inhabitants (source Czech Statistical Office);
- the organic pollution produced per inhabitant (source IPCC default value);
- the conditions under which the waste-water is treated. (source Czech Statistical Office, with some specific national factors);
- the amount of proteins in the diet of the population (source FAO).

Calculations for conditions in this country are based on pollution production per inhabitant of 18.25 kg BOD p.a. (IPCC, 1997), of which approx. 33% is present in the form of insoluble substances, i.e. is separated as sludge. This factor was slightly changed in 2003 mainly due to increasing water savings in water use (aprox. 10-20%). The total amount of organic pollution is same, but the density is higher than for the period before 2003. From 2003 onwards, we assume 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 waste-water collected in the sewers. gives the amounts for the time series. According to Good Practice Guidance (IPCC, 2000), the maximum theoretical methane production B₀ equals 0.25 kg CH₄/kg COD, corresponding to 0.6 kg CH₄/kg BOD. This data is used to determine the emission factors for municipal waste-water and sludge. In determining the emission factor for sludge, it is necessary to evaluate the technology used to treat the particular sludge and to assign a conversion factor to it - MCF - Methane Conversion Factor - giving the part of the organic material that will be transformed as methane (the remainder to CO₂). 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, the IPCC methodology (IPCC, 1997; IPCC, 2000) recommends that separation into waste-water and sludge not be carried out (this corresponds to latrines, septic tanks, cesspools, etc.). The residual waste-water in the Czech Republic which does not enter the sewer system is considered to be treated on site. All methane generated in anaerobic processes for sludge is considered to be removed (recovered for energy purposes or flared). The remaining methane is considered to be emitted. This assumption is based on Czech national standards (to certain degree similar to ISO standards) CSN 385502, CSN 105190 and CSN 756415. On the basis of these standards, every waste-water treatment facility is obliged to maintain safety and abate gas emission. Leakage might occur only during accidents, but the amount of methane emitted is assumed to be insignificant (the estimate based on expert judgment is less than 1% of the total amount) (Zábranská, 2004).

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

Tab. 8-10 Population connection to sewers and share of treated water, 1990-2012, 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 | 2001 | 10 224 | 74.9 | 95.5 |
| 1991 | 10 308 | 72.3 | 69.6 | 2002 | 10 201 | 77.4 | 92.6 |
| 1992 | 10 317 | 72.7 | 78.7 | 2003 | 10 202 | 77.7 | 94.5 |
| 1993 | 10 330 | 72.8 | 78.9 | 2004 | 10 207 | 77.9 | 94.9 |
| 1994 | 10 336 | 73.0 | 82.2 | 2005 | 10 234 | 79.1 | 94.6 |
| 1995 | 10 330 | 73.2 | 89.5 | 2006 | 10 267 | 80.0 | 94.2 |
| 1996 | 10 315 | 73.3 | 90.3 | 2007 | 10 323 | 80.8 | 95.8 |
| 1997 | 10 303 | 73.5 | 90.9 | 2008 | 10 486 | 81.1 | 95.3 |
| 1998 | 10 294 | 74.4 | 91.3 | 2009 | 10 492 | 81.3 | 95.2 |
| 1999 | 10 282 | 74.6 | 95.0 | 2010 | 10 517 | 81.9 | 96.2 |
| 2000 | 10 272 | 74.8 | 94.8 | 2011 | 10 496 | 82.6 | 96.8 |
| | | | | 2012 | 10 509 | 82.5 | 97.1 |

Tab. 8-11 Methane conversion factors (MCF) and share of individual technology types [%], 1990-2012

| | MCF | 1990 | 1993 | 1996 | 1999 | 2002 | 2005 | 2008 | 2010 | 2011 | 2012 |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| On-site treatment ¹² | 0.15 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Discharged into rivers | 0.05 | 27 | 21 | 10 | 5 | 7 | 5 | 5 | 4 | 3 | 3 |
| Aerobic water | 0.05 | 48 | 54 | 65 | 70 | 68 | 72 | 73 | 73 | 74 | 74 |
| Anaerobic water | 0.50 | 25 | 25 | 25 | 25 | 25 | 23 | 23 | 23 | 23 | 23 |
| Aerobic sludge | 0.10 | 45 | 40 | 35 | 30 | 20 | 15 | 15 | 15 | 15 | 15 |
| Anaerobic sludge | 0.50 | 55 | 60 | 65 | 70 | 80 | 85 | 85 | 85 | 85 | 85 |

The method of quantification is described in the Good Practice Guidelines (IPCC, 2000) as a Tier 1 approach and we follow it in this subcategory without any modification. The amount of methane emitted from 6B2 is given by the equation:

$$\text{Total Gg CH}_4 \text{ p.a.} = \text{Gg CH}_4 (\text{tos}) + \text{Gg CH}_4 (\text{wwt}) + \text{Gg CH}_4 (\text{sld}) - R$$

Where tos is the part of the waste-water treated on site, wwt is the part treated as waste-water and sld is the part treated as sludge. R is the recovered methane (flared or used as gas fuel). Each part (tos, wwt, sld) is calculated as the share of this part in the organic pollution (according to Tab. 8-1 and share of individual technology types [%], 1990-2012), multiplied by an emission factor.

Particular MCFs are calculated as a weighted average – thus, the wwt emission factor is, in fact, the maximum methane capacity multiplied by the weighted average of MCF for aerobic, anaerobic and river discharge treatment options. The results for 2009 are presented in Tab. 8-12.

Tab. 8-12 Emissions of CH₄ and N₂O [Gg] from 6B2 and 6B3, 1990-2012, Czech Republic

| | 1990 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2009 | 2011 | 2012 |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| 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 |
| 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 |
| 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 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. 8-10)

Determination of N₂O emissions from municipal waste-water 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.

Tab. 8-13 Indirect N₂O [Gg] from 6B2 and 6B3, 1990-2012, Czech Republic

| | Per Capita Protein Consumption (g/capita/day) | Population (1000 inhabitants) | Fraction of Nitrogen In Protein Frac(NPR) (kg N/kg protein) | Emission factor (kg N ₂ O-N/kg sewage-N produced) | Total Annual N ₂ O Emissions (Gg N ₂ O) |
|-------|---|-------------------------------|---|--|---|
| 1990 | 105.8 | 10363 | 0.16 | 0.01 | 1.0062 |
| 1991 | 93.0 | 10309 | 0.16 | 0.01 | 0.8798 |
| 1992 | 87.4 | 10318 | 0.16 | 0.01 | 0.8276 |
| 1993 | 93.1 | 10330 | 0.16 | 0.01 | 0.8826 |
| 1994 | 88.5 | 10336 | 0.16 | 0.01 | 0.8395 |
| 1995 | 93.2 | 10330 | 0.16 | 0.01 | 0.8836 |
| 1996 | 95.6 | 10315 | 0.16 | 0.01 | 0.9050 |
| 1997 | 93.3 | 10303 | 0.16 | 0.01 | 0.8822 |
| 1998 | 96.7 | 10294 | 0.16 | 0.01 | 0.9136 |
| 1999 | 91.2 | 10282 | 0.16 | 0.01 | 0.8606 |
| 2000 | 90.0 | 10272 | 0.16 | 0.01 | 0.8484 |
| 2001 | 92.1 | 10203 | 0.16 | 0.01 | 0.8624 |
| 2002 | 90.8 | 10201 | 0.16 | 0.01 | 0.8500 |
| 2003 | 90.8 | 10201 | 0.16 | 0.01 | 0.8501 |
| 2004 | 95.8 | 10206 | 0.16 | 0.01 | 0.8974 |
| 2005 | 98.7 | 10234 | 0.16 | 0.01 | 0.9270 |
| 2006 | 93.5 | 10267 | 0.16 | 0.01 | 0.8810 |
| 2007 | 93.4 | 10322 | 0.16 | 0.01 | 0.8848 |
| 2008 | 91.9 | 10467 | 0.16 | 0.01 | 0.8828 |
| 2009 | 92.2 | 10492 | 0.16 | 0.01 | 0.8878 |
| 2010* | 92.2 | 10517 | 0.16 | 0.01 | 0.8899 |
| 2011 | 92.2 | 10496 | 0.16 | 0.01 | 0.8882 |
| 2012 | 92.2 | 10509 | 0.16 | 0.01 | 0.8892 |

*Data for latest available year are used

The values of 0.16 kg N/kg protein and 0.01 kg N₂O-N/kg N correspond to the mass fraction and standard recommended emission factor. The amount of proteins consumed in the Czech Republic is derived from the nutrition statistics of FAO (Faostat, 2014).

8.3.3 Uncertainties and time-series consistency

This particular category is methodologically consistent and is quantified each year using same method. Data sources for methane activity data are the same and therefore we can assume activity data consistency in time as well. Very few country-specific factors are used (mainly the fraction of each treatment technology in the country) and most of activity data are based on the statistics of the central statistical office.

Consistency of time series can be disturbed by a discontinuous change in the technology share, which is based on particular studies in time and as happened in the case of industrial water through a change in the activity data from the survey results, where the statistical office may deny access to data that are the subject of business secrets.

Consistency of N₂O quantification is disturbed by a change in of activity data source in 2000 (global nutrition values were replaced by country-specific protein consumption) which led to a slight increase in this subcategory. It is planned to smooth the trend and recalculate this according to new data, but this is of low priority at the moment due to the overall insignificance of this sub-category.

The uncertainty in most of the factors (default IPCC values) is determined according to 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 last year expert team reviewed waste sector and suggested and developed new uncertainty ranges. They all can be found in uncertainty chapter in 6C Waste incineration.

8.3.4 Source-specific QA/QC and verification

During the year 2013 we updated QA/QC plan for the sector. Quality assurance entails structured checklists of activities that are dated and signed by sector reporter and verified by external control of activity data. Activity data taken for this sector are approved by the data producer and are verified by him before they are used for calculation.

Because waste sector is fairly small we do not use external subject to provide QC instead QC is done by NIS coordinator and its results are communicated to sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms but NIS team has limited insight into it.

8.3.5 Source-specific recalculations

Based on request of UNFCCC review team we have recalculated source category for N₂O emissions from municipal water. Method remained same but key activity data – protein consumption per capita was updated for whole time series. Originally we used world average protein consumption as a country proxy, in recalculated version we use country specific protein consumption based on FAOStat food balance sheets. There is slight increase of N₂O due to that (in general for 0.2 Gg of N₂O).

8.3.6 Source-specific planned improvements

We plan to review industry wastewater source category. Reason is that due to extensive use of biogas Ministry of Industry and Trade started to gather data about water treatment and gas production. In the light of this data we will review this category and we might eventually recalculate it according to the new findings.

8.4 Waste incineration (6C)

8.4.1 Overview

This category contains emissions from waste incineration in the Czech Republic. Types of waste incinerated include industrial waste, hazardous waste and clinical waste. Waste incineration is defined as the combustion of waste in controlled incineration facilities. Modern waste incinerators have tall stacks and specially designed combustion chambers, which ensure high combustion temperatures, long residence times, and efficient waste agitation while introducing air for more complete combustion. This category includes emissions of CO₂, CH₄ and N₂O from such practices.

This year, the whole category was changed as part of the incinerated MSW was shifted to the energy chapter. MSW in the country is used as fuel, so the logic behind this switch 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) – H/IW.

8.4.2 Source category description

There are also 76 other facilities incinerating or co-incinerating industrial and hazardous waste with a total capacity 600 Gg of waste. Most of this capacity is not used. Some of the incinerators have energy recovery but how much of the incinerated waste is used for energy purposes is still under review. Once we will be able to identify and split the total H/IW used for energy/non-energy purposes, we will move the particular part of this category to the energy sector.

8.4.3 Methodological issues

In line with the Revised 1996 Guidelines (IPCC, 1997), only CO₂ emissions resulting from oxidation, during incineration and from open burning of carbon in waste of fossil origin (e.g., plastics, rubber, liquid solvents, and waste oil) are considered in the net emissions and should be included in the national CO₂ emissions estimate. Additionally, incinerator plants produce small amounts of methane and nitrous oxide. All these emissions are reported in category 6C2. This year we also estimated biogenic emissions from H/IW and these are reported under 6C1.

Estimation of CO₂ emissions from H/IW incineration is based on the Tier 1 approach (IPCC, 2000). It is assumed that 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. As no country-specific data were available for the necessary parameters, the calculation default data was taken from the Good Practice Guidance (IPCC, 2000), see Tab. 8-13. To save place in the table, the results are split into biogenic and non-biogenic parts of the waste only for important gases – CO₂. Methane and nitrous oxide are listed together in this table although they are reported in the UNFCCC reporter separately from the biogenic and fossil parts of the waste.

The activity data are based on the statistical surveys performed by ISOH – waste management information system on operated by MoE/CENIA and the missing data (system does not contain data before 2002) was obtained by taking data 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 is all hazardous from point of management. We avoid underestimation by using hazardous waste emission factors for whole HW/IW/CW/Sludge mixture that is incinerated in HW/IW facilities as HW emission factors are far bigger than sludge and CW.

Tab. 8-14 H/IW incineration in 1990 – 2012 with used parameters and results

| | 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 |
| Amount of carbon fraction | 0.5 | | | | | | | | | | |
| Fossil 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 ₂ O/Gg | 1.0E-04 | | | | | | | | | | |
| 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 ₂ O (Gg N ₂ O) | 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 |
| 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 |
| Amount of carbon fraction | 0.5 | | | | | | | | | | |
| Fossil 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 ₂ O/Gg | 1.0E-04 | | | | | | | | | | |
| 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 |
| 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 |
| 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-05 |
| Total N ₂ O (Gg N ₂ O) | 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 |

The suggested default emission factors for hazardous waste incineration were 100 kg of N₂O per Gg of incinerated HW and 0.56 kg of methane per Gg of incinerated HW. Recently we also estimated biogenic emissions of CO₂ from this category. The approach is based on the default factor for fossil carbon, as we assume that the rest of the carbon in the material is non-fossil.

8.4.4 Uncertainties and time-series consistency

Uncertainty in waste sector is a wicked problem. Activity data required by methodology is most of time derived from other data. These additional step(s) are increasing uncertainty of real activity data. Moreover data providers do not produce any relevant statistics that would help us determine standard deviation or other useful data characteristic. Main data provider is statistical office. A Czech Statistical Office does not produce descriptive statistics about his data. Data produced by office are often the only one available based on total survey. Another problem with uncertainty in category 6A is time scale. For emission in 2012 we use data from 1950 on. And the uncertainty is varies among particular years and there is no tool how to handle this correctly. That's why we most of time use expert judgment to assess the uncertainty.

Tab. 8-15 Uncertainty estimates for sector Waste

| Gas | Category | AD uncertainty [%] | EF uncertainty [%] | Origin of the parameters |
|------------------|---------------------------|--------------------|--------------------|--|
| CH ₄ | 6A Landfills | 30 | 40 | Combined uncertainty of quantification parameters Expert judgement M. Havránek, verification P. Slavíková (CENIA) |
| CH ₄ | 6B.1 Communal wastewater | 21 | 50 | Combined uncertainty of quantification parameters Expert judgement M. Havránek |
| N ₂ O | 6B1 Communal wastewater | 26 | 50 | AD Expert judgement M. Havránek; EF IPCC default |
| CH ₄ | 6B2 Industrial wastewater | 40 | 50 | Combined uncertainty of quantification parameters + IPCC Default values, Expert judgement M. Havránek |
| CO ₂ | 6C HW/TW incineration | 15 | 5 | AD Expert judgement M. Havránek; EF IPCC default |
| N ₂ O | 6C HW/TW incineration | 20 | 70 | AD Expert judgement M. Havránek; EF IPCC default |
| CH ₄ | 6C HW/TW incineration | NA | NA | NA |
| CO ₂ | 1A1a MSW incineration | 20 | 20 | AD Expert judgement M. Havránek; EF IPCC default |
| N ₂ O | 1A1a MSW incineration | 20 | 70 | AD Expert judgement M. Havránek; EF IPCC default |
| CH ₄ | 1A1a MSW incineration | NA | NA | NA |

8.4.5 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) with addition with data from ISOH – information system on waste management run by MoE/CENIA. However, the inaccuracy or uncertainty of this data is not quantified but estimated by expert judgment. We cross-checked the data on incineration with the top-down data produced by other State agencies.

8.4.6 Source-specific recalculations

No recalculations performed in this submission.

8.4.7 Source-specific planned improvements

We do not plan any improvement in this particular sub-category. We might eventually try to split part of this category to energy sector as we did with MSW if data are available. We always encourage state administration to gather data useful for GHG inventories.

9 Other (CRF sector 7)

No sector 7 is defined in the Czech inventory.

10 Recalculations and Improvements

The driving forces in applying recalculations in the Czech greenhouse gas inventory are provided by the implementation of the guidance given in the IPCC Good Practice Guidance reports (IPCC, 2000; IPCC, 2003) and the recommendations from the UNFCCC inventory reviews. Recalculations of previously submitted inventory data are performed following the above-mentioned IPCC manuals only to improve the GHG inventory.

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 Overview of former recalculations

10.1.1 Recalculations performed in the submission 2010

10.1.1.1 Recalculations in sector 1 Energy

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

The recalculation involves improvement and specification of activity data by using questionnaires elaborated by the Czech Statistical Office (CzSO) for IEA and Eurostat, while the emissions and oxidation factors remain unchanged. This recalculation was facilitated by concluding a Memorandum of understanding between CHMI and CzSO on data exchange, which made the questionnaires mentioned above available for the inventory team. In the past, the activity data were taken from the annually published “Energy balances of the Czech Republic” and were less suitable for conversion to UNFCCC/CRF categorization.

The year 2003 was chosen as the starting year because data for detailed splitting for 1A2 (i.e. 1A2a - 1A2f) have been available since 2003.

The reasons for this recalculation were discussed during the “In-country review” (October 2009, Prague) with the ERT that supported this concept. In addition, the last EU check called “Consistency Report CZ 2009” found obvious inconsistencies in 1A2 category allocation.

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

The reasons for this recalculation were discussed during the “In-country review” (October 2009, Prague) with the ERT, which suggested the addition of a missing fuel type “Other fuels” used mainly in cement kilns to improve the completeness of the process.

Recalculation of CH₄ emission in sub-sector 1A3e since 1990

The reasons for this recalculation were discussed during the recent “In-country review” (October 2009, Prague) with the ERT, which suggested substitution of the non-transparent CH₄ EF by the IPCC default value.

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

Based on the above inquiry, the value of the CO₂/CH₄ ratio in Natural Gas was found and thus it was possible to estimate the relevant emissions of CO₂ in sub-sector 1B2b and thus to improve completeness.

10.1.1.2 Recalculations in sector 2 Industrial Processes

One recalculation in the period 2004 - 2007 was performed for N₂O emissions from HNO₃ production. Estimation of these emissions in the Czech Republic is based on the use of technology-specific emissions factor taking into consideration process conditions in Czech plants. The emission factors respect the three levels of pressure employed (0.1, 0.4 and 0.7 MPa) and relevant cases of NO_x and/or N₂O abatements: selective catalytic reduction (SCR) of NO_x, non-selective catalytic reduction (NSCR) of NO_x that also reduces emissions of N₂O, and recently introduced N₂O mitigation based on catalytic N₂O decomposition for 0.7 MPa technology.

For 0.4 MPa technology in combination with NSCR, an emission factor of 1.09 kg N₂O/t HNO₃ was used for 1990 - 2003 while, starting from 2004, this EF was increased to 2.72 kg N₂O/t HNO₃. However, new plant measurements revealed that the original EF 1.09 kg N₂O/t HNO₃ is suitable even for the years after 2003.

Consequently, in the recalculation, EF = 1.09 kg N₂O/t HNO₃ was used over the whole time period since 1990 for the 0.4 MPa technology combined with NSCR. This recalculation improves the quality of the inventory in accordance with good practice and improves the time series consistency. The approaches used for the other technologies mentioned above remain unchanged.

10.1.1.3 Recalculations in sector 4 Agriculture

The following recalculations regarding N₂O emissions were performed for the whole time period since 1990 as a consequence of discussions with the ERT during the “in-country review” in October 2009

N₂O from manure management (non-KC)

According to the recommendation from the Good Practice Guidance 2000 (IPCC, 2000), the default parameters characterizing AWMS for dairy cattle, non-dairy cattle, and swine were taken from Tables B-3 through B-6 in the Revised 1996 Guidelines (IPCC, 1997)(Reference Manual) instead of the existing values taken from Table 4-21. The values for the other animals remained unchanged.

N₂O emissions from agricultural soils - Animal manure applied to soils (KC)

In the recalculation, the more suitable equation 4.23 from the Good Practice Guidance 2000 (IPCC, 2000) was used instead of the existing equation from the Revised 1996 Guidelines, p. 4.93 (IPCC, 1997).

N₂O emissions from agricultural soils - Crop residues (KC)

The Tier 1a method described in the Good Practice Guidance 2000 (IPCC, 2000) was used to estimate emissions in this category. The reasons for this recalculation were:

- The default value for Fra_{C_{BURN}} (0.1) has been used although burning of crop residues does not occur in the CR.

- Because of the small error in the existing calculation spreadsheets, the residues from pulses have not been included in the calculations.
- The amount of crops has been transformed to dry matter using a default $Frac_{DM}$ value of 0.85. This is in accordance with the Revised 1996 Guidelines (IPCC, 1997) but, according to the 2000 GPG (IPCC, 2000), the crops $Frac_{DM}$ should not be employed if the simple Tier 1 (Tier 1a) method is used.

N₂O emissions from 4.D.1.3 N-fixing crops

In recalculation of emissions from N-fixing crops, the production of soya beans has also been included (even though this production is very limited in the Czech Republic).

10.1.1.4 Recalculations in sector 5 LULUCF

All recalculations in LULUCF sector were performed for the whole time period since 1990.

1. Several LULUCF categories were recalculated following the revision of biomass conversion and expansion factors (BCEFs). These factors were revised utilizing the new data from the Czech landscape inventory (CzechTerra). This statistical inventory covers the entire territory of the country and its first cycle was conducted during the years 2008 and 2009. The application of the new BCEFs affects all the LULUCF categories related to forest land, namely:

- 5.A.1. Forest Land remaining Forest Land
- 5.A.2. Land converted to Forest Land (all relevant sub-categories)
- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

2. This inventory submission additionally contains estimates of carbon stock change in dead organic matter following the conversion of Forest land to other land use categories. This implementation concerns the following categories:

- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

10.1.2 Recalculations performed in the submission 2011

10.1.2.1 Recalculation in sector 1 Energy

Recalculation of Road Transportation (1A3b)

Recalculation of emissions from road transport was performed for all the greenhouse gases (CO₂, CH₄, N₂O) 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 N₂O emissions from biomass, CNG and LPG from 1A3b (Road Transport) were substituted by emission estimates of N₂O using relevant default EFs taken from the 2006 Guidelines (IPCC, 2006).

Recalculation in sector 1B Fugitive Emissions from Fuels (1B2a)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 1B2a-ii (oil production). In this subcategory, the Czech Republic reported only CH₄ emissions from oil production, while CO₂ emissions and emissions of CO₂, CH₄ and N₂O 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 CO₂ emissions from oil production and emissions of CO₂, CH₄ and N₂O 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.

10.1.2.2 Recalculation in sector 2 Industrial Processes

Recalculation of Soda Ash Use (2A4)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 2A4 (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 CO₂, which was not reported. Therefore, in its resubmission of CRF mentioned above, the Czech Republic supplemented this missing source of CO₂ 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 CO₂ from soda ash use in the pulp and paper industry are not very significant in the Czech Republic (less than 1 Gg CO₂).

Recalculation of Mineral Products - Other (2A7.2)

CO₂ and CH₄ 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. 2A7.2 Brick and ceramics is not a significant category for CO₂ emissions (approximately 150 Gg CO₂) and CH₄ emissions are even lower. The effect of recalculation of the CO₂ emissions is small and results in a decrease in emissions in 2006 – 2007 by approximately 1 % CO₂ and an increase in 2008 by 8 %.

Recalculation of Metal Production – Iron and Steel Production (2C1)

The recalculation in the period 2003 - 2008 was performed in the case of CO₂ 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 CO₂ emission is 1.2% lower than the original value, for 2008 the recalculated CO₂ emission is 3.8% lower than the original value and for 2009 the newly estimated CO₂ emission is 4.4% higher than would be the value obtained by the older approach.

10.1.2.3 Recalculation in sector 6 “Waste”

Recalculation of Solid Waste Disposal on Land – Managed Waste Disposal in Land (6A1) and Waste incineration - Other (6C2)

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 6C (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 6A1 category (Managed landfills).

10.1.3 Recalculation performed in the submission 2012

10.1.3.1 Recalculation in sector 1 Energy

Recalculation of 1A Energy - stationary combustion

Expert review team (ERT) during In country review in August/September 2011 raised recommendation to prolong data series in subcategories 1A2a – 1A2f 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. To ensure consistency of data used, the recalculation was performed for all categories in whole 1A except of 1A3 – mobile combustion (i.e. 1A1, 1A2, 1A4, 1A5, 1AD, 1A3e). In 1A1, 1A4, 1A5, 1AD and 1A3e was recalculation carried out using data from CzSO Questionnaires since 1995. In 1A2 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 1A 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 1A3a and 1C1a, 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 1A3 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 1B Fugitive Emissions from Fuels (1B1 Solid Fuels) - Recalculation of CH₄ emissions from underground mining activities

By FCCC/ARR/2008/CZE was recommended to update CH₄ 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 CH₄. The recalculation was therefore made for 2000 – 2008. For data 2008 onwards is used average EF value from 2000 - 2008 EFs. The range of CH₄ emission decrease due to this recalculation is 23 - 40%.

Recalculation in sector 1B Fugitive Emissions from Fuels (1B1 Solid Fuels) - Recalculation of CO₂ emissions from underground mining activities

ERT during ICR 2011 and FCCC/ARR/2010/CZE raised recommendation to provide estimates for CO₂ emissions from underground and surface mining. We put main focus on CO₂ emissions from underground mining. A special study was performed for CO₂ emission factor. The emission factor was recalculated for 1990 – 2009 and for years onwards was also recommended specific value.

10.1.3.2 Recalculation in sector 2 Industrial Processes

Recalculation of Metal Production – Iron and Steel Production (2C1)

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 CO₂ emissions calculated from the two sources are less than 2%. Similarly as for the 2011 submission, these recalculations also were harmonized with recalculations performed in the Energy sector.

10.1.3.3 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 N₂O 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 an 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
- 2) More accurate animal population data (not rounded up to thousands) reported (cattle, swine, sheep, poultry).
- 3) More accurate data for cattle population reported (not rounded to thousands) for the period since 2006.
- 4) Recalculation of N₂O 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.
- 5) 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 4A 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 4B Manure Management (N₂O)

The estimation of N₂O 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 N₂O emission estimation from Manure

management.

Using the above changes, the N₂O 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 4D Agricultural soils (4D1b, 4D2 and 4D3)

Given that the value of Nex for cattle was revised, it led to the increased N₂O emissions from:

- 1) animal manure applied to soils (4D1b)
- 2) pasture, range and paddocks (4D2)
- 3) atmospheric deposition (4D3.1)
- 4) N lost through leaching and run-off (4D3.2)

Also these changes apply for the entire reporting period.

10.1.3.4 Recalculation in sector 5 LULUCF

Recalculation of LULUCF – Other (5G)

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 5A Forest Land, the corresponding emissions are reported under 5G 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 CO₂ 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).

10.1.3.5 Recalculation in sector 6 Waste

First recalculation was minor changes in activity data in 6A (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 6C2 MSW incineration under 1A1A. This shift is in compliance with the suggestion of the IPCC methodology. In addition to this shift, we quantified emissions of CO₂ 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 CO₂ for this category.

10.1.4 Recalculation performed in the submission 2013

10.1.4.1 Recalculation in sector 1A 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 1A 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.

10.1.4.2 Recalculation of gaseous fuel in 1A Energy

Another improvement provided by the Czech Republic consists in new country specific CO₂ 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 1A Energy.

10.1.4.3 Recalculation/reallocation of solid fuels in sectors 1A1c Energy - Manufacture of Solid Fuels and Other Energy Industries and 1A2 Energy- Manufacturing Industries and Construction

One of the improvements implemented by the Czech Republic considers reallocation of solid fuels and associated emissions between 1A1c and 1A2. 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 1A2 autoproducers. The QA/QC procedure ascertained that this consumption of solid fuels should be included in 1A1c category; in this submission solid fuels were reallocated. This reallocation affects consumption of solid fuels and associated emissions in 1A1c category and in 1A2a-1A2f (autoproducers consumption).

10.1.4.4 Recalculation in sector 1A2c 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 1A2c, 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.

10.1.4.5 Recalculation in 1A3 Energy - Road Transportation - Diesel Oil

QC/QC procedures identified typographic error in this category - N₂O emissions, 2010. This issue has been rectified.

10.1.4.6 Recalculation in sector 1A4b 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 CH₄ and N₂O 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 CO₂ emissions using country specific emission factor.

10.1.4.7 Recalculation in sector 1AD Energy - Feedstocks and non-energy use of fuels

In category 1AD 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.

10.1.4.8 Recalculation in sector 1B1b 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.

10.1.4.9 Recalculation in sector Cement Production (2A1)

In this submission the recalculation of CO₂ emissions was performed. In 2003-2005 period was discovered computational error, which was now corrected.

10.1.4.10 Recalculation in sector Soda Ash Use (2A4 2)

The activity data for this category were verified for 2009 and 2010, which introduced also recalculation of CO₂ emissions.

10.1.4.11 Recalculation in sector Other – Glass Production (2A7 1)

For 2005 was found the error in reported CO₂ emissions in this category. This discrepancy was corrected in this submission.

10.1.4.12 Recalculation in sector 2F3 Industrial Processes, Fire Extinguishers

Technical Expert Review Team (TERT) raised recommendation during ESD review in July 2012 to include split for 1st 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.

10.1.4.13 Recalculation in sector 3 Solvent and Other Product Use

QC/QC procedures identified typographic errors in this sector – CO₂ emissions, 2010. This issue has been rectified.

10.1.4.14 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 N₂O 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 N₂O 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 N₂O 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 N₂O emissions for the entire time series and

- 2) Potatoes and sugarbeet crops produced in the country were included in the estimations of N₂O emissions from crop residues returned to soils for the entire time series

The “Saturday paper” recalculation led to increased emissions in 4D.1 category (Direct emissions from agricultural soils) after recalculation by 6.9 % in 2010. Using the above changes, the N₂O direct emissions from Agricultural soils were calculated with Tier 2 method for the entire reporting period.

10.1.4.15 Recalculation in sector 4D Agricultural Soils (4D1 3, 4D1 4)

The estimation of N₂O Direct emissions from Agricultural soils for 1990-2010 was performed using the statistical crop production data and country-specific parameters.

Category 4D1 3

IPCC GPG was applied and available information on production of crops (alfalfa and clover) and national values were used to estimate N₂O 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 N₂O emissions from Agricultural soils (N-fixing crops) has form

$$\text{FBN} = \text{Crop} * \text{FracDM} * \text{FracNCRBF}.$$

Category 4D1 4

N₂O 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 N₂O 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.

10.1.4.16 Recalculation in sector 5 “LULUCF” (5G)

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.

10.2 New recalculations performed in this submission

10.2.1 Recalculation in sector 1A Energy

10.2.1.1 Recalculation of liquid fuels in 1A Energy

One of the improvements provided by the Czech Republic consists in new country specific CO₂ emission factors for LPG and Refinery Gas. Specific data about composition of these fuels were obtained from Česká rafinérská, a.s. and based on these data were developed country specific emission factors.

Since this submission updated emission factors are used for all categories in 1.A Energy.

10.2.1.2 Recalculation in 1A3 Energy - Road Transportation

During QA/QC procedure were found new updated activity data, which were used for the emission estimations in this category. This issue is relevant for CH₄ emissions for the time period 2000 – 2011 for Gasoline and Diesel Oil and for N₂O emissions for Gasoline, Diesel Oil and Natural gas also for time period 2000 – 2011.

10.2.2 Recalculation in sector 2 Industrial processes

10.2.2.1 Recalculation in sector Iron and Steel Production (2C1)

CO₂ emissions were recalculated using Tier 2 methodology in line with the improvement plan of the Czech Republic. This recalculation caused decrease of emissions in this category in 1990 for about 0.82 % and in 2011 for about 2.18 %.

10.2.2.2 Recalculation in sector Refrigeration and air-conditioning equipment (2F1)

Category 2.F.1 suffered major recalculation which has been triggered by a potential problem found during UNFCCC expert review in September 2013.

Potential problem stated that although inventory team was able to determine life cycle of refrigeration equipment it still does not account for emissions from deceased equipment. This was a well justified assumption as the time since introduction exceeded the published life-cycle which indicated possible underestimation.

Inventory team revised the emissions estimate calculation routines in an attempt to resolve the potential problem and changed significantly the results in whole time series for all gases in 2.F.1 category. Actual emissions time-series now keep much more conservative trends, also the amount of f-gases being stored in functional equipment or deceased equipment is now being reported correctly.

10.2.3 Recalculation in sector 4 Agriculture

10.2.3.1 Recalculation in sector Manure Management of Cattle

According to ERT recommendation (mentioned in ARR reports), the Czech Republic recalculated the methane emissions from Manure Management of cattle. In line with the IPCC GPG a higher-tier method to estimate the CH₄ 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. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (see Table 6-1 in NIR 2013).

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 (1990-2012). Gross energy (GE) values are estimated based on the national study Kolář et al. (2004). These GE parameters are annually reported in CRF as a country-specific data for entire reported period (1990-2012). The current updated data of AWMS distribution were applied for emission estimation. Based on the Dämmgen et al. (2012), the other specific parameters for estimation of emission factors for cattle were obtained (Bo, MCF). 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. Therefore the parameters from Dämmgen et al. (2012) were utilized for the emission estimation. The equation for determination of emission factors and estimation of methane emissions were taken from the IPCC (2006).

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 (4B) increased after recalculation by 7 % in 1990, resp. by 26 % in 2011. The study Exnerova (2013, in Czech) describing a new method was elaborated. A detailed description of new method and data implemented to emission inventory are presented in the corresponding chapter of the National Inventory Report (NIR 2014, Chapter 6 - Agriculture).

10.2.4 Recalculation in sector 5 “LULUCF” and KP LULUCF activities

For the NIR submission in 2014, the emission estimates were recalculated for the entire reporting period. This was due to the rectified activity data and emission factors.

The rectified activity data included the land use areas and data on biomass residues associated with wood harvest on forest land. As for the land use data, on request of the latest review, these data were newly crosschecked in order to improve data consistency. This request concerned primarily the historical data since 1969 to 1992, which are available at the country level (NUTS 4). Following the consultation with the supplier, i.e., the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz), these data are now used in its original form with no additional corrections applied. These changes in practice mean rectifying land use matrices for the entire reporting period and for the all land use categories. It is due to the adopted IPCC default of 20 years applicable for soil carbon pool change due to land conversions, which technically requests activity data since 1969 and any corrections in land areas affect the period of 20 years following the year of intervention. As for the activity data on biomass residues applicable to wood loss, the Czech emission inventory use a new information on harvest residues reported by the Czech Statistical Office. For the remaining (older) period, the expert judgment of harvest loss as adopted earlier is retained equally for all tree species.

The rectified emission factors concern the applied carbon fraction in woody biomass. This was changed from the previously adopted 0.50 t C/t biomass (IPCC 2003) to a more conservative 0.49 and 0.48 for the coniferous and broadleaved species, respectively (IPCC 2006). The latter value was also used for all harvest residues under burning. These corrections leading to somewhat more conservative estimates affect all emission categories associated with forest land and its conversion.

10.2.5 Recalculation in sector 6 Waste

10.2.5.1 Recalculation in sector Domestic and Commercial wastewater (6B2)

Centralized review noted possible underestimation of N₂O emissions from domestic and commercial wastewater treatment 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 - 2012. Average change in amount of GHG in source category was about 14% per year.

10.3 Response to the review process and planned improvements in the inventory

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 1B2a-ii (Oil Production). In this subcategory, the Czech Republic reported only CH₄ emissions from oil production, while CO₂ emissions and emissions of CO₂, CH₄ and N₂O 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 N₂O 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 N₂O 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) CO₂ emissions from 1A Stationary Combustion
- 2) CO₂, CH₄ and N₂O emissions from 1A3a Civil Aviation
- 3) CH₄ and N₂O emissions from 1A4b Residential
- 4) CH₄ emissions from 1B1b Solid Fuel Transformation
- 5) N₂O emissions from 4D1 3 N-fixing crops
- 6) N₂O emissions from 4D1 4 Crop residue
- 7) CH₄ emissions from 6A Solid Waste Disposal
- 8) CH₄ and N₂O emissions from 6C 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 SF₆ emissions from consumption of halocarbons and SF₆ and N₂O emissions from domestic and commercial wastewater handling (human sewage);
- 2) A complete resubmission of the 2013 CRF tables, reflecting the revised estimates;
- 3) 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)

10.3.1 Overview of implemented improvements in the 2013 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 2014 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 32,33 | NIR, chapter 10.3.2 |
| Archiving | Revised archiving routines | ARR 2010, para 34, 38b ARR 2011, para 48 | NIR, chapter 1.3.3 |
| Sector: Energy – emissions from combustion | | | |
| 1A, LPG, Refinery Gas, CO₂ | New country specific CO ₂ emission factor for LPG and Refinery Gas combustion, updated NCV for LPG and Refinery Gas | Improvement suggested by Party | NIR, chapter 3.7.1, Annex 2 |
| 1A3b, N₂O, CH₄ | Recalculation of activity data in 1A3b in period 2000 – 2011 | Improvement suggested by Party | NIR, chapter 3.7.3 |
| Sector: Industrial processes and Solvent use | | | |
| 2C1 | Recalculation caused by implementing Tier 2 methodology | Improvement suggested by Party | NIR, chapter 4.4 |
| 2 F | Revised methodology implementation; Revised calculation spreadsheets | Improvement suggested by Party | NIR, chapter 4.7.6 |
| Sector: Agriculture | | | |
| 4B CH₄ | Recalculation of methane emissions from Manure Management of cattle. In line with the IPCC (2006) a higher-tier method to estimate the CH ₄ emissions from cattle category was implemented in the 2014 submission. | Improvement suggested by ERT | NIR, chapter 6.3 |
| Sector: LULUCF & KP LULUCF | | | |
| 5A, 5B, 5C, 5D, 5E | Revised background activity data on land areas for the period 1969 to 1992, affecting (due to the 20-year default accumulation period) the activity data on land until 2012 | Improvements suggested both by ERT and by Party | NIR, chapter 7.2 |
| 5A, CO₂ | Improved activity data on wood (harvest) loss | Improvements suggested by Party | NIR, chapter 7.3.2 |
| 5A, 5B, 5C, 5D, 5E, CO₂ | Revised emission factor on carbon fraction in woody biomass | Improvements suggested by Party | NIR, chapter 7.3.5, 7.4.5, 7.5.5, 7.6.5, 7.7.5 |

Tab. 10-2 Methodological descriptions in submission 2013

| 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 |
| 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 | | | |
| 2. Industrial Processes | | | |
| A. Mineral Products | | | |
| B. Chemical Industry | | | |
| C. Metal Production | √ | √ | |
| D. Other Production | | | |
| E. Production of Halocarbons and SF ₆ | | | |
| F. Consumption of Halocarbons and SF ₆ | √ | √ | |
| G. Other | | | |
| 3. Solvent and Other Product Use | | | |
| 4. Agriculture | | | |
| A. Enteric Fermentation | | | |
| B. Manure Management | √ | √ | |
| C. Rice Cultivation | | | |
| D. Agricultural Soils | | | |
| E. Prescribed Burning of Savannas | | | |
| F. Field Burning of Agricultural Residues | | | |
| G. Other | | | |
| 5. Land Use, Land-Use Change and Forestry | | | |
| A. Forest Land | √ | √ | |
| B. Cropland | | √ | |
| C. Grassland | | √ | |
| D. Wetlands | | √ | |
| E. Settlements | | √ | |
| F. Other Land | √ | √ | |
| G. Other | | √ | |
| 6. Waste | | | |
| A. Solid Waste Disposal on Land | | | |
| B. Waste-water Handling | √ | √ | |
| C. Waste Incineration | | | |
| D. Other | | | |
| 7. Other (as specified in Summary 1.A) | | | |
| | | | |
| Memo Items: | | | |
| International Bunkers | | | |
| Aviation | | | |
| Marine | | | |
| Multilateral Operations | | | |
| CO ₂ Emissions from Biomass | | | |
| 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 | | | |

10.3.2 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 CO₂ 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 2A Mineral Product (e.g. 2A1 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 2A3 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

| Sec. | Key Categories (KC) | GHG | %*) of GHG | Type of KC | Present situation (CRF Tab Sum 3) | | Planned improvement | For submission |
|-----------|---|------------------|---------------|---------------|---|--|---|----------------|
| | | | | | | | | |
| 1A | 1A Stationary Combustion - Solid Fuels | CO ₂ | 42.79 | LA, TA | Country specific factors for coals, for other fuels default EFs | | Update of these factors from EU ETS data | 2015 |
| 1A | 1A.3.b Transport - Road Transportation | CO ₂ | 10.59 | LA, TA | Default EFs | | Country specific EFs for gasoline, motor diesel oil, LPG | 2015 |
| 1A | 1A Stationary Combustion - Liquid Fuels | CO ₂ | 3.30 | LA, TA | Default EFs | | Country specific EFs for fuel oils | 2014, 2015 |
| 1A | 1A5b Mobile sources in Agricult. & Forestry | CO ₂ | 0.76 | LA | Default EFs | | Country specific EFs for gasoline and motor diesel oil | 2015 |
| 1A | 1A3b Transport - Road Transportation | N ₂ O | 0.84 | LA, TA | Default EFs | | Country specific EFs for gasoline and motor diesel oil | 2015 |
| 2 | 2F1-6 F-gases Use - ODS substitutes | F-gas | 1.93 | LA, TA | Tier 2 | | Split of 2F11 domestic refrigeration into its correct categories | 2014 |
| 2 | 2B2 Nitric Acid Production | N ₂ O | 0.32 | TA | Tier 2, 3 | | Tier 3: Direct N ₂ O measurements from EU ETS reporting forms | 2015 |
| 4 | 4D1 Agricultural Soils, Direct Emissions | N ₂ O | 2.78 | LA, TA | Tier 2 | | Defaults EFs from 2006 Guidelines, Country specific parameters for crops | 2015 |
| 4 | 4D3 Agricultural Soils, Indirect Emissions | N ₂ O | 1.79 | LA, TA | Tier 1 | | Application of defaults EFs from 2006 Guidelines with regard to good practice principle | 2015 |
| 6 | 6A Solid Waste Disposal on Land | CH ₄ | 2.67 | LA, TA | Tier 2 | | Specification/estimate of waste composition with regard to good practice principle | 2015 |

Part 2: Supplementary Information Required under Article 7, paragraph 1

11 KP LULUCF

Emission and removal estimates from land use, land-use change and forestry (LULUCF) activities under Article 3.3 and 3.4 of the Kyoto Protocol.

11.1 General Information

The information provided in this chapter follows the requirements set in “Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol” (Annex to decision 15/CMP.1, FCCC/KP/CMP/2005/8/Add.2).

The current text reflects the recommendations of the latest reviews. However, it should be noted that the report of the last review conducted in 2013 had not been made available to the inventory team at the time of compiling this inventory submission. Any further recommendations will be considered for implementation in the next inventory submissions.

11.1.1 Definition of forest and any other criteria

For reporting LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol, forest land is defined as land with tree crown cover over at least 30 % (or equivalent stocking density) and an area of more than 0.05 hectares. Trees should reach a minimum height of 2 meters at maturity. Tree rows less than 20 meters wide are not considered to form a forest.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

In addition to the mandatory activities of Afforestation/Reforestation (further denoted as *AR*) and Deforestation (*D*) under Article 3, paragraph 3, of the Kyoto Protocol, the Czech Republic elected the optional activity of Forest Management (*FM*) under Article 3.4 of the Kyoto Protocol to be included in the accounting for the first commitment period. The accounting for KP LULUCF activities will be performed for the entire commitment period

11.1.3 Implementation and application of activities and elected activities under Article 3.3 and Article 3.4

Due to the tight links imposed between the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the emission estimates of KP LULUCF activities and those reported for the LULUCF sector under the Convention. Hence, reference is frequently made to the corresponding methodologies described in Chapter 7 of the NIR 2013 text, while additional and specific information related to the KP LULUCF activities is highlighted here.

The conceptual linkage between the *AR*, *D* and *FM* activities and the reporting based on land use categories under the Convention is as follows:

AR activity may represent the following types of land-use conversions:

- 5.A.2.1. Cropland converted to Forest Land
- 5.A.2.2. Grassland converted to Forest Land
- 5.A.2.3. Wetlands converted to Forest Land
- 5.A.2.4. Settlements converted to Forest Land

D activity may represent the following situations:

- 5.B.2.1. Forest land converted to Cropland
- 5.C.2.1. Forest land converted to Grassland
- 5.D.2.1. Forest land converted to Wetlands
- 5.E.2.1. Forest land converted to Settlements

FM activities relate to emissions and removals correspondingly as described in category 5A1 Forest land remaining Forest land

In this way, *AR* activities generally always represent a land-use conversion from a land-use category other than forest land to the land use category of forest land. Similarly, *D* is an activity when forest land is converted to other types of land-use, as shown above. These links are retained consistently for the entire reporting period, similarly as for the adopted methodology. This ensures consistent treatment of the activity data and methodologies across the Kyoto Protocol 1st Commitment Period, as well as for the reporting period under the Convention, i.e., since 1990, and in some applicable instances since 1969. Other details can be found below.

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified.

Since only one activity of the listed Article 3.4 activities was elected by the Czech Republic, no precedence conditions and/or hierarchy among Article 3.4 activities are applicable.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Land areas associated with the LULUCF activities are identified within a geographic boundary encompassing units of land or land subject to multiple activities under article 3.3 and 3.4 activities (i.e. reporting method 1, GPG for LULUCF, IPCC 2003). Considering the small area of the country and its specific conditions, there is no applicable stratification that would justify reporting on smaller than a country-level unit. This is also supported by the attributes of the available activity data. However, the land-use representation and land-use change identification system developed for the KP and UNFCCC reporting purposes permit a truly detailed spatial assessment and identification of *AR* and *D* activities at the level of the individual cadastral units. The system is exclusively based on the annually updated data on land use from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of approximately 13 thousands individual cadastral units (Fig. 11.1). Specifically in 2012, the areas of *AR* and *D* were estimated at the level of 13 013 cadastral units, including 12 integrated cadastral units in the country. The mean area of these 13 013 units that enter the analysis of land-use change was 6.07 km². The cadastral information on particular land-use categories has a resolution of m². The minimum assessment unit for land-use change detection is 0.05 ha. This is linked to the spatial parameters of the forest definition applied in the Czech Republic.

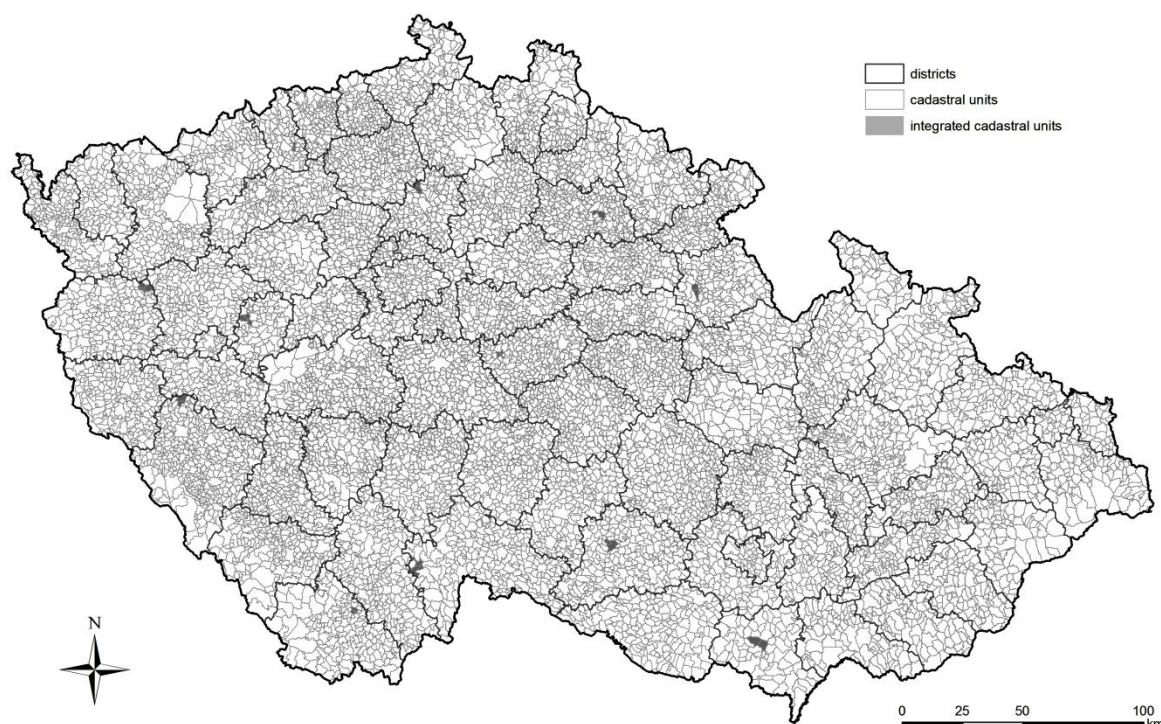


Fig. 11-1 The spatial detail of the land use representation and land-use change identification system used for detecting land use change associated with ARD activities. In 2012, the areas of ARD were estimated at the level of 13 013 individual cadastral units including 12 integrated cadastral units.

11.2.2 Methodology used to develop the land transition matrix

The land use representation and land-use change identification system was created in several steps, namely 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time-series. These steps are described in detailed in Section 7.2.1 of the Czech NIR 2014 submission. The result is a system of consistent representation of land areas, ranking as Reporting Method 1 of the GPG for LULUCF (IPCC, 2003), having the attributes of both Approach 2 and Approach 3 and permitting accounting for all mandatory land-use transitions in annual time steps.

Tab. 11-1 The identified land-use change from Cropland (C), Grassland (G), Wetlands (W) and Settlements (S) to Forest Land (F), categorized as AR (kha/year) and land use change from F to land use categories C, G, W and S, which represent D (kha/year).

| Year | Afforestation/Reforestation (AR, kha/year) | | | | | Deforestation (D, kha/year) | | | | |
|------|--|--------|--------|--------|-------|-----------------------------|--------|--------|--------|-------|
| | C to F | G to F | W to F | S to F | Total | F to C | F to G | F to W | F to S | Total |
| 1990 | 0.50 | 0.37 | 0.01 | 0.00 | 0.88 | 0.03 | 0.07 | 0.02 | 0.28 | 0.40 |
| 1991 | 0.25 | 0.07 | 0.00 | 0.02 | 0.33 | 0.02 | 0.34 | 0.06 | 0.13 | 0.54 |
| 1992 | 0.12 | 0.07 | 0.01 | 0.00 | 0.20 | 0.03 | 0.20 | 0.02 | 0.19 | 0.44 |
| 1993 | 0.09 | 0.12 | 0.01 | 0.18 | 0.39 | 0.19 | 0.07 | 0.02 | 0.55 | 0.82 |
| 1994 | 0.20 | 0.21 | 0.12 | 0.90 | 1.43 | 0.11 | 0.08 | 0.02 | 0.38 | 0.59 |
| 1995 | 0.31 | 0.36 | 0.02 | 0.47 | 1.16 | 0.15 | 0.08 | 0.02 | 0.27 | 0.52 |
| 1996 | 0.86 | 0.40 | 0.03 | 0.50 | 1.79 | 0.18 | 0.35 | 0.02 | 0.36 | 0.90 |
| 1997 | 0.31 | 0.43 | 0.04 | 0.90 | 1.69 | 0.23 | 0.17 | 0.04 | 0.37 | 0.80 |
| 1998 | 0.48 | 0.68 | 0.10 | 2.25 | 3.51 | 0.39 | 0.39 | 0.05 | 0.53 | 1.37 |
| 1999 | 0.33 | 0.45 | 0.04 | 0.72 | 1.54 | 0.12 | 0.08 | 0.05 | 0.60 | 0.84 |
| 2000 | 0.47 | 0.54 | 0.08 | 2.36 | 3.46 | 0.10 | 0.14 | 0.06 | 0.37 | 0.67 |
| 2001 | 0.44 | 0.49 | 0.04 | 1.15 | 2.12 | 0.07 | 0.08 | 0.02 | 0.33 | 0.49 |
| 2002 | 1.13 | 0.94 | 0.03 | 2.54 | 4.64 | 0.04 | 0.06 | 0.08 | 0.32 | 0.50 |
| 2003 | 0.70 | 0.57 | 0.03 | 0.72 | 2.02 | 0.08 | 0.14 | 0.05 | 0.52 | 0.78 |
| 2004 | 0.75 | 0.84 | 0.02 | 0.64 | 2.26 | 0.10 | 0.07 | 0.03 | 0.50 | 0.69 |
| 2005 | 0.86 | 0.90 | 0.01 | 0.58 | 2.35 | 0.10 | 0.09 | 0.03 | 0.43 | 0.66 |
| 2006 | 1.05 | 0.65 | 0.03 | 0.45 | 2.18 | 0.05 | 0.06 | 0.03 | 0.32 | 0.47 |
| 2007 | 0.92 | 0.58 | 0.02 | 0.92 | 2.45 | 0.02 | 0.07 | 0.02 | 0.26 | 0.38 |
| 2008 | 0.80 | 0.47 | 0.09 | 0.91 | 2.27 | 0.10 | 0.05 | 0.03 | 0.26 | 0.44 |
| 2009 | 0.78 | 0.67 | 0.09 | 1.10 | 2.65 | 0.04 | 0.11 | 0.03 | 0.28 | 0.47 |
| 2010 | 1.10 | 0.63 | 0.08 | 0.93 | 2.74 | 0.10 | 0.09 | 0.06 | 0.32 | 0.56 |
| 2011 | 0.81 | 0.61 | 0.11 | 1.43 | 2.95 | 0.07 | 0.07 | 0.06 | 0.24 | 0.44 |
| 2012 | 0.83 | 0.70 | 0.05 | 1.02 | 2.60 | 0.06 | 0.10 | 0.04 | 0.27 | 0.47 |

The identified annual land use changes among the major land use categories as defined in the Czech emission inventory are shown Tab. 11-1. The mean area of AR activities reached 2.07 kha per year during the 1990 to 2012 period, which yields a cumulative area of 47.6 kha. For the same period, the mean area of D reached 0.62 kha per year, which amounts to 14.2 kha for the entire period. The difference between AR and D corresponds to the net increment of cadastral forest land as shown in Fig. 7-4 of NIR 2012.

Although the system of land-use representation and land-use identification is basically identical for both KP-reporting and Convention reporting, there are some notable differences that have implications for the reported areas of KP activities (Tab. 11-2). These differences are imposed by the specific requirements for the reporting of LULUCF activities under the Kyoto protocol, namely:

- 1) AR activities that qualify under KP accounting are only those commenced since 1990
- 2) AR land must be traced under KP reporting, i.e., it never enters the land registered under FM activity.

To handle this issue in the KP LULUCF reporting, two additional technical sub-categories were introduced for FM reporting in the UNFCCC CRF Reporter. One is "*Forest land remaining Forest land in KP reporting*", while the second is "*Residual afforested land from before 1990 (in conversion status)*". The entire land qualified as the area under FM activity represents the sum of these two categories.

Tab. 11-2: The forest areas of subcategories by four major tree species (Beech, Oak, Pine, Spruce) and the temporary unstocked areas (clearcut, CA), which altogether form the category 5A1 of the Convention reporting. Although not explicitly labelled in this table, until 2009, 5A1 is identical with the category of Forest Land remaining Forest Land (FLRFL) used in the KP reporting of FM. 5A2 represents Land converted to Forest land, remaining in conversion status for the period of 20 years. 5A1 and 5A2 form the entire category 5A Forest Land used in the Convention reporting. Residual afforestation (RA) represents the fraction of AR areas afforested prior 1990, which form a part of FM area (FM = FLRFL+RA), while the AR since 1990 (Art. 3.3) is treated separately and shown in Tab. 11-1 above

| Year | Convention and KP LULUCF reporting categories and their areas (kha) since 1990 | | | | | | | | | |
|------|--|-------|-------|---------|------|------|---------|--------|------|--------|
| | Beech | Oak | Pine | Spruce | CA | 5A2 | 5A | FLRFL | RA | FM |
| 1990 | 372.1 | 152.4 | 455.4 | 1 503.8 | 40.6 | 52.6 | 2 576.9 | 2534.6 | 41.4 | 2576.0 |
| 1991 | 375.3 | 153.0 | 455.5 | 1 500.2 | 40.7 | 51.9 | 2 576.7 | 2535.0 | 40.5 | 2575.5 |
| 1992 | 378.7 | 154.2 | 454.3 | 1 500.3 | 41.9 | 47.1 | 2 576.5 | 2539.0 | 36.1 | 2575.1 |
| 1993 | 381.3 | 154.9 | 452.6 | 1 499.7 | 41.4 | 46.1 | 2 576.1 | 2539.1 | 35.1 | 2574.2 |
| 1994 | 384.9 | 155.0 | 450.9 | 1 502.1 | 39.8 | 44.2 | 2 576.9 | 2541.3 | 32.4 | 2573.7 |
| 1995 | 388.3 | 155.6 | 451.2 | 1 503.0 | 38.9 | 40.6 | 2 577.5 | 2544.8 | 28.3 | 2573.1 |
| 1996 | 391.0 | 157.3 | 450.5 | 1 502.0 | 38.1 | 39.5 | 2 578.4 | 2546.2 | 26.0 | 2572.2 |
| 1997 | 394.4 | 157.4 | 450.1 | 1 503.2 | 36.0 | 38.1 | 2 579.2 | 2547.8 | 23.5 | 2571.3 |
| 1998 | 400.9 | 157.8 | 452.8 | 1 499.1 | 33.7 | 36.8 | 2 581.1 | 2550.3 | 19.5 | 2569.8 |
| 1999 | 403.7 | 159.7 | 448.9 | 1 504.1 | 32.2 | 33.1 | 2 581.8 | 2553.9 | 15.0 | 2568.9 |
| 2000 | 408.1 | 161.8 | 447.7 | 1 503.6 | 31.0 | 32.4 | 2 584.5 | 2556.6 | 11.5 | 2568.2 |
| 2001 | 413.2 | 163.0 | 446.5 | 1 503.0 | 29.8 | 30.7 | 2 586.1 | 2559.3 | 8.3 | 2567.6 |
| 2002 | 419.0 | 164.5 | 444.5 | 1 499.2 | 28.3 | 34.6 | 2 590.2 | 2559.2 | 7.9 | 2567.0 |
| 2003 | 426.3 | 166.1 | 443.3 | 1 493.2 | 27.0 | 35.4 | 2 591.3 | 2559.1 | 7.0 | 2566.1 |
| 2004 | 431.9 | 166.9 | 440.9 | 1 489.8 | 26.8 | 36.6 | 2 592.8 | 2559.1 | 6.3 | 2565.4 |
| 2005 | 438.0 | 167.5 | 439.4 | 1 486.0 | 26.3 | 37.3 | 2 594.5 | 2559.7 | 5.0 | 2564.7 |
| 2006 | 442.4 | 169.4 | 437.6 | 1 482.9 | 25.9 | 37.9 | 2 596.2 | 2560.3 | 3.9 | 2564.2 |
| 2007 | 448.2 | 170.7 | 435.7 | 1 479.1 | 26.1 | 38.5 | 2 598.2 | 2561.3 | 2.5 | 2563.8 |
| 2008 | 455.2 | 173.0 | 433.9 | 1 471.9 | 27.1 | 38.9 | 2 600.0 | 2562.2 | 1.1 | 2563.3 |
| 2009 | 461.5 | 174.2 | 432.0 | 1 466.7 | 27.6 | 40.0 | 2 602.1 | 2562.8 | 0.0 | 2562.8 |
| 2010 | 465.9 | 176.2 | 430.8 | 1 461.6 | 28.1 | 41.5 | 2 604.2 | 2562.2 | 0.0 | 2562.2 |
| 2011 | 470.6 | 178.3 | 428.3 | 1 456.2 | 29.1 | 43.9 | 2 606.6 | 2561.6 | 0.0 | 2561.6 |
| 2012 | 476.3 | 180.0 | 427.1 | 1 449.3 | 29.9 | 46.2 | 2 608.7 | 2561.1 | 0.0 | 2561.1 |

Since the Czech inventory system adopts the 20-year default period for preserving lands under conversion status as recommended by GPG for LULUCF (IPCC, 2003), the areas of the sub-category *Forest land remaining Forest land in KP reporting* are equal to the areas in the category 5A1 under Convention reporting. In KP reporting, the entire area of FM must additionally include the fraction of land afforested prior 1990, which is represented by the second introduced sub-category, i.e., “Residual afforested land from before 1990 (i.e., in conversion status)”, which is abbreviated as RA in Tab. 11-2.

Since the reported year 2010, the area of FLRFL becomes equal to FM and the area of RA becomes zero. At the same time, the FM area becomes smaller than that reported under 5A1 under the Convention reporting (5A1 is not explicitly shown in Tab. 11-2, but it is equal to 5A - 5A2) and hence also the areas of the individual species group differ under the Convention and KP reporting. This is due to the actual D activities that are not compensated by any residual areas of formerly afforested land, because since 2010 these are registered exclusively under AR activities.

The system of land use the land-use representation and the land-use change identification as currently implemented in this inventory represents the most advanced approach achievable within the conditions of the country. It should be understood that it is basically a bottom-up system using a detailed information at the level of individual cadastral units (n=13 013 as of 2012). The information as reported in the CRF tables represents sum-up values of the individual cadastral units, involving 10 land use types of the original categorization and the time span from 1969 to 2012. It should also be noted the reconciled official land use information of COSMC undergoes a continuous update and accuracy improvement due to the progressing digitalization of the original maps. The resulting digital maps are distinguished by the source information and its coordination system. As also noted in section 7.2 of the NIR 2014 (see also the footnote 3 nad), the LULUCF inventory team newly consulted the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) on the issues related to the information on land areas in the Czech Republic. This was also in response to the

latest inventory review, which specifically inquired about the origin of the small inconsistencies in the summarized cadastral values. To illustrate the process of the ongoing digitalization of cadastral maps in the county, we include the map of the current (as of 2013) state of the art in this process (Fig. 11.2, based on COSMC). It gives an overview of the national cadastral system under the process of digitalization, with different categories by source map origin, coordination system, scale and completeness labelled by individual colours. Evidently, this gradual digitalization leads to rectified area information on individual cadastral parcels, units and therefore also entire country. This also explains the nature of the ongoing area rectifications in the official reports on areas of land and land use categories in the country.

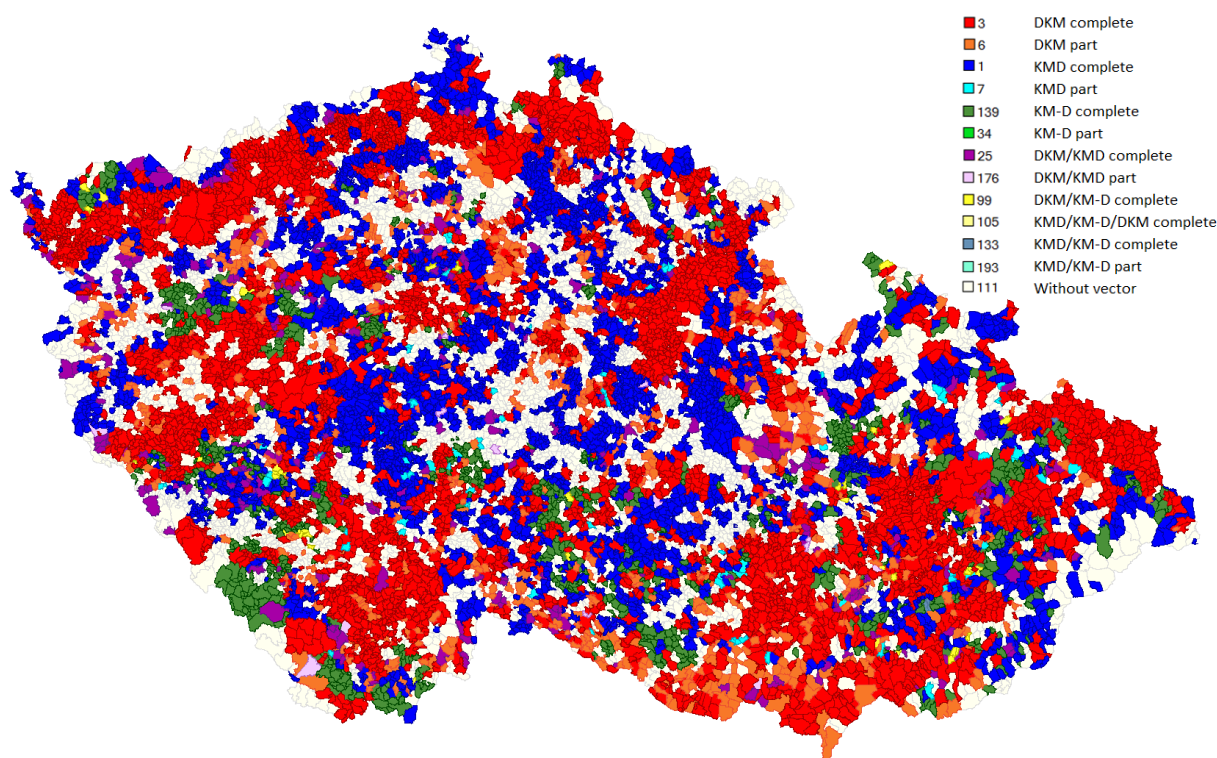


Fig. 11-2 The ongoing digitalization of the Czech cadastral land use information with units identified by categories of source map origin, coordination system and scale (DKM, KMD, KM-D and their combination) and completeness labelled by individual colours. Based on the information of COSMC as of 2013.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The KP LULUCF reporting of the Czech Republic is based on the annually updated data from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of about 13 thousands individual cadastral units (Fig. 11-1), which represent the Czech cadastral system. At that level, land use change is identifiable, using the standard identification codes and names of the Czech cadastral system, while additional codes for the small fraction of aggregated cadastral units were prepared by the LULUCF emission inventory team.

The spatial resolution of the adopted land-use representation and land-use change identification system is depicted in Figs. 11-3 and 11-4, which show the identified units with *AR* and *D* activities, respectively, in 2012.

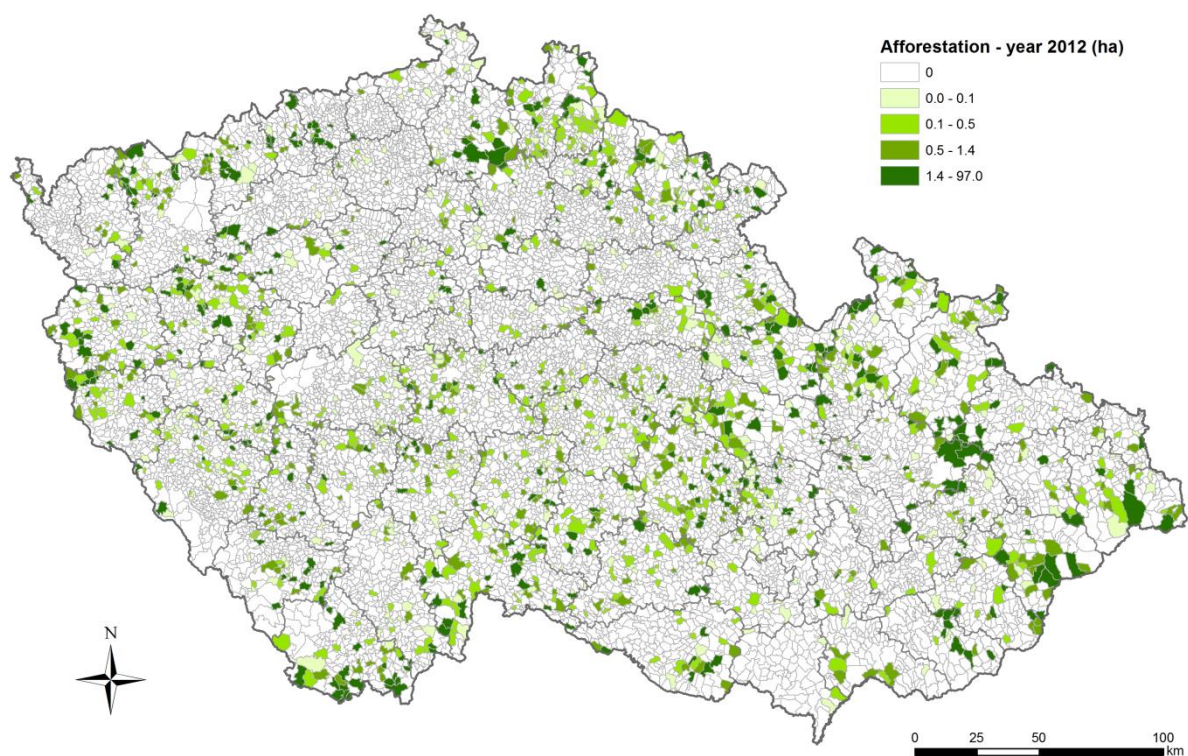


Fig. 11-4 The cadastral units with identified afforestation (AR) activities in 2012.

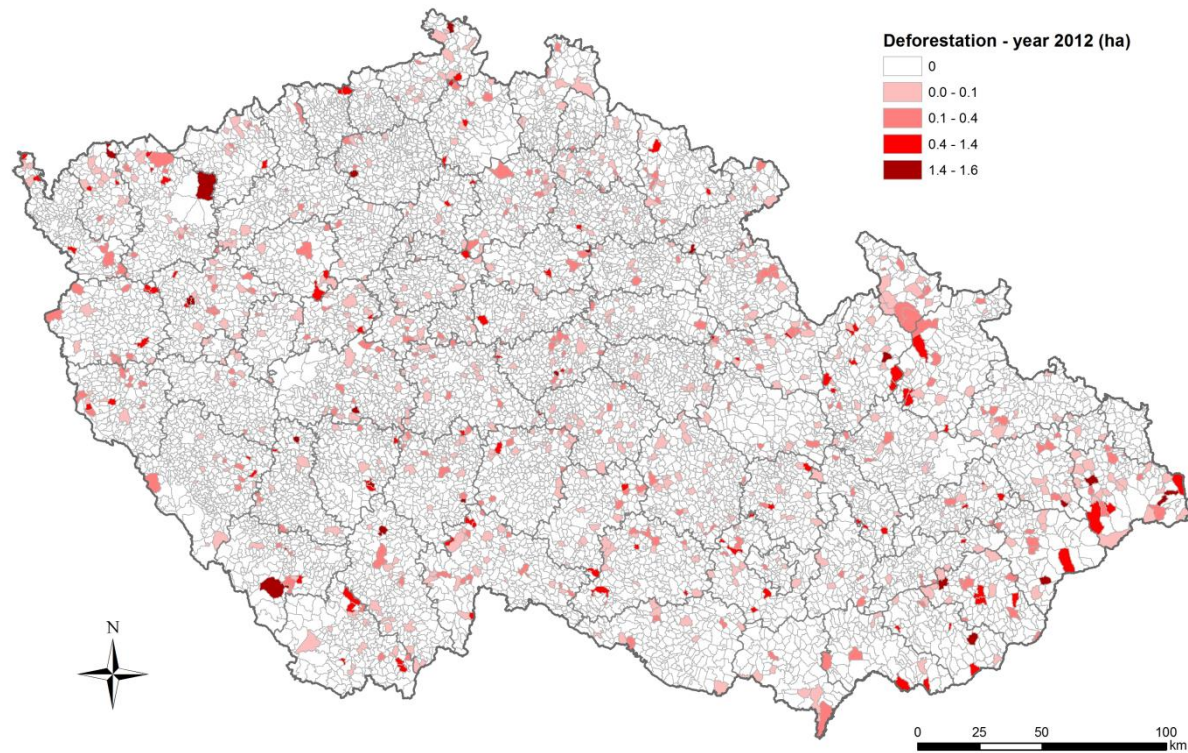


Fig. 11-4 The cadastral units with identified deforestation (D) activities in 2012.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Due to efforts to link the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the KP LULUCF activities and the relevant LULUCF categories under the Convention reporting. These are described in detail in Chapter 7 (LULUCF) of the 2014 NIR submission. Hence, reference is often made to these methodologies, while additional and specific information related to the Kyoto Protocol LULUCF activities is highlighted here.

For AR activities, the applicable methodology of GPG for LULUCF (IPCC, 2003) for estimating emissions and removals is given in Chapter 3.2.2. Correspondingly, the emissions due to D were estimated based on the guidance given in Chapters 3.3.2, 3.4.2, 3.5.2 and 3.6.2. For specific details on the approaches employed, country-specific activity data and factors, Chapter 7 of the NIR 2014 submission should be consulted.

In the KP LULUCF reporting, the emissions and/or removals of CO₂ are quantified for changes in five ecosystem carbon pools, namely above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter. Hence, some methodological differences result from the fact that the Convention reporting uses only three pools, aggregating above-ground and below-ground biomass into living biomass, and dead wood and litter into dead organic matter (see Table 3.1.2 in GPG for LULUCF, IPCC 2003).

Changes in above-ground biomass carbon pool were estimated primarily on the basis of forest taxation data in Forest Management Plans (further denoted as FMP), disaggregated in line with the country-specific approaches at the level of the four major tree species, namely beech, oak, pine and spruce (Chapter 7.3.1 of NIR 2014).

Since the estimates of biomass carbon stock change on Forest Land under the Convention involve one default coefficient for the root/shoot ratio (R ; 0.20) and the equations of the default method involving multiplicative members, the attributing of carbon stock change to the below- and above-ground components, required for the reporting under Kyoto Protocol, was determined solely by R .

The carbon stock change in the litter carbon pool for AR and D activities was estimated jointly with the soil carbon pool. This follows the methodology of soil carbon stock change estimation resulting from land use change among the land use categories of Forest Land, Cropland and Grassland, based on the interpreted soil carbon stock maps (Section 7.3.2.2, NIR 2013). Therefore, the notation key "IE" (included elsewhere) was used in the CRF Tables to indicate that the litter carbon stock change is estimated inherently with changes in the soil carbon pool. Complementarily, for sub-categories involving Wetland and Settlements, "NA" was used in association with the soil carbon pool, as no adopted applicable methodology is listed for this pool in GPG for LULUCF (IPCC, 2003) for the symmetric types of land-use conversion events.

The carbon stock change in deadwood was estimated for all types of D events. It was based on the information on standing and lying deadwood that was obtained from the recently (2008 to 2009) conducted field campaign of the landscape inventory project CzechTerra (MoE 2007; www.czechterra.cz). This project provides relevant data on mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood (7.5 m³/ha) classified in four categories according to degree of decomposition. These categories are defined as follows: i) basically solid wood; ii) peripheral layers soft, central hard; iii) peripheral layers hard, central soft; iv) totally rotten wood. The amount of carbon held in lying deadwood was estimated as the product of the wood volume, density weighted by the mean growing stock volume of major tree species (0.433 t/m³), reduction coefficients of 0.8, 0.5, 0.5, 0.2 (Cerny et al., 2002; Carmona et al., 2002) applicable to the above described decomposition categories, respectively, and the carbon fraction in the wood (0.5 t C/t biomass). A default, conservative assumption that no deadwood is present following a land use change was adopted in this calculation.

For the FM activity, which resembles category 5A1 *Forest Land remaining Forest Land*, the Tier 1 methodology assumption of GPG for LULUCF (IPCC, 2003), cf. the IPCC Guidelines (IPCC, 2006), of no significant change in the deadwood carbon pool was adopted under UNFCCC Reporting. Since Tier 1 methodology does not meet the requirements of KP LULUCF reporting, justification for using this assumption under FM activity reporting is provided in Section 11.3.1.2. Note also that there is a common misunderstanding on what Tier 1 reporting means in terms of using appropriate notation keys. In our case, the notation key "R" is used in order to distinguish a deliberate consideration of Tier 1 assumption as compared to "NE" (not estimated). NE

inherently implies that the Tier 1 assumption cannot be considered and a carbon pool under this notation may actually represent a significant source or sink of emissions, which is not the case in this inventory. More information on the deadwood carbon pool considerations is therefore provided in Section 11.3.1.2, which justifies our inexplicit reporting of the deadwood carbon pool. It should also be noted that the carbon stock change of deadwood for *FM* activity may later be revised using Tier 2 or Tier 3 methodology estimation based on the results of the recently conducted CzechTerra statistical landscape inventory in the Czech Republic.

In contrast, the carbon stock change of the soil carbon pool under *FM* was not estimated and the “NE” notation key is used. This implicitly also applies to the litter carbon pool, which is included in the soil carbon pool for the reasons noted above in the section on *AR* and *D* reporting, as well as due to the YASSO soil model concept, which is used for justification when omitting these carbon pools in Section 11.3.1.2 below.

Additional emissions of CO₂ may arise from liming on forest soil. Note that liming on forest soil is not included in the Convention reporting, where the emission reporting concerning liming is restricted to the agricultural land-use categories of Cropland and Grassland. Since some liming on Forest Land occurs in the Czech Republic, it is reported in this submission in the corresponding CRF KP LULUCF table for FM. For these emissions, the methodology described in Section 3.3.1.2.1 of GPG for LULUCF (IPCC, 2003) was used. The activity data in terms of forest area and amount of limestone applied were taken from the national report on Czech forestry (Green report, MA 2013). In 2012, the amount of lime applied to forest soils equalled 30 t and concerned an area of 13 ha.

Additional greenhouse gases (CO₂, CH₄ and N₂O) are reported from biomass burning. Burning is explicitly confined to the activity of FM and thus matches the corresponding estimates under the Convention for the land-use category *5A1 Forest Land remaining Forest Land*. The emissions are estimated identically as described in Section 7.3.2.1 of the NIR 2014 text.

There are no N₂O emissions from N-fertilization and soil drainage, which are therefore not applicable for the reporting period. On the contrary, N₂O emissions are reported for deforestation of Forest land that is converted to Cropland. This estimation is identical to that reported under the Convention and described in NIR 2014, Section 7.4.2.2 for land use category *5.B.2.1*.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

First, justification is provided for the deadwood carbon pool, which is currently reported using the Tier 1 assumption that the time average values of this pool will remain constant with inputs balanced by outputs (GPG for LULUCF, IPCC 2003). As this is inadequate under KP LULUCF reporting, we use the following argumentation supporting the assumption that the deadwood carbon pool does not represent a source of emissions. We use both reasoning based on sound knowledge of likely system responses and empirical data.

The reasoning is based on the long term trend of increasing growing stock in our country, which is also demonstrated for the reporting period under the Convention (cf. Chapter 7 of NIR text). On large temporal and spatial scales, the amount of deadwood is roughly proportional to the growing stock. Since the growing stock has been steadily increasing during the reporting period in the forests of this country, there is basically the same trend as for deadwood volume. An increasing pool of deadwood volume basically means removals of emissions (fixing carbon). In other words, this pool is not a source of emissions.

The statistically representative empirical data that have recently been acquired in the Czech Republic offer additional support for this trend. Specifically, information on dead wood pool is available from two independent statistical inventories. One is the National Forest Inventory (NFI), whose first and so far the only cycle was performed during 2001-2004. This inventory includes about several thousand sample plots covering the entire forest area in the country. The results of this inventory campaign were published by the Forest Management Institute, Brundýš n. Labem (FMI), in 2007 and also included the information on deadwood (FMI 2007). The second data source is the ongoing project of the National landscape inventory (CzechTerra - adaptation of landscape carbon reservoirs in the context of global change), a project funded by the Ministry of the Environment (SP/2d1/93/07). CzechTerra conducted its initial field sampling during 2008 and 2009 and the results are already available (www.czechterra.cz). This project also contains a statistically representative assessment of the deadwood pool in forests applicable at a country level. Since both NFI and CzechTerra use an identical assessment method for lying deadwood volume, a straightforward comparison can be performed to assess the trend of lying dead wood pool change in Czech forests during very recent years. It can be assumed

that NFI sampling represents the year 2003, while CzechTerra sampling represents the year 2009. Lying deadwood volume is estimated for four classes of decay stages, which are summarized in Table 1 below.

Tab. 11-3 Mean volume of lying deadwood on forest land by decay classes as estimated by the NFI and CzechTerra inventory programs. The unit is mil. m³ and the parentheses show the 95% confidence interval.

| Campaign Decay stage | NFI – ref. year 2003 | CzechTerra – ref. year 2009 |
|-----------------------------|----------------------|-----------------------------|
| Wood is hard | 7.47 (7.02 - 7.93) | 9.54 (7.58 – 11.5) |
| Soft periphery, centre hard | 3.75 (3.48 - 4.02) | 5.10 (2.81 – 7.38) |
| Hard periphery, centre soft | 0.82 (0.73 - 0.90) | 1.28 (0.72 – 1.85) |
| Totally soft/rotten | 6.28 (5.98 - 6.59) | 4.79 (3.84 – 5.74) |

The volume of dead wood estimated by the CzechTerra campaign, representing the situation as of 2009, is larger for most of the decay stage classes as compared to the estimates by NFI conducted as of 2003. To envisage this trend more clearly, dead wood volume can be converted into biomass and carbon quantities as the product of the wood volume, density weighted by the mean growing stock volume of major tree species, reduction coefficients applicable to individual decomposition categories and wood carbon fraction as given in Section 11.3.1.1 above. The result of this recalculation is shown in Table 2.

Tab. 11-4 Carbon stock held in lying deadwood on forest land by decay classes as estimated by the NFI and CzechTerra inventory programs. The unit is mil. t C.

| Campaign Decay stage | NFI – ref. year 2003 | CzechTerra – ref. year 2009 |
|-----------------------------|----------------------|-----------------------------|
| Wood is hard | 1.29 | 1.65 |
| Soft periphery, centre hard | 0.65 | 0.88 |
| Hard periphery, centre soft | 0.09 | 0.14 |
| Totally soft/rotten | 0.27 | 0.21 |
| Total quantity | 2.30 | 2.88 |

To interpret the estimates shown in Table 2, we see that the total carbon content held in dead wood increased from 2.30 mil. t C in 2003 to 2.88 mil. t C in 2009. The difference is 0.58 mil. t C accumulated during the period of 6 years. Thus, the annual accumulation of carbon held in deadwood was 0.096 mil. t C, which represents a CO₂ sink of -0.35 mil. t CO₂/year.

To conclude, the above quantitative assessment from the two country-level statistical inventory programs (with identical methodology to obtain deadwood volume estimates by decay classes) demonstrates that the deadwood carbon pool is currently not a source of emissions under the conditions of the Czech Republic. However, it is planned that both the data and the underlying assumptions for deadwood carbon pool estimation will be further examined to explore the possibility of its specific accounting also under *FM* activity.

Secondly, we provide justification for omitting the soil carbon pool (and inherently litter carbon pool) from the reporting under *FM* activity. Here it is also assumed that under the conditions of current forestry practices at the country level, forest soils do not represent a net source of CO₂ emissions. Justification for this approach is based on the targeted peer-reviewed modelling analysis performed for the actual circumstances of *FM* in the country (Cienciala et al., 2008b). It uses a well-established soil model YASSO (Liski et al., 2003, 2005) in combination with a similarly known and established forest scenario model EFISCEN (e.g., Karjalainen et al., 2002) and the actual data for forest biomass, growth performance and growing conditions in the country. The analysis shows that, under the adopted sustainable forest management practices implemented in the Czech Republic, the forest soil carbon pool (including litter) does not decrease, i.e., it is not a net source of emissions. The study contains further details on the country-specific model application, definition of scenarios and results related to both biomass and soil carbon pools, including the probable effect of changing climatic conditions. It also contains a discussion that elucidates the aspect of the YASSO model concept of litter input and aggregated output for litter/organic and mineral soil layers and its justification, as well as the reasoning with respect to the Kyoto protocol LULUCF reporting requirements. There is a wealth of literature on the YASSO model application that can be further consulted (www.environment.fi/syke/yasso).

To conclude, the forest soil carbon pool and inherently the litter carbon pool under current forest management practices and growth trends can be assumed not to be a source of emissions. The underlying assumptions will be further verified.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

The indirect and natural GHG emissions and removals were not factored out.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

The adopted data and methods have not changed since the previous submission and hence no recalculations were performed in this submission.

11.3.1.5 Uncertainty estimates

The uncertainty estimates were prepared following the methodological guidance of GPG for LULUCF (IPCC, 2003). The uncertainty estimation was revised in the NIR 2012 submission (inventory year 2010). The details of this revision were initially described in Section 7.3.3 of the NIR 2012 text. It also partly concerns the previously (NIR 2011 submissions) noted issue of combining uncertainties that is considered questionable when uncertainties associated with removals and emissions are to be combined, which may result in a denominator close to or equal to zero (which is not admissible). Since the last revision introduced in the NIR 2012, no other changes have been implemented for the uncertainty estimation in the NIR 2013 and 2014 submissions.

In 2012, the estimated overall uncertainty for *AR* activities reached 41.1 %. The overall uncertainty for *D* reached 67 %. As for *FM*, the overall uncertainty reached 20.2 %. This is similar as reported in the previous NIR submission.

11.3.1.6 Information on other methodological aspects

Despite efforts to make the reporting of KP LULUCF activities correspond to that under the Convention, there are some aspects that make the direct comparison difficult. Specifically for *FM*, a direct comparison with the emission estimates of the related category 5A1 under the Convention reporting will reveal some differences. There are two aspects to be considered when comparing the quantitative estimates of these categories.

First, the KP LULUCF reporting of *FM* additionally includes the contribution of forest areas afforested prior 1990. In this inventory, these are registered in the sub-category "Residual afforested land from before 1990 (in conversion status)". Second, the KP LULUCF reporting of *FM* also includes the emissions from lime application in forests, while the Convention reporting considers lime application only for the land use categories Cropland and Grassland (this issue was, however, addressed by including emissions from lime application on forest land under category 5G *Other* since the 2012 NIR for inventory year 2010). It was verified that, once the two aspects are properly sorted out, the *FM* reporting matches that of category 5A1 under the Convention.

11.3.1.7 The year of the onset of an activity, if after 2008

Not applicable.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are directly human-induced

The annually updated cadastral information from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) refers exclusively to intentional, i.e., human-induced interventions into land use. These interventions are thereby reflected in the corresponding records, including the time attribute, collected and summarized at the level of cadastral units and individual years.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on Forest land, while deforestation is a permanent cadastral change of land use from Forest land to other categories of land use.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested.

Any deforestation in terms of land use change requires an official administrative decision. Hence, no permanent loss of forest cover may occur prior this approval, which is reflected in cadastral land use. The above also implies that there is no afforestation occurring on previously deforested land by the administrative decision. A temporary loss of forest cover up to an area of 1 ha may occur as part of forest management operations on Forest land (units of land subject to *FM*), which is not qualified as deforestation in terms of Art. 3.3. KP LULUCF activity.

11.4.4 Information on estimated emissions and removals of activities under Art. 3.3

In 2012, the estimated removals from *AR* activities reached -329.3 Gg CO₂ eq. The estimated emissions from *D* reached 169.8 Gg CO₂ eq. The details can be found in the corresponding CRF Tables of KP LULUCF.

11.5 Article 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

The Czech Republic adopted the broad definition (FCCC/CP/2001/13/Add.1; IPCC 2003) of *FM*. It reads *"Forest management" is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.*" This decision implies that entire forest area in the country is subject to *FM* interventions, as guided by the Forestry Act (No. 289/1995 Coll.).

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Not applicable for the Czech Republic.

11.5.3 Information relating to Forest Management

As noted in Section 11.5.1 above, the practice of *FM* is generally guided by the Forestry Act (No. 289/1995 Coll.).

11.5.4 Information on estimated emissions and removals of Forest Management activity under Art. 3.4

In 2012, the estimated removals from *FM* reached -7 316 Gg CO₂ eq. The details can be found in the corresponding CRF Tables of KP LULUCF.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

As stated in CRF KP-LULUCF table “NIR-3”, there was one key category identified among the KP LULUCF activities, namely *FM*. Similarly to its associated LULUCF category *5A1 Forest land remaining Forest land*, it was identified by level assessment. Emissions or removals through other activities are not expected to increase substantially. Hence, no other activity is identified as key (Chapter 5.4.4, IPCC 2003).

11.7 Information relating to Article 6

No LULUCF joint implementation project under Art. 6 concerns the Czech Republic.

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 2013 to 31st of December 2013 is provided in standard electronic format in Annex 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 2013 corresponded to 683,178,969 t CO₂ eq., of which 348,528,647 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 18,747 t CO₂ eq., in the entity holding accounts and 18,735,943 in the retirement account.

The CER units in the registry corresponded to 19,889,117 t CO₂ eq., of which 12,738 units were in the entity holding accounts, 19,874,444 in the retirement account and 1935 in other cancellation accounts.

There were no RMUs, t-CERs or I-CERs and no units in the Article 3.3/3.4 net source cancellation accounts and the t-CER and I-CER replacement accounts.

The total amount of units in the registry corresponded to 721,822,776 t CO₂ eq.

The Czech Republic's assigned amount equals 789,859,031 t CO₂ eq.

12.3 Discrepancies and notifications

No CDM notifications and non-replacements occurred in 2013.

No invalid units exist as at 31 December 2013.

No discrepant transactions occurred in 2013.

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.

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 (year 2012), which is calculated below¹³.

$$5 \times 131,466,115 = 657,330,575 \text{ tonnes CO}_2 \text{ eq.}$$

$$5 \times 131,466,030 = 657,330,150 \text{ tonnes CO}_2 \text{ eq.}$$

Provisions of this chapter have been changed due to findings during UNFCCC expert review. CPR calculation has been adjusted accordingly, although the original value has been kept for future reference.

- Original CPR value in grey
- Revised CPR value in bold black.

For details on the changes see chapter on p. 10.

¹³ For CPR calculation used Czech Republic's total CO₂ equivalent emissions without LULUCF in 2011 (source: CZE-2013-2011-v1.2.xls, Summary2, cell: H57).

13 Information on changes in National System

13.1 Previous Review Recommendations

In document FCCC/ARR/2012/CZE ERT requested the Party to promptly make all non-confidential information in accordance with decision 13/CMP.1, annex, chapter II.E, paragraphs 44–48, available to the public.

The Annual Review Report for the 2013 centralized review was not published as of March 2014.

13.2 Changes to National Registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

- 1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- 2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- 3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- 4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- 5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
- 6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
- 7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
 - With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
 - The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

- With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
- The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
- In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of the Czech Republic have therefore occurred in 2013:

| Reporting Item | Description |
|---|---|
| 15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact | There is a new Czech Registry Administrator since 2013: Ms Helena Hulova Email: hhulova@ote-cr.cz Tel: +420 296 579 331 |
| 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. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduces changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry 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 in release 5 and 6 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 2014 and the successful test report has been attached. 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 |
| 15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information | No change to the list of publicly available information occurred during the reporting period. |
| 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. |

| Reporting Item | Description |
|---|---|
| <p>15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results</p> | <p>Changes introduced in release 5 and 6 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.</p> <p>Annex H testing was carried out in February 2014 and the successful test report has been attached.</p> |

14 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 1990–2011 and inventory report 2013 and will be also provided in the European Union submission for the year 2014. 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 14-1 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. Results 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 planned CCS programme or demonstration project in the Czech Republic. There has been no development in this area in 2013. |
| (e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities. | The Czech Republic supports technology and capacity development through development assistance. Example of such activities is a project for modernization of powering and control of power plant block connected with establishment of a technical training centre at the University in Ulan Bator, Mongolia. |
| (f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies. | The Czech Republic is cooperating in several bilateral development assistance projects focusing on reduction of fossil fuels dependence and development of renewable energy sources, inter alia: - Increasing energy independence of remote regions in Georgia with solar thermal and photovoltaic systems |

| | |
|--|---|
| | <ul style="list-style-type: none"> - 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 <p>All of the above mentioned projects are being implemented in the period 2011 – 2013.</p> |
|--|---|

15 Other Information

No other information submitted in 2012.

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Abbreviations

| | |
|-------------|---|
| AALC | 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 |
| CzSO | Czech Statistical Office |
| 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) |

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Annexes to the National Inventory Report

Annex 1 Key Categories

Tab. A1 - 1 Spreadsheet for Tier 1 KC Analysis

| IPCC Source Categories | GHG | LA % | TA % | Cum. LA | Cum. TA | KC_L | KC_T | KC Type |
|--|------------------|-------|-------|---------|---------|------|------|---------|
| 1.A Stationary Combustion - Solid Fuels | CO ₂ | 45.45 | 22.05 | 45.45 | 22.05 | 1 | 1 | LA,TA |
| 1.A.3.b Transport - Road Transportation | CO ₂ | 11.37 | 19.88 | 56.83 | 41.94 | 2 | 2 | LA,TA |
| 1.A Stationary Combustion - Gaseous Fuels | CO ₂ | 10.80 | 11.49 | 67.63 | 53.43 | 3 | 3 | LA,TA |
| 5.A.1 Forest Land remaining Forest Land | CO ₂ | 5.00 | 6.59 | 72.63 | 67.65 | 4 | 5 | LA,TA |
| 2.C.1 Iron and Steel Production | CO ₂ | 3.76 | 5.69 | 76.40 | 73.34 | 5 | 6 | LA,TA |
| 1.A Stationary Combustion - Liquid Fuels | CO ₂ | 3.48 | 7.63 | 79.88 | 61.06 | 6 | 4 | LA,TA |
| 1.B.1.a Coal Mining and Handling | CH ₄ | 2.34 | 3.39 | 82.22 | 76.72 | 7 | 7 | LA,TA |
| 4.D.1 Agricultural Soils, Direct Emissions | N ₂ O | 2.03 | 1.61 | 84.25 | 84.72 | 8 | 10 | LA,TA |
| 6.A Solid Waste Disposal on Land | CH ₄ | 1.99 | 2.79 | 86.24 | 83.11 | 9 | 9 | LA,TA |
| 4.A Enteric Fermentation | CH ₄ | 1.45 | 1.51 | 87.69 | 86.23 | 10 | 11 | LA,TA |
| 2.F.1-6 F-gases Use - ODS substitutes | HFC,PFC | 1.50 | 3.59 | 89.19 | 80.31 | 11 | 8 | LA,TA |
| 4.D.3 Agricultural Soils, Indirect Emissions | N ₂ O | 1.29 | 1.04 | 90.48 | 90.77 | 12 | 15 | LA,TA |
| 2.A.3 Limestone and Dolomite Use | CO ₂ | 0.79 | 1.10 | 92.36 | 89.73 | 14 | 14 | LA,TA |
| 4.B Manure Management | N ₂ O | 0.47 | 0.89 | 93.62 | 92.63 | 16 | 17 | LA,TA |
| 1.A.3.b Transport - Road Transportation | N ₂ O | 0.47 | 0.97 | 94.09 | 91.74 | 17 | 16 | LA,TA |
| 2.A.2 Lime Production | CO ₂ | 0.44 | 0.54 | 94.53 | 95.41 | 18 | 22 | LA,TA |
| 2.A.1 Cement Production | CO ₂ | 1.09 | 0.34 | 91.57 | 97.67 | 13 | | LA |
| 1.A.5.b Mobile sources in Agriculture and Forestry | CO ₂ | 0.79 | 0.01 | 93.15 | 99.99 | 15 | | LA |
| 2.B.1 Ammonia Production | CO ₂ | 0.41 | 0.03 | 94.94 | 99.71 | 19 | | LA |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CH ₄ | 0.39 | 0.14 | 95.32 | 98.88 | 20 | | LA |
| 1.A Stationary Combustion - Solid Fuels | CH ₄ | 0.13 | 1.27 | 99.29 | 87.50 | | 12 | TA |
| 5.B.1 Cropland remaining Cropland | CO ₂ | 0.07 | 1.13 | 99.59 | 88.63 | | 13 | TA |
| 2.B.2 Nitric Acid Production | N ₂ O | 0.31 | 0.60 | 96.33 | 93.23 | | 18 | TA |
| 1.A Stationary Combustion - Biomass | CH ₄ | 0.26 | 0.56 | 96.59 | 93.79 | | 19 | TA |
| 1.A Stationary Combustion - Other fuels - 1A2 | CO ₂ | 0.23 | 0.55 | 97.31 | 94.33 | | 20 | TA |
| 1.A Stationary Combustion - Other fuels - MSW | CO ₂ | 0.24 | 0.54 | 96.84 | 94.87 | | 21 | TA |
| 6.B Wastewater Handling | CH ₄ | 0.37 | 0.10 | 95.69 | 99.09 | | | |
| 4.B Manure Management | CH ₄ | 0.34 | 0.46 | 96.03 | 95.87 | | | |
| 5.A.2 Land converted to Forest Land | CO ₂ | 0.24 | 0.32 | 97.08 | 97.34 | | | |
| 5.C.2 Land converted to Grassland | CO ₂ | 0.22 | 0.36 | 97.53 | 96.69 | | | |
| 1.A Stationary Combustion - Solid Fuels | N ₂ O | 0.21 | 0.09 | 97.74 | 99.26 | | | |
| 6.B Wastewater Handling | N ₂ O | 0.20 | 0.10 | 97.93 | 98.99 | | | |
| 1.A.3.c Transport - Railways | CO ₂ | 0.20 | 0.30 | 98.13 | 97.98 | | | |
| 1.B.1.a Coal Mining and Handling | CO ₂ | 0.19 | 0.09 | 98.32 | 99.18 | | | |
| 4.D.2 Pasture, Range and Padock Manure | N ₂ O | 0.19 | 0.07 | 98.50 | 99.40 | | | |
| 2.A.7 Glass, Bricks and Ceramics | CO ₂ | 0.18 | 0.05 | 98.68 | 99.64 | | | |
| 3 Solvents and Other Product Use | CO ₂ | 0.16 | 0.27 | 98.84 | 98.24 | | | |
| 3 Solvents and Other Product Use | N ₂ O | 0.17 | 0.15 | 99.01 | 98.74 | | | |
| 6.C Waste Incineration | CO ₂ | 0.15 | 0.33 | 99.16 | 97.01 | | | |
| 1.A Stationary Combustion - Biomass | N ₂ O | 0.09 | 0.19 | 99.38 | 98.44 | | | |
| 5.E.2 Land converted to Settlements | CO ₂ | 0.07 | 0.07 | 99.45 | 99.34 | | | |
| 2.B.5 Other | N ₂ O | 0.07 | 0.06 | 99.52 | 99.47 | | | |
| 5.B.2 Land converted to Cropland | CO ₂ | 0.06 | 0.01 | 99.65 | 99.86 | | | |
| 1.A.3.e Transport - Other Transportation | CO ₂ | 0.05 | 0.45 | 99.70 | 96.33 | | | |
| 5.A.1 Forest Land remaining Forest Land | CH ₄ | 0.04 | 0.01 | 99.74 | 99.85 | | | |
| 2.C.1 Iron and Steel Production | CH ₄ | 0.04 | 0.06 | 99.78 | 99.59 | | | |
| 2.F.8 F-gases Use - Electrical Equipment | SF ₆ | 0.00 | 0.00 | 99.78 | 99.68 | | | |
| 1.A Stationary Combustion - Gaseous Fuels | CH ₄ | 0.02 | 0.02 | 99.80 | 99.75 | | | |
| 2.B.5 Other | CH ₄ | 0.02 | 0.02 | 99.81 | 99.73 | | | |
| 5.D.2. Land converted to Wetlands | CO ₂ | 0.02 | 0.02 | 99.83 | 99.82 | | | |
| 1.A.5.b Mobile sources in Agriculture and Forestry | N ₂ O | 0.02 | 0.02 | 99.85 | 99.79 | | | |

| IPCC Source Categories | GHG | LA % | TA % | Cum. LA | Cum. TA | KC_L | KC_T | KC Type |
|--|------------------|------|------|---------|---------|------|------|---------|
| 1.A.3.b Transport - Road Transportation | CH ₄ | 0.01 | 0.00 | 99.86 | 100.00 | | | |
| 1.A.3.d Transport - Navigation | CO ₂ | 0.01 | 0.04 | 99.87 | 99.68 | | | |
| 1.A Stationary Combustion - Liquid Fuels | N ₂ O | 0.01 | 0.02 | 99.88 | 99.77 | | | |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CO ₂ | 0.01 | 0.02 | 99.89 | 99.80 | | | |
| 1.A Stationary Combustion - Gaseous Fuels | N ₂ O | 0.01 | 0.01 | 99.90 | 99.88 | | | |
| 1.A.3.a Transport - Civil Aviation | CO ₂ | 0.01 | 0.16 | 99.90 | 98.60 | | | |
| 5.B.2. Land converted to Cropland | N ₂ O | 0.00 | 0.00 | 99.91 | 99.98 | | | |
| 5.A.1 Forest Land remaining Forest Land | N ₂ O | 0.00 | 0.00 | 99.91 | 99.99 | | | |
| 1.A.3.c Transport - Railways | N ₂ O | 0.00 | 0.01 | 99.91 | 99.97 | | | |
| 5.C.1 Grassland remaining Grassland | CO ₂ | 0.00 | 0.06 | 99.92 | 99.53 | | | |
| 1.B.1.b. Solid Fuel Transformation | CH ₄ | 0.00 | 0.01 | 99.92 | 99.90 | | | |
| 6.C Waste Incineration | N ₂ O | 0.00 | 0.01 | 99.92 | 99.89 | | | |
| 1.A Stationary Combustion - Other fuels - MSW | N ₂ O | 0.00 | 0.01 | 99.93 | 99.90 | | | |
| 1.A Stationary Combustion - Liquid Fuels | CH ₄ | 0.00 | 0.01 | 99.93 | 99.87 | | | |
| 2.F.9 F-gases Use - Other | SF ₆ | 0.06 | 0.05 | 99.99 | 99.96 | | | |
| 2.A.7 Glass, Bricks and Ceramics | CH ₄ | 0.00 | 0.00 | 99.99 | 99.99 | | | |
| 2.F.7 F-gases Use - Semiconductor Manufacture | PFC | 0.00 | 0.01 | 100.00 | 99.97 | | | |
| 1.A.5.b Mobile sources in Agriculture and Forestry | CH ₄ | 0.00 | 0.01 | 100.00 | 99.96 | | | |
| 1.A Stationary Combustion - Other fuels - 1A2 | N ₂ O | 0.00 | 0.00 | 100.00 | 99.98 | | | |
| 2.A.4 Soda Ash Use | CO ₂ | 0.00 | 0.00 | 100.00 | 99.98 | | | |
| 1.A Stationary Combustion - Other fuels - 1A2 | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.c Transport - Railways | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.a Transport - Civil Aviation | N ₂ O | 0.00 | 0.01 | 100.00 | 99.88 | | | |
| 1.A.3.d Transport - Navigation | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.e Transport - Other Transportation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.e Transport - Other Transportation | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.a Transport - Civil Aviation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.d Transport - Navigation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 5G Other - Liming of Forest Land | CO ₂ | 0.00 | 0.01 | 100.00 | 99.83 | | | |
| 6.C Waste Incineration | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A Stationary Combustion - Other fuels - MSW | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |

Tab. A1 - 2 Spreadsheet for Tier 2 KC Analysis

| IPCC Source Categories | GHG | LA % | TA % | Cum. LA | Cum. TA | KC_L | KC_T | KC Type |
|---|------------------|-------|-------|---------|---------|------|------|---------|
| 1.A Stationary Combustion - Solid Fuels | CO ₂ | 42.78 | 20.35 | 42.78 | 20.35 | 1 | 1 | LA,TA |
| 1.A.3.b Transport - Road Transportation | CO ₂ | 10.59 | 18.14 | 53.37 | 38.49 | 2 | 2 | LA,TA |
| 1.A Stationary Combustion - Gaseous Fuels | CO ₂ | 10.06 | 10.49 | 63.43 | 48.98 | 3 | 3 | LA,TA |
| 5.A.1 Forest Land remaining Forest Land | CO ₂ | 5.30 | 6.84 | 68.72 | 62.92 | 4 | 5 | LA,TA |
| 2.C.1 Iron and Steel Production | CO ₂ | 3.79 | 5.61 | 72.51 | 68.52 | 5 | 6 | LA,TA |
| 1.A Stationary Combustion - Liquid Fuels | CO ₂ | 3.30 | 7.10 | 75.81 | 56.07 | 6 | 4 | LA,TA |
| 4.D.1 Agricultural Soils, Direct Emissions | N ₂ O | 2.78 | 2.16 | 78.59 | 82.27 | 7 | 10 | LA,TA |
| 6.A Solid Waste Disposal on Land | CH ₄ | 2.67 | 3.68 | 81.26 | 76.73 | 8 | 8 | LA,TA |
| 1.B.1.a Coal Mining and Handling | CH ₄ | 2.38 | 3.38 | 83.64 | 80.11 | 9 | 9 | LA,TA |
| 2.F.1-6 F-gases Use - ODS substitutes | HFC,PFC | 1.93 | 4.53 | 85.57 | 73.05 | 10 | 7 | LA,TA |
| 4.D.3 Agricultural Soils, Indirect Emissions | N ₂ O | 1.79 | 1.41 | 87.35 | 88.66 | 11 | 14 | LA,TA |
| 4.A Enteric Fermentation | CH ₄ | 1.57 | 1.60 | 88.93 | 87.25 | 12 | 13 | LA,TA |
| 1.A.3.b Transport - Road Transportation | N ₂ O | 0.84 | 1.70 | 90.77 | 83.97 | 14 | 11 | LA,TA |
| 2.A.3 Limestone and Dolomite Use | CO ₂ | 0.76 | 1.03 | 92.28 | 90.80 | 16 | 16 | LA,TA |
| 4.B Manure Management | N ₂ O | 0.55 | 1.02 | 93.44 | 91.82 | 18 | 17 | LA,TA |
| 2.A.2 Lime Production | CO ₂ | 0.40 | 0.48 | 94.35 | 95.36 | 20 | 23 | LA,TA |
| 4.B Manure Management | CH ₄ | 0.39 | 0.53 | 95.15 | 94.88 | 22 | 22 | LA,TA |
| 2.A.1 Cement Production | CO ₂ | 1.00 | 0.31 | 89.93 | 97.20 | 13 | | LA |
| 1.A.5.b Mobile s. in Agriculture and Forestry | CO ₂ | 0.76 | 0.01 | 91.53 | 99.99 | 15 | | LA |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CH ₄ | 0.61 | 0.21 | 92.89 | 98.22 | 17 | | LA |
| 6.B Wastewater Handling | CH ₄ | 0.51 | 0.14 | 93.95 | 98.84 | 19 | | LA |
| 2.B.1 Ammonia Production | CO ₂ | 0.40 | 0.03 | 94.75 | 99.63 | 21 | | LA |
| 1.A Stationary Combustion - Solid Fuels | CH ₄ | 0.17 | 1.68 | 98.75 | 85.65 | | 12 | TA |
| 5.B.1 Cropland remaining Cropland | CO ₂ | 0.07 | 1.12 | 99.56 | 89.78 | | 15 | TA |
| 1.A Stationary Combustion - Biomass | CH ₄ | 0.35 | 0.74 | 95.50 | 92.56 | | 18 | TA |
| 1.A Stationary Combustion - Other fuels - MSW | CO ₂ | 0.28 | 0.61 | 97.03 | 93.17 | | 19 | TA |
| 2.B.2 Nitric Acid Production | N ₂ O | 0.32 | 0.61 | 96.15 | 93.78 | | 20 | TA |
| 1.A Stationary Combustion - Other fuels - 1A2 | CO ₂ | 0.24 | 0.57 | 97.55 | 94.34 | | 21 | TA |
| 1.A Stationary Combustion - Biomass | N ₂ O | 0.14 | 0.27 | 99.20 | 97.47 | | | |
| 1.A Stationary Combustion - Gaseous Fuels | CH ₄ | 0.02 | 0.03 | 99.76 | 99.71 | | | |
| 1.A Stationary Combustion - Gaseous Fuels | N ₂ O | 0.01 | 0.01 | 99.88 | 99.88 | | | |
| 1.A Stationary Combustion - Liquid Fuels | CH ₄ | 0.00 | 0.01 | 99.92 | 99.83 | | | |
| 1.A Stationary Combustion - Liquid Fuels | N ₂ O | 0.01 | 0.03 | 99.86 | 99.68 | | | |
| 1.A Stationary Combustion - Other fuels - 1A2 | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A Stationary Combustion - Other fuels - 1A2 | N ₂ O | 0.00 | 0.00 | 100.00 | 99.97 | | | |
| 1.A Stationary Combustion - Other fuels - MSW | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A Stationary Combustion - Other fuels - MSW | N ₂ O | 0.00 | 0.01 | 99.91 | 99.87 | | | |
| 1.A Stationary Combustion - Solid Fuels | N ₂ O | 0.30 | 0.12 | 96.75 | 99.20 | | | |
| 1.A.3.a Transport - Civil Aviation | CO ₂ | 0.01 | 0.15 | 99.90 | 98.56 | | | |
| 1.A.3.a Transport - Civil Aviation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.a Transport - Civil Aviation | N ₂ O | 0.00 | 0.01 | 100.00 | 99.90 | | | |
| 1.A.3.b Transport - Road Transportation | CH ₄ | 0.02 | 0.00 | 99.79 | 99.97 | | | |
| 1.A.3.c Transport - Railways | CO ₂ | 0.18 | 0.28 | 98.40 | 97.75 | | | |
| 1.A.3.c Transport - Railways | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.c Transport - Railways | N ₂ O | 0.01 | 0.01 | 99.88 | 99.86 | | | |
| 1.A.3.d Transport - Navigation | CO ₂ | 0.01 | 0.04 | 99.87 | 99.60 | | | |
| 1.A.3.d Transport - Navigation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.d Transport - Navigation | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.e Transport - Other Transportation | CO ₂ | 0.05 | 0.42 | 99.66 | 95.78 | | | |
| 1.A.3.e Transport - Other Transportation | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.3.e Transport - Other Transportation | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 1.A.5.b Mobile s. in Agriculture and Forestry | CH ₄ | 0.00 | 0.01 | 100.00 | 99.90 | | | |
| 1.A.5.b Mobile s. in Agriculture and Forestry | N ₂ O | 0.02 | 0.02 | 99.81 | 99.78 | | | |
| 1.B.1.a Coal Mining and Handling | CO ₂ | 0.21 | 0.10 | 98.22 | 99.31 | | | |
| 1.B.1.b. Solid Fuel Transformation | CH ₄ | 0.00 | 0.01 | 99.90 | 99.89 | | | |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CO ₂ | 0.01 | 0.02 | 99.85 | 99.74 | | | |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | N ₂ O | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 2.A.4 Soda Ash Use | CO ₂ | 0.00 | 0.00 | 100.00 | 99.98 | | | |
| 2.A.7 Glass, Bricks and Ceramics | CO ₂ | 0.18 | 0.05 | 98.58 | 99.56 | | | |

| IPCC Source Categories | GHG | LA % | TA % | Cum. LA | Cum. TA | KC_L | KC_T | KC Type |
|---|------------------|------|------|---------|---------|------|------|---------|
| 2.A.7 Glass, Bricks and Ceramics | CH ₄ | 0.00 | 0.00 | 99.92 | 99.98 | | | |
| 2.B.5 Other | CH ₄ | 0.02 | 0.03 | 99.83 | 99.66 | | | |
| 2.B.5 Other | N ₂ O | 0.09 | 0.08 | 99.42 | 99.39 | | | |
| 2.C.1 Iron and Steel Production | CH ₄ | 0.05 | 0.07 | 99.71 | 99.45 | | | |
| 2.F.7 F-gases Use - Semiconductor Manufacture | PFC | 0.00 | 0.01 | 99.99 | 99.97 | | | |
| 2.F.8 F-gases Use - Electrical Equipment | SF ₆ | 0.00 | 0.00 | 99.81 | 99.56 | | | |
| 2.F.9 F-gases Use - Other | SF ₆ | 0.07 | 0.06 | 99.99 | 99.96 | | | |
| 3 Solvents and Other Product Use | CO ₂ | 0.15 | 0.25 | 98.91 | 98.01 | | | |
| 3 Solvents and Other Product Use | N ₂ O | 0.22 | 0.19 | 98.01 | 98.41 | | | |
| 4.D.2 Pasture, Range and Paddock Manure | N ₂ O | 0.33 | 0.12 | 95.83 | 99.08 | | | |
| 5.A.1 Forest Land remaining Forest Land | CH ₄ | 0.06 | 0.02 | 99.62 | 99.80 | | | |
| 5.A.1 Forest Land remaining Forest Land | N ₂ O | 0.01 | 0.00 | 99.89 | 99.98 | | | |
| 5.A.2 Land converted to Forest Land | CO ₂ | 0.30 | 0.39 | 96.45 | 96.17 | | | |
| 5.B.2 Land converted to Cropland | CO ₂ | 0.07 | 0.01 | 99.49 | 99.81 | | | |
| 5.B.2. Land converted to Cropland | N ₂ O | 0.00 | 0.00 | 99.91 | 99.98 | | | |
| 5.C.1 Grassland remaining Grassland | CO ₂ | 0.00 | 0.06 | 99.92 | 99.51 | | | |
| 5.C.2 Land converted to Grassland | CO ₂ | 0.23 | 0.38 | 97.78 | 96.55 | | | |
| 5.D.2. Land converted to Wetlands | CO ₂ | 0.03 | 0.02 | 99.74 | 99.76 | | | |
| 5.E.2 Land converted to Settlements | CO ₂ | 0.13 | 0.13 | 99.33 | 98.96 | | | |
| 5G Other - Liming of Forest Land | CO ₂ | 0.00 | 0.01 | 100.00 | 99.84 | | | |
| 6.B Wastewater Handling | N ₂ O | 0.28 | 0.14 | 97.31 | 98.70 | | | |
| 6.C Waste Incineration | CO ₂ | 0.16 | 0.35 | 99.07 | 96.89 | | | |
| 6.C Waste Incineration | CH ₄ | 0.00 | 0.00 | 100.00 | 100.00 | | | |
| 6.C Waste Incineration | N ₂ O | 0.00 | 0.01 | 99.90 | 99.85 | | | |

Annex 2 Detailed discussion of methodology and data for estimating CO₂ emissions from fossil fuel combustion

Country specific CO₂ 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. A2 - 1.

Tab. A2 - 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. A2 - 3.

Tab. A2 - 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 A2-4

$$1000 \cdot 0.8258/45.945 = 17.974 \text{ t C/TJ} \quad (\text{A2-1})$$

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. A2 – 3 indicates comparison of the newly developed country specific CO₂ 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. A2 - 3 Comparison of country specific CO₂ 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).

Country specific CO₂ 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 CO₂ emission factor from combustion of Refinery Gas. These analyses obtain the information about content of hydrogen, content of CO₂, 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. A2 - 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.

Country specific CO₂ 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 CO₂ 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:

$$Q_m = \sum w_i \cdot Q_{mi} \quad (A2-2)$$

$$Q_v = Q_m \cdot d \quad (A2-3)$$

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/m³] is the net calorific values of Natural Gas related to its volume and d [kg/m³] is its density.

Tab. A2 - 5 lists the net calorific values of the basic components of Natural Gas.

Tab. A2 - 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

$$CEFTJ = CEF_m / Q_m \quad (A2-4)$$

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

$$EF(CO_2) = CEFTJ \cdot M_{CO_2} / M_C \quad (A2-5)$$

where M_{CO_2} 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

$$EF(CO_2) = 0.269 \cdot (Q_v/3.6)^2 - 2.988 \cdot (Q_v/3.6) + 59.212 \quad (A2-6)$$

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 Q_v : 34.11 – 34.27 MJ/m³. The lowest net calorific value (31.31 MJ/m³) was determined for sample number 3 (Dutch field) and the highest (38.28 MJ/m³) 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

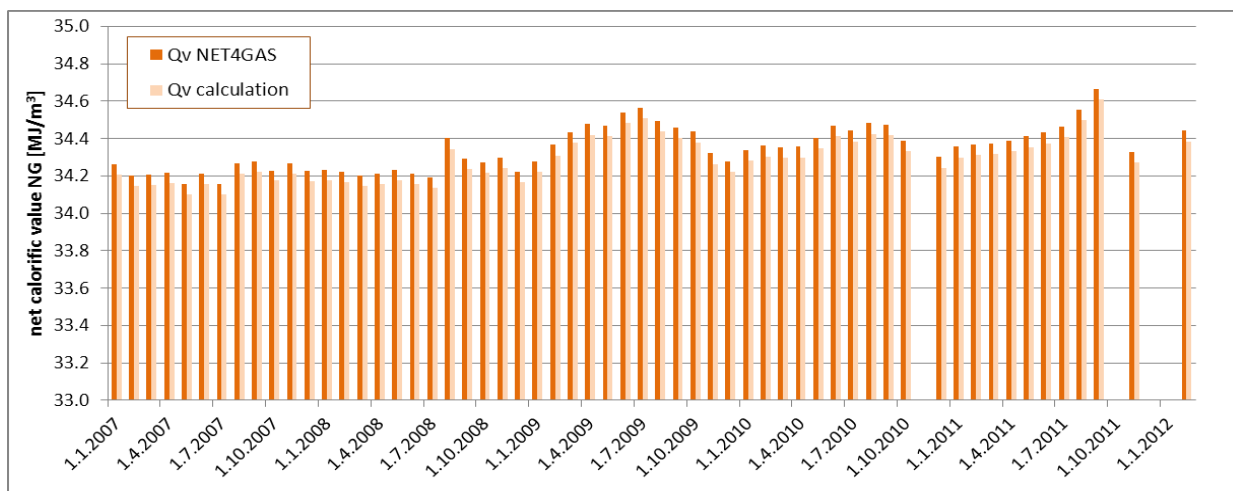


Fig. A2- 1 Net calorific values given in NET4GAS Ltd. reports and net calorific values calculated on the basis of composition of Natural Gas in 1.1.2007 – 1.2.2012 (both values are given at 15°C)

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 CO₂ 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.

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

$$EF (CO_2) = 0.787 \cdot Q_v + 28.21 \quad (A2-7)$$

where Q_v [MJ/m³] 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

$$EF (CO_2) = 0.6876 \cdot Q_v + 31.619 \quad (A2-8)$$

The second source for comparison is the paper of Čapla and Havlát (2006), where the correlation resulted in equation (A2-7).

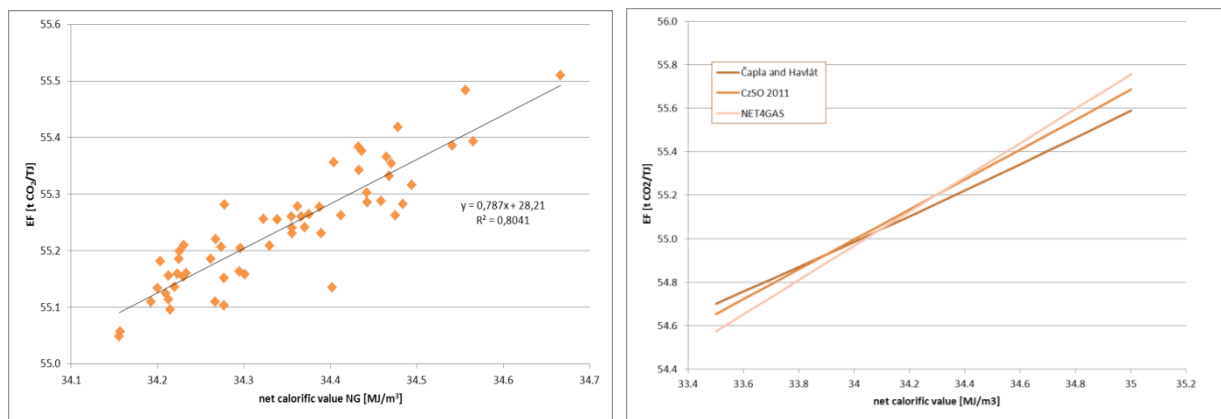


Fig. A2- 2 Correlation of EF [t CO₂/TJ] and net calorific value of Natural Gas and Comparison of three approaches used for calculation

Fig. A2- 3 indicates good correlation between all three approaches in the region of 34.1 – 34.3 MJ/m³, 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. A2- 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/m³. 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. A2- 4 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/m³ is depicted by the dashed line.

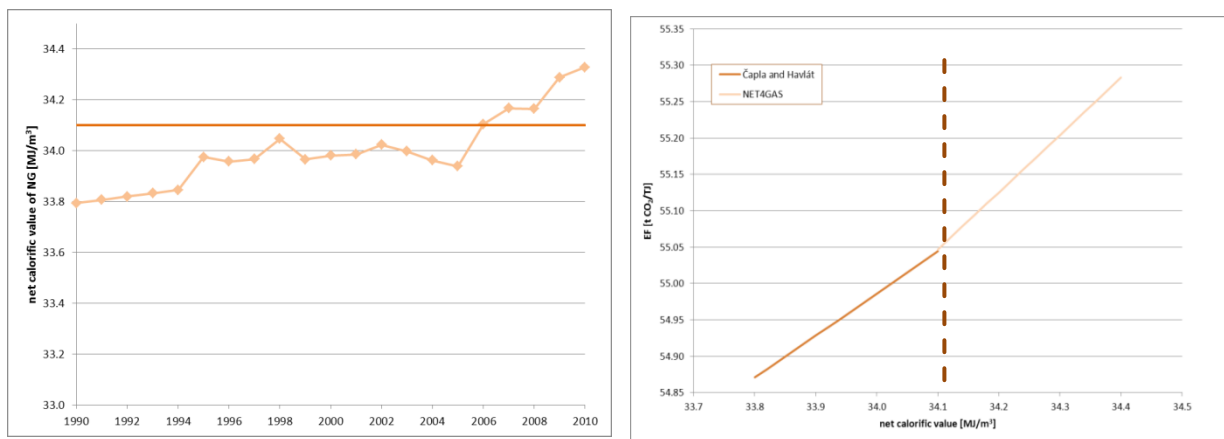


Fig. A2- 3 Trend in Natural Gas NCV 1990 – 2010 and Correlation between NCV and EF combined from two approaches – Čapla and Havlát (NCV lower than 34.1 MJ/m³) and computed correlation on the basis of NET4GAS dataset (NCV higher than 34.1 MJ/m³)

Evaluation of CO₂ 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 A2 - 6 lists all the calculated emission factors for both correlations; the recommended values are in bold.

Tab. A2 - 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 CO₂ 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 CO₂/TJ, which overestimated the CO₂ 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. A2-7):

$$EF (CO_2) = 0.787 \cdot Q_v + 28.21 \quad (A2-9)$$

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 CO₂ emissions from fossil fuel combustion please see the discussion of methodology in Chapter 3.4 and in the Annex 4.

Annex 3 Other detailed methodological descriptions for individual source or sink categories, including descriptions for KP-LULUCF activities

Methodology for Road Transport (1A3b)

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 CO₂, CO, NO_x, N₂O, CH₄, NMVOC, SO₂, 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 N₂O production from the total amount of NO_x. VOCs are separated into CH₄ (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., HUŽLÍK, 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/>

Annex 4 CO₂ Reference Approach and comparison with Sectoral Approach, and relevant information on the national energy balance

The IPCC Reference Approach (IPCC, 1997) is based on determining carbon dioxide emissions from domestic consumption of individual fuels (called also as apparent consumption).

In CRF Reporter are in category 1AD *Feedstock and non-energy use of fuels* included also consumptions of fuels which are for the purpose of inventory transferred to other sectors (in Czech Republic it means sectors 2C, 2B and 3). The carbon contained in Coke consumed in blast furnaces, Other oil for NH₃ production and Other Oil in Solvents is then in CRF Reporter automatically deducted from the Reference Approach. The TJ from the fuels in 1AD are then subtracted from the Reference Approach and the final value corresponds to the Apparent energy consumption. So the formula for calculating Apparent energy consumption is

$$\text{Reference Approach} - \text{TJ(fixed) in 1AD} = \text{Apparent energy consumption.}$$

Tab A4 – 1 and Tab A4- 2 provide overview of 1AD category.

The difference of activity data between Reference and Sectoral Approaches is presented in Tab A4 - 3.

Tab. A4 - 11AD Feedstock and non-energy use of fuels – fuel consumption

| | Naphtha [TJ] | Naphtha Fraction of carbon stored | Naphtha - fixed [TJ] | Lubricants [TJ] | Lubricants Fraction of carbon stored | Lubricants - fixed [TJ] | Bitumen [TJ] | Bitumen Fraction of carbon stored | Bitumen - fixed [TJ] |
|------|-----------------|--|----------------------------|--------------------|---|-------------------------------|-----------------|--|----------------------------|
| 1990 | 22 614 | 0.5 | 11 307 | 17 788 | 0.5 | 8 894 | 10 902 | 1 | 10 902 |
| 1991 | 21 521 | 0.5 | 10 761 | 3 524 | 0.5 | 1 762 | 14 665 | 1 | 14 665 |
| 1992 | 23 441 | 0.5 | 11 721 | 6 300 | 0.5 | 3 150 | 13 497 | 1 | 13 497 |
| 1993 | 26 965 | 0.5 | 13 483 | 4 252 | 0.5 | 2 126 | 15 683 | 1 | 15 683 |
| 1994 | 26 064 | 0.5 | 13 032 | 12 515 | 0.5 | 6 258 | 7 670 | 1 | 7 670 |
| 1995 | 22 543 | 0.5 | 11 272 | 6 752 | 0.5 | 3 376 | 14 349 | 1 | 14 349 |
| 1996 | 26 875 | 0.5 | 13 437 | 5 788 | 0.5 | 2 894 | 10 048 | 1 | 10 048 |
| 1997 | 24 733 | 0.5 | 12 366 | 5 145 | 0.5 | 2 572 | 7 396 | 1 | 7 396 |
| 1998 | 26 269 | 0.5 | 13 135 | 7 998 | 0.5 | 3 999 | 14 791 | 1 | 14 791 |
| 1999 | 30 187 | 0.5 | 15 094 | 7 677 | 0.5 | 3 838 | 14 630 | 1 | 14 630 |
| 2000 | 24 411 | 0.5 | 12 205 | 9 164 | 0.5 | 4 582 | 15 193 | 1 | 15 193 |
| 2001 | 29 343 | 0.5 | 14 672 | 7 355 | 0.5 | 3 678 | 14 992 | 1 | 14 992 |
| 2002 | 25 929 | 0.5 | 12 965 | 6 350 | 0.5 | 3 175 | 16 037 | 1 | 16 037 |
| 2003 | 26 580 | 0.5 | 13 290 | 6 511 | 0.5 | 3 256 | 18 851 | 1 | 18 851 |
| 2004 | 34 101 | 0.6 | 20 461 | 7 476 | 0.5 | 3 738 | 21 342 | 1 | 21 342 |
| 2005 | 37 957 | 0.7 | 26 570 | 7 596 | 0.5 | 3 798 | 21 584 | 1 | 21 584 |
| 2006 | 34 101 | 0.8 | 27 281 | 7 717 | 0.5 | 3 859 | 24 598 | 1 | 24 598 |
| 2007 | 30 623 | 0.8 | 24 498 | 8 481 | 0.5 | 4 240 | 21 825 | 1 | 21 825 |
| 2008 | 37 358 | 0.8 | 29 887 | 6 230 | 0.5 | 3 115 | 22 388 | 1 | 22 388 |
| 2009 | 34 235 | 0.8 | 27 388 | 5 426 | 0.5 | 2 713 | 18 569 | 1 | 18 569 |
| 2010 | 40 312 | 0.8 | 32 250 | 6 350 | 0.5 | 3 175 | 17 203 | 1 | 17 203 |
| 2011 | 37 112 | 0.8 | 29 689 | 7 114 | 0.5 | 3 557 | 16 640 | 1 | 16 640 |
| 2012 | 40 518 | 0.8 | 32 414 | 5 989 | 0.5 | 2 994 | 16 560 | 1 | 16 560 |

Liquid Fuels: Naphtha-fixed [TJ] + Lubricants -fixed [TJ] + Bitumen [TJ] + Other Oil (NH₃) [TJ] + Other Oil (Solvents) [TJ]

Solid Fuels : Coal Oils and Tars - fixed [TJ] + Coke consumed in blast furnaces [TJ]

Tab. A4 - 2 1AD Feedstock and non-energy use of fuels – fuel consumption

| | Coal Oils and Tars [TJ] | Coal Oils and Tars Fraction of carbon stored | Coal Oils and Tars - fixed [TJ] | Coke in BF [TJ]* | Coke in BF Fraction of carbon stored* | Other Oil (NH ₃) [TJ] | Other Oil (NH ₃) Fraction of carbon stored | Other Oil (NH ₃) - fixed [TJ] | Other Oil (Solvents) [TJ] | Other Oil (Solvents) Fraction of carbon stored | Other Oil (Solvents)-fixed [TJ] |
|------|-------------------------|--|---------------------------------|------------------|---------------------------------------|-----------------------------------|--|---|---------------------------|--|---------------------------------|
| 1990 | 14 281 | 0.75 | 10 711 | 118 229 | 1 | 11 113 | 0.99 | 11 002 | 7 504 | 1 | 7 504 |
| 1991 | 13 412 | 0.75 | 10 059 | 82 841 | 1 | 10 770 | 0.99 | 10 663 | 7 003 | 1 | 7 003 |
| 1992 | 12 846 | 0.75 | 9 635 | 96 506 | 1 | 11 104 | 0.99 | 10 993 | 6 497 | 1 | 6 497 |
| 1993 | 11 515 | 0.75 | 8 636 | 72 545 | 1 | 10 383 | 0.99 | 10 279 | 5 946 | 1 | 5 946 |
| 1994 | 10 850 | 0.75 | 8 138 | 77 645 | 1 | 11 593 | 0.99 | 11 477 | 5 475 | 1 | 5 475 |
| 1995 | 11 813 | 0.75 | 8 860 | 71 031 | 1 | 10 235 | 0.99 | 10 132 | 5 206 | 1 | 5 206 |
| 1996 | 12 060 | 0.75 | 9 045 | 74 161 | 1 | 11 015 | 0.99 | 10 905 | 5 074 | 1 | 5 074 |
| 1997 | 9 609 | 0.75 | 7 207 | 80 374 | 1 | 10 095 | 0.99 | 9 994 | 5 049 | 1 | 5 049 |
| 1998 | 8 324 | 0.75 | 6 243 | 77 663 | 1 | 10 407 | 0.99 | 10 303 | 4 989 | 1 | 4 989 |
| 1999 | 7 438 | 0.75 | 5 579 | 56 083 | 1 | 8 864 | 0.99 | 8 776 | 4 963 | 1 | 4 963 |
| 2000 | 7 496 | 0.75 | 5 622 | 66 292 | 1 | 10 144 | 0.99 | 10 043 | 4 828 | 1 | 4 828 |
| 2001 | 7 496 | 0.75 | 5 622 | 62 499 | 1 | 8 538 | 0.99 | 8 453 | 4 574 | 1 | 4 574 |
| 2002 | 18 388 | 0.71 | 12 965 | 64 727 | 1 | 7 449 | 0.99 | 7 374 | 4 434 | 1 | 4 434 |
| 2003 | 19 285 | 0.72 | 13 854 | 70 603 | 1 | 9 696 | 0.99 | 9 599 | 4 236 | 1 | 4 236 |
| 2004 | 21 388 | 0.74 | 15 848 | 73 560 | 1 | 9 721 | 0.99 | 9 624 | 4 156 | 1 | 4 156 |
| 2005 | 17 921 | 0.69 | 12 396 | 63 079 | 1 | 8 478 | 0.99 | 8 393 | 4 081 | 1 | 4 081 |
| 2006 | 18 118 | 0.86 | 15 520 | 71 436 | 1 | 8 086 | 0.99 | 8 005 | 4 069 | 1 | 4 069 |
| 2007 | 17 976 | 0.85 | 15 312 | 73 173 | 1 | 7 575 | 0.99 | 7 499 | 4 059 | 1 | 4 059 |
| 2008 | 19 647 | 0.83 | 16 280 | 67 459 | 1 | 8 487 | 0.99 | 8 402 | 3 856 | 1 | 3 856 |
| 2009 | 13 415 | 0.74 | 9 959 | 49 978 | 1 | 8 739 | 0.99 | 8 651 | 3 732 | 1 | 3 732 |
| 2010 | 17 101 | 0.73 | 12 484 | 55 841 | 1 | 8 510 | 0.99 | 8 425 | 3 539 | 1 | 3 539 |
| 2011 | 16 044 | 0.74 | 11 790 | 53 048 | 1 | 7 616 | 0.99 | 7 540 | 3 231 | 1 | 3 231 |
| 2012 | 16 564 | 0.76 | 12 605 | 50 688 | 1 | 7 899 | 0.99 | 7 820 | 3 231 | 1 | 3 231 |

Liquid Fuels: Naphtha-fixed [TJ] + Lubricants -fixed [TJ] + Bitumen [TJ] + Other Oil (NH₃) [TJ] + Other Oil (Solvents) [TJ]

Solid Fuels : Coal Oils and Tars - fixed [TJ] + Coke consumed in blast furnaces [TJ]

**Total amount of Coke consumed in blast furnaces is allocated to the category 2C1.4*

Tab. A4 - 3 Comparison of the Sectoral and Reference approaches – activity data

| | Reference Approach [PJ] | Sectoral Approach [PJ] | Apparent energy consumption [PJ] | Difference [%] |
|------|-------------------------|------------------------|----------------------------------|----------------|
| 1990 | 1 925 | 1 708 | 1 746 | 2.23 |
| 1991 | 1 772 | 1 641 | 1 634 | -0.43 |
| 1992 | 1 632 | 1 477 | 1 480 | 0.16 |
| 1993 | 1 586 | 1 462 | 1 457 | -0.34 |
| 1994 | 1 510 | 1 348 | 1 380 | 2.38 |
| 1995 | 1 535 | 1 396 | 1 410 | 1.03 |
| 1996 | 1 594 | 1 456 | 1 469 | 0.91 |
| 1997 | 1 604 | 1 416 | 1 479 | 4.44 |
| 1998 | 1 539 | 1 349 | 1 408 | 4.40 |
| 1999 | 1 422 | 1 303 | 1 312 | 0.71 |
| 2000 | 1 526 | 1 387 | 1 407 | 1.46 |
| 2001 | 1 553 | 1 409 | 1 438 | 2.07 |
| 2002 | 1 526 | 1 377 | 1 404 | 2.00 |
| 2003 | 1 547 | 1 408 | 1 413 | 0.35 |
| 2004 | 1 565 | 1 419 | 1 416 | -0.17 |
| 2005 | 1 547 | 1 418 | 1 407 | -0.84 |
| 2006 | 1 574 | 1 416 | 1 419 | 0.18 |
| 2007 | 1 576 | 1 406 | 1 423 | 1.18 |
| 2008 | 1 512 | 1 355 | 1 358 | 0.27 |
| 2009 | 1 393 | 1 294 | 1 269 | -1.96 |
| 2010 | 1 468 | 1 329 | 1 333 | 0.32 |
| 2011 | 1 420 | 1 291 | 1 293 | 0.12 |
| 2012 | 1 357 | 1 254 | 1 231 | -1.85 |

Tab. A4 - 4 Comparison of the Reference Approach and the total of emitted CO₂

| | Reference Approach [Gg] | Sectoral Approach [Gg] | Difference [%] |
|------|-------------------------|------------------------|----------------|
| 1990 | 148 500 | 145 593 | 2.00 |
| 1991 | 139 407 | 139 748 | -0.24 |
| 1992 | 125 299 | 124 144 | 0.93 |
| 1993 | 122 562 | 123 055 | -0.40 |
| 1994 | 115 057 | 113 377 | 1.48 |
| 1995 | 116 483 | 116 346 | 0.12 |
| 1996 | 119 744 | 120 008 | -0.22 |
| 1997 | 121 045 | 115 784 | 4.54 |
| 1998 | 114 026 | 109 342 | 4.28 |
| 1999 | 105 037 | 104 964 | 0.07 |
| 2000 | 115 141 | 113 591 | 1.36 |
| 2001 | 116 635 | 114 382 | 1.97 |
| 2002 | 113 744 | 111 511 | 2.00 |
| 2003 | 114 541 | 114 058 | 0.42 |
| 2004 | 114 529 | 114 550 | -0.02 |
| 2005 | 113 592 | 114 333 | -0.65 |
| 2006 | 115 066 | 114 142 | 0.81 |
| 2007 | 116 057 | 113 914 | 1.88 |
| 2008 | 109 826 | 109 137 | 0.63 |
| 2009 | 102 799 | 104 458 | -1.59 |
| 2010 | 106 801 | 106 585 | 0.20 |
| 2011 | 105 207 | 104 497 | 0.68 |
| 2012 | 99 380 | 101 289 | -1.89 |

The difference of CO₂ emissions between Reference and Sectoral Approaches

The following tables present the data of the national energy balance by IEA categories. Calorific values for unit conversion are presented in Chapter 3.

Tab. A4 - 5 Energy Balance of solid fuels 2012

| 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 | 5049 | 6 391 | 43 533 | 2 467 | 210 |
| Total Imports (Balance) | 849 | 774 | 338 | 458 | 250 |
| Total Exports (Balance) | 2946 | 2 084 | 1 203 | 471 | 13 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 207 | -1 999 | -105 | -72 | 1 |
| Inland Consumption (Calculated) | 3165 | 3 955 | 42 563 | 2 382 | 448 |
| Statistical Differences | 0 | -63 | -1 200 | -8 | 0 |
| Transformation Sector | 3165 | 3 240 | 40 034 | 1 924 | 24 |
| Main Activity Producer Electricity Plants | 0 | 943 | 25 281 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 2 063 | 10 339 | 0 | 3 |
| Main Activity Producer Heat Plants | 0 | 29 | 162 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 0 | 529 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 204 | 2 128 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 1 | 23 | 1 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 3165 | 0 | 0 | 98 | 0 |
| BKB Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 1 572 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 1 825 | 21 |
| Coal Liquefaction Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 52 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 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 | 52 |
| 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 | 37 | 9 | 0 | 0 |
| Total Final Consumption | 0 | 741 | 3 720 | 466 | 372 |
| Total Non-Energy Use | 0 | 0 | 0 | 0 | 320 |
| Final Energy Consumption | 0 | 741 | 3 720 | 466 | 52 |
| Industry Sector | 0 | 605 | 2 420 | 438 | 52 |
| Iron and Steel | 0 | 245 | 50 | 401 | 23 |
| Chemical (including Petrochemical) | 0 | 150 | 1 952 | 0 | 14 |
| Non-Ferrous Metals | 0 | 0 | 0 | 5 | 0 |
| Non-Metallic Minerals | 0 | 180 | 39 | 25 | 15 |
| Transport Equipment | 0 | 0 | 26 | 0 | 0 |
| Machinery | 0 | 0 | 30 | 3 | 0 |
| Mining and Quarrying | 0 | 1 | 5 | 0 | 0 |
| Food, Beverages and Tobacco | 0 | 16 | 70 | 4 | 0 |
| Paper, Pulp and Printing | 0 | 12 | 220 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 2 | 0 | 0 |
| Construction | 0 | 1 | 7 | 0 | 0 |
| Textiles and Leather | 0 | 0 | 11 | 0 | 0 |
| Non-specified (Industry) | 0 | 0 | 8 | 0 | 0 |
| Transport Sector | 0 | 0 | 1 | 0 | 0 |
| Other Sectors | 0 | 136 | 1 299 | 28 | 0 |
| Commercial and Public Services | 0 | 4 | 65 | 6 | 0 |
| Residential | 0 | 130 | 1 200 | 20 | 0 |
| Agriculture/Forestry | 0 | 2 | 26 | 2 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 8 | 0 | 0 |

Tab. A4 - 6 Energy Balance of solid fuels 2012 – continue

| SOLID FUELS | BKB-PB [kt/year] | Gas Works Gas [TJ/year] | Coke Oven Gas [TJ/year] | Blast Furnace Gas [TJ/year] | Oxy. Steel Furnace Gas [TJ/year] |
|---|---------------------|----------------------------|----------------------------|--------------------------------|-------------------------------------|
| Indigenous Production | 0 | 16 917 | 19 843 | 20 013 | 1773 |
| Total Imports (Balance) | 173 | 0 | 0 | 0 | 0 |
| Total Exports (Balance) | 11 | 0 | 0 | 0 | 0 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 3 | 0 | 0 | 0 | 0 |
| Inland Consumption (Calculated) | 165 | 16 917 | 19 843 | 20 013 | 1773 |
| Statistical Differences | 0 | -16 | 0 | 0 | 0 |
| Transformation Sector | 0 | 16 801 | 6 278 | 7 130 | 656 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 6 278 | 7 130 | 656 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 18 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 16 783 | 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 | 132 | 7 952 | 3 686 | 0 |
| Own Use in Electricity, CHP and Heat Pl. | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 132 | 0 | 0 | 0 |
| Patent Fuel Plants (Energy) | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 7 952 | 1 956 | 0 |
| BKB Plants (Energy) | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 1 730 | 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 | 306 | 603 | 18 |
| Total Final Consumption | 165 | 0 | 5 307 | 8 594 | 1099 |
| Total Non-Energy Use | 0 | 0 | 0 | 0 | 0 |
| Final Energy Consumption | 165 | 0 | 5 307 | 8 594 | 1099 |
| Industry Sector | 0 | 0 | 5 307 | 8 594 | 1099 |
| Iron and Steel | 0 | 0 | 5 093 | 8 535 | 1054 |
| Chemical (including Petrochemical) | 0 | 0 | 0 | 0 | 0 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 56 | 1 | 45 |
| Transport Equipment | 0 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 0 | 158 | 58 | 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 | 165 | 0 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 0 | 0 | 0 | 0 |
| Residential | 165 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 0 | 0 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 0 | 0 | 0 |

LIQUID FUELS

Tab. A4 - 7 Energy Balance of Crude Oil, Refinery Gas and Additives/Oxygenates – 2012

| LIQUID FUELS | Crude Oil [kt/year] | Refinery Feedstocks [kt/year] | Additives Oxygenates [kt/year] |
|--------------------------------------|------------------------|-------------------------------------|--------------------------------------|
| Indigenous Production | 156 | 0 | 165 |
| From Other Sources | 0 | 0 | 343 |
| From Other Sources - Coal | 0 | 0 | |
| From Other Sources - Natural Gas | 0 | 0 | |
| From Other Sources - Renewables | 0 | 0 | 337 |
| Backflows to Refineries | 0 | 66 | 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) | 7 074 | 2 | 14 |
| Total Exports (Balance) | 21 | 0 | 0 |
| International Marine Bunkers | 0 | 0 | 0 |
| Interproduct Transfers | 0 | 0 | 0 |
| Products Transferred | 0 | 158 | 0 |
| Direct Use | 0 | 0 | 188 |
| Stock Changes (National Territory) | 38 | 5 | -3 |
| Refinery Intake (Calculated) | 7 247 | 231 | 331 |
| Gross Inland Deliveries (Calculated) | 0 | 0 | 0 |
| Statistical Differences | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 0 | 0 | 0 |
| Refinery Intake (Observed) | 7 247 | 231 | 331 |

Tab. A4 - 8 Energy Balance of liquid fuels 2012

| 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 | 158 | 200 | 794 | 1 480 | 41 | 0 |
| Refinery Fuel | 136 | 0 | 0 | 0 | 0 | 0 |
| Total Imports (Balance) | 0 | 78 | 115 | 460 | 7 | 2 |
| Total Exports (Balance) | 0 | 112 | 5 | 298 | 10 | 0 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 0 | 2 | 17 | -27 | -5 | 0 |
| Gross Inland Deliveries (Calculated) | 22 | 208 | 921 | 1 669 | 87 | 2 |
| Statistical Differences | 0 | 0 | 0 | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 22 | 208 | 921 | 1 669 | 87 | 2 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | 0 |
| Inland Demand (Total Consumption) | 22 | 208 | 921 | 1 669 | 87 | 2 |
| Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 22 | 208 | 921 | 1 669 | 87 | 2 |
| Transport Sector | 0 | 71 | 0 | 1 669 | 87 | 2 |
| International Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 0 | 0 | 0 | 0 | 0 | 2 |
| Road | 0 | 71 | 0 | 1 669 | 87 | 0 |
| Rail | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Navigation | 0 | 0 | 0 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 22 | 127 | 921 | 0 | 0 | 0 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 0 |
| Chemical (including Petrochemical) | 22 | 102 | 921 | 0 | 0 | 0 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 1 | 0 | 0 | 0 | 0 |
| Transport Equipment | 0 | 1 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 6 | 0 | 0 | 0 | 0 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 0 |
| Food, Beverages and Tobacco | 0 | 1 | 0 | 0 | 0 | 0 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction | 0 | 2 | 0 | 0 | 0 | 0 |
| Textiles and Leather | 0 | 1 | 0 | 0 | 0 | 0 |
| Non-specified (Industry) | 0 | 13 | 0 | 0 | 0 | 0 |
| Other Sectors | 0 | 10 | 0 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 1 | 0 | 0 | 0 | 0 |
| Residential | 0 | 4 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 3 | 0 | 0 | 0 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 2 | 0 | 0 | 0 | 0 |
| Total Non-Energy Use | 22 | 102 | 921 | 0 | 0 | 0 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 22 | 102 | 921 | 0 | 0 | 0 |
| Of which: Non-Energy Use-Chemical/Petrochem | 22 | 102 | 921 | 0 | 0 | 0 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

Tab. A4 - 9 Energy Balance of liquid fuels 2012 – continue

| 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 | 143 | 0 | 3 115 | 106 | 128 | 145 |
| Refinery Fuel | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Imports (Balance) | 196 | 3 | 1 451 | 37 | 11 | 29 |
| Total Exports (Balance) | 1 | 0 | 730 | 29 | 23 | 73 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | -22 | 0 | 40 | 0 | 4 | 0 |
| Gross Inland Deliveries (Calculated) | 303 | 3 | 3 872 | 248 | 120 | 112 |
| Statistical Differences | 0 | 0 | -1 | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 303 | 3 | 3 873 | 248 | 120 | 112 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | 0 |
| Inland Demand (Total Consumption) | 303 | 3 | 3 873 | 248 | 120 | 112 |
| Transformation Sector | 0 | 0 | 1 | 0 | 1 | 61 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 6 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 27 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 17 |
| Main Activity Producer Heat Plants | 0 | 0 | 1 | 0 | 1 | 9 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 2 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 15 | 0 | 2 | 0 |
| Coal Mines | 0 | 0 | 13 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 2 | 0 | 2 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 303 | 3 | 3 857 | 248 | 117 | 51 |
| Transport Sector | 303 | 0 | 3 448 | 248 | 87 | 0 |
| International Aviation | 284 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 19 | 0 | 0 | 0 | 0 | 0 |
| Road | 0 | 0 | 3 356 | 248 | 0 | 0 |
| Rail | 0 | 0 | 87 | 0 | 87 | 0 |
| Domestic Navigation | 0 | 0 | 5 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 0 | 0 | 65 | 0 | 19 | 47 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 7 |
| Chemical (including Petrochemical) | 0 | 0 | 1 | 0 | 1 | 4 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 1 | 0 | 1 | 5 |
| Transport Equipment | 0 | 0 | 1 | 0 | 1 | 0 |
| Machinery | 0 | 0 | 2 | 0 | 2 | 2 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 2 |
| Food, Beverages and Tobacco | 0 | 0 | 2 | 0 | 2 | 2 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 5 |
| Wood and Wood Products | 0 | 0 | 1 | 0 | 1 | 3 |
| Construction | 0 | 0 | 47 | 0 | 4 | 2 |
| Textiles and Leather | 0 | 0 | 0 | 0 | 0 | 1 |
| Non-specified (Industry) | 0 | 0 | 10 | 0 | 7 | 14 |
| Other Sectors | 0 | 3 | 344 | 0 | 11 | 4 |
| Commercial and Public Services | 0 | 0 | 8 | 0 | 3 | 2 |
| Residential | 0 | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 324 | 0 | 5 | 2 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 3 | 12 | 0 | 3 | 0 |
| Total Non-Energy Use | 0 | 0 | 1 | 0 | 1 | 0 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 0 | 0 | 1 | 0 | 1 | 0 |
| Of which: Non-Energy Use-Chemical/Petrochem | 0 | 0 | 1 | 0 | 1 | 0 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

Tab. A4 - 10 Energy Balance of liquid fuels 2012 – continue

| 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 | 90 | 477 | 11 | 0 | 1015 |
| Refinery Fuel | 0 | 0 | 0 | 0 | 0 | 89 |
| Total Imports (Balance) | 16 | 133 | 255 | 7 | 8 | 175 |
| Total Exports (Balance) | 0 | 62 | 298 | 8 | 2 | 67 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | |
| Stock Changes (National Territory) | 0 | 2 | -3 | 0 | 0 | 23 |
| Gross Inland Deliveries (Calculated) | 15 | 149 | 412 | 11 | 6 | 911 |
| Statistical Differences | 0 | 0 | 0 | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 15 | 149 | 412 | 11 | 6 | 911 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | |
| Inland Demand (Total Consumption) | 15 | 149 | 412 | 11 | 6 | 911 |
| Transformation Sector | 0 | 0 | 0 | 0 | 0 | 66 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 66 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 15 | 149 | 412 | 11 | 6 | 845 |
| Transport Sector | 0 | 139 | 0 | 0 | 0 | 0 |
| International Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Road | 0 | 131 | 0 | 0 | 0 | 0 |
| Rail | 0 | 8 | 0 | 0 | 0 | 0 |
| Domestic Navigation | 0 | 0 | 0 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 15 | 10 | 410 | 11 | 6 | 845 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 0 |
| Chemical (including Petrochemical) | 1 | 0 | 0 | 0 | 0 | 569 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 0 | 0 | 0 | 7 |
| Transport Equipment | 0 | 0 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 0 | 0 | 0 | 6 | 0 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 0 |
| Food, Beverages and Tobacco | 0 | 0 | 0 | 0 | 0 | 1 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction | 0 | 0 | 410 | 0 | 0 | 3 |
| Textiles and Leather | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Industry) | 14 | 10 | 0 | 11 | 0 | 265 |
| Other Sectors | 0 | 0 | 2 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 0 | 0 | 0 | 0 | 0 |
| Residential | 0 | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 0 | 0 | 0 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 2 | 0 | 0 | 0 |
| Total Non-Energy Use | 15 | 0 | 410 | 11 | 0 | 635 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 66 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 15 | 0 | 410 | 11 | 0 | 569 |
| Of which: Non-Energy Use-Chemical/Petrochem | 0 | 0 | 0 | 0 | 0 | 569 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

Tab. A4 - 11 Energy Balance of Natural Gas – part Natural Gas Supply 2012 [TJ] in GCV

| | |
|--|---------|
| Indigenous Production | 9 951 |
| Associated Gas | 6 039 |
| Non-Associated Gas | 3 912 |
| Colliery Gas | 0 |
| From Other Sources | 0 |
| Total Imports (Balance) | 284 123 |
| Total Exports (Balance) | 284 |
| International Marine Bunkers | 0 |
| Stock Changes (National Territory) | 25 156 |
| Inland Consumption (Calculated) | 318 946 |
| Statistical Differences | 0 |
| Inland Consumption (Observed) | 318 946 |
| Recoverable Gas | |
| Opening Stock Level (National Territory) | 98 699 |
| Closing Stock Level (National Territory) | 73 543 |
| Memo: | |
| Gas Vented | |
| Gas Flared | 0 |
| Memo: Cushion Gas | |
| Cushion Gas Closing Stock Level | 41 870 |
| Memo: From other sources | |
| From Other Sources - Oil | 0 |
| From Other Sources - Coal | 0 |
| From Other Sources - Renewables | 0 |

Tab. A4 - 12 Energy Balance of Natural Gas – part Consumption and Energy Use 2012 [TJ] in GCV

| | |
|--|---------|
| Transformation Sector | 46 848 |
| Main Activity Producer Electricity Plants | 432 |
| Autoproducer Electricity Plants | 0 |
| Main Activity Producer CHP Plants | 16 320 |
| Autoproducer CHP Plants | 4 953 |
| Main Activity Producer Heat Plants | 22 486 |
| Autoproducer Heat Plants | 2 657 |
| 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 | 4 430 |
| Coal Mines | 0 |
| Oil and Gas Extraction | 187 |
| Petroleum Refineries | 4 243 |
| 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 | 6 228 |
| Transport Sector | 1 988 |
| Road | 580 |
| of which Biogas | 0 |
| Pipeline Transport | 1 408 |
| Non-specified (Transport) | 0 |
| Industry Sector | 94 276 |
| Iron and Steel | 9 709 |
| Chemical (including Petrochemical) | 12 344 |
| Non-Ferrous Metals | 1 270 |
| Non-Metallic Minerals | 21 865 |
| Transport Equipment | 7 932 |
| Machinery | 12 549 |
| Mining and Quarrying | 1 652 |
| Food, Beverages and Tobacco | 13 221 |
| Paper, Pulp and Printing | 4 876 |
| Wood and Wood Products | 1 219 |
| Construction | 1 997 |
| Textiles and Leather | 2 222 |
| Non-specified (Industry) | 3 420 |
| Other Sectors | 159 356 |
| Commercial and Public Services | 60 000 |
| Residential | 94 126 |
| Agriculture/Forestry | 2 350 |
| Fishing | 0 |
| Non-specified (Other) | 2 880 |

Annex 5 Assessment of completeness and potential sources and sinks of greenhouse gas emissions and removals excluded for the annual inventory submission and also for the KP-LULUCF inventory

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.

Tab. A5 - 1 First part CRF Table 9(a) - explanations for NE notations keys

| Sources and sinks not estimated (NE) ⁽¹⁾ | | | |
|---|------------------------|--|--|
| GHG | Sector ⁽²⁾ | Source/sink category ⁽²⁾ | Explanation |
| CO ₂ | 1 Energy | 1.B.1.A.1.2 Post-Mining Activities | Relevant data for emission factors are not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 1 Energy | 1.B.1.A.2.1 Mining Activities | Relevant data for emission factors are not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 1 Energy | 1.B.1.A.2.2 Post-Mining Activities | Relevant data for emission factors are not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 1 Energy | 1.B.1.B Solid Fuel Transformation | Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 1 Energy | 1.B.2.A.4 Refining / Storage | Emission factor is not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 1 Energy | 1.B.2.A.5 Distribution of oil products | Emission factor is not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CO ₂ | 2 Industrial Processes | 2.A.5 Asphalt Roofing | Relevant data are not available. Emissions are expected to be very low. |
| CO ₂ | 2 Industrial Processes | 2.A.6 Road Paving with Asphalt | Relevant data are not available. Emissions are expected to be very low. |
| CO ₂ | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no default adopted methodology available in GPG LULUCF) |
| CH ₄ | 1 Energy | 1.B.2.A.5 Distribution of oil products | Emission factor is not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| CH ₄ | 4 Agriculture | 4.D.1 Direct Soil Emissions | Default methodology unavailable |
| CH ₄ | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no adopted methodology available in GPG LULUCF) |
| N ₂ O | 1 Energy | 1.B.2.A.4 Refining / Storage | Emission factor is not available. Emissions are expected to be very low. Relevant EF was not found in existing IPCC methodology. |
| N ₂ O | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no adopted methodology available in GPG LULUCF) |
| N ₂ O | 6 Waste | 6.B.1 6.B.1 Industrial Wastewater | There is no defined method for estimating N ₂ O emissions in IPCC manuals. |
| N ₂ O | 6 Waste | 6.B.1 6.B.1 Industrial Wastewater | Unavailable data |
| SF ₆ | 2 Industrial Processes | 2.F.P2.2 In products | not available data |
| SF ₆ | 2 Industrial Processes | 2.F.P3.2 In products | not available data |

Tab. A5 - 2 Second part of CRF Table 9(a) - explanations for IE notations keys

| Sources and sinks reported elsewhere (IE) ⁽³⁾ | | | | |
|--|--|-----------------------------------|------------------------------|--|
| GHG | Source/sink category | Allocation as per IPCC Guidelines | Allocation used by the Party | Explanation |
| CO ₂ | 2.B.5.2 Ethylene | 2B5/Ethylene | 1A2c | disaggregated data not available |
| CO ₂ | 2.C.1.2 Pig Iron | 2C1 | 2C1/Steel | All CO ₂ from 2C1 are calculated from coke consumption in the blast furnace |
| CO ₂ | 2.C.1.3 Sinter | 2C1 | 2C1/Steel | All CO ₂ from 2C1 are calculated from coke consumption in the blast furnace |
| CO ₂ | 2.C.1.4 Coke | 2C1 | 2C1/Steel | All CO ₂ from 2C1 are calculated from coke consumption in the blast furnace |
| CO ₂ | 5.B.1 Cropland remaining Cropland | 5B1 (IV) Dolomite | 5B1 (IV) Limestone | Reported as aggregate estimates for total lime applications under limestone category. |
| CO ₂ | 5.C.1 Grassland remaining Grassland | 5C1 (IV) Dolomite | 5C1 (IV) Limestone | Reported as aggregate estimates for total lime applications under limestone category. |
| CH ₄ | 2.C.1.1 Steel | 2C1/Steel | 2C1/Coke | disaggregated data not available |
| N ₂ O | 6.B.2.1 Domestic and Commercial (w/o human sewage) | 6B21 | 6B22 | disaggregation of data not available |
| N ₂ O | 6.B.2.1 Domestic and Commercial (w/o human sewage) | 6B21 | 6.B.2.2 | disaggregation of data not available |
| N ₂ O | Treatment on site (latrines) | 6B3 | 6B22 | disaggregation of data not available |

Annex 6 Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

Standard electronic format (SEF) tables

Tab. A6 - 1

Party Czech Republic
Submission year 2014
Reported year 2013
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 | ICERs |
| Party holding accounts | 4.6E+08 | NO | NO | 641526 | NO | NO |
| Entity holding accounts | NO | 223615 | NO | 346403 | NO | NO |
| Article 3.3/3.4 net source cancellation accounts | NO | NO | NO | NO | | |
| Non-compliance cancellation accounts | NO | NO | NO | NO | | |
| Other cancellation accounts | NO | NO | NO | NO | NO | NO |
| Retirement account | 2.88E+08 | 3839463 | NO | 12495124 | NO | NO |
| tCER replacement account for expiry | NO | NO | NO | NO | NO | |
| ICER replacement account for expiry | NO | NO | NO | NO | | |
| ICER replacement account for reversal of storage | NO | NO | NO | NO | | NO |
| ICER replacement account for non-submission of certification report | NO | NO | NO | NO | | NO |
| Total | 7.48E+08 | 4063078 | NO | 13483053 | NO | NO |

Tab. A6 - 2

Party Czech Republic
Submission year 2014
Reported year 2013
Commitment period 1

Table 2 (a). Annual internal transactions

| Transaction type | Additions | | | | | | Subtractions | | | | | |
|--|-----------|--------|------|------|-------|-------|--------------|------|------|------|-------|-------|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| Article 6 issuance and conversion | | | | | | | | | | | | |
| Party-verified projects | | 106931 | | | | | 106931 | | NO | | | |
| Independently verified projects | | NO | | | | | NO | | NO | | | |
| Article 3.3 and 3.4 issuance or cancellation | | | | | | | | | | | | |
| 3.3 Afforestation and 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 | | |
| Article 12 afforestation and reforestation | | | | | | | | | | | | |
| Replacement of expired tCERs | | | | | | | NO | NO | NO | NO | NO | |
| Replacement of expired ICERs | | | | | | | 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 | | | | | | | 27 | NO | NO | 1935 | NO | NO |
| Sub-total | | 106931 | NO | | | | 106958 | NO | NO | 1935 | NO | NO |

| Transaction type | Retirement | | | | | |
|-------------------|------------|----------|------|---------|-------|-------|
| | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| Retirement | 47018962 | 14896480 | NO | 7379320 | NO | NO |

Tab. A6 - 2b

Party Czech Republic
 Submission year 2014
 Reported year 2013
 Commitment period 1

Table 2 (b). Annual external transactions

| | Additions | | | | | | Subtractions | | | | | |
|----------------------------|-----------|----------|------|---------|-------|-------|--------------|--------|------|---------|-------|-------|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| Transfers and acquisitions | | | | | | | | | | | | |
| GB | NO | NO | NO | NO | NO | NO | 1493 | 20336 | NO | NO | NO | NO |
| EU | 2 | 14896480 | NO | 7392213 | NO | NO | 64464212 | 275062 | NO | 1011984 | NO | NO |
| JP | NO | NO | NO | 25835 | NO | NO | 4488 | 16401 | NO | NO | NO | NO |
| Sub-total | 2 | 14896480 | NO | 7418048 | NO | NO | 64470193 | 311799 | NO | 1011984 | NO | NO |

Additional information

| | | | | | | | | | | | | |
|-----------------------------|--|--|--|--|--|--|--|----|--|--|--|--|
| Independently verified ERUs | | | | | | | | NO | | | | |
|-----------------------------|--|--|--|--|--|--|--|----|--|--|--|--|

Table 2 (c). Total annual transactions

| | | | | | | | | | | | | |
|---------------------------------|---|----------|----|---------|----|----|----------|--------|----|---------|----|----|
| Total (Sum of tables 2a and 2b) | 2 | 15003411 | NO | 7418048 | NO | NO | 64577151 | 311799 | NO | 1013919 | NO | NO |
|---------------------------------|---|----------|----|---------|----|----|----------|--------|----|---------|----|----|

Tab. A6 - 3

Party Czech Republic
 Submission year 2014
 Reported year 2013
 Commitment period 1

Table 3. Expiry, cancellation and replacement

| Transaction or event type | Expiry, cancellation and requirement to replace | | Replacement | | | | | |
|---|---|-------|-------------|------|------|------|-------|-------|
| | Unit type | | Unit type | | | | | |
| | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| 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 (ICERs) | | | | | | | | |
| Expired in retirement and replacement accounts | | NO | | | | | | |
| Replacement of expired ICERs | | | NO | NO | NO | NO | | |
| Expired in holding accounts | | NO | | | | | | |
| Cancellation of ICERs 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 |

Tab. A6 - 4

Party Czech Republic
 Submission year 2014
 Reported year 2013
 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 | ICERs |
| Party holding accounts | 3.49E+08 | NO | NO | 12738 | NO | NO |
| Entity holding accounts | NO | 18747 | NO | NO | NO | NO |
| Article 3.3/3.4 net source cancellation accounts | NO | NO | NO | NO | | |
| Non-compliance cancellation accounts | NO | NO | NO | NO | | |
| Other cancellation accounts | 27 | NO | NO | 1935 | NO | NO |
| Retirement account | 3.35E+08 | 18735943 | NO | 19874444 | NO | NO |
| tCER replacement account for expiry | NO | NO | NO | NO | NO | |
| ICER replacement account for expiry | NO | NO | NO | NO | | |
| ICER replacement account for reversal of storage | NO | NO | NO | NO | | NO |
| ICER replacement account for non-submission of certification report | NO | NO | NO | NO | | NO |
| Total | 6.83E+08 | 18754690 | NO | 19889117 | NO | NO |

Tab. A6 - 5 (a-c)

Party Czech Republic
 Submission year 2014
 Reported year 2013
 Commitment period 1

Table 5 (a). Summary information on additions and subtractions

| | Additions | | | | | | Subtractions | | | | | |
|--|-----------------|-----------------|-----------|-----------------|-----------|-----------|-----------------|----------------|-----------|-----------------|-----------|-----------|
| | Unit type | | | | | | Unit type | | | | | |
| Starting values | AAUs | ERUs | RMUs | CERs | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| Issuance pursuant to Article 3.7 and 3.8 | 8.94E+08 | | | | | | | | | | | |
| Non-compliance cancellation | | | | | | | NO | NO | NO | NO | | |
| Carry-over | NO | NO | | NO | | | | | | | | |
| Sub-total | 8.94E+08 | 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) | 6423610 | NO | NO | 5052040 | NO | NO | 35377857 | NO | NO | 722906 | NO | NO |
| Year 2 (2009) | 59665197 | 428939 | NO | 7722832 | NO | NO | 1.09E+08 | 330302 | NO | 6123076 | NO | NO |
| Year 3 (2010) | 40059068 | 2539673 | NO | 6751365 | NO | NO | 75690649 | 2136642 | NO | 2853506 | NO | NO |
| Year 4 (2011) | 19017124 | 3617809 | NO | 6025303 | NO | NO | 32202279 | 2306359 | NO | 3810407 | NO | NO |
| Year 5 (2012) | 5332856 | 4183302 | NO | 1967087 | NO | NO | 23922224 | 1933342 | NO | 525679 | NO | NO |
| Year 6 (2013) | 2 | 15003411 | NO | 7418048 | NO | NO | 64577151 | 311799 | NO | 1013919 | NO | NO |
| Year 7 (2014) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 8 (2015) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Sub-total | 1.3E+08 | 25773134 | NO | 34936675 | NO | NO | 3.41E+08 | 7018444 | NO | 15049493 | NO | NO |
| Total | 1.02E+09 | 25773134 | NO | 34936675 | NO | NO | 3.41E+08 | 7018444 | NO | 15049493 | NO | NO |

Table 5 (b). Summary information on replacement

| | Requirement for replacement | | Replacement | | | | | |
|---------------------|-----------------------------|-----------|-------------|-----------|-----------|-----------|-----------|-----------|
| | Unit type | | Unit type | | | | | |
| | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| Previous CPs | | | NO | NO | NO | NO | NO | NO |
| Year 1 (2008) | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 2 (2009) | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 3 (2010) | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 4 (2011) | NO | 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 | | | | | |
|---------------|-----------------|-----------------|-----------|-----------------|-----------|-----------|
| | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| 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) | 2.2E+08 | 754388 | NO | 9382544 | NO | NO |
| Year 5 (2012) | 67795483 | 3085075 | NO | 3112580 | NO | NO |
| Year 6 (2013) | 47018962 | 14896480 | NO | 7379320 | NO | NO |
| Year 7 (2014) | NO | NO | NO | NO | NO | NO |
| Year 8 (2015) | NO | NO | NO | NO | NO | NO |
| Total | 3.35E+08 | 18735943 | NO | 19874444 | NO | NO |

Tab. A6 - 6 (a-c)

Party Czech Republic
 Submission year 2014
 Reported year 2013
 Commitment period 1

Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions

| | Additions | | | | | | Subtractions | | | | | |
|--|-----------|------|------|------|-------|-------|--------------|------|------|------|-------|-------|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| | | | | | | | | | | | | |

Table 6 (b). Memo item: Corrective transactions relating to replacement

| | Requirement for replacement | | Replacement | | | | | |
|--|-----------------------------|-------|-------------|------|------|------|-------|-------|
| | Unit type | | Unit type | | | | | |
| | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| | | | | | | | | |

Table 6 (c). Memo item: Corrective transactions relating to retirement

| | Retirement | | | | | |
|--|------------|------|------|------|-------|-------|
| | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| | | | | | | |

Annex 7 Table 6.1 of the IPCC Good Practice Guidance

Tab. A7 - 1 Tier 1 Uncertainty Analysis - Modified Table 6.1 of the IPCC GPG, for full table please consult the annexed spreadsheet "CZE-Uncertainty-KC-analysis-2014-v1.3.xlsx"

| IPCC Source Category | Gas | Base year emissions abs | Latest reported year emissions abs | AD uncertainty | EF uncertainty | Combined uncertainty in % | Combined trend uncertainty |
|---|------------------|-------------------------|------------------------------------|----------------|----------------|---------------------------|----------------------------|
| 1.A Stationary Combustion - Biomass | CH ₄ | 56.48 | 364.43 | 8.00 | 50.00 | 1.32E-01 | 8.29E-02 |
| 1.A Stationary Combustion - Biomass | N ₂ O | 27.24 | 132.05 | 8.00 | 60.00 | 5.73E-02 | 3.44E-02 |
| 1.A Stationary Combustion - Gaseous Fuels | CO ₂ | 12 164.90 | 15 058.27 | 3.00 | 2.50 | 4.22E-01 | 3.26E-01 |
| 1.A Stationary Combustion - Gaseous Fuels | CH ₄ | 20.59 | 25.51 | 3.00 | 50.00 | 9.16E-03 | 2.85E-03 |
| 1.A Stationary Combustion - Gaseous Fuels | N ₂ O | 6.91 | 8.51 | 3.00 | 60.00 | 3.66E-03 | 1.13E-03 |
| 1.A Stationary Combustion - Liquid Fuels | CO ₂ | 13 501.18 | 4 854.65 | 5.00 | 3.00 | 2.03E-01 | 1.82E-01 |
| 1.A Stationary Combustion - Liquid Fuels | CH ₄ | 14.30 | 3.45 | 5.00 | 50.00 | 1.24E-03 | 1.58E-03 |
| 1.A Stationary Combustion - Liquid Fuels | N ₂ O | 33.99 | 12.77 | 5.00 | 60.00 | 5.51E-03 | 3.18E-03 |
| 1.A Stationary Combustion - Other fuels - 1A2 | CO ₂ | 0.00 | 318.12 | 10.00 | 15.00 | 4.11E-02 | 3.24E-02 |
| 1.A Stationary Combustion - Other fuels - 1A2 | CH ₄ | 0.00 | 0.66 | 10.00 | 50.00 | 2.41E-04 | 1.69E-04 |
| 1.A Stationary Combustion - Other fuels - 1A2 | N ₂ O | 0.00 | 1.40 | 10.00 | 60.00 | 6.10E-04 | 4.26E-04 |
| 1.A Stationary Combustion - Other fuels - MSW | CO ₂ | 36.53 | 339.93 | 20.00 | 20.00 | 6.89E-02 | 5.67E-02 |
| 1.A Stationary Combustion - Other fuels - MSW | CH ₄ | 0.00 | 0.00 | 20.00 | 50.00 | 3.96E-07 | 2.74E-07 |
| 1.A Stationary Combustion - Other fuels - MSW | N ₂ O | 0.41 | 3.78 | 20.00 | 70.00 | 1.97E-03 | 1.32E-03 |
| 1.A Stationary Combustion - Solid Fuels | CO ₂ | 110 713.47 | 63 393.66 | 4.00 | 3.00 | 2.27E+00 | 1.78E+00 |
| 1.A Stationary Combustion - Solid Fuels | CH ₄ | 1 335.45 | 178.03 | 4.00 | 50.00 | 6.40E-02 | 1.83E-01 |
| 1.A Stationary Combustion - Solid Fuels | N ₂ O | 494.53 | 290.80 | 4.00 | 60.00 | 1.25E-01 | 1.68E-02 |
| 1.A.3.a Transport - Civil Aviation | CO ₂ | 145.90 | 7.62 | 4.00 | 3.73 | 2.99E-04 | 1.72E-03 |
| 1.A.3.a Transport - Civil Aviation | CH ₄ | 0.60 | 0.03 | 4.00 | 21.00 | 4.69E-06 | 3.97E-05 |
| 1.A.3.a Transport - Civil Aviation | N ₂ O | 6.26 | 0.33 | 4.00 | 40.00 | 9.41E-05 | 7.86E-04 |
| 1.A.3.b Transport - Road Transportation | CO ₂ | 6 238.78 | 15 863.86 | 3.00 | 2.36 | 4.34E-01 | 3.59E-01 |
| 1.A.3.b Transport - Road Transportation | CH ₄ | 26.47 | 18.85 | 3.00 | 100.00 | 1.35E-02 | 5.03E-04 |
| 1.A.3.b Transport - Road Transportation | N ₂ O | 131.76 | 653.80 | 3.00 | 100.00 | 4.69E-01 | 2.78E-01 |
| 1.A.3.c Transport - Railways | CO ₂ | 651.48 | 273.01 | 5.00 | 1.48 | 1.02E-02 | 9.62E-03 |
| 1.A.3.c Transport - Railways | CH ₄ | 0.86 | 0.36 | 5.00 | 100.00 | 2.58E-04 | 1.15E-04 |
| 1.A.3.c Transport - Railways | N ₂ O | 11.58 | 4.85 | 5.00 | 100.00 | 3.49E-03 | 1.55E-03 |
| 1.A.3.d Transport - Navigation | CO ₂ | 56.41 | 15.69 | 5.00 | 1.50 | 5.87E-04 | 5.74E-04 |
| 1.A.3.d Transport - Navigation | CH ₄ | 0.07 | 0.02 | 5.00 | 50.00 | 7.45E-06 | 7.56E-06 |
| 1.A.3.d Transport - Navigation | N ₂ O | 1.00 | 0.28 | 5.00 | 90.00 | 1.80E-04 | 1.83E-04 |
| 1.A.3.e Transport - Other Transportation | CO ₂ | 483.53 | 69.88 | 4.00 | 3.00 | 2.51E-03 | 4.36E-03 |
| 1.A.3.e Transport - Other Transportation | CH ₄ | 0.93 | 0.13 | 4.00 | 50.00 | 4.79E-05 | 1.25E-04 |
| 1.A.3.e Transport - Other Transportation | N ₂ O | 0.27 | 0.04 | 4.00 | 60.00 | 1.69E-05 | 4.44E-05 |
| 1.A.5.b Mobile s. in Agriculture and Forestry | CO ₂ | 1 600.90 | 1 094.81 | 7.00 | 3.00 | 5.98E-02 | 5.35E-02 |
| 1.A.5.b Mobile s. in Agriculture and Forestry | CH ₄ | 7.05 | 1.59 | 7.00 | 50.00 | 5.77E-04 | 8.08E-04 |
| 1.A.5.b Mobile s. in Agriculture and Forestry | N ₂ O | 19.59 | 22.87 | 7.00 | 60.00 | 9.91E-03 | 3.00E-03 |
| 1.B.1.a Coal Mining and Handling | CO ₂ | 456.24 | 259.41 | 4.00 | 25.00 | 4.71E-02 | 9.90E-03 |
| 1.B.1.a Coal Mining and Handling | CH ₄ | 7 599.96 | 3 262.27 | 4.00 | 13.00 | 3.18E-01 | 1.56E-01 |
| 1.B.1.b. Solid Fuel Transformation | CH ₄ | 0.63 | 4.03 | 40.00 | 50.00 | 1.85E-03 | 1.43E-03 |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CO ₂ | 4.02 | 12.14 | 7.00 | 75.00 | 6.56E-03 | 3.52E-03 |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | CH ₄ | 897.48 | 538.35 | 7.00 | 75.00 | 2.91E-01 | 3.95E-02 |
| 1.B.2 Fugitive Emission from Oil, Natural Gas | N ₂ O | 0.01 | 0.04 | 7.00 | 75.00 | 1.92E-05 | 1.04E-05 |
| 2.A.1 Cement Production | CO ₂ | 2 489.18 | 1 517.03 | 2.00 | 2.00 | 3.08E-02 | 2.13E-02 |
| 2.A.2 Lime Production | CO ₂ | 1 336.65 | 608.57 | 2.00 | 2.00 | 1.23E-02 | 9.04E-03 |
| 2.A.3 Limestone and Dolomite Use | CO ₂ | 677.51 | 1 105.88 | 5.00 | 4.00 | 5.08E-02 | 4.06E-02 |
| 2.A.4 Soda Ash Use | CO ₂ | 0.00 | 1.09 | 5.00 | 10.00 | 8.72E-05 | 6.57E-05 |
| 2.A.7 Glass, Bricks and Ceramics | CO ₂ | 326.50 | 254.57 | 5.00 | 10.00 | 2.04E-02 | 9.01E-03 |

| IPCC Source Category | Gas | Base year emissions abs | Latest reported year emissions abs | AD uncertainty | EF uncertainty | Combined uncertainty in % | Combined trend uncertainty |
|---|------------------|-------------------------|------------------------------------|----------------|----------------|---------------------------|----------------------------|
| 2.A.7 Glass, Bricks and Ceramics | CH ₄ | 2.94 | 2.98 | 5.00 | 50.00 | 1.07E-03 | 2.57E-04 |
| 2.B.1 Ammonia Production | CO ₂ | 806.81 | 573.45 | 5.00 | 7.00 | 3.54E-02 | 2.00E-02 |
| 2.B.2 Nitric Acid Production | N ₂ O | 1 126.69 | 427.20 | 4.00 | 15.00 | 4.76E-02 | 2.84E-02 |
| 2.B.5 Other | CH ₄ | 15.31 | 24.58 | 5.00 | 40.00 | 7.11E-03 | 2.90E-03 |
| 2.B.5 Other | N ₂ O | 83.70 | 94.43 | 20.00 | 40.00 | 3.03E-02 | 1.51E-02 |
| 2.C.1 Iron and Steel Production | CO ₂ | 12 430.71 | 5 250.45 | 7.00 | 10.00 | 4.60E-01 | 3.04E-01 |
| 2.C.1 Iron and Steel Production | CH ₄ | 127.20 | 53.83 | 7.00 | 30.00 | 1.19E-02 | 5.65E-03 |
| 2.F.1-6 F-gases Use - ODS substitutes | HFC | 3.67 | 2 086.49 | 37.00 | 23.00 | 6.52E-01 | 5.89E-01 |
| 2.F.7 F-gases Use - Semiconductor Manufacture | PFC | 0.00 | 0.92 | 15.00 | 15.00 | 1.40E-04 | 1.18E-04 |
| 2.F.8 F-gases Use - Electrical Equipment | SF ₆ | 82.65 | 88.62 | 5.00 | 15.00 | 1.00E-02 | 3.88E-03 |
| 2.F.9 F-gases Use - Other | SF ₆ | 0.00 | 3.48 | 10.00 | 20.00 | 5.58E-04 | 4.21E-04 |
| 3 Solvents and Other Product Use | CO ₂ | 550.31 | 223.07 | 5.00 | 5.00 | 1.13E-02 | 8.68E-03 |
| 3 Solvents and Other Product Use | N ₂ O | 214.52 | 232.50 | 50.00 | 0.00 | 8.34E-02 | 8.12E-02 |
| 4.A Enteric Fermentation | CH ₄ | 4 219.42 | 2 026.88 | 5.00 | 20.00 | 3.00E-01 | 1.12E-01 |
| 4.B Manure Management | CH ₄ | 1 075.10 | 469.66 | 5.00 | 30.00 | 1.02E-01 | 4.33E-02 |
| 4.B Manure Management | N ₂ O | 1 708.42 | 660.88 | 5.00 | 30.00 | 1.44E-01 | 7.97E-02 |
| 4.D.1 Agricultural Soils, Direct Emissions | N ₂ O | 5 484.03 | 2 836.98 | 15.00 | 50.00 | 1.06E+00 | 3.77E-01 |
| 4.D.2 Pasture, Range and Paddock Manure | N ₂ O | 317.25 | 258.34 | 10.00 | 100.00 | 1.86E-01 | 2.67E-02 |
| 4.D.3 Agricultural Soils, Indirect Emissions | N ₂ O | 3 502.98 | 1 805.63 | 20.00 | 50.00 | 6.97E-01 | 2.93E-01 |
| 5.A.1 Forest Land remaining Forest Land | CO ₂ | 4 567.42 | 6 980.01 | 0.00 | 18.10 | 9.06E-01 | 3.43E-01 |
| 5.A.1 Forest Land remaining Forest Land | CH ₄ | 96.48 | 58.55 | 0.00 | 50.00 | 2.10E-02 | 1.94E-03 |
| 5.A.1 Forest Land remaining Forest Land | N ₂ O | 9.79 | 5.94 | 0.00 | 50.00 | 2.13E-03 | 1.97E-04 |
| 5.A.2 Land converted to Forest Land | CO ₂ | 220.80 | 339.52 | 0.00 | 38.78 | 9.44E-02 | 3.59E-02 |
| 5.B.1 Cropland remaining Cropland | CO ₂ | 1 089.07 | 92.99 | 0.00 | 12.47 | 8.31E-03 | 4.04E-02 |
| 5.B.2 Land converted to Cropland | CO ₂ | 108.61 | 81.53 | 0.00 | 38.54 | 2.25E-02 | 1.29E-03 |
| 5.B.2. Land converted to Cropland | N ₂ O | 10.97 | 6.40 | 0.00 | 2.83 | 1.30E-04 | 1.60E-05 |
| 5.C.1 Grassland remaining Grassland | CO ₂ | 57.93 | 4.51 | 0.00 | 9.39 | 3.04E-04 | 1.64E-03 |
| 5.C.2 Land converted to Grassland | CO ₂ | 140.72 | 306.19 | 0.00 | 18.64 | 4.09E-02 | 1.93E-02 |
| 5.D.2. Land converted to Wetlands | CO ₂ | 22.44 | 24.55 | 0.00 | 73.58 | 1.29E-02 | 3.31E-03 |
| 5.E.2 Land converted to Settlements | CO ₂ | 84.38 | 99.26 | 0.00 | 101.80 | 7.25E-02 | 2.07E-02 |
| 5G Other - Liming of Forest Land | CO ₂ | 11.82 | 0.01 | 0.00 | 15.00 | 1.42E-06 | 6.01E-04 |
| 6.A Solid Waste Disposal on Land | CH ₄ | 1 662.59 | 2 769.96 | 30.00 | 40.00 | 9.93E-01 | 6.63E-01 |
| 6.B Wastewater Handling | CH ₄ | 825.45 | 510.15 | 21.00 | 50.00 | 1.98E-01 | 7.62E-02 |
| 6.B Wastewater Handling | N ₂ O | 311.92 | 275.66 | 26.00 | 50.00 | 1.11E-01 | 5.22E-02 |
| 6.C Waste Incineration | CO ₂ | 23.15 | 206.86 | 20.00 | 5.00 | 3.06E-02 | 2.93E-02 |
| 6.C Waste Incineration | CH ₄ | 0.00 | 0.00 | 20.00 | 50.00 | 5.72E-07 | 3.96E-07 |
| 6.C Waste Incineration | N ₂ O | 0.44 | 3.91 | 20.00 | 70.00 | 2.04E-03 | 1.36E-03 |

Overall Tier 1 Uncertainty 3.21

Overall Tier 1 Uncertainty introduced by trend 2.20

Annex 8 General quality control protocol used in NIS

This Annex provides 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)

| Description of controls | Auto-control / control realisation | | Correction realisation | |
|---|------------------------------------|------------------|------------------------|---------------------------------------|
| | 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